Forensic Pathology Seminar Series

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DIVISION OF PATHOLOGY

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Introduction to Forensic Pathology

- What is forensic Pathology?

  - **Sub-speciality of pathology concerned with determining cause of death by examining a corpse.**
  - **Cause of death is determined by performing an autopsy or post-mortem examination on the deceased.**
  - **The order to perform the autopsy is issued by the coroner.**
  - **The autopsy is performed by a pathologist or a medical doctor.**

What is a coroner?

- A coroner is a government official appointed by NEC.
- A coroner has powers to operate within specified province or provinces stated in his/her appointment.
- Notice of appointment is published in the National Gazette.
- District officers by virtue of their office can act as coroners.
- Medical practitioners can be coroners but they cannot hold an inquest on the body of a person whom they attended professionally, at or immediately before death or during their last illness.
- Function: inquire into the manner cause of death of a person

History of the Coroner

- Officer of the coroner was formally established in England in 1194.
- Primary role: protect the financial interests of the crown.
- Apart of other duties, they were required to perform inquests on dead bodies.

- Read up more history on:
- http://forensicpathologyonline.com/

Role of the Forensic Pathologist

4 broad determinations to be made:

A. Cause of Death – medical diagnosis denoting disease or injury

B. Mechanism of Death – altered physiology by which disease/injury produces death (arrhythmia, exsanguination)

C. Manner of Death

1. Homicide 2. Suicide 3. Accidental 4. Natural Causes 5. Unknown

D. Time of Death

FORENSIC PATHOLOGY

- DEFINITIONS:
  - Cause of death: disease or injury responsible for death
    - E.g. stab wound to chest or head trauma
    - Time interval between cause and death may be brief or prolonged

FORENSIC PATHOLOGY

- DEFINITIONS
- Mechanism or Mode of Death: the chemobiodynamic change produced by the cause of death which is incompatible with continued life.
  - Exsanguination
  - Asphyxiation
  - Infarction

FORENSIC PATHOLOGY

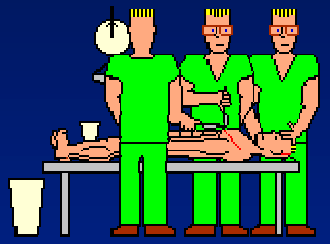
- Manner of Death: the way in which the cause of death comes into existence
  - Natural: death due to natural disease. E.g. TB
  - Accident: death due to unintended event (s) caused by actions of victim or another. E.g MVA
  - Homicide: death at the hand of another where action is known to be lethal or potentially lethal
  - Suicide: death at one's own hand
  - Undetermined: not enough information to make determination

FORENSIC PATHOLOGY

- Cause of death may be primary or contributing factor to the death
- If primary cause is a natural disease process, than manner is natural
- If primary cause is a natural disease but contributing cause is unnatural, than manner determined by contributing cause

Autopsy

- The job of a Forensic Pathologist is to determine Manner of Death and Cause of Death
- Manner of Death has four possibilities:
  1. Accidental
  2. Suicide
  3. Homicide
  4. Natural



- Cause of Death deals with the actual biological event that caused the victim's life to end
  - Many different causes of death, including:
    - Asphyxiation; Strangulation; Brain Aneurism; SIDS; etc.

Autopsy – Manner of Death

- Natural
  - Death due to disease; Organ failure; etc.
  - Could have injuries that would lead you to believe otherwise
- Accidental
  - Falls; car accidents; electrocutions; overdose; etc.
- Suicide
  - Hanging; gunshot; Asphyxia; cutting; stabbing; overdose; etc.
- Homicide
  - Gunshot; stabbing; poisoning; etc.

Types of Autopsy Examination

- Coroners Case
  - Death on arrival
  - Unknown cause of death outside a health facility
  - ?Criminal activity involved.
  - Death within within 24 hours of admission to a health facility
- Medical Case
  - No criminal activity
  - Other reasons to determine cause of death
  - Usually death within a health facility.

Limitations on Autopsies

- Middle Eastern religions forbid autopsies
- Forbidden by Egyptian polytheism (Mummification)
- Judaism, Islam and Christianity vary in their prohibitions
- Next of kin may object to autopsy
- Cultural practices & taboos

Required Autopsy

- A medical examiner/Coroner has the legal authority to order an autopsy without permission from family when
  - Sudden or unexpected
  - Results from an injury
  - Under suspicious circumstances
  - Other circumstances defined by law
  - In PNG, the police will be involved in almost all cases.

The Autopsy Examination Procedure

- External Examination
  - ID deceased first
  - History, charts, reports, x-rays
  - Physical examination
- Internal Examination
  - Inspecting organs and taking specimens as required

FORENSIC PATHOLOGY

- Examination of decomposed and skeletal remains
- ID: employment ID cards, medical records, police records, relatives etc
- Identification problems:
  - Unidentified body
  - decomposed

Decomposed Bodies

Skeletal Remains

Identification Problems

DNA TECHNOLOGY

- Identification problems
  - Victim
  - Offender
  - Paternity
- Specimens
  - Blood
  - Muscle
  - Spleen
  - Bone marrow
  - Teeth
- Rape
  - Oral swabs
  - Vaginal swabs
  - Rectal swabs
- Saliva
- Preservation
  - Freeze at -20º C if there is any delay anticipated

DNA TECHNOLOGY

- RFLP
- PC
- Y-STRs (detects male DNA component)
- Problems with contamination

4 Broad Determinations To Be Made

1. **Cause of Death – medical diagnosis (the injury)**
2. **Mechanism of Death –how the injury produced death (arrhythmia, exsanguination)**
3. **Manner of Death**
4. **1. Homicide 2. Suicide 3. Accidental 4. Natural Causes**
5. **D. Time of Death**

Reviewing Medical History

- Forensic pathologists deal primarily with determining cause of death, but also review past medical history to understand issues raised by that death
- Medical history is the starting point of investigation

Reviewing Medical History

- When death is reported to coroner or medical examiner, a two pronged test takes place:
  - Is the death sudden?
  - Is the death unexpected?

Reviewing Medical History

- To certify cause of death, forensic pathologists must:
  - Determine cause of death based on delayed effects of injury
  - Careful study of medical history to determine causes and manners of death of persons with trauma is required
  - Be able to discern injuries from treatment from emergency personnel- needle marks, incised wounds, etc

Reviewing Witness Statements

- Forensic pathologists seek to gather witness information about activities of deceased prior to death, because:
  - Assists in determining jurisdiction of death
  - Assists in recreating circumstances of death
  - Allows use of a hypothesis which can be tested scientifically based on statement of witness

Physical Examination

- The physical examination of the body is broken up into two parts.
  - External Examination
    - The external examination consists of inspecting the physical outer layer of the body for signs of foul play that would result in injury or death.
  - Internal Examination.
    - The internal examination consists of inspecting the internal organs of the body for evidence of trauma or other indications of the cause of death.

The Autopsy Room

The Autopsy Room

Time of Death

Can estimate time of death from

- **body temperature (algor mortis)**

  estimate: [98.6 ^{o}F – rectal temp]/1.5

- **insect action (forensic entomology)**
- **stomach contents (stage of digestion)**
- **last known activity (last sighting, newspaper/mail)**
- **normal postmortem changes**
- **In Practice – estimated from medical history, records or police reports.**

Algor mortis

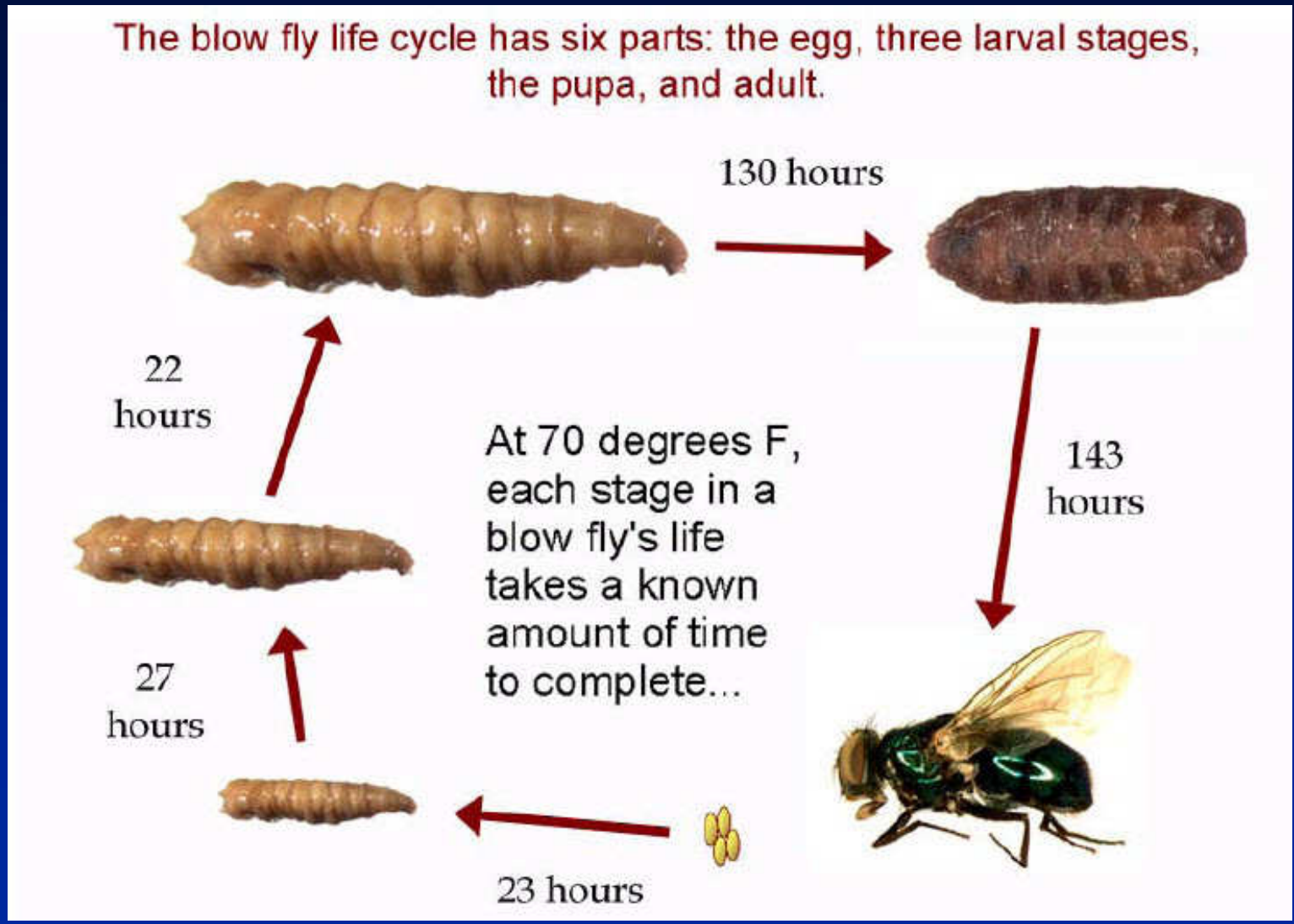
- Cooling of the body after death.
- Best indicator of TOD in 1st 24 hrs
- Taken:
  - Rectal
  - Liver

Algor mortis

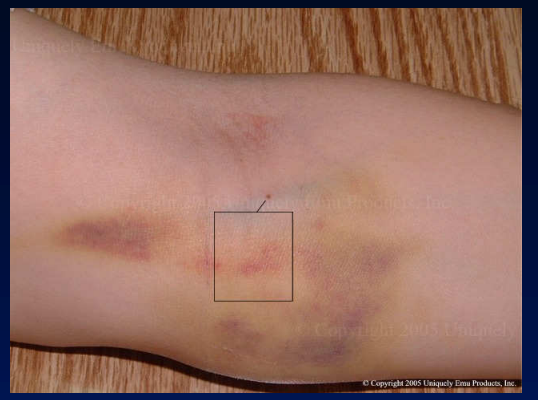
- Body cools approx 1.5 degrees C/hr
  - Skinny cools faster
  - No clothes cools faster
  - In water cools much faster
- normal temp–measured temp/ 1.5 = # hrs

Time of Death

Entomology

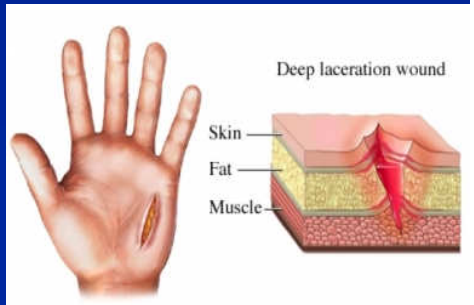


External Examination



Steps of an external examination.

1. Photographed.
2. Physical evidence collected off body.
3. Samples of hair, nails, etc. are collected.
4. Undressed, examined for wounds.
    1. Lacerations, abrasions, bruises.
5. Measured, weighed, cleaned.



Normal Postmortem Changes

1. rigor mortis
2. livor mortis
3. desiccation
4. Putrefaction – 4 to 10 days
5. cell autolysis (also called butyric fermentation) – 10 to 20 days.
6. dry decay – 20 to 50 days

Livor Mortis

- Defined as ‘Color of Death’.
  - Coloration of the skin.
    - At death, the heart stops working. When the heart stops working, the blood stops pumping. The blood stops pumping, the red blood cells and plasma gather on the bottom part of the body, closest to the floor.
    - A line forms after 8 hours if the body hasn’t been moved. If moved, a new line starts to form. It is impossible to tell which was first. The thicker the line, the longer the position the body was in.

Livor Mortis

Algor Mortis

- Defined as ‘Coolness of Death’.
  - Temperature of body.
    - In a controlled environment, stating at 37.5 degrees, drops by 2 degree Celsius in first hour then drop one degree Celsius per hour.
    - When taking the temperature of a corpse, you can’t take it in the mouth because the muscles will be relaxed and the tongue wont stay on top of the thermometer.
    - Thinner people cool faster then fat people.

normal temp – measured temp/ 1.5 = # hrs

Rigor Mortis

- Defined as ‘Stiffness of Death’.
  - Flexibility of the body.
    - Shows up 2 hours after death
    - Peaks 12 hours after death.
    - Takes 12-24 hours for entire rigor mortis effect to take place.
    - At approximately 0 hours after death, the body is at its stiffest.
    - The eyelids are affected first, the the jaw, face, trunk, arms, legs.
    - Ends after 24-36 hours.

Rigor Mortis

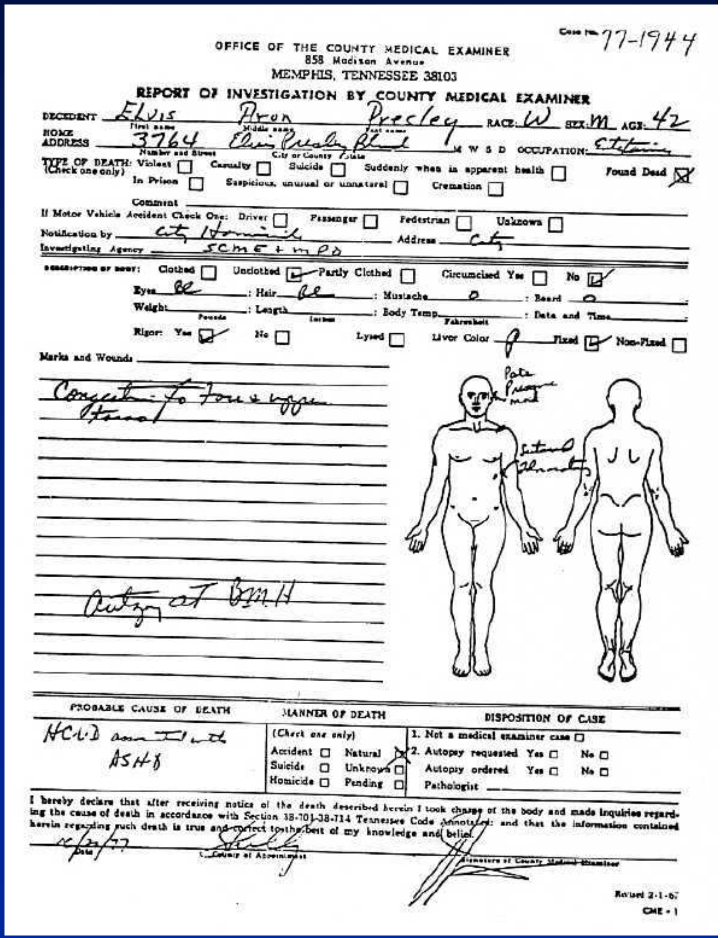
Pallor Mortis

- Defined as ‘Paleness of Death’.
  - Tone of the body.
    - Happens 15-20 minutes after death.
    - Happens due to lack of capillary circulation in the body.
    - Can not be used to determine time of death except if body is found still with color.

Pallor Mortix

External Exam

- External examination
  - Abnormalities of the body
  - Any trauma, current or past
  - Fingernail clippings; clothing; scars; swabs; etc



Case No. 77-1944

OFFICE OF THE COUNTY MEDICAL EXAMINER
858 Madison Avenue
MEMPHIS, TENNESSEE 38103

REPORT OF INVESTIGATION BY COUNTY MEDICAL EXAMINER

DECEDENT Elvis (First name) Aron (Middle name) Presley (Last name) RACE: W SEX: M AGE: 42

HOME ADDRESS 3764 (Number and Street) Elvis Presley Blvd (City or County / State) M W S D OCCUPATION:

TYPE OF DEATH: (Check one only) Violent ☐ Casualty ☐ Suicide ☐ Suddenly when in apparent health ☐ Found Dead ☒
In Prison ☐ Suspicious, unusual or unnatural ☐ Cremation ☐

Comment

If Motor Vehicle Accident Check One: Driver ☐ Passenger ☐ Pedestrian ☐ Unknown ☐

Notification by City Homicide Address City

Investigating Agency SCME + MPD

DESCRIPTION OF BODY: Clothed ☐ Unclothed ☐ Partly Clothed ☐ Circumcised Yes ☐ No ☑

Eyes Bl : Hair Bl : Mustache 0 : Beard 0

Weight (Pounds) : Length (Inches) : Body Temp. (Fahrenheit) : Date and Time

Rigor: Yes ☑ No ☐ Lysed ☐ Liver Color Fixed ☑ Non-Fixed ☐

Marks and Wounds

Autopsy at BMH

PROBABLE CAUSE OF DEATH	MANNER OF DEATH	DISPOSITION OF CASE
HCVD	(Check one only) Accident ☐ Natural ☒ Suicide ☐ Unknown ☐ Homicide ☐ Pending ☐	1. Not a medical examiner case ☐ 2. Autopsy requested Yes ☐ No ☐ Autopsy ordered Yes ☐ No ☐ Pathologist

I hereby declare that after receiving notice of the death described herein I took charge of the body and made inquiries regarding the cause of death in accordance with Section 38-701-38-714 Tennessee Code Annotated: and that the information contained herein regarding such death is true and correct to the best of my knowledge and belief.

Date — County of Appointment — Signature of County Medical Examiner

Revised 2-1-67
CME - 1

Trauma to the Human Body

Role of the Pathologist

1. Determine type of wound
2. Measure the dimensions (length, width, depth)
3. Position relative to anatomical landmarks
4. Determine initial location if wound involves cutting, slashing, etc.
5. Determine height from heel

Types of Wounds (Trauma)

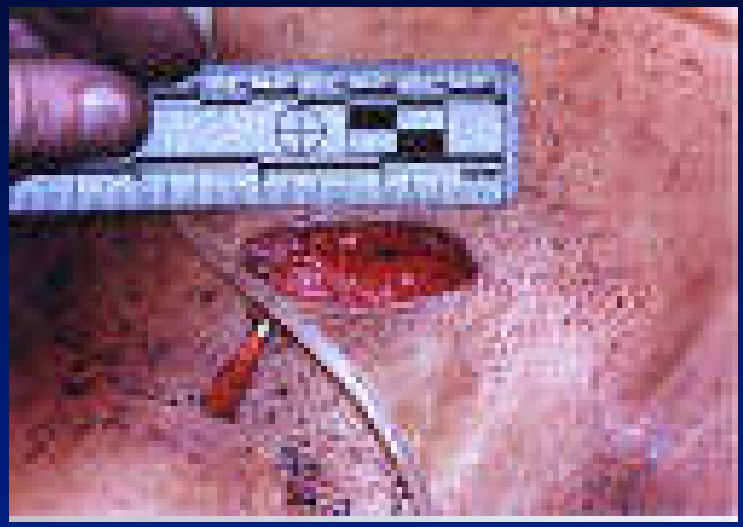
- **Lacerations: a tear in the skin. Vary in width and depth. Wound can be jagged. Can be caused by a sharp object or blunt object. Application of force is direct**
- **Incised Wound: wounds caused by sharp clean object.**

Lacerations

Incised Wounds

Slash

Stab

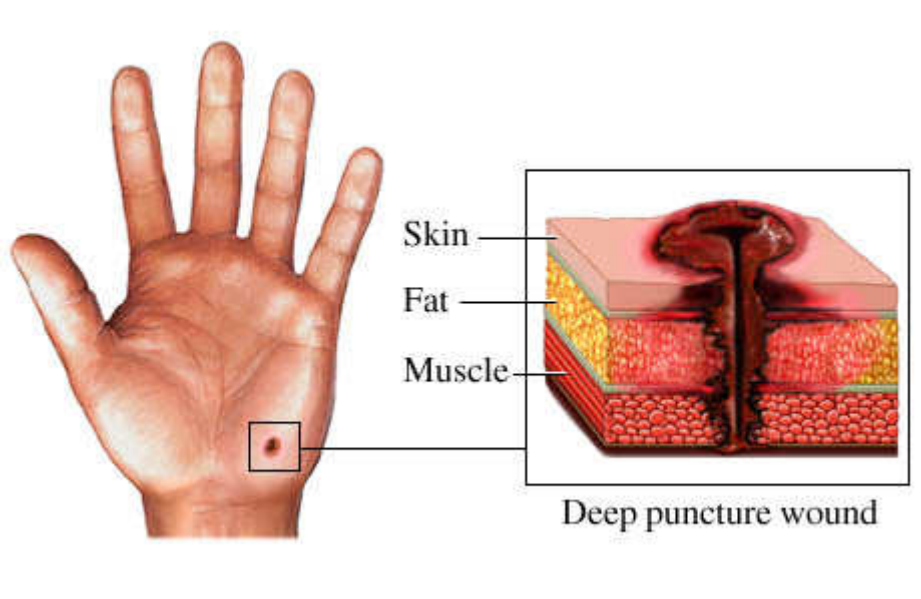


Puncture – penetrating injury due to an object with no blade

Types of wounds

- **Puncture: caused by an object (usually sharp pointed) piercing the skin and creating a small hole. The width is smaller than the depth.**
- **Abrasion: superficial damage to skin, no deeper than the epidermis. Less severe than a laceration. Caused by friction wearing or rubbing skin away.**

Puncture wound



Abrasions

Types of wounds

- **Contusion: another term for a bruise. Caused by blow with a blunt object with break in the epithelium. Capillaries are ruptured giving characteristic color.**
- **Gunshot: various type depending on type of weapon and distance from muzzle.**

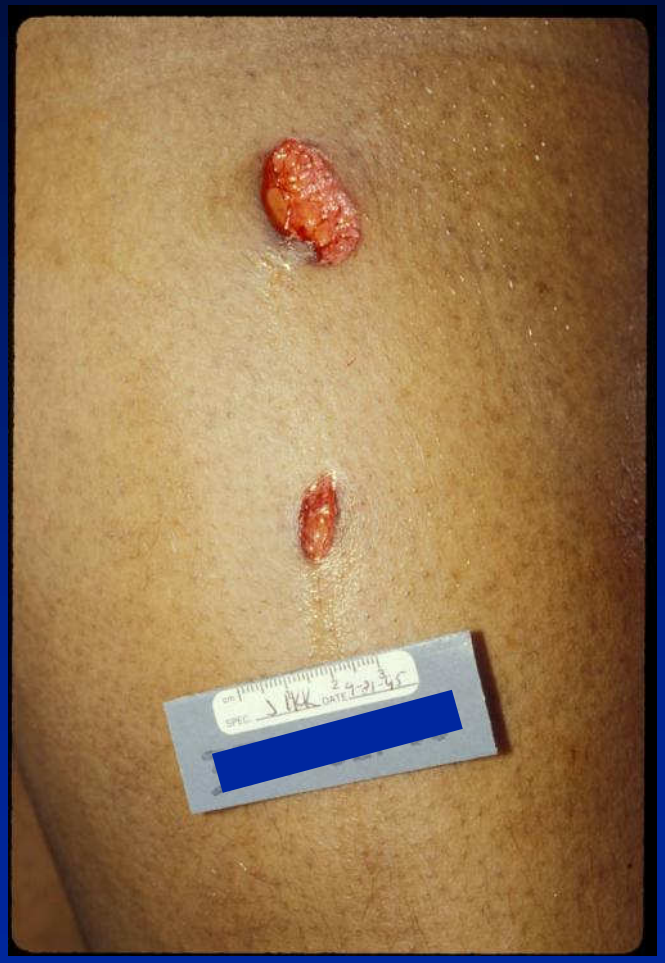
Contusions

Color changes a bruise goes through can give rough estimate of time of injury

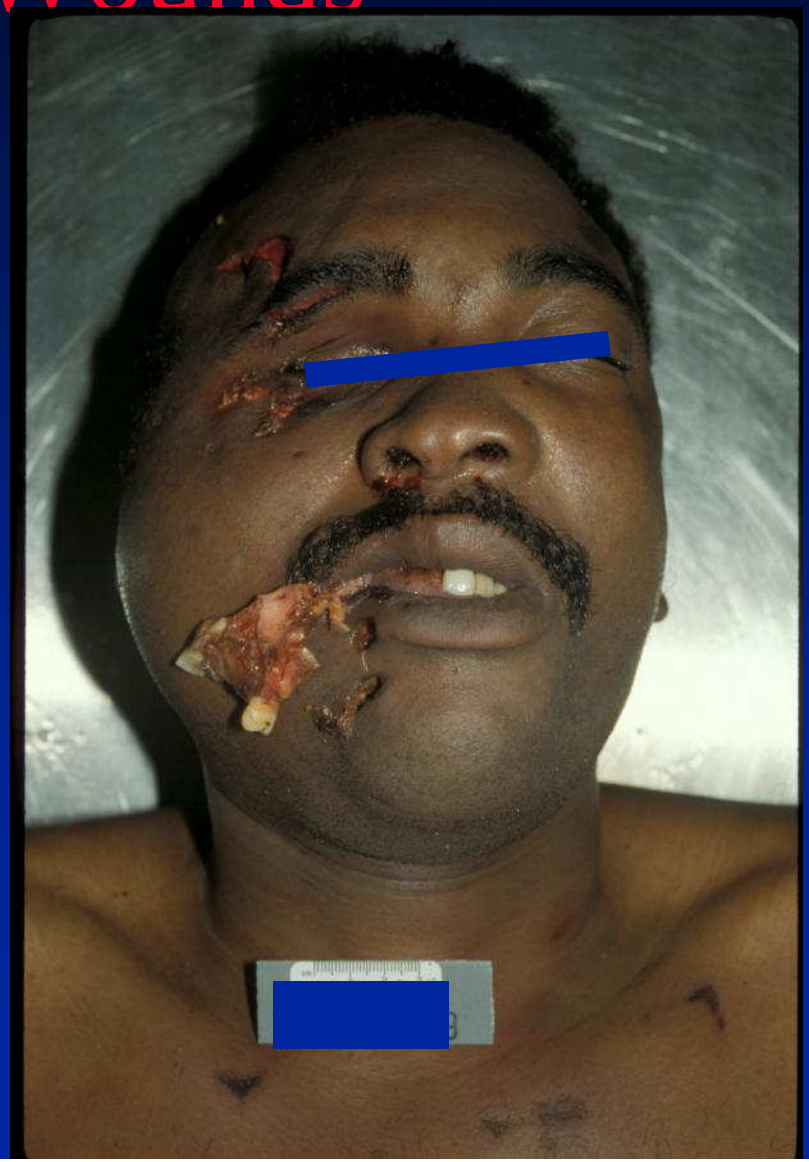
- **Dark blue/purple (1-18 hours)**
- **Blue/brown (~1 to 2days)**
- **Green (~ 2 to 3 days)**
- **Yellow (~3 to 7 days)**

Assumes person is healthy.

Stab Wounds



Chop Wounds



Gunshot Wounds

- type of firearm
- distance of gun to victim
- entrance vs exit wounds
- track of projectile

Gunshot wounds

- **Contact Wound:** Muzzle applied to skin at shooting.
- Impression of muzzle burned around entrance wound
- **Close Range (6-8 inches):** Stippling
- **Intermediate Range (1- 3 ft.):** hot fragments of burning gunpowder; “ball”
- **Distant (greater than 3 ft.):** No soot or burning of wound margins
- Entrance wound: surrounding skin dragged in
- Exit wound: skin pushed out

Close range

- **Close Range**
- **(5-20 cm):** Entrance surrounded by stippling- HOT soot traveling for short distance; BURNS

Intermediate range

- Intermediate range
- 30cm-90cm
- Gunpowder “ball”

Gunshot Wounds

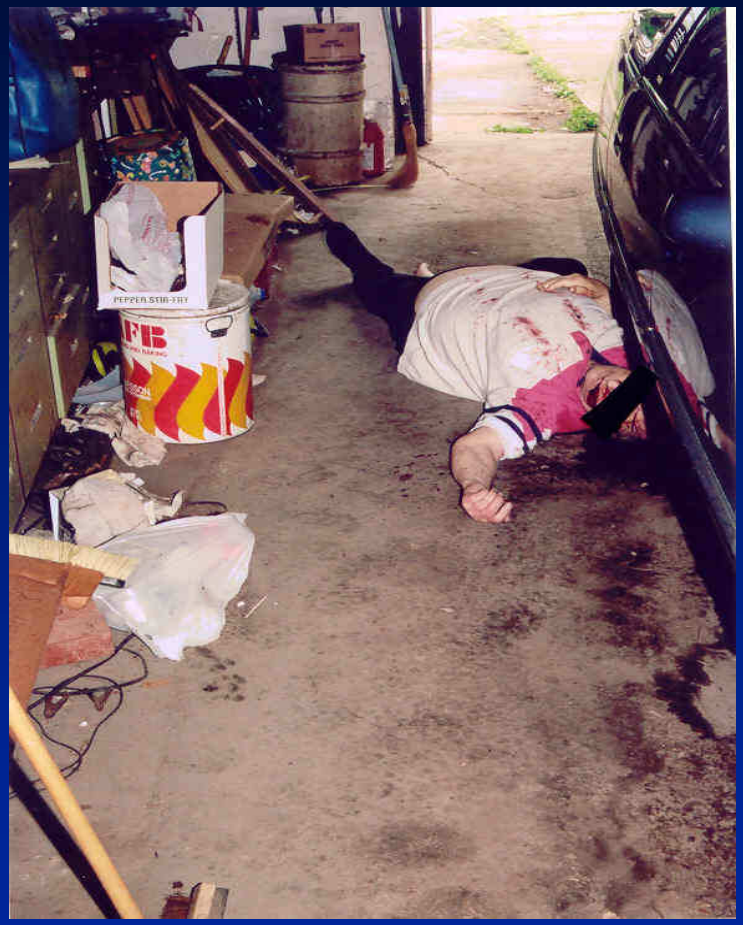
Starring of a contact wound – barrel touching the skin. Close range wound.

Stippling – powder burns on the skin when the gun is intermediate range from the victim

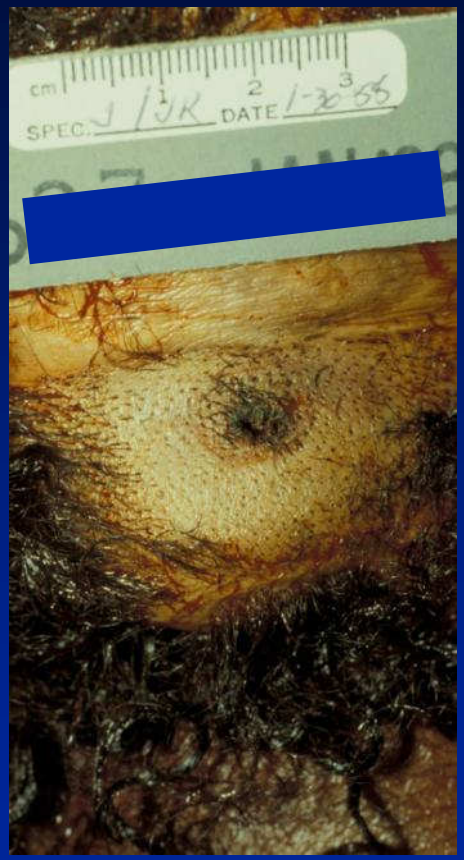
Gunshot Wounds

12 Gauge Shotgun – 00 Buckshot

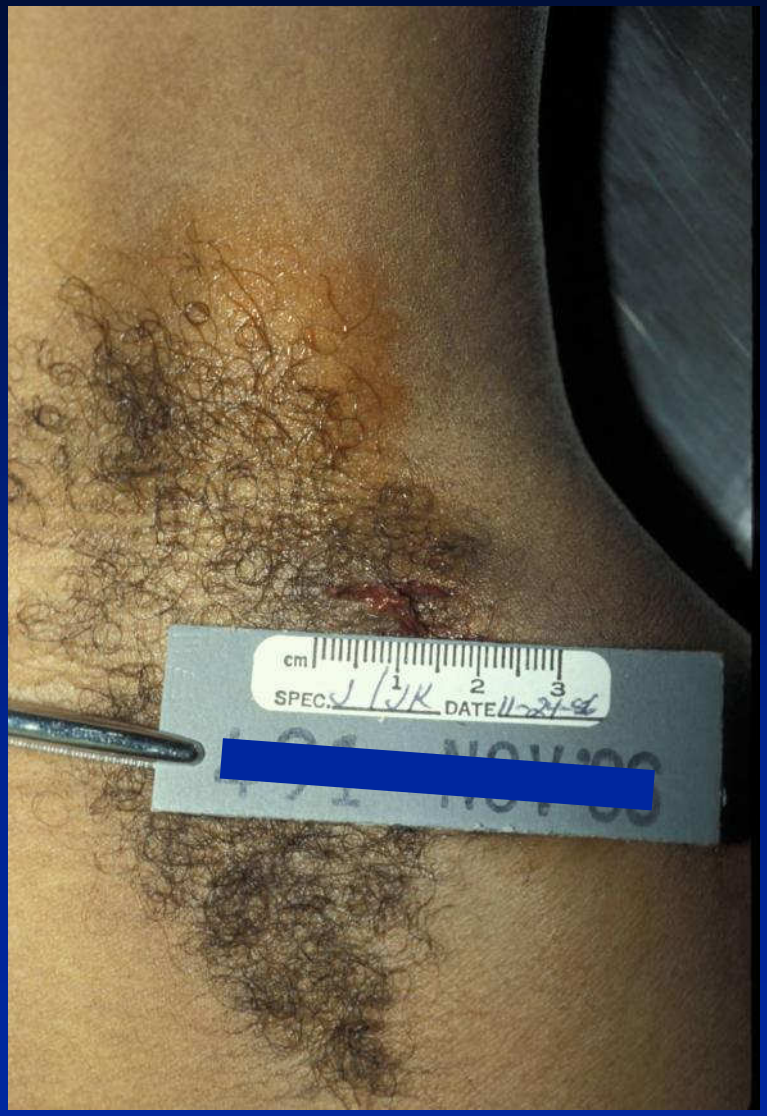
Homemade Firearm



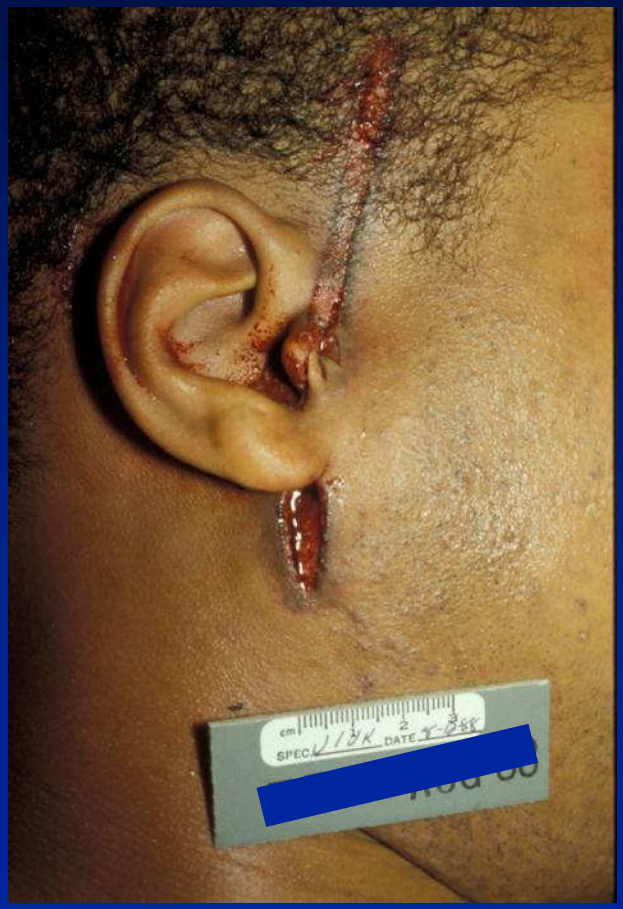
Gunshot Entrance Wounds



Gunshot Exit Wounds



Graze Wound

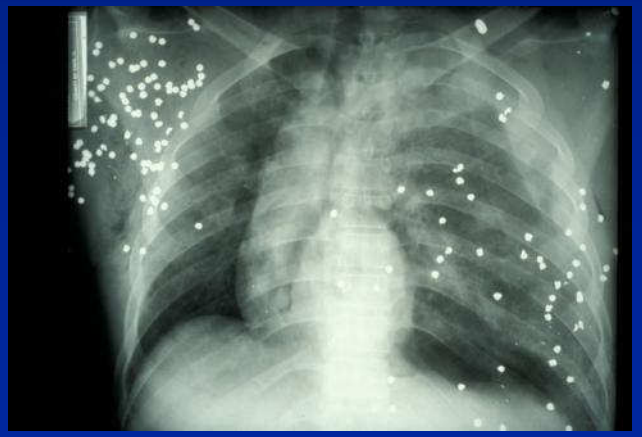


Shotgun Wounds

Contact range

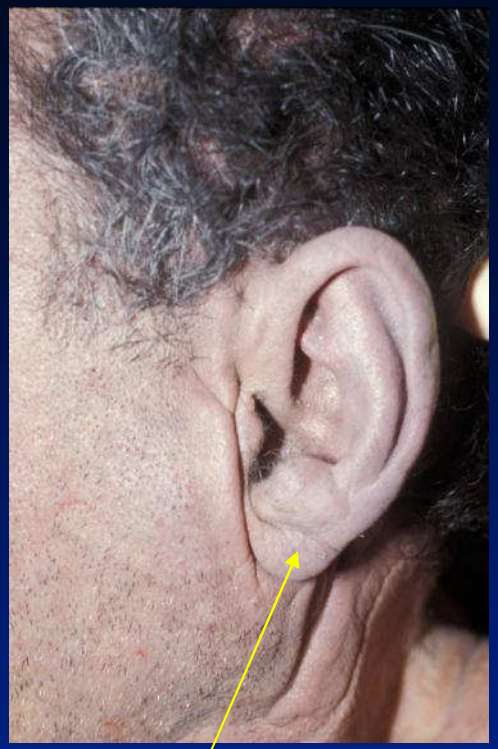
Close range

Distant range

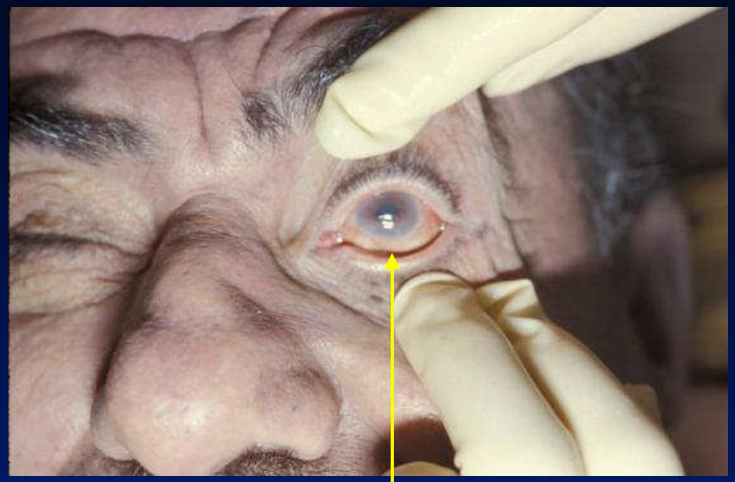


X ray appearance

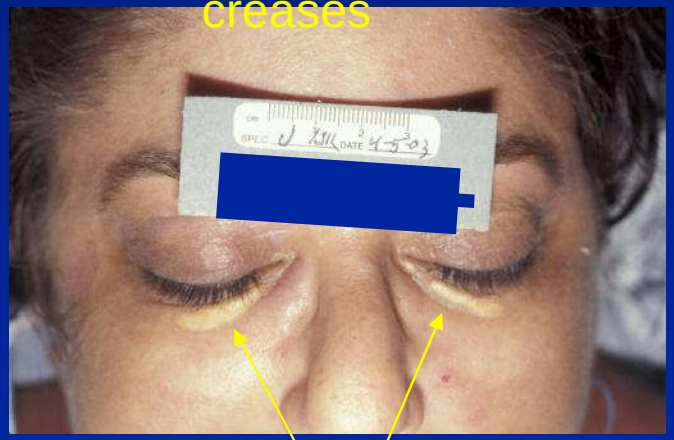
DEATHS DUE TO NATURAL DISEASE



Earlobe creases



Arcus senilis



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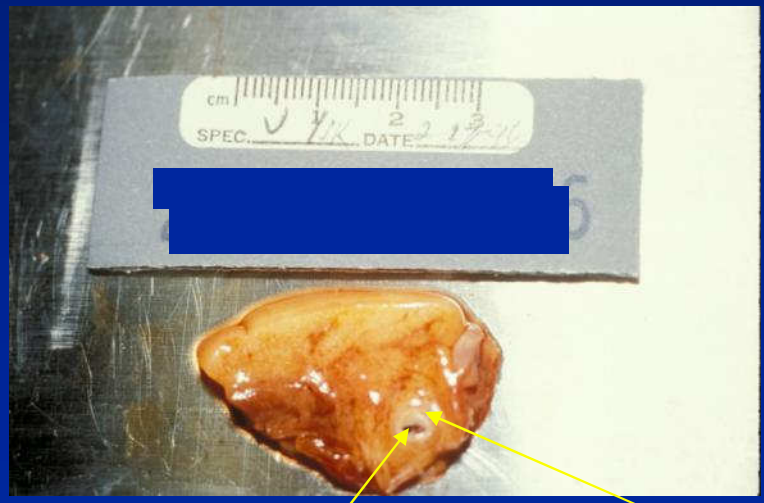


Coronary artery with atherosclerosis and an acute thrombus

Internal Examination

Internal Examination

Steps Involved:

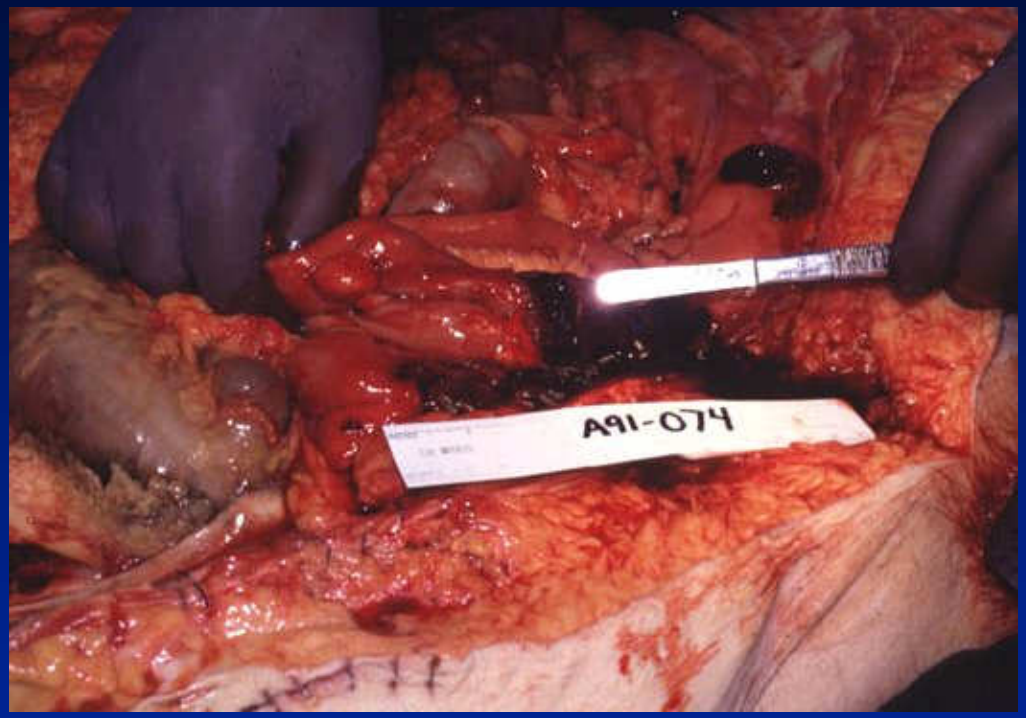
1. ***External Examination***
    - ***a. measurements - length, weight***
    - ***b. inspection of external surface***
2. ***Opening of Trunk***
    - ***a. 'Y' incision***
    - ***b. Open rib cage***
    - ***c. Condition of heart***
    - ***d. Remove organs***

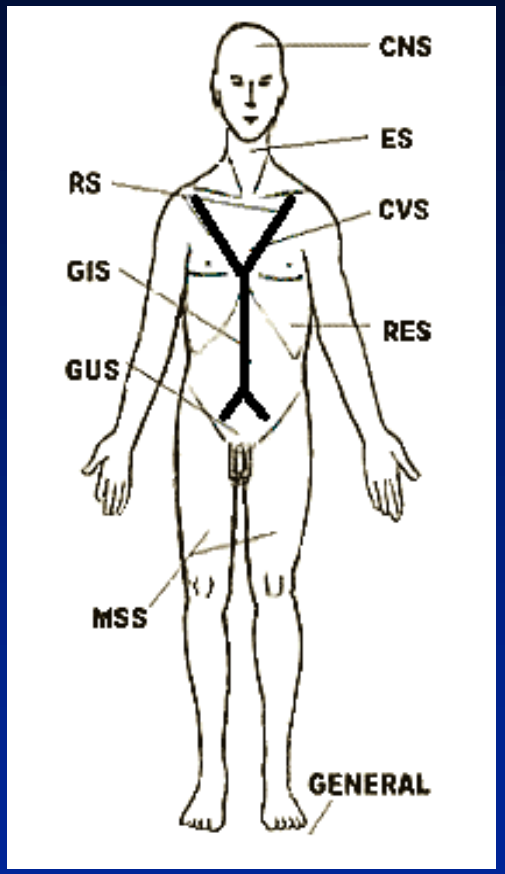
Forensic Pathologist's Tools of the Trade

More autopsy tools…

Stryker Saw:
good for cutting into skull

Autopsy





Y incision

Autopsy Process

- Incisions created in chest, abdomen and head
- Removal of organs from those areas of the body
- T-shaped incision is typically used, because it facilitates examination of tongue and neck

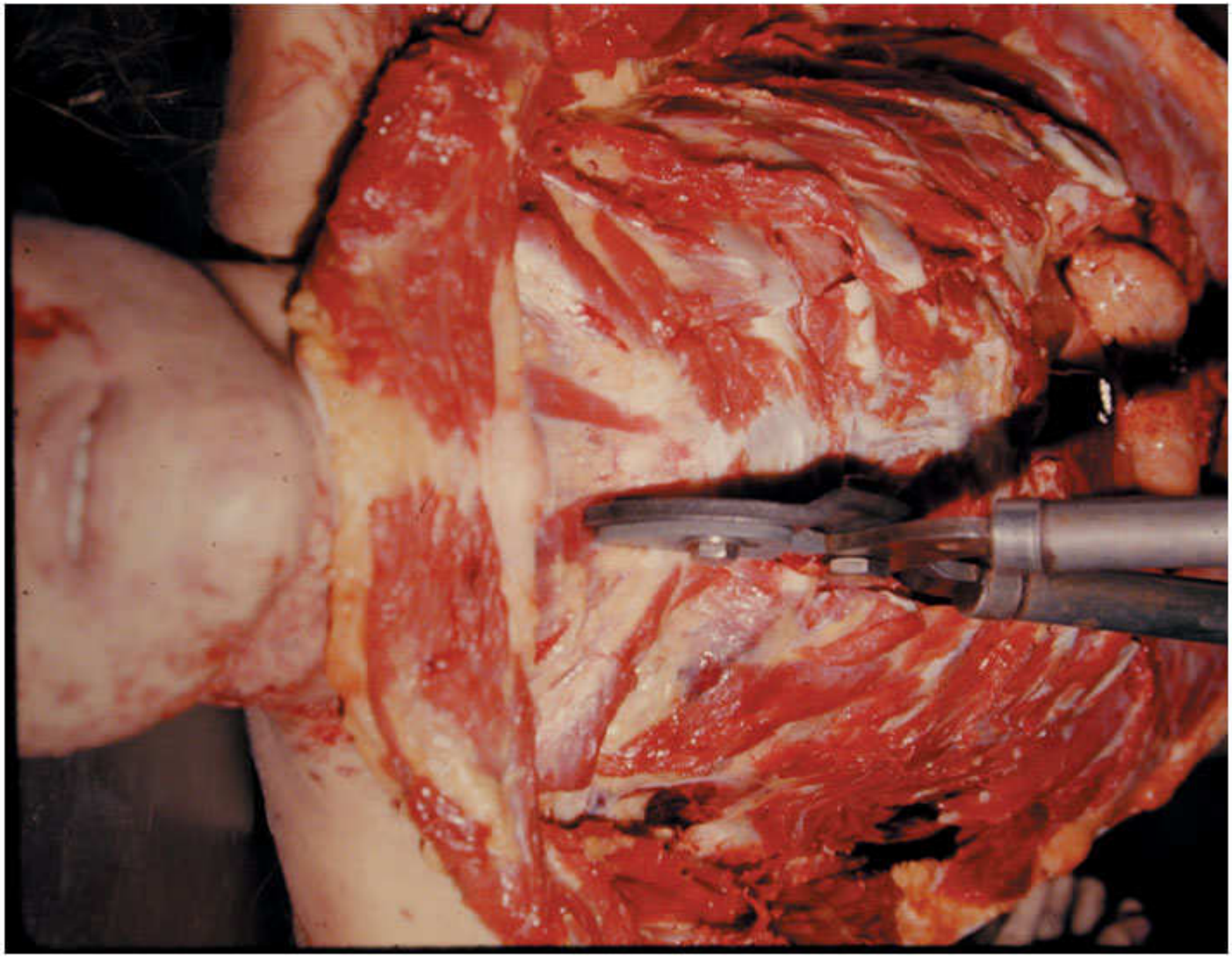


Figure 2.01 Forensic Science, 2/e (© CRC Press 2005)

Autopsy

Remove Organs:

• must cut ligaments holding organs in the body cavity and through the trachea and rectum

• transfer organ block to a dissecting table

• examine organs in proper order (weigh, physical exam in and out, take tissue samples, save other appropriate samples)

heart → liver → spleen → kidneys → pancreas → bladder → genitalia → complete G.I. tract

- save postage stamp sized amount of tissue

- examine tissue under a microscope for bacteria, disease

Autopsy

Steps Involved:

3. Remove brain

cut around cranium using "Stryker saw"

store for 2 weeks in 10% formaldehyde

4. Closing

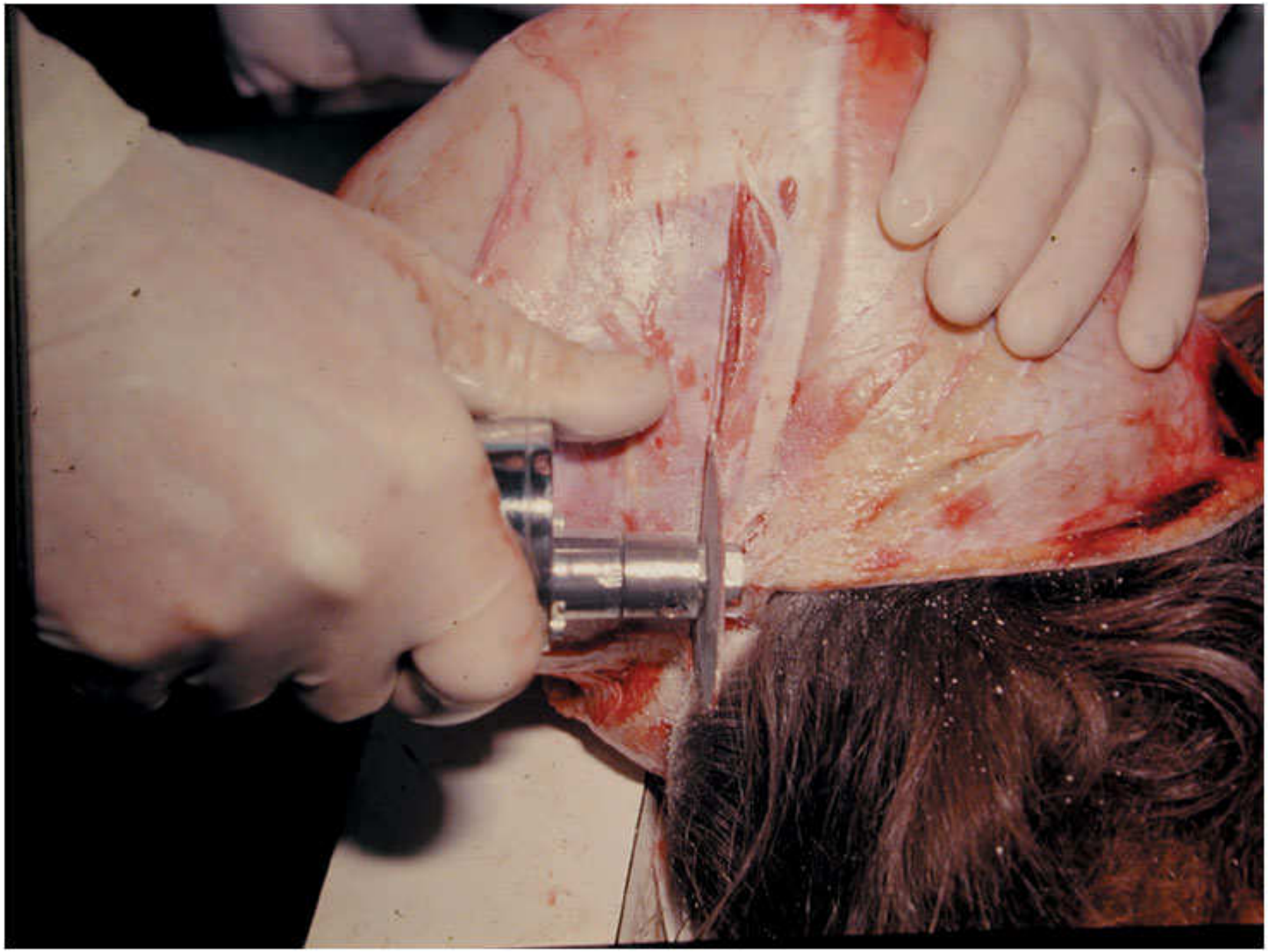


Figure 2.02 Forensic Science, 2/e (© CRC Press 2005)

Autopsy Process

- Brain is removed via incision from behind one ear to behind other ear
- Scalp is pulled upward and backward
- Skull is sawed circularly or in a tonsorial manner
- Brain may be dissected immediately, or placed in formaldehyde to preserve tissue for better examination

Autopsy Process

- Other internal organs are removed and weighed
- Organs are also dissected to determine disease or injury
- In certain cases such as child abuse, spinal injury, and subtle blunt trauma more extensive dissection and removal may be completed

Obtaining Appropriate Specimens

- Toxicology requires adequate specimens for testing
- Blood is usually taken from aorta
- Bile taken from gall bladder

Obtaining Appropriate Specimens

- Blood, urine, liver, kidney and brain used to determine presence of drugs
- Blood- alcohol or Urine- drugs
- Information from medical history, witness statements, scene examination, and autopsy may be used to search for other drugs or poisons

Microscopic Examination

- Small portions of organs are put into a solution of formaldehyde to preserve them for study
- Diseased or injured sections of tissue are taken, as is normal tissue
- Tissue is encased in paraffin and mounted on slides with H&E dye for examination under light microscope

Figure 2.07 Forensic Science, 2/e (© CRC Press 2005)

Figure 2.08 Forensic Science, 2/e (© CRC Press 2005)

DNA Analysis

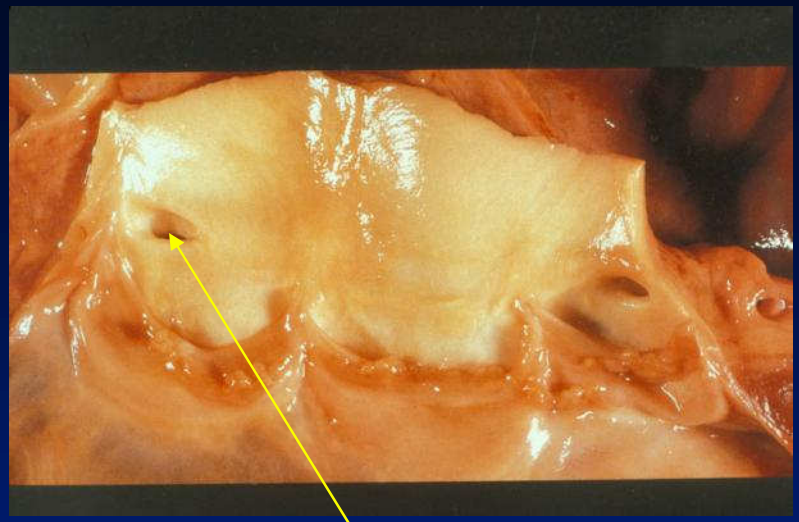
- Most coroners and medical examiners preserve one specimen of tissue for DNA analysis
- If tissue sits in formaldehyde for too long, DNA becomes hydrolyzed and unsuitable for study
- DNA embedded in paraffin blocks or cut into sections and made into slides will not further decompose

DNA Collection

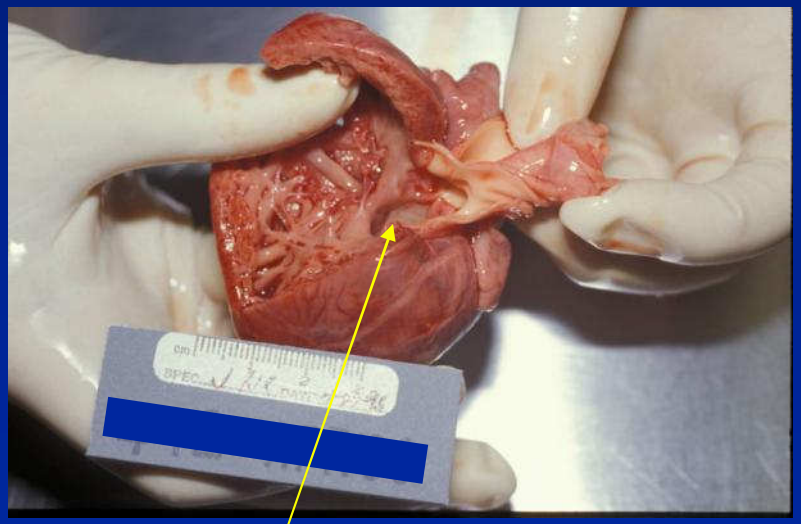
- Methods to accomplish this:
  - Blood spotted on absorbent paper allowed to dry then stored in envelope
  - Pull head hairs, including bulbs, and place in envelope
  - Cut hair has mitochondrial DNA, bulbs include nuclear DNA

Examples of pathology

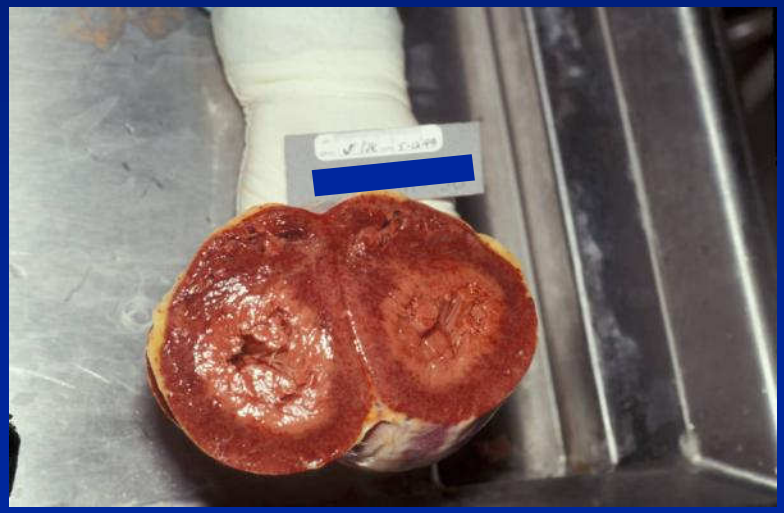
Ruptured myocardial infarction



anomalous coronary artery



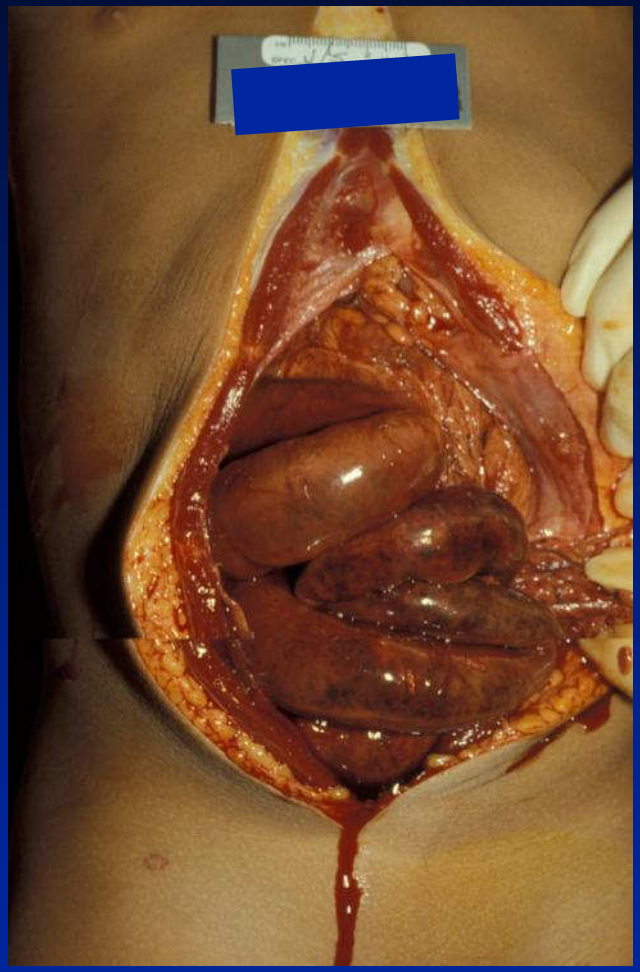
Ventricular septal defect

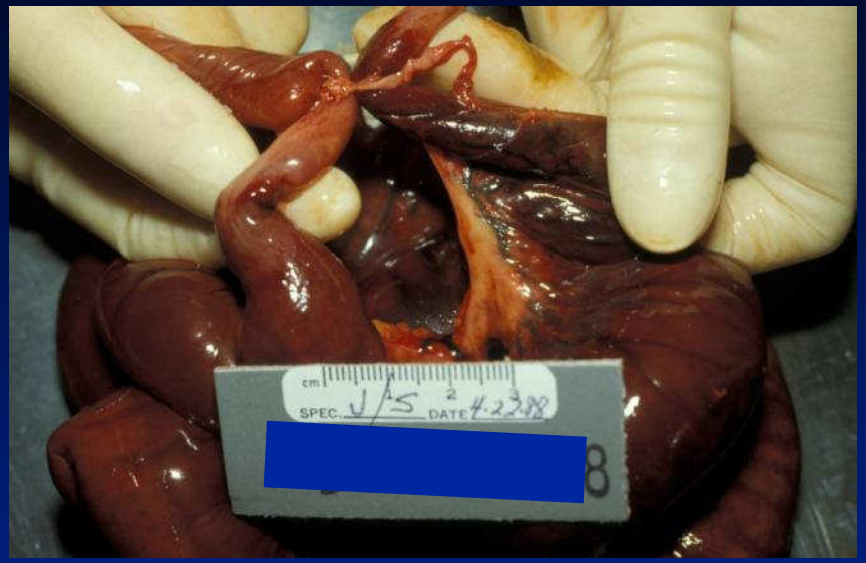


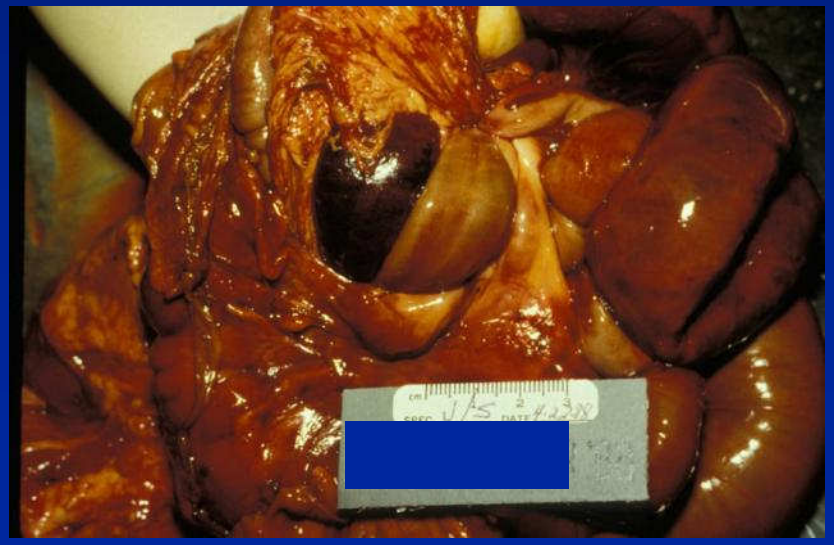
acute viral myocarditis

Peritonitis and acute appendicitis

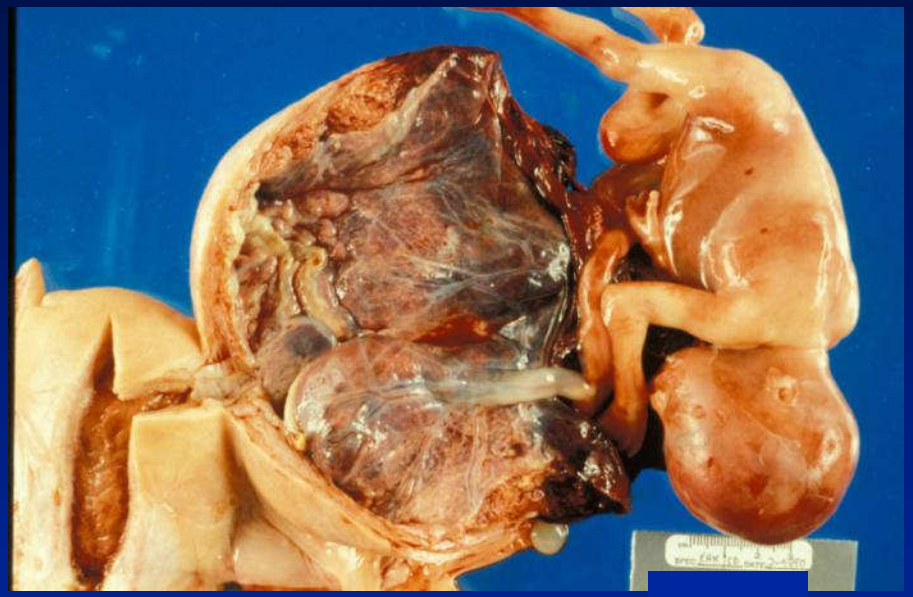
Volvulus



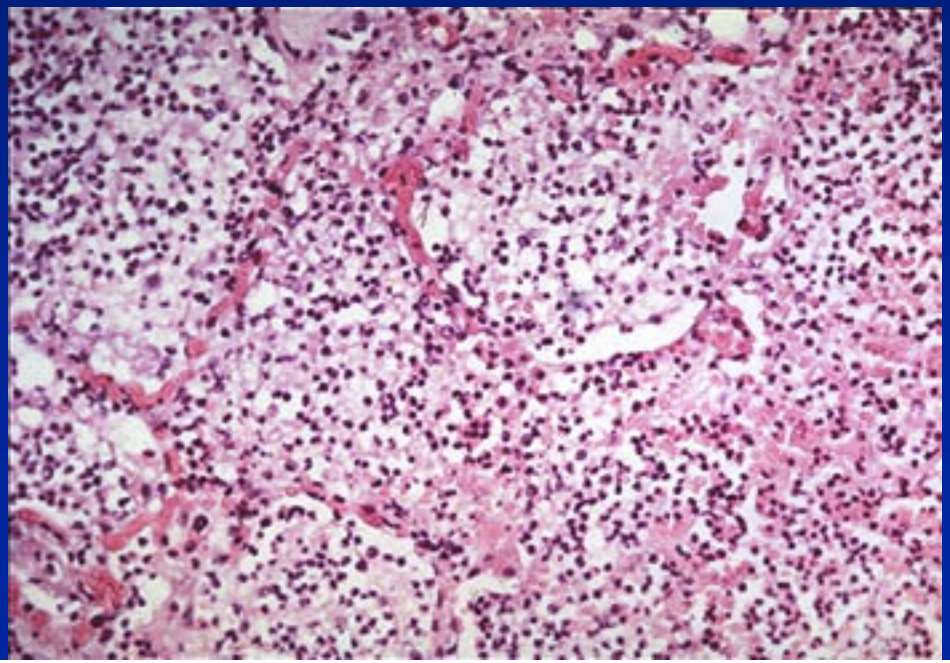




Ruptured ectopic pregnancy

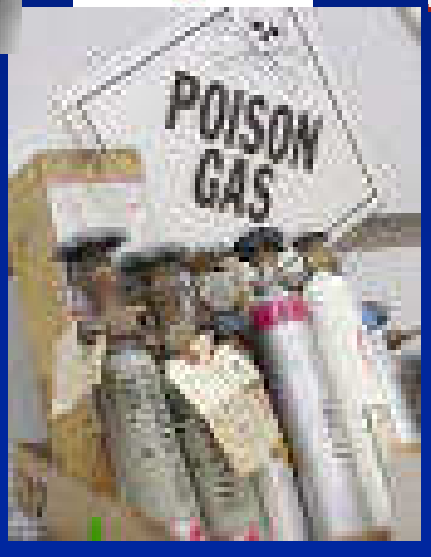


Gross and microscopic appearance of pneumonia

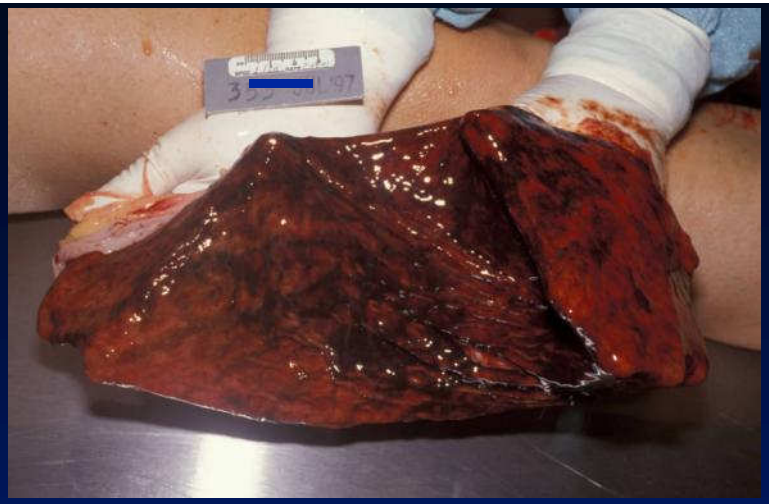


DEATHS DUE TO ALCOHOL AND DRUGS:

POISONING



- Determined by discolorations on body
- Cherry- red lividity is sign of carbon monoxide poisoning
- Toxins give off unusual odors
- Certainty of diagnosis requires toxicological confirmation
- Samples taken of stomach, vomit, kidney, lungs, liver



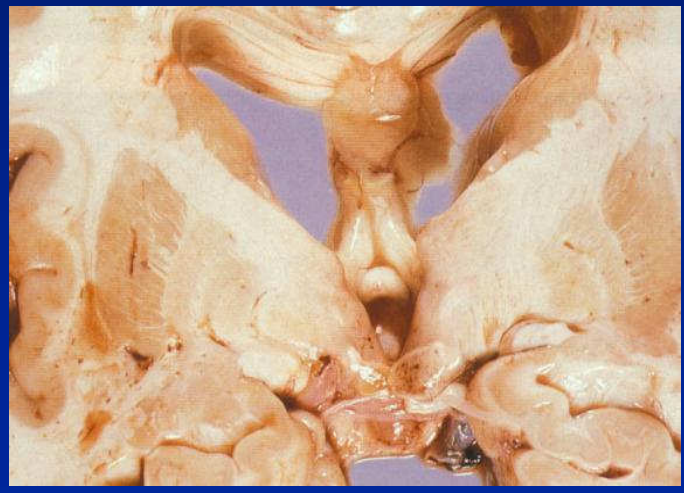
Acute hemorrhagic gastritis

ascitis

Cirrhosis

fatty liver

Wernicke’s encephalitis

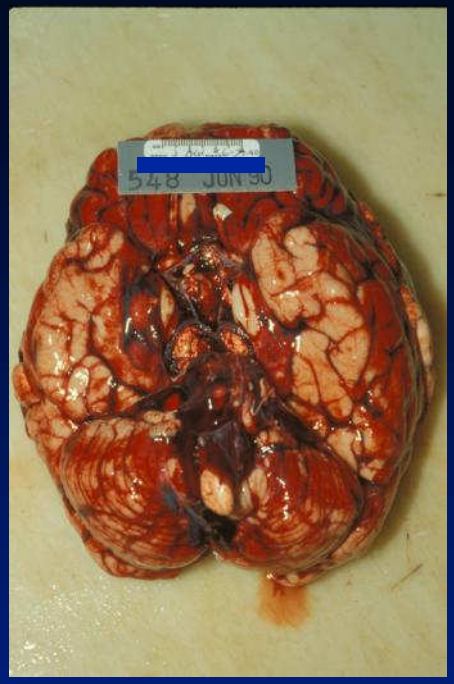


Cocaine

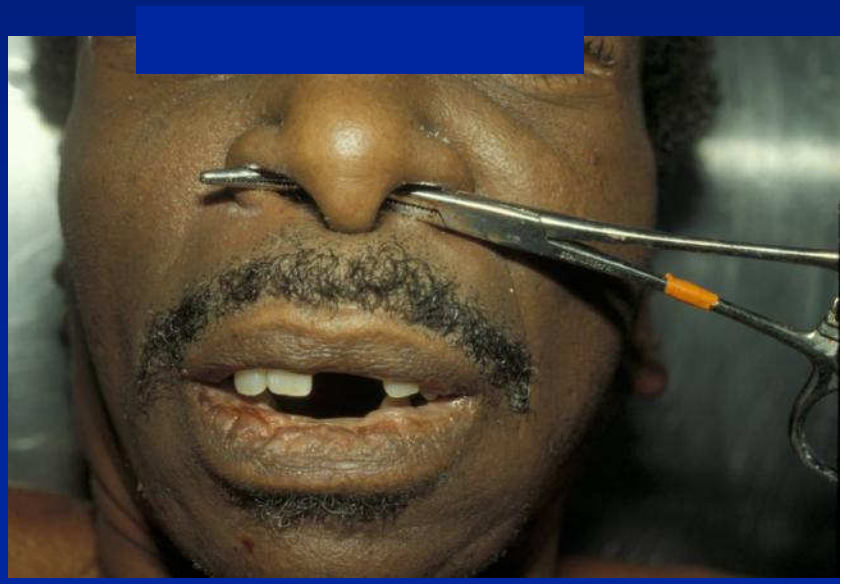
Cocaine

Aborted fetus

Subarachnoid hemorrhage

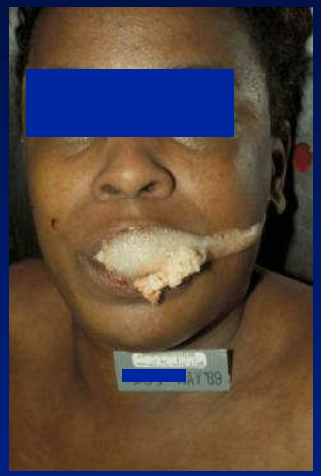


Cocaine in nostril

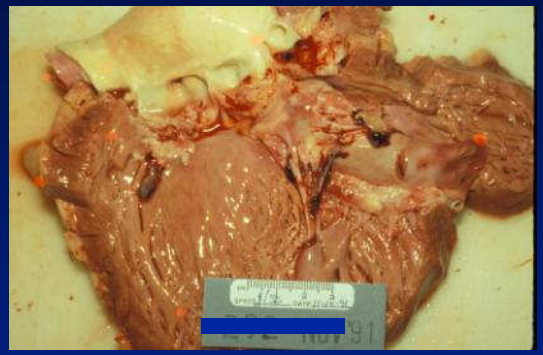


Perforated nasal septum

Heroin



Foam cone



bacterial endocarditis

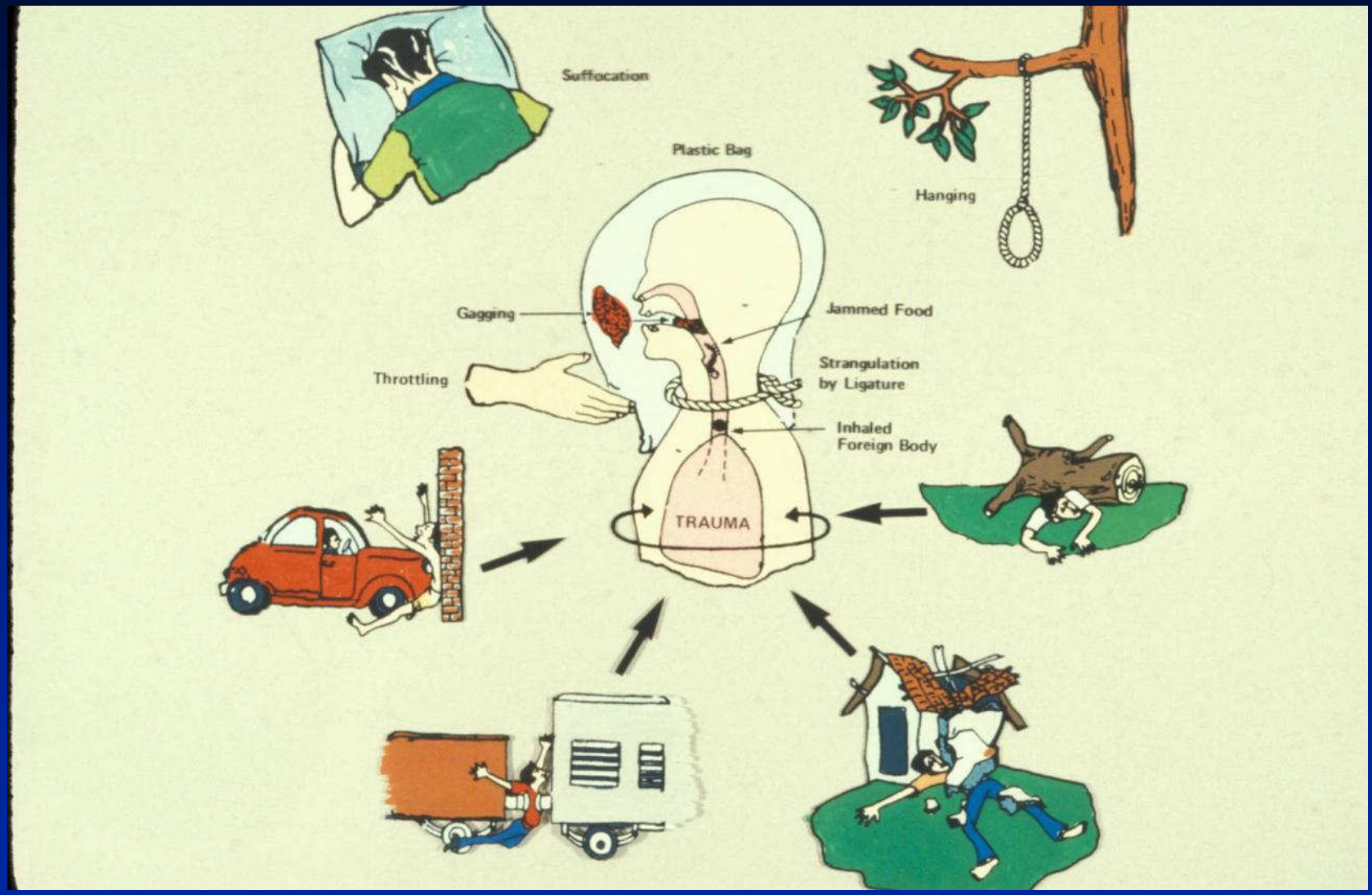
abscess

Tracks and recent needle mark

drugs in colon

brain abscess

DEATHS DUE TO ASPHYXIA



adipocere

Foam cone

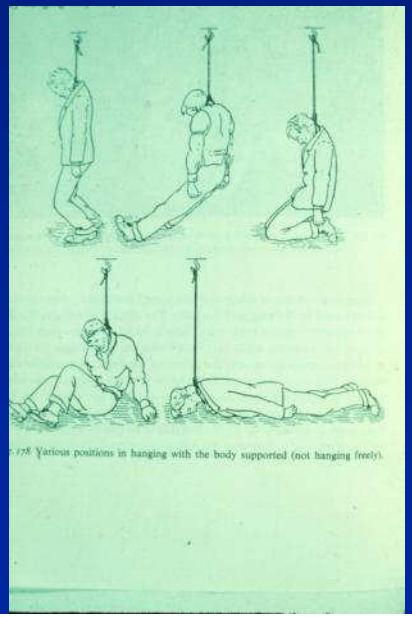
air embolus

Algae in skin

Drowning

Abrasions on hand from
Sand in lake and on shore

Hanging



178. Various positions in hanging with the body supported (not hanging freely).

Smothering

Strangulation

Exclusion of oxygen

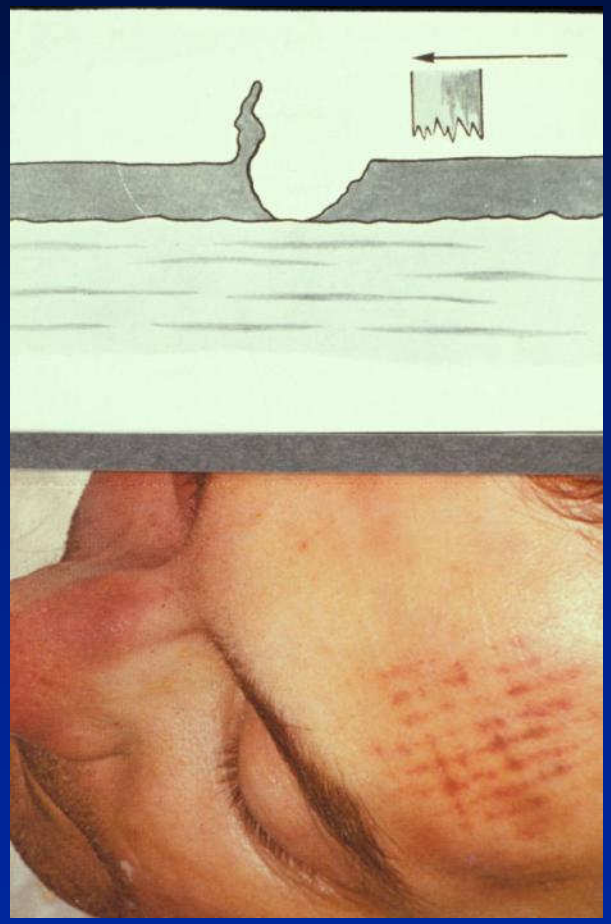
Positional and Compressional asphyxia

DEATHS DUE TO BLUNT TRAUMA

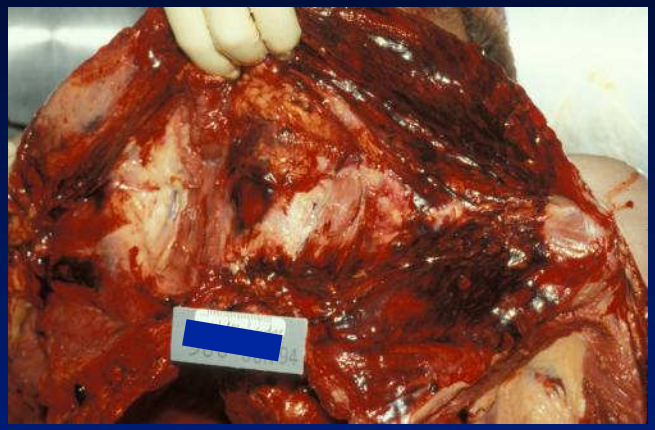
Blunt force trauma

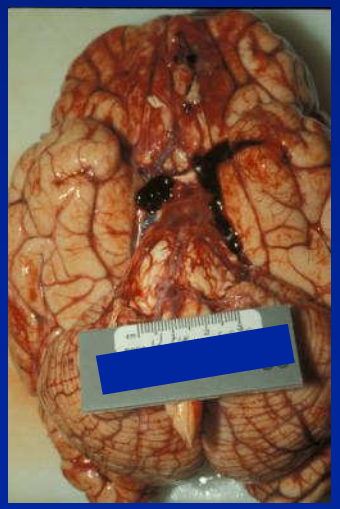
- Blunt Force trauma results from clubbing, kicking, or hitting the victims.
- The blow produces a crushing effect on the human body, resulting in contusions, abrasions, lacerations, fractures, or rupture of vital organs.
- Red-blue contusions are always present, but this varies by the weight of the individual (obese people bruise easier than lean people)

Abrasions

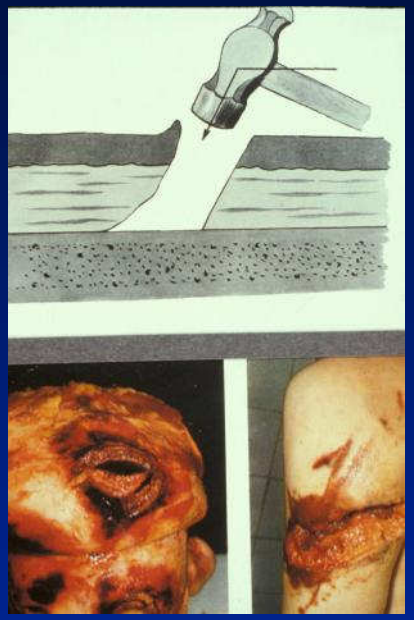


Contusions

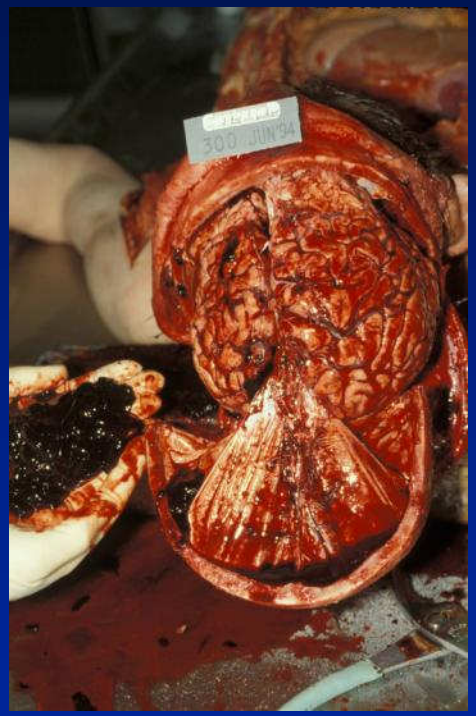


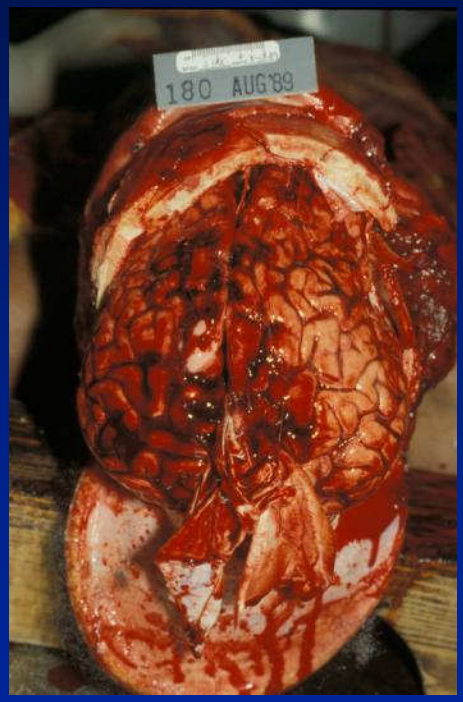


Lacerations



Subdural Hematoma and Subarachnoid Hemorrhage





Patterned Injury

Bite Marks

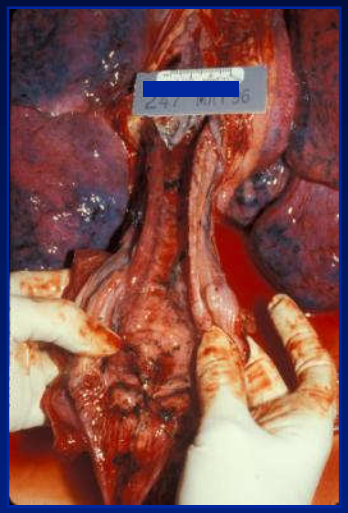
Forensic Pathology

- Deaths due to thermal injury
  - Heat
  - Cold
- Death due to electricity and lightening

BURN

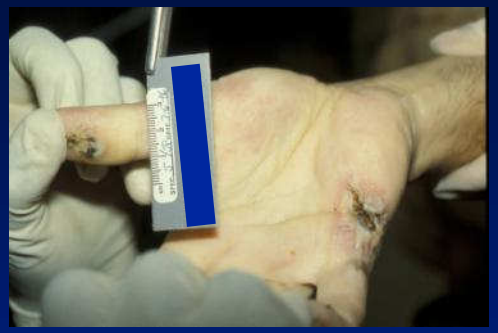
- Scorching or burning of skin leads to sepsis and is immediate cause of death
- Wounds caused by heat, chemicals, or electricity
- Fire victims found in “pugilistic” position: clenched fists, resembling pose of boxer
- Heat causes protein in body to contract
- Blood and lung samples taken

Thermal Injury



Hypothermia

Electrical and Lightening



HOW TO WRITE A POST AUTOPSY REPORT

HOW TO COMPLETE A DEATH CERTIFICATE