

Chapter 1

The “Complete Autopsy”

The Management of Risk

Summary

Many medicolegal death investigations rely on information derived from autopsies. The success of an autopsy in answering questions (e.g., identification, injury causation) depends on a systematic approach by the pathologist. The “complete autopsy” is a series of necessary steps taken by the pathologist, who receives background information about the deceased, performs an external examination and internal dissection, and collects appropriate bodily samples for supplementary testing. The care exercised by the pathologist in this process is reflected in an accurate autopsy report, which addresses the most important question—the cause of death. The pathologist must be aware of potential pitfalls at every step of the postmortem investigation, any of which can pose a risk to the final resolution of a medicolegal investigation.

Key Words: Forensic pathology; autopsy; risk management.

1. INTRODUCTION

A pathologist is a medical specialist who has the unique training and experience to acquire and apply knowledge from an autopsy (1). Death is not the end of a physician–“patient” relationship. A pathologist has an ethical obligation to reliably ensure that the medical observations and conclusions, based on autopsy findings and other information, are valid and do not breach the trust or confidence of family, caregivers, the community, and society (1–5).

A major focus of any autopsy is the determination of the cause of death (i.e., why did the person die?). This allows the certification of an individual’s death (2,6,7). A “hospital” autopsy (i.e., an autopsy done with the consent of a deceased’s family members or a legally authorized representative) has other broader objectives, such as the study of a disease process, an audit of the effectiveness of therapy and accuracy of diagnostic

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By: M. J. Shkrum and D. A. Ramsay © Humana Press Inc., Totowa, NJ

procedures, clinicopathological correlation, education of health care professionals, and subject to ethical considerations, research (2,6,8–14). A “forensic” or statutory medicolegal autopsy also addresses these objectives, but a pathologist must be able to answer other questions, that is the five “Ws” (Table 1) (15).

Forensic pathology is the study of how diseases cause sudden and unexpected death and how external agents or forces cause fatal injury (4). Autopsies do improve the accuracy of death certificates and vital statistics (2,12,14,22,26–28). Clinical studies have shown that at least 10% of deaths have a major pathological diagnosis that, if it had been detected during life, might have resulted in survival with appropriate medical treatment (6,14,29–33).

An autopsy is an essential component of many medicolegal death investigations. The pathologist must have the necessary training and/or experience to answer the challenges posed by such investigations (13,34). To maintain a high standard of practice in forensic pathology, a pathologist must participate in peer-review, self-evaluation, and continuing education programs (33). Professional competence is a part of quality assurance—i.e., the structure and systematic actions necessary to provide adequate service with accurate results (1,6,35). In dealing with issues arising from an injury case, pathologists must have a fundamental understanding of trauma pathology (36). Hirsch commented that, “too many pathologists think that the pathology of trauma is simple. Such pathologists fall into one of two groups: those who have not seen traumatic pathology and those who have not thought about what they have seen” (36).

2. THE COMPLETE AUTOPSY

A pathologist does not work in isolation. A complete autopsy requires the integration of information from various investigative sources occurring in stepwise progression (Fig. 1) (4). This systematic approach usually reaches successful conclusions regarding the cause of death, the pathophysiological mechanisms or terminal events leading to death, and the manner of death (13,22,37). Communication among the different investigators is essential (13). Deviations from the standards of investigative practice, either by omission or commission, increase the risk of failure of a medicolegal death investigation. The time period of death investigation varies depending on the circumstances. For example, a suspicious death involving unidentified skeletal remains may remain “open” indefinitely.

3. THE PSYCHOLOGICAL AUTOPSY

The use of the “psychological” autopsy can assist in the determination of the manner of an unnatural death when the circumstances are equivocal (37–43). This approach is useful in cases of suspected suicide when initial information is limited. Interviews with family, friends, co-workers, physicians, and others by investigators provide insight into the deceased’s state of mind and behavior in the past, and in the period preceding death. This will assist in analysis of an individual’s suicidal intent (see Chapter 3, Heading 14 [44]).

4. THE SCENE (“WHERE?”)

4.1. “Dead at the Scene”

Not examining a body at the scene has been considered a potential pitfall for the pathologist in a medicolegal death investigation (15,23). Scene visitation is not always

Table 1
Autopsy Authorization and the Five “Ws”

	Hospital autopsy	Forensic autopsy
Authorization (13,16–21)	Usually by appropriate family member or legally authorized representative	Mandated by statute. Depending on jurisdiction—coroner, medical examiner, or other legal authority
“Why”?—The cause of death	A major focus	A major focus
“Under what circumstances?”—The manner of death (2,6,8,13,22)	Natural death, i.e., caused by disease and/or age	The cause of death can assist in assigning a manner of death Natural <ul style="list-style-type: none"> • A sudden and unexpected death from disease • Any disease that could account for death and was unattended by a physician Accident <ul style="list-style-type: none"> • A death from an unintentional and unpredictable event/act Suicide <ul style="list-style-type: none"> • A death from a self-intentional act Homicide <ul style="list-style-type: none"> • A death from the harmful intentions of another Undetermined <ul style="list-style-type: none"> • A death in which there is insufficient or incomplete information to determine the manner (e.g., conflicting versions of events leading to death, skeletal remains)
“Where?”—The scene (2,10,23)	Hospital Other health care facilities Home (rarely; chronically ill person under palliative care and no suspicions regarding the circumstances of death)	Anywhere The medicolegal investigation may have to consider more than one scene—where the body was discovered, where the individual was actually injured/died and subsequently moved, where he/she was last seen alive
“Who?”—Identification (2,13,20,24,25)	Usually known Confirmed at autopsy by <ul style="list-style-type: none"> • Hospital bracelets (wrist, ankle) 	Investigation of death in health care institution, identification as for “hospital” autopsy

(Continued)

Table 1 (Continued)

	Hospital autopsy	Forensic autopsy
	<ul style="list-style-type: none"> • Tags (body bag, toe) • Review of medical records 	<p>Presumptive</p> <ul style="list-style-type: none"> • Visual identification. • Clothing and personal effects. • Circumstances (e.g., sole occupant of a locked apartment). • General physical features (age, race, sex, height) <p>Confirmatory—i.e., comparison of unique antemortem/postmortem information</p> <ul style="list-style-type: none"> • Fingerprints • Dental examination • Radiology • Specific physical features (e.g., cutaneous findings such as tattoos, scars, previous surgery, deformity) • DNA
“When?”—Time of death (see Chapter 2)	<p>Pronouncement of death in medical setting</p> <p>Exact time if witnessed, e.g., during resuscitation</p>	<p>Exact time if reliable witness</p> <p>Unwitnessed death → assessment of certain postmortem changes (rigor mortis, livor mortis, temperature, decomposition) can assist in estimating time of death</p>

necessary or possible for a pathologist conflicted by other duties. Death scene and witness information from different investigators (coroner, medical examiner or investigator, police, fire marshal, etc.) can be communicated to the pathologist by various means (diagrams, photographs, video and digital images) prior to the autopsy (13,23).

If called to the scene, the pathologist needs to document where the death occurred, who was present, and when the scene was attended. At the scene, the pathologist’s focus must be on the deceased and the surroundings relevant to cause of injury and death (e.g., blood stain on a surface, medications, medical paraphernalia, etc.). Investigators can question family and witnesses about medical, psychiatric, family, and occupational history. If an individual had been hospitalized previously, hospital charts must be obtained through a formal medicolegal request. Note is made of any resuscitation efforts that could have created artifactual injuries (see Chapter 3, Subheading 2.6. and Chapter 8, Subheading 6.2.). Information about the deceased’s position and observable postmortem changes needs to be documented (13). The body must not be moved prematurely. Premature or inappropriate removal of a body at the scene compromises the assessment of the relation of certain findings to the surroundings, including postmortem changes used to assess time of death; affects the collection of evidence; raises issues about the presence and integrity of certain personal effects and clothing; and potentially causes

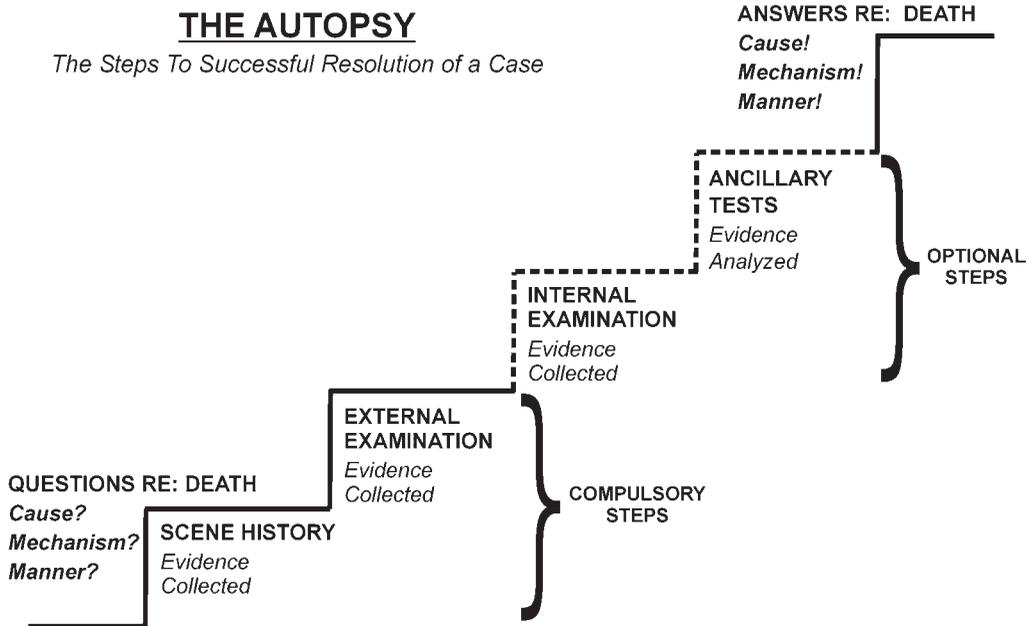


Fig. 1. The autopsy. The necessary investigative steps to successfully resolve a medicolegal death investigation.

postmortem artifacts. Any initial manipulation of the body is confined to the recovery of trace evidence (e.g., hair, fibers) that could be lost during transport, a search for means of identification, and an overview of injuries (13,23). Evidence must be preserved by using a sealed body bag if the death is suspicious. Detailed examination is deferred until the actual examination of the body in the autopsy facility.

4.2. Rushed to the Hospital

The immediate cause of death (i.e., the fatal condition closest to the time of death in a hospitalized trauma patient) can be from natural causes (e.g., pulmonary thromboembolism; *see* Chapter 8, Subheading 12.3.). The individual is predisposed by the antecedent or “proximate” cause of death—i.e., the underlying factor (e.g., multiple injuries) that initiated an uninterrupted series of pathophysiological events culminating in death (i.e., the “mechanism”—hypercoagulability and venous stasis from immobilization; *see* Heading 11. [20,22]).

In the situation of the delayed death of a hospitalized individual from natural causes owing to trauma, the pathologist must recognize the following:

- These cases require medicolegal investigation, which may not have been apparent to the clinical team, and the coroner or medical examiner must be notified.
- Well-recognized complications leading to death (immediate causes of death) arise during the clinical care of trauma victims and are similar to those arising in the course of a disease (36).

Delayed trauma deaths, particularly in an intensive care setting, can result in voluminous charts requiring time and care when reviewed by a pathologist prior to the autopsy. A cursory perusal jeopardizes the approach required during the postmortem

examination to answer clinical questions and satisfy the needs of a medicolegal investigation. Patience is needed when dealing with disorganized charts, and any missing records need to be found. The pathologist must be able to not only decipher but also appreciate the significance of the “alphabet soup” of complications arising from trauma.

4.3. Some Complications During Intensive Care

The clinical picture of adult respiratory distress syndrome (ARDS) is characterized by progressive respiratory failure that onsets within a few hours of an abnormal stimulus (45). Hypoxemia requiring intubation, decreased pulmonary compliance, and bilateral chest radiograph abnormalities in the absence of congestive heart failure are typical of ARDS (46). Trauma can either independently cause ARDS by triggering an inflammatory reaction or requires the mediation of other risk factors (e.g., shock).

Diffuse alveolar damage (DAD) is a nonspecific pathological lung reaction occurring in different situations (e.g., pneumonia, aspiration, sepsis, shock, trauma, fat embolism, burns, near-drowning; see Chapter 3, Subheading 3.4.; Chapter 4, Subheading 5.2. and Table 1; Chapter 5, Subheading 4.4.; and Chapter 8, Subheading 12.1. [46]). In DAD, inflammatory cell mediators damage alveolar endothelial cells and pneumocytes, resulting in an exudative phase within the first week, characterized by heavy, red edematous lungs at autopsy (45). Microscopic examination reveals precipitation of fibrin membranes (hyaline membranes) in the alveoli, mononuclear cell inflammation in the interstitium, platelet and fibrin microthrombi, and, toward the end of the first week, proliferation of type II pneumocytes. This is followed by an organizing phase during which fibroblasts proliferate in the interstitium and alveolar spaces. There is either eventual resolution or progressive scarring, leading to “honeycomb” lungs.

Systemic inflammatory response syndrome (SIRS) is characterized by hyperthermia or hypothermia, tachycardia, tachypnea, and an elevated or decreased white cell count, mimicking a septic picture (47,48). SIRS results from a systemic activation of an immune response to various infectious and noninfectious processes or diseases associated with tissue hypoperfusion (e.g., infection, trauma, burns). Inflammatory mediators can be demonstrated in the circulation (e.g., C-reactive protein) (49).

Multi-organ failure (MOF)/multiple organ dysfunction syndrome (MODS)/multiple organ failure-syndrome (MOFS) is a possible consequence of SIRS. The typical scenario is that of a multiple trauma patient who is treated for shock but develops MOF days to weeks later (50,51). MOF is implicated in more than 60% of delayed trauma deaths (52). One theory of pathogenesis proposes that release of endogenous gastrointestinal bacteria or their products from an ischemic gut into the circulation results in a septic picture, but positive cultures during the clinical course may be a consequence, not a cause, of organ failure (51,53). Despite the septic picture, no infectious focus is found at autopsy (53). Postmortem blood cultures rarely provide information that was not already known during the clinical course (54). A false-positive blood culture is either the result of contaminants introduced during the obtaining of the specimen at autopsy or agonal bacteremia, particularly if there is an increased postmortem interval (54).

Frank hemorrhage in the background of normal coagulation parameters and platelet count means that the bleeding is potentially corrected by surgery. Disseminated intravascular coagulation (DIC) is the activation of blood clotting owing to endothelial and/or tissue damage from various nontraumatic and traumatic causes (55). There is

consumption of platelets and coagulation factors leading to a bleeding diathesis. Blood oozing from cutaneous puncture sites, incisions, and an operative bed, associated with cutaneous purpura/ecchymoses and patchy visceral hemorrhages (e.g., brain, kidneys, gastrointestinal tract, lungs), suggests a coagulopathy. Concurrent widespread ischemic changes result from platelet–fibrin thrombi in various organs. Fibrinolysis and heparin therapy cause thrombi to disappear so that they are not seen in microscopic sections.

Massive transfusions can lead to coagulopathy (56,57). Packed red blood cells have no functional platelets and decreased levels of certain coagulation factors (V, VIII). Clotting ability is also reduced by hemodilution from a small amount of solution in the transfused-packed red blood cells and platelets. Clotting factors are further diluted by fluid shifts from the interstitium to the intravascular compartment as a result of blood loss. Hypothermia reduces enzyme activity in the coagulation sequence. Decreased body temperature results from emergency transfusion of cold blood and intravenous fluids, diminished heat production by reduced muscular activity, and increased heat loss by immobilization anesthesia. Acidosis caused by tissue hypoperfusion and exacerbated by transfusion of older stored blood decreases platelet function and clotting.

5. IDENTIFICATION (“WHO?”)

Accurate identification of an unknown individual or human remains is essential for the following:

- Notification of family to allow for emotional closure, settlement of estates and insurance claims.
- Completion of official records (e.g., death certification, closure of police records).
- Medicolegal investigation to allow questioning of potential witnesses and known associates of the deceased.
- Criminal and civil legal proceedings (6,25).

Misidentification can lead to the following:

- An unauthorized autopsy being done on the wrong body.
- Release of a wrongly identified body to a family and consequent emotional distress and administrative delays.
- Wasted investigative efforts.
- Jeopardized legal proceedings.

Misidentification arises from incomplete, inaccurate, or misleading information. The problem is compounded in a high-volume autopsy facility where the haste to complete cases can lead to the misreading of identifying labels.

Visual recognition by someone who knows the deceased is presumptive but suffices in most cases. Viewing of a body is either at the death scene or in the autopsy facility (6,13). If done at the scene, then information about the identification (e.g., identification bracelet) must be conveyed to the pathologist. Failure to provide this information may require visual identification by the police scene investigator or coroner/medical examiner to the pathologist prior to commencement of the autopsy. Added stress is placed on a family member asked to repeat a viewing. The body removal service sometimes assists in the identification. If a person has been hospitalized, then institutional bracelets identify the deceased.

Depending on the circumstances and nature of the scene, viewing in a morgue may be preferable because of better lighting, ventilation, and security. Viewing in a separate

room outside the main body storage area provides the necessary privacy for the identifier(s) and does not disrupt the normal work flow in a busy facility. Viewing can occur before or after the postmortem. Autopsy personnel prepare the body and make the face “presentable,” i.e., clean off blood and debris (58). Reconstructing a badly injured face may be necessary. Before the face is cleaned or altered, the pathologist must accurately document any findings that could be changed. The pathologist assesses whether the face is not viewable because of decomposition, charring, or massive trauma. If part of the face is not presentable because of trauma, then it can be covered by towels when the body is viewed.

Use of photographic images of the face is an alternative to direct viewing. In such cases, use of a photographic image requires appropriate angling to minimize the adverse emotional effects of an injury (25). The person who identifies the deceased must be accompanied by appropriate personnel. A body-viewing protocol can involve autopsy facility staff, nurses in a hospital, social workers, pastoral care providers, police officers, and coroners/medical examiners. Even when the body of the deceased is preserved, stress sometimes causes the identifier to provide a false-positive or -negative identification. Emotions at the time of viewing cloud perception. Recognition is difficult because the face of the deceased is expressionless. Denial or fatalistic acceptance by the identifier compounds the problem. Rarely, an individual is deliberately misidentified for fraudulent purposes (e.g., concealment of crime, false insurance claim). Viewing of a body for reasons other than identification (e.g., emotional closure, culture, religious practice) is preferable at a funeral home, but use of the autopsy facility may be the only option.

The documentation of clothing and personal effects is another presumptive means of identification. Clothing may be distinctive. An accurate description of the deceased’s clothing provides emotional consistency for a family member who last saw the individual alive. Personal effects can be deliberately switched or planted to mislead identification efforts. Clothing and personal effects may have already been removed or altered at the scene (25). A listing of jewelry items and examination of wallet contents at the scene or in the autopsy facility are necessary steps in the identification process. The pathologist must record clothing and personal effects in the autopsy report. A protocol that outlines items released to police or a funeral home reduces accusations of theft or loss.

Confirmation of identity is required when:

- No one is available to visually identify the deceased.
- Presumptive means of identification (viewing, clothing and personal effects, circumstances) are ambiguous in an otherwise intact body.
- The deceased is not identifiable by presumptive means because of decomposition, charring, skeletonization, or extensive trauma.

Confirmation of identity is by comparison of postmortem findings with ante-mortem records (Table 1). Various sources of information (e.g., police files including fingerprint records and missing person reports, dental records, medical and other health care files, radiographs, laboratory records and samples, employment and military records) are used.

6. *EXTERNAL EXAMINATION*

The ability of a pathologist to observe, document, and interpret the significance of external injuries is fundamental to forensic practice (13). The emphasis on the external

examination distinguishes a medicolegal (forensic) autopsy from a family-authorized postmortem (hospital autopsy [13]). Inaccurate or incomplete documentation of external findings is a potential pitfall for the pathologist (15).

A cursory external examination with a focus on the internal dissection to determine cause of death provides little insight into how fatal injuries originated. A cutaneous injury can provide an important clue as to the cause of death. In most instances, skin injuries themselves have no significant pathophysiological effects, but their documentation provides investigative information about what caused those injuries, fatal or nonfatal. If an injured person is hospitalized, then the pathologist must review any medical records, noting resuscitative efforts and any therapeutic and diagnostic procedures that could alter an injury or create external and internal trauma (*see* Chapter 3, Subheading 2.6.; Chapter 8, Subheading 6.2.). Perusal of a hospital chart may provide little solace for a pathologist searching for a detailed description of external injuries. Medical efforts in a clinical setting, particularly when dealing with a severely injured patient, are directed to life-threatening trauma. Relatively little attention is given to cutaneous injuries. Health care personnel usually do not have the expertise to interpret external injuries (e.g., firearm injuries; *see* Chapter 6, Heading 17.). The pathologist must not ignore seemingly trivial injuries that may have medicolegal importance. Failure to note details can undermine the credibility of the pathologist during the investigation and any eventual judicial proceedings.

Various methods of documentation are used to provide an effective record. Narrative descriptions can be too lengthy. If injuries are not described in continuity, then the report is difficult to follow. Word descriptions are enhanced by use of body diagrams (“a picture is worth a thousand words” [59]). A diagram also provides an overall impression of the extent of injuries, emphasizing their severity (20). Diagrams help in the interpretation of photographs. Diagrams can be used as demonstrative evidence in legal proceedings instead of photographic images that may be too graphic for jurors (20,59). Photographic images assist investigators, other experts, and the court in understanding the findings in a case (2,20,59). Although images are not part of the pathologist’s report, they do provide a visual record that assists in the preparation of the report (20,59). Photographic images are not a substitute for a carefully prepared, accurate report. A pathologist must either take or supervise the taking of an adequate number of good-quality images, and be able to state that those images accurately portray the observations made at autopsy (20,59). In a criminally suspicious case, the pathologist must disclose in the autopsy report that photographic images are available, because this information is evidence.

6.1. Photography During External Examination of Cases With Potential for Legal Proceedings or for Education

- If the administrative and legal framework exists, a pathologist may be requested to examine injuries prior to death (e.g., in an intensive care unit) with the assistance of a police identification officer providing photographic documentation.
- If a hospitalized trauma patient’s death is expected but delayed and the case is under police investigation, then the police, with proper authorization, may take images of evolving external injuries to assist the pathologist.
- The pathologist needs to view images (print, digital, video) taken by police of the scene in certain cases (e.g., “suspicious” deaths, homicides, industrial accidents).

- If the body is sealed, then an identification officer may photograph seals on cooler doors and body bags.
- If images are to be used for educational purposes or other demonstrations, then the face must be masked and genital areas covered.
- Photograph the face, before and after cleaning, for injury documentation and identification (*see* Heading 5.).
- Attempt to crop unwanted details (e.g., pools of blood, gloves, instruments, glare from the autopsy table) from the background of any image.
- Photograph the body overall with clothing.
- Photograph the body overall as various layers of clothing are removed, avoiding cutting or tearing, and noting any defects and foreign material (13).
- Attempt to correlate any defects with observed injuries (13).
- Clothing that is damp from water or blood needs to be examined after it has dried.
- Photograph the unclothed body (front and back) overall, making note of resuscitation and other medical procedures (59).
- Focus on certain findings—foreign material, identifying features, and injuries (59).
- Take photographs of injuries before and after cleaning to ensure that certain features (e.g., bloodstain patterns) are not lost (59).
- “Negative” findings (e.g., lack of injuries on hands) need to be documented (59). Avoid fingerprinting until the hands have been examined.
- Images, particularly close-up views, require a scale with the autopsy accession number (either a straight or L-shaped American Board of Forensic Odontology ruler [59]).
- The scale needs consistent orientation (e.g., scale occupies the more inferior part of the body in the image), particularly in close-up views (59).
- Close-up images can be oriented by including an anatomical landmark. If a landmark is not seen in the close-up, then an overall image is done.
- If separate sets of images are taken by the pathologist and police, review the latter for content and orientation, particularly if legal proceedings are likely.
- The pathologist must realize that a personal collection of autopsy images can be used as evidence.

6.2. Autopsy Limited to External Examination Only

Family objections to dissection may necessitate only an external examination, provided that the medicolegal investigation is not compromised (*see* Heading 7. and refs. 8, 13, 19, and 60–62). An investigating medical examiner or coroner can limit the post-mortem examination to an external examination only, based on adequate background information (63). Certain types of cases (e.g., suicidal hanging, massive trauma) may be suitable for this type of examination. One study showed that the large majority of trauma deaths assessed in emergency departments had unsurvivable injuries. Misdiagnosis at this stage had no bearing on the clinical course (64). A well-documented clinical course (e.g., motor vehicle collision victim), supplemented by diagnostic procedures (laboratory tests, radiology), provides enough information, although internal trauma has been missed in hospitalized patients (14,62,65). Alternatively, an internal examination is essential for a proper medicolegal death investigation, if a cause of death is not apparent (66). Some presumed natural deaths are uncovered as unnatural following an autopsy (67–71). The converse also occurs (63,67,69,70). Studies have compared the accuracy in the determination of cause and manner of death based on initial history and external examinations, which were then supplemented by an autopsy

(63,67,68). The cause of death was accurate in the large majority of unnatural deaths, mostly accidents, in one review (63). In contrast, about one-third of natural deaths had an erroneous assigned cause of death not supported at postmortem (63,68). Another study revealed that certain injuries (e.g., skull fractures) were not appreciated by external examination only (67). The determination that death is a consequence of trauma is very important in criminal investigations, work-related compensation cases, and insurance claims (37,72).

The use of radiology to determine a cause of death, including death in trauma cases, has been described (24,60,73–81). Postmortem radiology is helpful in the detection of injuries (*see* Chapter 5, Subheading 14.8.; Chapter 6, Heading 16.; Chapter 7, Heading 9.). The disadvantages of the use of sophisticated radiological techniques are the cost and the availability of equipment and radiologists to provide opinions.

7. INTERNAL EXAMINATION

If there is a death in a clinical setting that does not require medicolegal investigation, then a pathologist, in most jurisdictions, may proceed only with an autopsy that has been authorized by the family or appropriate legal representative (10,18,60,62,82). The request for the autopsy, including internal examination, is initiated by either the family or a physician. Unless there is direct contact with the family, the pathologist relies on a health care professional, usually a physician, to obtain the appropriate informed consent for an autopsy (2,8,10,12,21). The health care professional who interacts with the family members must be aware of their perspective, understand the value of a postmortem examination, and appreciate the institutional process related to the autopsy (2,30). The hospital may provide information pamphlets to next of kin to assist them in understanding the process (2).

The number of hospital autopsies with consent has declined. From 1972 to 1992, the percentage of hospital deaths autopsied with consent decreased to less than 10% in the United States (6). Certain trends or perceived barriers have accounted for the decline. Some of these are:

- A certain percentage of hospital deaths having autopsies is no longer required for institutional accreditation (6,30,83).
- Advances in diagnostic tests lessen the need for autopsies (2,6,30,84).
- Some pathologists are ambivalent about performing postmortems for various reasons (e.g., professionally unrewarding in terms of income, advancement, and educational value; distaste regarding autopsy procedures; fear of infection; perceived lack of sophistication of autopsy pathology; low clinical interest; isolation from other colleagues [1,6,14,30,83]).
- The perception exists that family emotions around the time of death prevent obtaining an autopsy consent (9,14,21,85).
- There may be negative perceptions of the autopsy by the family (the patient has "suffered enough" [14]).
- Other family members may object to the autopsy (83).
- Lack of communication between physicians and family about postmortem results may exist.
- The decreased teaching of pathology to health care undergraduates means that fewer professionals in the future will have the knowledge and training to properly inform families about the nature and benefits of the autopsy (1,2,6,8,9,12,14,21).

Beyond its scientific and educational benefits, the autopsy assists families during bereavement (2,58,85,86). Emotional closure is possible when the cause of death is known. Suspicion and guilt are allayed when reassurance is given that medical care was appropriate (1,9,14,85,87).

During a 20-yr study period, the overall percentage of deaths in the United States having a medicolegal postmortem held steady at about 5% (6). Statutory obligations dictate that certain deaths are investigated, and many of these cases require an autopsy (60,62). During a medicolegal death investigation, the investigator has temporary proprietary rights over the deceased until the body is released to the family (16,21,88). The pathologist acts as a consultant to a coroner or medical examiner if an autopsy is ordered (8,13). The nature of the jurisdiction dictates what percentage of investigations need an autopsy (e.g., increased if there is a high homicide rate). The barriers to the performance of hospital autopsies also exist for medicolegal cases (62). The pathologist relies on the ability of the coroner or medical examiner to explain to a family the nature of and necessity for an autopsy. Although concerns and objections are overridden by statute, a coroner/medical examiner and pathologist still must address them (62). Studies have shown that next of kin are more receptive to the performance of a medicolegal autopsy if the cause of death is unknown or uncertain, there is a suspicion of a crime, ambiguities regarding a life insurance claim are removed, and information about the necessity of an autopsy was communicated (12,58,83).

7.1. The Limited Autopsy

In the clinical setting, family authorization for a complete autopsy allows for examination of all body cavities, dissection of all body organs, retention of tissues and fluid for microscopic examination, and other testing for the determination of pathological diagnoses that point to a cause of death (2,14). The family can ask that the autopsy be restricted to the examination of certain organs and cavities.

In forensic practice, complete autopsies are the ideal, but postmortem examinations can be limited or modified. A high-volume practice and few experienced professional and support staff can limit the completeness of an autopsy (20). Bodies repatriated from other countries may have only body incisions without evidence of further dissection (89). Certain steps are followed to satisfy religious requirements (e.g., *in situ* examination of organs and return of fluids to the body of a deceased of the Orthodox Jewish faith [60]). A medicolegal autopsy may be limited to finding only the cause of death to facilitate timely body release, particularly with pressure from funeral directors, and to allow prompt completion of reports. Limiting the autopsy, however, can cause findings that contribute to the injury causation to be overlooked (e.g., undiagnosed brain tumor contributing to a motor vehicle collision) or fail to answer other questions unrelated to trauma (90).

Endoscopy has been used as an autopsy technique (91,92). Needle insertion (e.g., cisternal tap to rule out subarachnoid hemorrhage) has been done but assumes the bleeding is not artifactual (60).

7.2. Organ Harvesting

For a family of a hospitalized, severely injured patient, the option of organ donation may be offered. This provides emotional closure for the family by reconciling them

to the fact that their loss will do some good (93). A medicolegal investigation, particularly into a criminally suspicious death, takes precedence over organ donation (94). Although pressure by family and the transplantation service may be applied, there must be assurance that harvesting does not compromise the collection of evidence (e.g., toxicology specimens), the documentation and interpretation of injuries, and the determination of the cause of death (95–98). Communication among police, medical examiner/coroner, medical staff, transplant team, and pathologist is essential (94,99). Isolated injuries (e.g., head trauma) allow for both organ donation and a limited autopsy. Radiographic examinations and other testing (e.g., echocardiogram) can rule out other trauma. In addition to conducting the autopsy, the pathologist may be asked to examine the eyes prior to removal of corneas, provide an intraoperative consultation for harvested organs, and examine organs not used for transplantation (95). If the pathologist does not attend the operating room during organ harvesting, then the attending surgeon must confirm that any removed organs did not show injuries (94).

7.3. Organ Retention

There are varying amounts of tissue retained from an autopsy. At one end of the spectrum, the final report is based only on the “gross” or external findings (e.g., massive trauma). The sampling of tissues used to prepare microscopic slides and storage of representative tissue in formaldehyde (“stock material”) is not done in these cases. In contrast, whole organs and *en bloc* specimens are kept for review, particularly if legal proceedings are a possibility.

Depending on the jurisdiction, relatives do have proprietary rights over the deceased that allow certain postmortem procedures (e.g., burial) to proceed (16,17,88,93,100–102). In the United Kingdom, parents’ anger, expressed during the Bristol inquiry, about the postmortem retention of their children’s organs prompted the Royal College of Pathologists (RCPATH) to reassess its policies regarding organ retention in hospital-consent and medicolegal autopsies (17,21,101). Similar issues have arisen in Australia (2). There is a varying degree of public and professional awareness of this issue in other jurisdictions.

The RCPATH has proposed guidelines pertaining to tissue retention:

- Retention must be lawful—i.e., it must not contravene statute or breach a common-law tenet (e.g., obscene display).
- The reasons for organ retention must be defensible, open, and justifiable in law and clinical practice (7,8).

A hospital-authorized autopsy requires an informed relative’s agreement and gives a pathologist permission for organ and tissue retention for diagnostic, educational, and research purposes (2,7,18,101). A medicolegal autopsy can override a family’s objections because of the circumstances of the death (2,21). Nevertheless, there are constraints on retention in both types of autopsies (14). The need for retention to establish the cause of death is justified and hopefully accepted by next of kin (7,103). In some cases, the pathologist retains an organ that, in retrospect, does not assist in the determination of the cause of death (e.g., brain, if “no anatomic cause of death” at autopsy [101,104]). Families are more receptive if they are aware of the other benefits of the autopsy (8). The pathologist must be discreet in the use of tissues and images for rounds and other educational purposes (21). Depending on a relative’s perception of research,

there may be no objection to the use of excess tissue normally removed for diagnostic purposes (12,14). Ethical approval is still required (2). In cases in which research is centered on use of tissue beyond what is customarily removed (e.g., spinal column), then special permission from a family member is needed (21). In forensic cases, permission from the head of the medicolegal jurisdiction (chief coroner, chief medical examiner) and family may be required to use any material for education and research, which are outside the scope of the death investigation (7,14,17,18,105).

- Another guideline proposes that, unless the postmortem examination is directed by law, autopsy procedures must be sufficiently flexible to reflect the wishes of relatives while maintaining the standards of diagnostic accuracy (7).

Prohibition of tissue and organ retention may mean an inadequate postmortem examination (7,21). A pathologist, under these circumstances, could decline to do the autopsy (103). There should be latitude to allow organ retention, if there are unexpected findings (7). Adoption of these proposals means an increased administrative burden on already busy autopsy services (21).

- The RCPATH also proposes that, if an autopsy is directed by law, where possible and practicable, the relatives should be fully informed before the examination of what is to be done and its purpose (7).

The pathologist should inform the coroner or medical examiner about retention of an organ (2,7,21,103). This information needs to be conveyed to the family (17). A family may attach symbolic, religious, or cultural significance to certain organs (e.g., brain), but this may not necessarily apply to representative tissue samples for microscopy (2,8–11,14,17,19,21,83,101,106,107). Brain retention is necessary to determine the cause of death in many trauma cases (7,17,103).

Issues regarding the means of tissue disposal (e.g., incineration) and duration of organ retention may arise (7). Relatives may request the return of an organ to the body or a separate burial by the funeral director; however, if legal issues regarding injury and death causation arise pertaining to that organ, then retention is required until the matter is resolved or adjudicated (7,13,94,103).

8. TESTS

8.1. Microscopy

Study of microscopic sections is the most common test that a pathologist does. Microscopy is an audit of the reliability of the interpretations made during the dissection (7). Not all forensic autopsies require microscopy, but the criteria are vague and rely on the discretion of the pathologist and the nature of the case (6,13,20,35). Selective sectioning, instead of routine sampling of all organs, can decrease the time to report a case (11,14,108). Without microscopy in certain trauma cases, pathological diagnoses bearing on the cause of death cannot be determined (e.g., traumatic axonal injury). Depending on the circumstances of death, unprocessed formalin-fixed tissue is kept for a finite period and then disposed. Glass slides and paraffin blocks are part of the medical record and are archived (7,21). If required in a legal proceeding, slides must be available for review by other pathologists to allow confirmation or revision of the original findings (6,21,103).

8.2. Other Specimens

The recognition and collection of evidence is an important part of forensic pathology practice and distinguishes it from a hospital-consent autopsy (6,13,20). Toxicological analysis assists in the determination of the cause of death in certain cases (e.g., suspected medication or illicit drug overdose) when there is “no anatomic cause of death,” i.e., no gross or microscopic cause of death. Toxicology samples—most commonly blood and urine—are collected. To ensure continuity of evidence, sample tubes and containers are sealed. The seal label indicates the name of the deceased, case number, date and time sealed, and the type of specimen, and is signed by the pathologist or police officer attending the autopsy. If an injured individual survives in the hospital for a period of time and then dies, any ethanol or other drugs will have metabolized, rendering postmortem specimens useless for meaningful analysis (109). Admission blood samples, if available, need to be obtained. The laboratory must be informed to hold these samples either by a coroner/medical examiner or designate (pathologist, police officer). In this situation, the hospital needs to have a tracking system to ensure continuity (13,35). If samples do not require analysis, they can be stored.

Pathologists are also responsible for the examination of surgically resected specimens from trauma cases.

9. OBSERVERS AT AUTOPSY

One purpose of the hospital-consent autopsy is to educate. A spectrum of health care professionals and trainees are involved. Medicolegal autopsies are also educational, but because of confidentiality, particularly in criminal investigations, attendance at the autopsy is restricted (105).

10. COMMUNICATION OF AUTOPSY FINDINGS AND REPORT

Following the completion of a family-authorized autopsy, the pathologist may speak with the attending physician and provide a brief summary of the initial autopsy findings (“provisional anatomical diagnoses”). The clinician conveys these results to the family. After the microscopic examination and other tests have been completed, a final report is issued, usually to the family doctor and attending physicians. A copy of the report is filed in the hospital health records department and becomes available to other clinicians and family, with proper authorization. Following the completion of a medicolegal postmortem, the pathologist reports the findings to a coroner or medical examiner, who interacts with the next of kin. At this stage, any conclusions about the cause of death may be limited and need to await further testing (15,22). The pathologist may discuss the death with the clinical team caring for a hospitalized individual provided the coroner/medical examiner and family have no concerns about the quality of medical care.

A confidential written report is issued to the coroner/medical examiner and other parties by statute. Depending on the jurisdiction, distribution of the report varies (13). Requests by family may be deferred, if there are pending criminal proceedings. A forensic pathologist, functioning as a medical examiner, communicates directly with the family about the autopsy report (110). This report is also viewed by various agencies and

other professionals (110). A release from a coroner/medical examiner may be required before a pathologist's report of a trauma patient is sent to the hospital health records department, where it is available to clinicians. Families appreciate timely release of autopsy reports (110). For hospital deaths, the College of American Pathologists Laboratory Accreditation Program recommends 30 d for completion of routine cases and 90 d for complicated cases (111). The pathologist must expedite a report if there are inquiries from the family and other interested parties. Slow reporting of cases delays not only a family's emotional closure, but also various financial and legal matters (e.g., insurance claims, criminal proceedings).

The format of a report varies, but certain elements are constant (34,111). In addition to the name of the deceased and an accession number, the report records the autopsy pathologist, assistants, and attendees. The name of the coroner or medical examiner who ordered the autopsy is noted. The location of the autopsy and the time and date the case began are given. An external examination, including means of identification and documentation of clothing, follows. Postmortem changes (rigor, livor, decomposition) can be of a greater import than in a hospital case. Signs of recent therapeutic intervention are noted. The internal examination is a listing of findings according to organ systems. A section devoted to external and internal injuries is in the forensic report. Injuries need to be described in continuity rather than being scattered in the narrative to allow for easier reading. Reference to diagrams assists in understanding the trauma observed. Microscopy and other ancillary testing (e.g., toxicology, radiology) are recorded. Any evidence collected and images, particularly of a criminally suspicious death, need to be mentioned. Microscopic sections and photographic images are records that allow an objective review of a case, particularly if it involves a criminal investigation (34).

11. CAUSE OF DEATH: THE "BOTTOM LINE"

An autopsy authorized by next of kin on an individual dying of natural disease yields a number of pathological diagnoses. Although the autopsy report in these cases does not necessarily require a cause of death, a listing of these abnormal findings ("anatomical diagnoses") provides information to the physicians caring for the patient that helps explain to the family why the individual died. In a medicolegal case, the onus is on the pathologist to provide a cause of death, which assists the coroner or medical examiner to accurately certify a death and assign the appropriate manner.

Adelson defined cause of death as "the injury, disease or the combination of the two responsible for initiating the train of physiological disturbances, brief or prolonged, which produced the fatal termination" (112). The cause of death is immediate if the injury or disease kills so quickly that there are no sequelae or complications (112,113). If a complication (e.g., pneumonia) develops during a period of survival, then that sequela becomes the immediate cause of death, and the initiating event is the proximate or antecedent cause, provided a direct relation exists (see Subheading 4.2. and refs. 112 and 113). If an individual survives for a period of time, then clinicians may lose sight of the initiating injury that ultimately led to apparent death from natural causes. The pathologist, on perusal of a hospital chart, needs to be aware of this and contact the coroner or medical examiner.

In many trauma cases, the cause of death is well defined (e.g., massive craniocerebral trauma caused by motor vehicle collision [104,113–117]). In other cases of injury with survival, the cause of death can be multifactorial (114). Each of these factors make some contribution to the death of that individual (113,116). Other conditions and diseases could have precipitated the event and influenced the course of the illness but are not directly related to the immediate cause of death. These “significant” factors may or may not contribute to the cause of death (e.g., cause of death: subdural hemorrhage; significant factors: acute ethanol intoxication, diabetes mellitus [113]).

Finding a potential cause of death at autopsy is interpreted in the context of the scene investigation and circumstances of the death (115,116). Historical events provided by the coroner/medical examiner and other investigators are relevant to death by trauma; however, this information may be based on unreliable witness accounts and may evolve (116).

A systematic approach, in most cases, leads to a successful conclusion as to the determination of the cause, mechanism, and manner of death (Fig. 1). In some trauma cases, the cause of death is undetermined (“no anatomic cause of death”). Decomposition renders soft tissue trauma uninterpretable (*see* Chapter 2 and ref. 115). A cause of death may not be determined if there is a lack of investigative information, undue haste, misinterpretation of findings, and an incomplete autopsy (114). In rare instances of trauma, an anatomic cause of death is not found despite a carefully performed postmortem (*see* Chapter 8, Subheading 6.4.3. and ref. 118).

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