**Forensic Pathology Notes**

**Canadian Assiocation of Pathologists Residents Review Course**

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**Introduction:** Forensic pathology is a vast field of subspecialty within pathology. As anatomical and general pathology trainees, you are **not expected** to have the knowledge of a “forensic pathologist”. Rather you should be familiar with the common death-investigation scenarios which may present themselves to any “non-forensic” pathologist who does so-called “routine” (non-criminally suspicious) medico-legal autopsies. Keep in mind that the definition of a “routine” case is a moving target and therefore it is challenging to decide what material to include in this review. For example, all firearms death cases in Ontario, including suicides, are autopsied exclusively by forensic pathologists.

I have based the presentation on images, providing what I think is the most efficient way to review this material. Much of forensic work involves **recognition and interpretation of findings** so that is what we will do in this session. Rather than provide overall review notes, I have listed below the slide key with a brief indicator of the teaching point that each slide is designed to illustrate. Space has been left for you to add notes if desired. I have not provided my PowerPoint presentation to you due to the sensitive nature of many of the images.

Before we start, remember to familiarize yourself with the basic structure of medico-legal death investigation systems in Canada; both **Coroner’s systems and Medical Examiner’s systems**. Realize that all jurisdictions have legislation governing medico-legal death investigation, two main goals of which are to determine the **cause and manner of death**. Possible manners of death are **natural, accidental, suicide, homicide, undetermined**.

**Presentation Slide Key**

1. Title
2. Disclosure
3. Topics

* Identification
* Postmortem changes
* Asphyxial deaths
* Drowning
* Hypothermia
* Blunt force injury
* Pedestrian/motor vehicle deaths
* Craniocerebral trauma
* Sharp force injury
* Drugs and alcohol
* Firearms
* Electrocution
* Fire deaths
* Child abuse/ elder abuse
* Natural disease in death investigation

1. Body bag seal
   * Continuity of evidence
2. Identification, dental

* Requires antemortem records, reliable

1. Identification, fingerprint

* Requires antemortem records, reliable

1. Identification, DNA

* Requires sample comparison, reliable

1. Identification, medical history

* Variably reliable

1. Identification, tattoo

* Variably reliable

1. Identification, personal effects

* Less reliable

1. Postmortem changes, livor mortis

* Areas of blanching
* May indicate postmortem positioning of body, moving of body after death
* Poor indicator of time of death

1. Postmortem changes, livor mortis

* With petechial hemorrhages (“Tardieu spots”)

1. Postmortem changes, bright red lividity

* Consider carbon monoxide toxicity
* Possible sources – furnace, gas fireplace, kerosene heater, etc…

1. Postmortem changes, rigor mortis

* Highly variable time course: onset 3-6 hrs, fully developed 6-12 hrs, disappears 24-36 hrs
* not a reliable indicator of time of death
* Sped up by heat, physical activity prior to death, fever
* Onset delay by cold
* May indicate that body was moved after death

1. Postmortem changes, scleral drying artifact
2. Postmortem changes, decomposition patterns

* Mummification – dry environment
* Putrefaction – warm, humid environment (skin slippage, green black skin, blisters, marbling, bloating, fluid purge from orifices)

1. Postmortem changes, skin “marbling”.
2. Postmortem changes, fly eggs

* Forensic entomology – may be used to determine time of death based on development of insects on body
* Postmortem “predation” by insects and other animals create artefacts
* Postmortem “predation” wounds lack hemorrhage/vital reaction

1. Asphyxial deaths, classification

* Suffocation (smothering, choking, confined spaces), strangulation (ligature strangulation, manual strangulation, hanging), mechanical asphyxia (positional asphyxia, traumatic asphyxia)

1. Asphyxia, suffocation/smothering

* “plastic bag” asphyxia
* Car exhaust inhalation – note: cars are “clean-burning” so in most of these cases, the blood CO level is not elevated; death is due to hypoxia.

1. Asphyxia, choking

* Blockage of airway, often food bolus – risk factors: intoxication, dementia, edentulousness

1. Positional asphyxia

* Position of body such that the airways or ability to ventilate is impaired
* Risk factors: obesity, intoxication, motor impairment
* Scene photos very important

1. Traumatic asphyxia

* Compression of chest impairs ability to ventilate
* Children at risk
* Signs of congestion in head and neck due to decreased venous return to chest

1. Hanging

* Typical ‘parchment’ like furrow mark matching the ligature, usually rises upward to a point of suspension
* +/- signs of congestion in face including cutaneous and ocular petechiae (often absent if tight ligature completely occluding carotid inflow to head)
* Ligature is tightening by weight of the body; person does not have to be upright or fully suspended to achieve

1. Neck compression, internal neck structures

* Superior horns of thyroid cartilage and hyoid bone examined for fractures
* Variably present in manual strangulation, ligature strangulation and hanging

1. Ocular petechiae

* Not a specific finding or marker of asphyxia
* Due to rupture of capillaries due to increased venous pressure
* Many different causes including: neck compression, face-down positioning, Valsalva/vomiting/ coughing

1. Autoerotic asphyxia

* Usually “hanging” apparatus to induce hypoxia, with sexual paraphernalia
* Manner of death is suicide

1. Drowning, airway froth

* Transient, may be present at scene, dissipates before autopsy
* Due to mixing of inhaled water and lung surfactant
* Good sign of drowning as it indicates water inspiration

1. Drowning, hyperinflated wet lungs.

* Lungs stay “inflated” upon chest opening
* Weights significantly increased (>1 kg combined; usually heavier)
* Cut surfaces express clear fluid
* Good signs of drowning, also indicating water inspiration

1. Drowning, signs associated with immersion but not diagnostic of drowning

* Skin wrinkling, mastoid hemorrhages
* Other: marine animal predation; trauma from waves, boats, etc; water in sinuses

1. Hypothermia

* Paradoxical undressing
* Gastric erosions (“Wischnewski ulcers”)
* Frost erythema; red discoloration around large joints

1. Blunt force injury classification

* Abrasion, bruise (contusion), laceration

1. Blunt force injury, abrasion
2. Blunt force injury, patterned abrasion
3. Blunt force injury, bruises

* Colour not a good indicator of age
* Factors affecting size: force of impact, body site, age/tissue fragility, bleeding disorders

1. Blunt force injury, patterned bruise

* May be a “negative” impression of the impacting object

1. Blunt force injury; seatbelt bruising pattern
2. Blunt force injury; iron stain of bruise

- Good method for dating bruises; hemosiderin-laden macrophages begin to appear about 2 days after occurrence

1. Bruise mimicker; Mongolian spot

* Sacral region infants

1. Blunt force injury; laceration
2. Comparison of laceration with sharp force wound (stab)

* Laceration has tissue bridging, irregular edges
* Stab wound has no bridging, smooth edges

1. “Dicing” lacerations

* Due to “cubed” fragments of broken tempered glass; side windows of vehicle (windshield is laminated safety glass which does not cube like this)

1. Image showing abrasion, laceration, bruise
2. Pedestrian/motor vehicle collision

* Primary impact to legs with front bumper
* Secondary impact to front hood or windshield; often with head
* Tertiary impact to the ground; often resulting in diffuse “brush” abrasion

1. Pedestrian injuries; primary impact “bumper” fracture

* Should dissect the legs to look for bruising +/- fractures
* Evidence that the deceased was upright at the time of impact

1. Pedestrian injuries; secondary impact
2. Pedestrian injuries; tertiary impact “brush abrasion”
3. Internal injuries, aortic laceration

* Common injury in fatal MVC, falls from height, or other sudden deceleration

1. Craniocerebral trauma

* Typical scenario; fall down stairs

1. Craniocerebral trauma; external injuries
2. Craniocerebral trauma

* Blood from ear canals usually indicator of transverse basal skull fracture through petrous temporal bone

1. Craniocerebral trauma

* Periorbital ecchymosis may be a marker of orbital plate fracture

1. Skull fracture types

* Linear fracture
* Depressed fracture indicative of focal concentrated impact force (example – hammer)

1. Subdural hematoma, acute

* Clotted blood
* Volume important; > 100 mL can result in life-threatening mass effect
* Onset of clinical signs/symptoms may be delayed hours/days after event

1. Subdural hematoma, chronic

* Membrane of resolving subdural

1. Epidural hematoma

* Classic scenario: linear skull fracture associated with injury to middle meningeal artery

1. Cortical contusions

* Along crests of gyri
* May be opposite to the site of impact: “contre-coup” contusions

1. Old cortical contusions, “plaques jaunes”
2. Brain swelling, gyral flattening
3. Brain swelling, midline shift
4. Brain swelling, necrotic herniated cerebellar tonsils
5. Sharp force injury
6. Sharp force injury; incised wound

* Wound length > wound depth

1. “Hesitation” incised wounds to neck

* Supportive of suicidal manner

1. Self-harm “cutting” incised wounds
2. Incised wounds to wrist

* Multiple motions, supportive of suicidal manner

1. Defensive incised wounds to hand

* Bruises, abrasions, lacerations may also be defensive in nature

1. Stab wounds

* Wound depth > wound length

1. Stab wounds

* Dimensions may approximate blade dimensions
* Characteristic of wound outline may indicate features of knife; ie – single edged, serrated.

1. Drug-related deaths; drug paraphernalia amongst personal effects
2. Fentanyl transdermal patches

* Fentanyl and other new high-potency opioids are a huge increasing problem
* Fentanyl may be smoked, injected, or ingested/sucked (look in mouth/pharynx for patches)

1. Drug-related deaths; pulmonary edema

* May be a sign of opiate toxicity

1. Drug-related deaths; chronic scarring along veins of injection sites “track marks”

* Microscopy will show chronic vasculitis with refractile foreign material

1. Drug-related deaths; disease complications

* IV drug related infective endocarditis
* Cirrhosis; EtOH or hepatitis-C
* Acute pancreatitis (EtOH)
* Steatohepatitis/ fatty liver (EtOH)

1. Drug-related deaths; toxicological sample collection

* Peripheral venous blood samples are best to test; less affected by postmortem distribution of drug
* Samples must be sealed to maintain continuity of evidence
* Vitreous humour useful for biochemical analysis: useful in assessing for dehydration, uremia, ketoacidosis

1. Firearms
2. Bullet components

* Cartridge consists of cartridge casing, propellant (gunpowder), and bullet

1. “Rifled” weapons; handguns and rifles

* Ridges (lands and grooves) spiraled along barrel impart spin to bullet; markings left on bullet base can be matched to specific weapon of origin

1. Firearms; X-rays

* X-ray all firearm deaths; useful in determining number of projectiles, their location, and wound tracks.

1. Gunshot wounds; entrance vs. exit

* Entrance typically round, with marginal abrasion
* Exit typically irregular, lacking marginal abrasion

1. Gunshot entrance wounds; range of firing

* Soot, gunpowder particles, and gases leave muzzle along with projectile

1. Gunshot entrance wounds; range of firing examples

* Contact: soot in wound, some on skin if loose contact
* Intermediate: “stippling/tattooing” – fine punctate abrasions due to impact by gunpowder particles
* Distant: no soot, no stippling

1. Shotgun with ammunition

* Cartridge includes outer shell, with propellant, waddings (plastic petal), and projectiles (usually multiple pellets; sometimes single slug)

1. Shotgun wounds; entrance wound appearance with varying range of firing

* Pellets exit muzzle as single mass/bolus
* If close to muzzle the wound will be a single large defect
* As pellets begin to separate with increasing distance, the wound will show scalloping of edges and eventual separate wounds from individual pellets

1. Electrocution

* Path of electricity through the body, with entrance (contact with source) and exit (grounded)

1. Electrocution; entrance burn

* Often on hands; may be subtle, sometimes no burn at site of entrance (if insufficient resistance and heat)

1. Electrocution; exit burn

* Look carefully at footwear and feet

1. High voltage electrocution

* High voltage electricity source or lightning
* Usually much more heat generated than with low-voltage; therefore usually extensive burns
* Fractal pattern of Lichtenburg figures characteristic for lightning

1. Fire deaths; body posture

* “pugilistic” posturing of arms and legs due to heat contractures

1. Fire deaths; artefactual skin splits
2. Fire deaths; artefactual heat epidural hematoma
3. Fire deaths; smoke inhalation

* Soot staining of respiratory mucosa beyond the larynx is indicative of smoke inhalation (ie. Breathing after onset of fire)
* Absence of soot along trachea does not necessarily mean that the victim was dead before onset of fire (flash fire scenario)
* Carboxyhemoglobin saturation >10% indicative of breathing after fire onset

(smokers may have up to 10%)

1. Child abuse; head injury findings

* “triad” injury pattern of abusive head injury: subdural hematoma, retinal hemorrhages, encephalopathy

1. Child abuse; other non-accidental traumatic injuries

* Skeletal X-ray survey to look for occult bone trauma/ old healed fractures

1. Elder abuse; emaciation and decubitus ulcers

* Emaciation may be related to dementia, malignant disease

1. Sudden natural death
2. Sudden natural death; hemopericardium due to free wall rupture due to acute myocardial infarction due to coronary thrombosis

* Atherosclerotic coronary artery disease by far the most common cause of sudden natural death; usually fatal arrhythmia, severe coronary artery disease is present but finding an acute infarct is uncommon.

1. Sudden natural death; acute aortic dissection

* Outward rupture of the dissection plane, usually into the pericardial sac, is the most common outcome.

1. Sudden natural death; massive pulmonary thromboembolism

* Usually secondary to deep venous thrombosis of leg; may appear swollen and inflamed
* Coiled up within proximal large pulmonary artery
* Risk factors: immobility, hypercoagulability, injury

1. Sudden natural death; asthma

* Hyperinflated due to air trapping

1. Sudden natural death; asthma

* Mucus plugging of airways
* Basement membrane thickening and eosinophils

1. Sudden natural death; basal subarachnoid hemorrhage

* Most commonly due to rupture of berry aneurysm
* Other possibility vertebral artery dissection, arteriovenous malformation

1. Sudden unexpected death in epilepsy

* May or may not be associated with seizure activity at time of death
* Incontinence, tongue bruises may be a sign
* Difficult to prove; really a diagnosis of exclusion in the presence of an established previous diagnosis of epilepsy.

1. Sudden natural death; gastrointestinal hemorrhage

* Many possible causes included peptic ulcer disease, esophageal varices
* “coffee-grounds” emesis
* Melena stool
* Evidence of blood loss at scene

1. ..The End!