Autopsies for the Living: Forensic Pathology at Mayo Clinic

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Department of Laboratory Medicine and Pathology Grand Rounds
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Disclosures

Relevant Financial Relationship(s):

Peter T. Lin, M.D. none

The DLMP Grand Rounds Planning Committee members listed below declare that they have nothing to disclose in relation to this presentation:

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Elitza S. Theel, Ph.D. Joanne Yi, M.D.
Thomas Huntley Denise Skudlarek
Learning Objectives

Following this presentation, participants should be able to:

• Identify how forensic autopsies help the living (families, public health, justice, etc.).

• Distinguish between cause of death and manner of death.

• Describe some recent changes in the practice of forensic pathology at Mayo.

1. Which of the following is a competent underlying cause of death?

A. Sepsis
B. Hypoxemic respiratory failure
C. Pulmonary thromboembolism
D. All of the above
E. None of the above
2. Which of the following is not a manner of death?
   A. Accident
   B. Suicide
   C. Homicide
   D. Natural
   E. Undetermined
   F. Supernatural

3. How many board-certified forensic pathologists are practicing full-time in the U.S.?
   A. 50
   B. 500
   C. 5,000
   D. 50,000
   E. Too many
"The forensic pathologist occupies a unique position in the field of laboratory medicine. The major portion of his uniqueness derives from his case material and courtroom activity as he participates in the investigation and adjudication of unexpected, violent, and suspicious deaths. A rarely mentioned but important difference between him and his clinical counterpart (the hospital pathologist) resides in their relationship with and responsibility to the families and friends of the decedents who come within their purview.


Case Example
- 45 y/o man with hx of alcohol abuse
- Recently complained of epigastric pain
- Visited clinic and diagnosed with GERD
- Found unresponsive at home, decomposed
- Family initially objects to autopsy
Following day

- Autopsy performed
  - 250 ml hemopericardium
  - Ruptured aortic dissection
  - Dilated aortic root
- Cause of death: Ruptured aortic dissection...

Is that the end of the autopsy?

- What is the cause of the aortic dissection?
  - Hypertension?
  - Underlying connective tissue disorder?
    - Marfan, Loeys Dietz, FTAAD
  - Associated findings?
    - Bicuspid aortic valve? Enlarged heart? Nephrosclerosis? Trauma (recent or old)?
  - Toxicology?
    - Cocaine? Methamphetamine?
What needs to be done?

• Talk to family. Family history?
• Pending toxicology
• Histology of aorta
• Histology of heart and kidneys
• Review medical records
• Molecular genetic studies (if possible)
• Consultation with cardiovascular pathologist?
• Referral to genetic counselor?

Case epilogue

• Spoke with brother on day of autopsy
• Explained that mechanism of death was aortic dissection, aorta appeared dilated, pending tox

• Toxicology comes back positive for cocaine.
• Called brother to inform….
  • Having aortic root surgery the following week
Outline

• Overview of death investigation in the U.S.

• How to determine cause of death?

• What is the manner of death?

• Recent changes in SE Minnesota

Death of Julius Caesar, 44 BC
Coroner vs. Medical Examiner

<table>
<thead>
<tr>
<th>Coroner</th>
<th>Medical Examiner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usually lay person (MN requires medical license)</td>
<td>Forensic pathologist, board-certified</td>
</tr>
<tr>
<td>Elected</td>
<td>Appointed</td>
</tr>
<tr>
<td>Relies solely on law enforcement for investigation</td>
<td>Independent scene investigators with medical training</td>
</tr>
<tr>
<td>Autopsy performed by contract pathologist</td>
<td>ME performs autopsy directly</td>
</tr>
<tr>
<td>Coroner interprets report, issues death certificate</td>
<td>ME produces report, issues DC</td>
</tr>
</tbody>
</table>
2009 NAS Report

“Congress should authorize and appropriate incentive funds…to states and jurisdictions to establish medical examiner systems, with the goal of replacing and eventually eliminating existing coroner systems.”

“Strengthening Forensic Science In the United Stated: A Path Forward” by Committee of Identifying the Needs of the Forensic Science Community, Committee on Science, Technology, and Law Policy and Global Affairs, and the Committee on Applied and Theoretical Statistics Division on Engineering and Physical Sciences of the National Academies Press, Washington D.C.

Why has the U.S. not converted to ME death investigation systems?

• Complicated answer
  • No federal mandate
  • Long established coroner systems
  • Lack of funding
  • Insufficient numbers of forensic pathologists
    • 800,000 physicians in US
    • 20,000 pathologists in US
    • 500 forensic pathologists in US
Role of medical examiner office

- Certify cause and manner of death
- Investigate deaths (DSI, law enforcement)
- Perform autopsy and order ancillary studies
- Interpret findings
- Communication with families, law enforcement, physicians, attorneys, vital records, etc.
- Facilitate organ and tissue donation
- Testify in court

Uses of death certificate data

- Vital records (local, state, CDC)
  - Trends
  - Most common causes of death
- Public safety
  - Crime tracking data
  - Epidemics – infectious, overdoses
- Family
  - Closure of estate issues
  - Emotional closure
# Death certificate format

<table>
<thead>
<tr>
<th>PART 1</th>
<th>PART 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Immediate Cause</td>
<td>Other significant conditions contributing to death but not resulting in the underlying cause</td>
</tr>
<tr>
<td>b. Due to or as a consequence of</td>
<td></td>
</tr>
<tr>
<td>c. Due to or as a consequence of</td>
<td></td>
</tr>
</tbody>
</table>

# MANNER:

## Cause of death

“The initial disease or injury that started the chain of events leading to death”

- Usually a chronic disease
- Most infections have an underlying cause
- Must be etiologically specific
- No time limit between injury/disease and death
Sample Case

- Spinal cord injury with quadriplegia
- Decubitus ulcers
- Sepsis
- Remote gunshot wound

*complication

Death certificate

PART 1

a. Immediate Cause

Sepsis with decubitus ulcers

b. Due to or as a consequence of

Quadriplegia

c. Due to or as a consequence of

Remote gunshot wound with spinal cord injury

Other significant conditions contributing to death but not resulting in the underlying cause

PART 2

MANNER: Homicide
Sample death certificates

Too little information

<table>
<thead>
<tr>
<th>Cause of Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth</td>
</tr>
<tr>
<td>Due to or as a consequence of</td>
</tr>
</tbody>
</table>

Too much information

<table>
<thead>
<tr>
<th>Cause of Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia, severe respiratory failure, and discontinuation of LVAD support</td>
</tr>
<tr>
<td>Due to or as a consequence of</td>
</tr>
<tr>
<td>Community-acquired pneumonia, recurrent hypoxemia</td>
</tr>
<tr>
<td>Acute lymphoblastic leukemia</td>
</tr>
<tr>
<td>Chronic, restrictive, severe lung disease and LVAD explantation, and renal insufficiency</td>
</tr>
<tr>
<td>Other significant conditions:</td>
</tr>
<tr>
<td>Renal failure, chronic obstructive pulmonary disease,</td>
</tr>
<tr>
<td>LVAD-related, sepsis,</td>
</tr>
<tr>
<td>Cerebrovascular accident</td>
</tr>
<tr>
<td>Cardiac arrest,</td>
</tr>
<tr>
<td>Other causes of death:</td>
</tr>
<tr>
<td>Death due to</td>
</tr>
</tbody>
</table>

Clinical medicine vs. Death certification
Manner of death

Natural: 100% natural
Accident: unintentional, non-criminal act leading to death
Suicide: intent to take one’s own life
Homicide: “death at the hand of another”
Therapeutic complication: death due to therapeutic or diagnostic procedure
Undetermined: none of the above

Manner of death certification

• Not equivalent to legal determination
  • Homicide vs. justifiable homicide
  • Motor vehicle accidents
• Primarily for statistical purposes, but carries significant weight with families, courts
• Insurance policies
• Oliver Wendell Holmes, Jr:
  • “The life of the law is not logic; it is experience”
An autopsy is not a laboratory test that produces "cause of death" as a result.
Death certificates are not written in stone

Undetermined cause / manner of death

<table>
<thead>
<tr>
<th>Cause</th>
<th>Manner</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undetermined</td>
<td>Undetermined</td>
<td>Criminality suspected or Asphyxia suspected or Infant deaths (SIDS, SUDC, SUDEP)</td>
</tr>
<tr>
<td>Undetermined</td>
<td>Natural</td>
<td>More likely to be cardiac arrhythmia-related</td>
</tr>
<tr>
<td>Undetermined</td>
<td>Homicide</td>
<td>Eg. Skeletonized remains in car trunk</td>
</tr>
<tr>
<td>Known</td>
<td>Undetermined</td>
<td>Accident vs. suicide</td>
</tr>
</tbody>
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Postmortem genetic testing

- Approximately 30% mutation yield rate for sudden unexplained death with “negative autopsy”
- Variants of uncertain significance
- Autopsy findings of uncertain significance

Class of findings*

- Class 1: Incompatible with life (~5%)
- Class 2: Probably lethal (~60%)
- Class 3: Possibly lethal (~20%)
- Class 4: Non demonstrable (~10%)
- Class 5: Undetermined (~5%)

How to solve this problem?

• More data – esp. phenotypic data

• More autopsies

• More genetic testing

• Standardization in death investigation, death certification, and autopsy practices

SUDC Research Consortium

• Registry of sudden childhood deaths

• Adjudicated review
  • 2 independent reviews of each case by forensic pathologists
  • Adjudication procedure if disagreement
  • Subspecialty reviews: cardiac and neuro

• Whole-exome sequencing
Recent developments in SE Minnesota

• Growth of SMRMEO
• NAME Accreditation
• Office of Decedent Affairs
• Religious objection law
• Emerging infectious diseases
• Mass fatality planning
Full NAME Accreditation (2015-2020)

Office of Decedent Affairs

- Located within Pathology Department
- Responds to all hospital deaths
- Handles communication with family
- Consent for autopsy
  - doubling of hospital autopsy rate since implementation of ODA
Religious Objection Law

- Instances of failure by ME/Coroner to accommodate religious and cultural practices after death

- Sets limits on when forensic autopsy can be performed over a religious objection.
- 24 hour hold to allow notification of families
- Notification of right to object based on religion
Mass fatality training

Mass fatality management

• Manifest
  • Open or closed

• Family assistance center
  • Antemortem data
  • Communication

• Identification and return of bodies
  • Evidence collection
Emerging Infectious Diseases

- HIV
- Hantavirus
- West Nile Virus
- Novel H1N1 influenza virus
- Ebola
- CDC-MDH Unexplained Death Program

Pulmonary pathology in 2009 H1N1 pandemic

Value of autopsy as surveillance method for emerging infections and new therapies

1) Provides tissue not easily available through biopsy for understanding pathogenesis

2) Able to reach populations not encountered in typical healthcare settings (homeless, drug abuse, young and healthy, etc.)

3) Understand the role of co-existing diseases as contributory factors
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