Case Studies in Forensic Pathology
Part II

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Case 1

- 33 yo male with h/o depression/suicide attempts found dead on living room floor
Questions

- What type of weapon could cause this injury?
- What is the perforation velocity of skin?
The Weapon

- Benjamin Sheridan Air Rifle
- Single bolt action, pneumatic
- .177 caliber
The Ammunition
Ballistics Testing

- Peak trigger pull force = 5.115 to 5.343 lbs.
- Advertised velocity 800 fps

<table>
<thead>
<tr>
<th>No. of Pumps</th>
<th>$V_{\text{ave}}$ (fps)</th>
<th>No. of Pumps</th>
<th>$V_{\text{ave}}$ (fps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>309</td>
<td>6</td>
<td>702</td>
</tr>
<tr>
<td>2</td>
<td>459</td>
<td>7</td>
<td>738</td>
</tr>
<tr>
<td>3</td>
<td>546</td>
<td>8</td>
<td>769</td>
</tr>
<tr>
<td>4</td>
<td>610</td>
<td>9</td>
<td>802</td>
</tr>
<tr>
<td>5</td>
<td>662</td>
<td>10</td>
<td>835</td>
</tr>
</tbody>
</table>
Air Guns

- Rifles and pistols
- Mechanism
  - Pneumatic (multi-stroke, single stroke, charged)
  - Spring-piston
  - CO₂ canisters
- Muzzle velocity
  150–1200 fps
## Comparative Muzzle Velocities

<table>
<thead>
<tr>
<th>Weapon</th>
<th>Muzzle velocity (fps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>.22 pistol</td>
<td>800</td>
</tr>
<tr>
<td>.38 pistol</td>
<td>870</td>
</tr>
<tr>
<td>Multi-stroke air rifle</td>
<td>900</td>
</tr>
<tr>
<td>.30–06 rifle</td>
<td>2500</td>
</tr>
<tr>
<td>M16 rifle</td>
<td>3250</td>
</tr>
</tbody>
</table>
Air Gun Lethality

- 16,650 nonfatal BB/Pellet gunshot injuries reported to CDC in 2016
- 4 BB/pellet rifle fatalities per year reported to USCPSC
  - Most are accidents in young males
  - Numerous reported suicides and homicides
Perforation Velocities

- Skin perforation *(DiMaio 1982)*
  - 0.177 air rifle and pellets
  - Human lower extremities
  - Skin perforation 331 fps

- Eye perforation *(Powley 2004)*
  - Crossman Power Master Model 760 BB gun
  - Crossman Copperhead BBs
  - Pig eyeballs in gelatin blocks
  - \(V-50 = 246\) fps
Case 2

- 33 yo male found DIB after drinking heavily and allegations of poisoning
Questions

- What additional testing would you perform?
## Toxicology

### Testing Requested:

<table>
<thead>
<tr>
<th>Analysis Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>90025B</td>
<td>Postmortem, Expanded, Blood (Forensic) (CSA)</td>
</tr>
<tr>
<td>90025 2</td>
<td>Postmortem, Expanded, Blood (Forensic) (CSA)</td>
</tr>
<tr>
<td>90025 3</td>
<td>Postmortem, Expanded, Blood (Forensic) (CSA)</td>
</tr>
</tbody>
</table>
Novel Psychoactive Substances

- Compounds designed to mimic existing established recreational drugs
- Legal highs
- Categories
  - Stimulants (e.g. cathinones or bath salts)
  - Cannabinoids (e.g. spice)
  - Hallucinogens
  - Depressants
Synthetic Cannabinoids

- Hundreds of chemicals since 2008
  - K2, Spice, Joker, Black Mamba, Kush, Kronic
- Interact with THC receptors
- Forms
  - Chemicals sprayed on dried, shredded plant material for smoking or brewing
  - Liquids for vaping in e-cigarettes and other devices
- 7,794 calls to PCC in 2015
- Deaths reported
- Addiction/withdrawal
5F-ADB

- Synthetic cannabinoid
- Adverse effects
  - GI (nausea/vomiting)
  - CNS (agitation, altered mental status, seizures, convulsions, loss of consciousness)
  - Cardiovascular (tachycardia, HTN, cardiotoxicity)
- Fatal and nonfatal overdoses
- Temporary CSA Schedule 1 in April 2017
May 25, 2018

Multistate outbreak of coagulopathy from synthetic cannabinoids containing brodifacoum (vitamin K–dependent antagonist)
Case 3

- 16 yo boy with lacerated aorta and liver
Questions

- What questions do you have for the medicolegal investigator?
- What is the etiology?
- What additional testing could be performed to confirm your diagnosis?
Additional Information

- No history of trauma
- Mildly dysplastic TV with mild to moderate TR
- Bilateral club foot
- Short stature
- Easy bruising with occasional nose/gum bleeding
- Fragile friable tissues at autopsy (skin, muscle, liver, spleen)
Aortic Dissection

- Intimal tear followed by dissection of blood within the media
  - Most within 10 cm of aortic valve
- Sudden severe CP radiating to back and moving downwards
- Rupture into pericardial, pleural or peritoneal cavities
- Two groups at risk
  - 40–60 yo males with HTN
  - Younger patients with connective tissue disorders
Inherited Aortic Pathology

Table 1. Inherited autosomal-dominant aortic conditions.

<table>
<thead>
<tr>
<th>Genes</th>
<th>Protein</th>
<th>Associated disorder</th>
<th>Cardiovascular features</th>
</tr>
</thead>
<tbody>
<tr>
<td>FBN1</td>
<td>Fibrillin 1</td>
<td>Marfan syndrome</td>
<td>TAA (usually at sinuses of Valsalva), AI, MVP, MR</td>
</tr>
<tr>
<td>COL3A1</td>
<td>Type 3 pro-collagen</td>
<td>Ehlers–Danlos syndrome, vascular type</td>
<td>TAA, AAA, MVP, aortic rupture without aneurysm</td>
</tr>
<tr>
<td>TGFBR1</td>
<td>Transforming growth factor</td>
<td>Loeys–Dietz syndrome, type I</td>
<td>TAA, arterial tortuosity, widespread aortic and arterial</td>
</tr>
<tr>
<td></td>
<td>receptor 1</td>
<td></td>
<td>aneurysm, PDA</td>
</tr>
<tr>
<td>TGFBR2</td>
<td>Transforming growth factor</td>
<td>Loeys–Dietz syndrome, type II</td>
<td>TAA, arterial tortuosity, widespread aortic and arterial</td>
</tr>
<tr>
<td></td>
<td>receptor 2</td>
<td></td>
<td>aneurysm, PDA</td>
</tr>
<tr>
<td>SMAD3</td>
<td>SMAD3</td>
<td>Loeys–Dietz syndrome, type III</td>
<td>TAA, arterial tortuosity, arterial aneurysm</td>
</tr>
<tr>
<td>TGFb2</td>
<td>TGF-b2</td>
<td>Loeys–Dietz syndrome, type IV</td>
<td>TAA, arterial tortuosity, widespread aortic and arterial</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>aneurysm, PDA</td>
</tr>
</tbody>
</table>

AAA = abdominal aortic aneurysm; AI = aortic insufficiency; MR = mitral regurgitation; MVP = mitral valve prolapse; PDA = patent ductus arteriosus; TAA = thoracic aortic aneurysm

Papagiannis 2017
### Additional Testing

**Gene Sequence & Deletion/Duplication Analyses of COL3A1 Reflex to TAADNext**

<table>
<thead>
<tr>
<th>RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COL3A1</strong></td>
</tr>
<tr>
<td>Variant, Likely Pathogenic: c.898-2A&gt;G</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SUMMARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>POSITIVE: Likely Pathogenic Variant Detected</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INTERPRETATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>This individual is heterozygous for the c.898-2A&gt;G likely pathogenic variant in the COL3A1 gene.</td>
</tr>
<tr>
<td>This result is consistent with a diagnosis of vascular Ehlers-Danlos syndrome (EDS).</td>
</tr>
<tr>
<td>The expression and severity of disease for this individual cannot be predicted.</td>
</tr>
<tr>
<td>Genetic testing for likely pathogenic variants (VLPS) in family members can be helpful in identifying at-risk individuals.</td>
</tr>
<tr>
<td>Genetic counseling is a recommended option for all individuals undergoing genetic testing.</td>
</tr>
</tbody>
</table>
Vascular Ehlers–Danlos Syndrome

- Ehlers–Danlos type IV
- Autosomal dominant – 50% no family history
- Mutation (COL3A1) in gene encoding type III collagen (blood vessels, hollow organs)

Features
- Easy bruising
- Skin lucency
- Club foot, congenital hip dislocation
- Facial features

Median life span 51 years
- Males <20 yo increased risk sudden death
Facial Features

- Triangular face
- Pointed nose
- Thin lips
- Hypertelorism
- Prominent eyes
Case 4

- 48 yo male with self-inflicted GSW
Questions

- What questions do you have for the medicolegal death investigator?
- What is the range of fire?
- What is the manner of death?
No history of depression or suicide attempts or ideation
Financially tight and stressed at work
Active, well-liked, well-respected in town
Daily drinker but not alcoholic
Decedent’s .38 pistol near right foot
Range of Fire
Range of Fire
Range of Fire?

A. Contact
B. Close
C. Intermediate
D. Distant
E. Indeterminate
Manner of Death?

A. Accident
B. Suicide
C. Homicide
D. Undetermined
Case 5

- Term male infant delivered into tub
Questions

- What questions do you have for the medicolegal death investigator?
- Should any additional studies be performed?
- What is the cause and manner of death?
Additional Information

- Mother denies knowledge of pregnancy so no prenatal care
- GM states infant never cried or made purposeful movements
- Mother admitted to the ICU with hypotension and “abnormal lab results”
Acute Funisitis
Cause and Manner of Death?

- Intrauterine fetal demise due to acute chorioamnionitis and funisitis
- Natural
Intrauterine Fetal Demise

- Maceration (sterile autolysis)
  - Erythematous skin
  - Sloughing epidermis
  - Overriding skull bones
- Observed > 4–6 hrs
Case 6

- 55 yo female found dead 2 days after liposuction
Questions

- What additional studies should be performed?
- What is the cause of death?
Additional Studies?

- Fat stains on lung tissue
  - Negative
- Microbiology
  - Blood culture
  - Wound (left thigh) culture
  - CSF culture
  - *Clostridium perfringens* in blood and wound
- Histology
Histology
Necrotizing Fasciitis

- Rapidly progressive infection of fascia
- May follow surgery or minimal trauma
- Diabetes most common comorbidity
- Pain and fever with minimal physical findings
  - Early – soft tissue edema and erythema
  - Late – bullae and necrosis
- Group A streptococcus, mixed facultative and anaerobic flora, *Clostridium perfringens*
- Mortality rate 30 – 100%
Marchesi et al 2017
18 cases of NF after aesthetic surgery
10 liposuction
  ◦ 8 buttocks and lower extremity
9 *Streptococcus pyogenes*
  ◦ 3 fatal septic shock
Presented within three days of surgery
  ◦ Local erythema, edema, pain at surgical site
  ◦ Fever, hypotension, tachypnea
Case 7

- 57 yo male shot by roommate
Questions

- What questions do you have for the medicolegal death investigator?
- What is the manner of death?
- What is the range of fire?
- What caused the marks on the chest?
Additional Information

- Weapon belonged to the deceased
- Shooter not familiar with firearms
- Standing perpendicular and 1 to 2 feet apart
- Shooter uses right hand to pull weapon from holster on left hip
- Weapon discharges as arm is raised
- No history of suicide attempts or ideation
- No history of DV
Manner of Death?

A. Accident
B. Suicide
C. Homicide
D. Undetermined
Range of Fire?

A. Contact
B. Close
C. Intermediate
D. Distant
E. Indeterminate
Cylinder Gap

- Gap between cylinder and barrel of revolver
- Gas, soot and powder emerge from gap at right angle to barrel
- May be deposited on skin or clothing
Case 8

- 36 yo male found dead in upstairs bedroom with two shotguns
Questions

- How would you characterize the gunshot wounds?
- Would it be possible to move after sustaining these wounds?
- What is the manner of death?
Characterize Wounds

- Tangential (gutter) wound of face
Bullet strikes skin at a shallow angle producing an abrasion (graze) or laceration (tangential)
Skin tears point in the direction bullet is travelling
Characterize Wounds

- Tangential (keyhole) wound of vertex
Tangential Wound of Skull (keyhole)

Bullet strikes skull at shallow angle causing fragment to exit while bulk of bullet enters cranial cavity.
Movement After Wounding?

- Tissue fragments found on outside deck and lawn behind house with wad
- Bloody trail through house and up stairs
Manner of Death?

A. Accident
B. Suicide
C. Homicide
D. Undetermined
Multiple GSW suicides

- Uncommon but not rare
- Initial wound not immediately fatal
  - Lack of knowledge of anatomy
  - Flinching at time of trigger pull
  - Defective ammunition
  - Missing vital organ
41 yo female witnessed arrest after vomiting blood and SOB/HTN/tachycardia
Questions

- What is the cause of death?
- Should any additional procedures be performed?
Cause of Death?

- Cardiac arrhythmia due to left ventricular hypertrophy due to hypertensive heart disease
Additional Studies?

- Histology
Left Adrenal Tumor

Adrenal cortical adenoma
Right Adrenal Tumor
Immunohistochemistry

chromogranin
Pheochromocytoma

- Neuroendocrine tumors of adrenal medulla
- Synthesize and secrete catecholamines
- 4% of primary adrenal tumors
- 0.2–0.4% of hypertensive patients
- Most sporadic
- Familial syndromes (e.g. MEN type 2)
Manifestations

- **Common**
  - Paroxysmal HTN (90%), H/A, sweating, palpitations, anxiety, tremors

- **Less common**
  - Shock, MI, dysrhythmias, pulmonary edema (catecholamine cardiomyopathy)
  - Stroke, renal failure
Diagnosis

- Tissue diagnosis
- Lab diagnosis
  - Increased urinary excretion of free catecholamines and metabolites (vanillylmandelic acid and metanephrines)
Real Cause of Death

- Cardiac arrhythmia due to left ventricular hypertrophy due to hypertensive heart disease due to pheochromocytoma
- Catecholamine induced cardiotoxicity due to pheochromocytoma
Case 10

- 27 yo IVDA, IDDM witnessed PEA arrest
Questions

- What is the cause of death?
- What questions do you have for the medicolegal death investigator?
- Should any additional studies be performed?
Cause of Death?

- Pulmonary thromboembolism due to deep venous thrombosis of lower extremity due to?
Virchow’s Triad

- Endothelial Injury
- Thrombosis
- Abnormal Blood Flow
- Hypercoagulability
Endothelial Injury

- Hypertension
- Valvulopathy
- Endotoxin
- Hyperhomocysteinemia
- Hypercholesterolemia
- Radiation
- Tobacco
Abnormal Blood Flow

- Aneurysms
- MI
- Mitral stenosis
- Hyperviscosity syndromes
- Sickle cell disease
- Immobilization
- Bed rest
- Tumor
- Pregnancy
- Obesity
Hypercoagulable States

Hereditary
- Factor V Leiden
- Prothrombin mutation
- ATIII deficiency
- Protein C deficiency
- Protein S deficiency
- MTHRF mutation (hyperhomocysteinemia)

Acquired
- Cardiac failure
- Trauma
- Pregnancy
- OCP/HRT
- Cancer
- Age
- Smoking
- Obesity
- Lupus Anticoagulant
Additional Information

- No PMH of DVT/PE
- Strong FMH of DVT
  - Maternal GM, mother, sister
Additional Studies?

- Thrombosis Screen
  - Prothrombin mutation (20210G>A)
  - Factor V Leiden (1601G>A)
  - MTHFR mutation (677 C>T)

12/21/2017 15:05 MTHFR Mut
RESULT: HETEROZYGOUS POSITIVE for the 5,10-Methylene tetrahydrofolate reductase (MTHFR) 677C>T gene variant

INTERPRETATION: This patient carries one variant 677C>T MTHFR allele (NM_005957.4:c.665C>T, p.Ala222Val, rs1801133). While presence of this variant may predispose to mild hyperhomocysteinemia in the setting of suboptimal folate stores, in the absence of hyperhomocysteinemia the polymorphism on its own does not appear to be a significant risk factor for venous thromboembolism in most studies. Other risk factors for VTE are not excluded. Clinical correlation is recommended.
MTHFR, Homocysteine & Thrombosis

Folic acid → THF → Methionine → B12 → MTHFR → MTHF

Methionine → Cysteine

CBS → B6 → Thrombosis

Endothelial dysfunction → ?
MTHFR Mutation and VTE

- Hyperhomocysteinemia is independent risk factor for VTE
  - Endothelial dysfunction
  - Inhibition of fibrinolysis
  - Increased platelet reactivity
- MTHFR C677T mutation
  - Hyperhomocysteinemia if homozygous and ↓ folate
  - No to mild increased risk of VTE
  - No association with recurrent VTE
  - No increase in cardiovascular mortality
  - Routine testing not recommended for etiology of VTE
But...

- 19 yo AA male found dead in bed
  - Hypertension, obesity and sickle cell trait
  - CVT at age 16
    - Heterozygote MTHFR C677T without hyperhomocysteinemia
- Recurrent CVT at autopsy
- Recommend genetic testing for all fatal thromboses to determine true prevalence
CME Question 1

Which of the following is true regarding air guns?

A. The minimum velocity needed to perforate skin is less than that needed to perforate the eye
B. Muzzle velocities may exceed that of a semi-automatic pistol
C. Thousands of fatalities are reported each year
D. Air guns are appropriate for young children
CME Question 2

Which of the following is most helpful in differentiating stillbirth from live birth?

A. Acute chorioamnionitis/funisitis
B. Reddened skin with skin slippage and peeling
C. Expanded lungs
D. Air in the stomach
CME Question 3

Which of the following is true regarding Necrotizing Fasciitis?

A. It is slowly progressive
B. Patients typically present with localized painless erythema
C. It is a common complication of liposuction
D. It is most commonly caused by Group A Streptococcus