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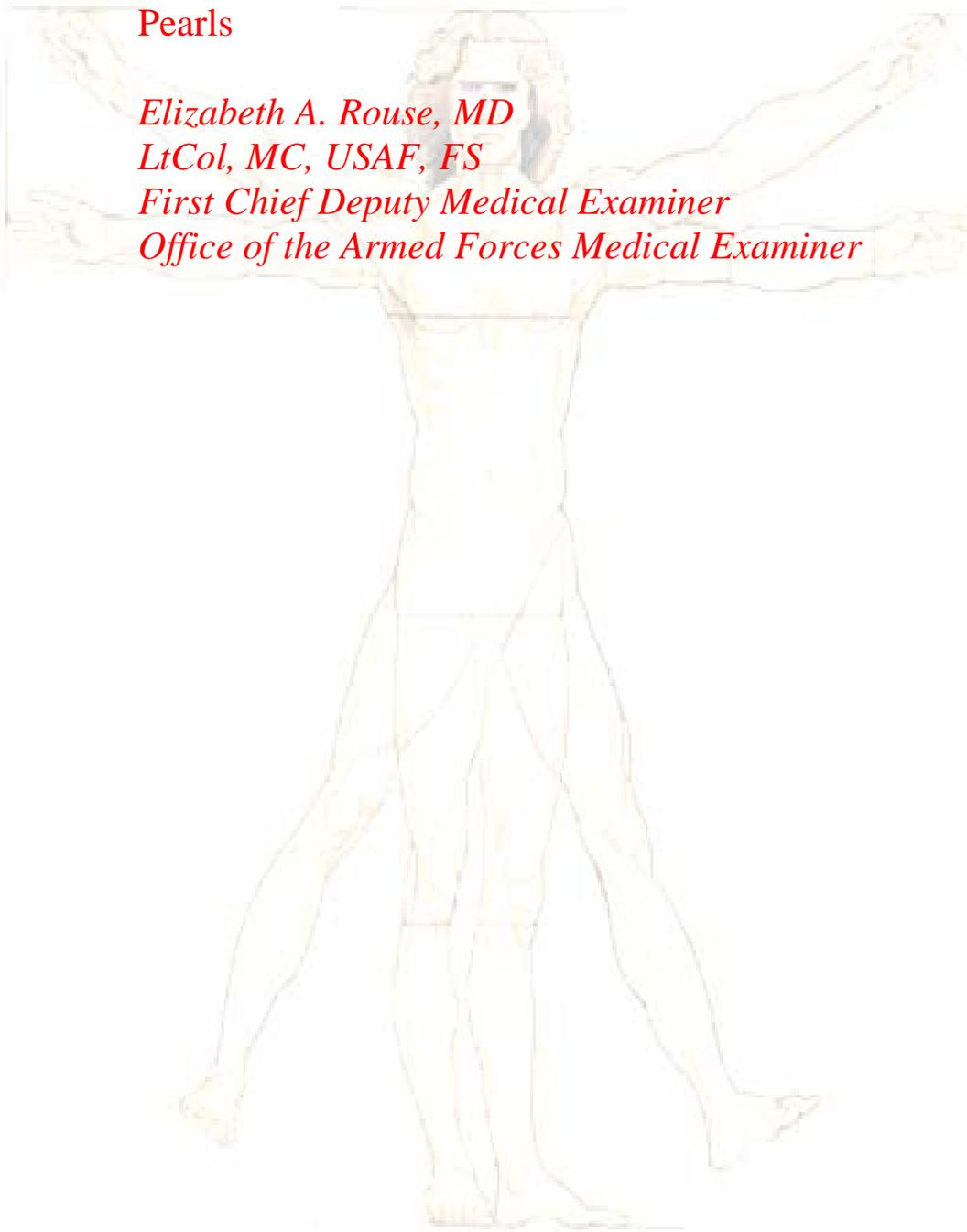
Forensic Medicine: Principles, Applications, and Pearls

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FORENSIC MEDICINE

Principles and Applications

I. Rules of Engagement:

A. ***In forensic medicolegal investigations there are traditionally seven fundamental questions asked which must be answered as comprehensively as possible:***

1. Who is the casualty? (identification)
2. What are the injuries, conditions, or diseases? (cause of death and contributing factors)
3. When did these injuries occur? (temporal relationship, time)
4. Where did these injuries occur? (location)
5. How did these injuries occur? (mechanism of injury, biomechanics of injury),
6. Why (human factors, behavioral sciences) and
7. If by another-by whom?

B. ***For the medical examiner-coroner these questions are embodied in the statutory nature of the death certificate if the casualty or patient is dead. These findings exist as:***

1. The identity of the casualty,
2. Determination of the cause of death,
3. Identification of contributing factors, and
4. Written opinion as to manner of death-homicide, suicide, accident, natural, undetermined/unclassified.

II. Jurisdiction—Know Before You Act.

A. ***Authority for such an inquiry exists in statute usually as a public-health or safety issue.***

B. ***An important aspect is who has jurisdiction of the case.***

1. Medical Examiner/Coroner jurisdiction is determined where the death occurred not necessarily where the injury occurred.
2. Prosecution and overall jurisdiction of the case is usually where the injury occurred.
3. Jurisdiction may be federal, concurrent, or proprietary.
4. Jurisdiction of the case is determined by the death location and secondarily where the injury occurred if different.
5. The majority of cases in the United States will either be proprietary or concurrent.
6. A death on federal property always has a federal component in the investigation but may not have medical examiner authority except where there is exclusive federal jurisdiction.
7. Civilian authorities can waive a military case to the military.

III. Identification:

A. *Perhaps the most labor-intensive aspect of a medicolegal death investigation is the identification process. There are three types of identification:*

1. Presumptive,
2. Positive and
3. By exclusion.

B. *The majority of people go their grave or crematorium with a presumptive visual identification usually based on recognition by family, friends or co-workers. These include personal effects and anthropological class characteristics such as:*

1. Age,
2. Sex,
3. Stature,
4. Weight,
5. Muscularity,
6. Blood type,
7. Hair color.

C. *Positive identification includes:*

1. Dermatoglyphics (finger, foot or palm prints),
2. Dental,
3. DNA polymorphisms, or
4. Radiological superimpositions.

D. *In each case a premortem record is compared with a postmortem record for unique identifying characteristics.*

E. *Identification by exclusion requires that there be a closed population and all others are accounted for by presumptive and/or positive identifications.*

F. *Multiple casualty incidents provide the greatest level of challenge because of the resources required to accession, process and store remains as well as the challenges of commingling and fragmentation and thermal injuries.*

G. *A number of supporting methodologies are used including:*

1. Facial reconstructions,
2. Computer aging,
3. Artistic or graphic renditions based on witness descriptions, etc, and occasionally
4. Forensic serology.

IV. CAUSE and MANNER of DEATH

A. *The disease of injury that initiated the lethal chain of events that brought about a person's death*

1. Immediate
2. Intermediate

3. Proximal

B. *Not causes of death*

1. Cardiac arrest
2. Respiratory arrest
3. Cardiorespiratory arrest
4. Renal failure
5. Asystole

C. *Mechanism of death*

1. Nonspecific final pathway by which the cause of death exerts its lethal effects
2. The manner of death opinion expressed in the death certificate is often a major determinant as to the time and resources invested in death investigations.

D. *Manner of death is the circumstances under which a person dies*

1. Natural
2. Accident
3. Suicide
4. Homicide
5. Undetermined
6. (Combat-related)

V. *Time of Death*

A. *The time of death is one of the most difficult to refine and ranges from precise witnessed events to guesses and becomes more difficult with time. The postmortem interval (PMI) in the early stages is often based on:*

1. Algor mortis – temperature
2. Rigor mortis - stiffening
3. Livor mortis – settling of blood
4. Gastric contents
5. Circumstantial data.

B. *Determination of the time of death is dependent on:*

1. The circumstances,
2. Whether the injury or death was witnessed,
3. The post mortem interval (PMI) as assessed by
 - a. Rigor mortis,
 - b. Serial body core temperature readings,
 - c. Vitreous humor potassium levels and
 - d. A variety of enzyme ratios
4. The condition of the remains as a result of
 - a. Time,
 - b. Burial,
 - c. Immersion,
 - d. Dehydration,
 - e. Encasement, or

- f. Other environmental conditions.
- 5. Lividity or hypostasis is a useful means of assessing time of death (similar to rigor mortis) and whether the remains have been moved. Different lividity patterns suggest a change in position of the body during the first 8-12 hours postmortem. Lividity patterns are demonstrable in the skin and the internal organs.

C. *Decomposition is a reflection of autolysis and putrefaction and begins in a sequential manner including:*

- 1. Liquefaction and skeletonization or mummification and adipocere formation.
- 2. Insect activity (instars) are used to estimate the PMI as well as vegetation and other soft markers.
- 3. Another time issue is determination of the time of injury versus the time of death. Even lethal injuries often have a survival interval that may be measurable. Methodologies include
 - a. Biochemical (serotonin and histamine),
 - b. Inflammatory responses (phases of response and healing),
 - c. Degree of hemorrhage, and
 - d. Evidence of circulation-bone marrow and fat emboli, etc.
- 4. Special stains and immunohistochemistries are helpful if used with controls
 - a. H&E,
 - b. PAS,
 - c. Reticulum,
 - d. Masson,
 - e. Iron stain,
 - f. Selective fibrin stain (Martius scarlet blue) and
 - g. Immunohistochemistries including factor VIII.
- 5. Both histology and radiology is used in child abuse cases to identify and age injuries, especially repetitive or sequential wounds. The color and degree of tissue response in bruises and fracture calluses are examples of wound measurements used for timing estimates.
- 6. Another area of timing that occurs with some frequency is determination of live versus stillbirth infants. The most used marker is evidence of feeding, followed by lung expansion and general measurements of maturity.

D. *The identification and association is based on Locard's Principle which states that there is always a transfer of evidence with any interaction. That evidence presents in many forms both macroscopic and microscopic.*

VI. Injury Patterns:

The injury patterns documented and the underlying pathophysiology constitute the means of determining the cause of death versus a cause of death. The injury patterns may be traumatic or infectious, each with their own classifications. Typical traumatic injury categories include:

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1. Gunshot wounds
 - a. Types of weapons
 - i. Handguns
 - ◆ Revolver
 - ◆ Semiautomatic
 - ii. Assault rifles
 - iii. Rifles
 - iv. Machine guns
 - v. shotguns
 - b. Rifling
 - c. Ammunition
 - i. Centerfire
 - ii. Rimfire
 - iii. Bullets
 - ◆ Jacketed
 - ◆ Nonjacketed
 - ◆ Semi-jacketed
 - iv. Velocity
 - ◆ Handgun - think 1000 fps
 - ◆ Rifle – think 3000 fps
 - d. Wounding theory
 - i. Mechanical
 - ii. Cavity
 - e. Perforating
 - f. Penetrating
 - g. Range of fire
 - i. Contact
 - ii. Loose-contact
 - iii. Intermediate
 - iv. Distant
2. Sharp force-slicing
 - a. Stabbing
 - b. Incised
 - c. Chop
 - d. Defense wound
3. Asphyxia-strangulation
 - a. Hanging
 - b. Positional
 - c. Compression
 - d. Mechanical obstruction
 - e. Autoerotic
 - f. Drowning
 - g. Cherry red lividity
 - i. Carbon monoxide
 - ii. Cyanide
 - iii. Cold
4. Children

- a. Scope
- b. Adult vs. child deaths
- c. Shaken baby vs. impact
- d. Head trauma
- e. Abdominal trauma
- f. Fractures
- g. SIDS
 - i. Definition
 - ii. Incidence
 - iii. Theory
 - iv. Position
 - v. Overlaying
- 5. Thermal injuries including inhalation of products of combustion
 - a. Hyperthermia
 - i. Cramps
 - ii. Exhaustion
 - iii. Stroke
 - b. Hypothermia
 - i. Effects
 - ii. Paradoxical undressing
- 6. Electrical injury
 - a. AC/DC
 - b. Low vs. high voltage
 - c. Resistance and current flow
 - d. Requirements for electrocution
 - e. Entrance and exit wounds
 - f. Lightning
 - i. Lichtenburg figures or ferning
- 7. Blunt force-abrasions
 - a. Contusions
 - b. Lacerations
 - c. Fractures/dislocations
 - d. Avulsions
- 8. Blast injuries
 - a. Biology of blast injuries
 - b. Mechanism of blast injury
 - i. Primary
 - ii. Secondary
 - iii. Tertiary
 - iv. Miscellaneous

VII. Additional Pearls

A. *Pre-existing disease and toxicology studies are important. Most casualties have measurable pre-existing disease, it may be:*

- 1. Incidental,
- 2. Contributing or
- 3. Proximal to the cause of death.

- B. In general, there are only three systems that can kill suddenly:**
 1. Nervous system,
 2. Cardiovascular or
 3. Respiratory.
- C. An unexpected, sudden natural death will have its etiology in one or more of these three systems.**
- D. Drowning and electrocution are usually diagnoses by exclusion as is sudden infant death syndrome.**
- E. An extensive scene as well as autopsy investigation is indicated.**
- F. Radiology should be used routinely and is always necessary in:**
 1. Gunshot wound cases,
 2. Fire and explosion injuries,
 3. Transportation mishaps and
 4. Child abuse cases.

Evidence may be testamentary, demonstrative or physical and must have relevance, materiality, credibility and competency to be admitted. Testamentary evidence includes fact witnesses and expert witnesses.

VIII. Forensic textbooks every pathologist should own

- A. DiMaio, Vincent J. and Dimaio, Dominick, *Forensic Pathology*, second edition, CRC Press, 2001.**
- B. DiMaio, Vincent J., *Gunshot Wounds; Practical Aspects of Firearms, Ballistics and Forensic Techniques*, second edition, CRC Press, 1998.**
- C. Karch, Steven B, *The Pathology of Drug Abuse*, third edition, CRC Press, 2001.**
- D. Baselt, Randall C, *Disposition of Toxic Drugs and Chemical in Man*, fifth edition, Chemical Toxicology Institute, 2000.**