REVIEW ARTICLE

Forensic Pathology

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N Engl J Med 2025;393:62-71.
DOI: 10.1056/NEJMra2406208

For many people, forensic pathology seems forbidding and dark. It deals intimately with death, crime, and disaster and is most often represented through the artifice of television shows and movies. The field of forensic sciences, of which forensic pathology is a part, is broader than usually appreciated and goes far beyond the autopsy examinations performed by forensic pathologists, encompassing aspects of anthropology, criminalistics, and toxicology. Here, we provide an overview of the roles played by forensic pathologists and coroners in the United States as part of the overarching commitments to public health, to families affected by sudden or violent death, and to the justice system. The principles we present are based on our experience in a major U.S. city, as well as our participation in international forensic congresses and teaching abroad. These principles apply to the practice of forensic pathology globally; however, the details of systems outside the United States are beyond the scope of this review.

History and Status as a Specialty

Historically, and even in some contemporary mindsets, forensic practice has been equated with investigation of criminal matters. Originating in medieval England, with coroners appointed by the Crown, forensic investigation was formalized in the 12th century when King Richard I created coroner posts to investigate murder and suicide, which were construed as criminal offenses in part because of losses of taxation revenue.[1] Over subsequent centuries, the role of coroner was expanded to include investigation of deaths that aroused public health concerns, such as disease outbreaks (e.g., the coronavirus disease 2019 [Covid-19] pandemic), natural disasters (e.g., the 2023 Maui wildfires), and the sequelae of terrorism (e.g., the September 11, 2001, attacks in the United States), as well as documentation of atrocities in human conflict.[2]

In the United States, the system of medicolegal death investigation has evolved into a patchwork of agencies overseen by elected or appointed coroners (who may have limited or no medical training) or by specialty physicians known as medical examiners (also known as forensic pathologists) (Fig. 1).[3-5] In 2022, there were 2071 medical examiner or coroner offices nationally,[6,7] a subset of which were staffed by about 750 board-certified forensic pathologists, with the remainder staffed by coroners, many of whom were nonphysicians. Among the 50,413 registrants for the 2024 National Resident Matching Program for all medical specialties, only 621 first-year pathology residency spots were filled (i.e., 1.2% of physicians chose pathology as a specialty).[8]

Forensic pathologists certified by the American Board of Pathology must complete accredited training programs of at least 3 years in anatomical pathology or combined anatomical and clinical pathology, followed by 1 year of training in forensic pathology. Only 50 forensic pathology training programs are recognized by the

KEY POINTS

FORENSIC PATHOLOGY

- Forensic pathology is a specialty that addresses society's need for accurate certification of natural and nonnatural deaths for public health surveillance and allocation of resources.
- Often behind the scenes, forensic pathologists communicate autopsy results to families, which involves answering questions about their loved one's death and addressing heritable causes of illness that are directly relevant to the survivors, especially when the cause is confirmed by molecular genetic testing.
- In deaths associated with disasters such as infections, weather catastrophes, mass accidents, and acts of violence, forensic pathologists and allied experts in forensic anthropology, criminalistics, toxicology, and medicolegal death investigation, among others in the larger field of forensic sciences, have a crucial role in identifying remains and discerning among injurious forces.
- Forensic pathologists interface with, but are independent from, the justice system and can educate the public about deaths highlighted by the media.
- Forensic pathologists may facilitate donation of autopsy tissue for the advancement of research on human disease.

Accreditation Council for Graduate Medical Education, with 37 of those programs participating in the National Resident Matching Program in 2024,[9,10] and approximately 30 to 60 program graduates take the board examinations in forensic pathology each year.[11] Although a deficit of physicians in all medical specialties has been projected, the shortfall is proportionally greatest in pathology.[12] Thus, a substantial deficit of medical examiners in the workforce is an ongoing concern and is part of the shortage in the larger field of forensic sciences.[13]

The reasons for the shortage of pathologists, and in turn of forensic pathologists, are multifactorial and arise, in part, from the dwindling exposure of medical students to autopsy (the "act of seeing with one's own eyes, direct observation," derived from the Greek *aut*, meaning self, and *opsia*, a later variant of *opsis*, meaning "act of seeing, sight").[14] Once considered the foundation of medicine, the autopsy remains the ultimate means of quality assurance for current diagnostic approaches. However, since 2019, when the Centers for Medicare and Medicaid Services rescinded the requirement for a hospital to provide autopsy services in order to qualify for Medicare reimbursement, the autopsy has been abandoned by all but the most committed academic centers, and even at these centers, it may be available only to families with means.[15,16] The consequent lack of exposure to autopsy on the part of house staff and medical students, only 31% of whom observed or participated in an autopsy in medical school,[17] has resulted in unfamiliarity with its value. In one study, senior medical students asserted that social media impressions of pathology as a specialty are not encouraging, with only 29% of the students believing it to be a "highly regarded specialty."[17] With respect to the practice of forensic pathology specifically, the perceived unpleasantness of the autopsy and the workplace where it is performed, the often less-than-competitive salaries offered in government-based offices, and apprehension about having to testify in criminal trials may be additional detractors for physicians who might otherwise consider forensic pathology as a career.[18]

OBLIGATION OF FORENSIC PATHOLOGY TO PUBLIC HEALTH

ACCURATE DEATH CERTIFICATION

With some variability in practice reflecting local norms, the medical examiner or coroner has statutory jurisdiction to order an autopsy under the circumstances outlined in Table 1. Although consent of the next of kin is not required, medical examiners and coroners do their best to accommodate family wishes or cultural or religious norms when there are objections to performing an autopsy. A coroner who is an elected or appointed nonpathologist may direct the autopsy to be performed by a suitably trained physician in the geographic region. Beyond the key obligation to the families of decedents (discussed below), the medical examiner or coroner has a responsibility to promote public health and safety by creating accurate death certification records, which allow tracking of incidence and prevalence trends in natural disease, as well as "unnatural" deaths, defined as those resulting from violence (accidents, homicides, or suicides) or other public

Table 1. Circumstances of Death Generally Leading to Autopsy by a Medical Examiner or Coroner.

Circumstances of Death	Comments
Unwitnessed, sudden, or unexpected, including a child's death	Death of an adult with known medical disease may be certified without autopsy; death of a child may warrant interaction with child protective services
Resulting from violence, intoxication, natural disaster, fire, or climatic or environmental exposure	Requires interaction with law enforcement, fire marshal, or other authorities
Occurring in police custody or correctional facility	"Custody" extends to a person being pursued but not yet apprehended
Involving a vulnerable person in an institutional or other caretaking setting, shelter, or single-room occupancy facility	"Vulnerable" persons include those of any age with cognitive or physical limitations or both or with socioeconomic disadvantage requiring assistance; may warrant interaction with services for older adults or homeless services
Occurring in a workplace	Compels interaction with occupational health and safety authorities
Involving infectious disease with potential for outbreak	Requires interaction with local, state, and national public health authorities
Occurring within 24 hr after medical procedure or hospital visit, including emergency department	Not applicable in some jurisdictions

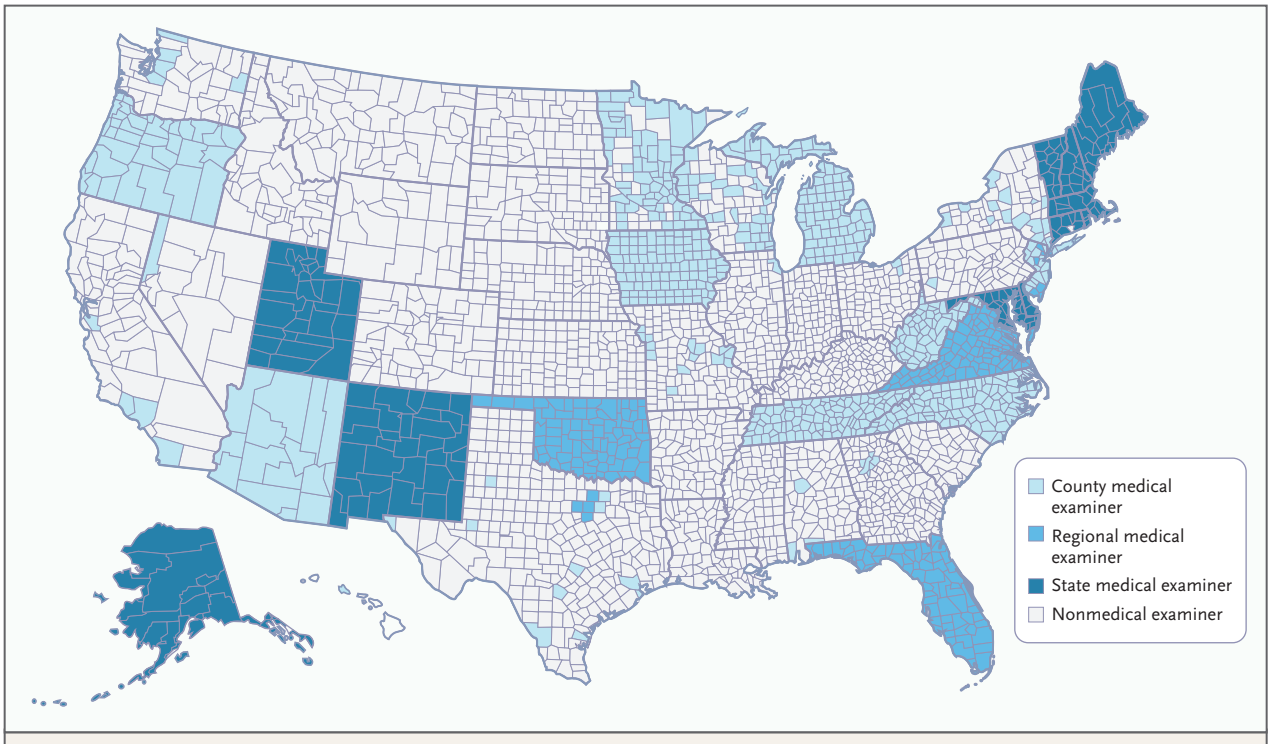

Figure 1. Types of Death Investigation across Counties in the United States.

Shown is the distribution of county, regional, and state medical examiners and nonmedical examiners (i.e., coroners). The map is adapted from information provided by the Centers for Disease Control and Prevention.[5]

Table 2. Terms Used by Medical Examiners and Coroners in Formulating the Cause and Manner of Death.*

Term	Definition
Cause of death	Disease, injury, or both responsible for the death
Proximate cause	Disease or injury that causes the death in a natural and continuous sequence, with no intervening cause, and without which the death would not have occurred; etiologically specific
Immediate cause	One or more complications of the underlying cause, temporally occurring between the underlying cause and death; not etiologically specific
Mechanism	Alterations of physiology and biochemistry initiated by the underlying cause, leading to death
Manner of death	Explanation of how the cause arose (natural or unnatural), based on circumstances and informed by the proximate cause
Natural death	Death entirely due to disease or old age
Accident	Violent (unnatural) death that is not the result of an intentional act of another person (i.e., inadvertent)
Suicide	Violent (unnatural) death caused by an intentional act to end one's own life
Homicide	Violent (unnatural) death at the hand of another person, or death due to the hostile or illegal act (or acts) of another person
Complication of therapy	Death from a known or predictable consequence of appropriate therapy
War injury	Death due to sequelae of injuries received in combat during active military service

* Adapted from Ely and Gill.[21]

health threats (Table 1). The data in these legal documents figure heavily in the allocation of resources for public health efforts.

Probably all physicians have had to fill out a death certificate at some point in their careers, but they may have received little specific training in doing so during medical school or residency. Hence, the approach taken by medical examiners or coroners may differ appreciably from that of many clinicians. Studies have shown that when pathologists review death certificates completed by clinicians, errors are frequently detected that would be propagated in public health data.[19,20]

The aim of death certification is to record a specific cause of death, any factors contributing to the death, and the manner of death as an explanation for how the cause arose (Table 2). For example, listing "heart failure" is insufficient when death follows a recognizable pathogenetic sequence of "rupture of an abdominal aortic aneurysm," even though heart failure inevitably ensues from major internal blood loss. The manner of death is chosen from among a short list of medicolegally recognized definitions, comprising natural death, accident, suicide, homicide, and in some jurisdictions, complication of therapy. Should there be insufficient data for reasonable certainty about the manner of death, or should two competing definitions be considered equally likely, the category of the manner of death may be classified as undetermined (Table 2).

Not every case accepted by the medical examiner or coroner requires a full internal autopsy examination. Some cases may undergo an external examination, sometimes with sampling of blood or other fluids, and a review of medical records. Certification of natural deaths at the scene or nonnatural deaths occurring in hospitals may be performed by a medical examiner or coroner after an adequate investigation of the death scene, including investigation by specially trained medicolegal death investigators (Fig. 2). A full treatment of the nuances of death certification, including the issue of "brain death," occupies multiple chapters in forensic textbooks.[21]

MASS DISASTER MANAGEMENT

In *De Morbis Popularibus ("Of Disease in the Populace")*, Hippocrates (circa 460–370 B.C.E.) astutely noted the association between seasons and epidemic

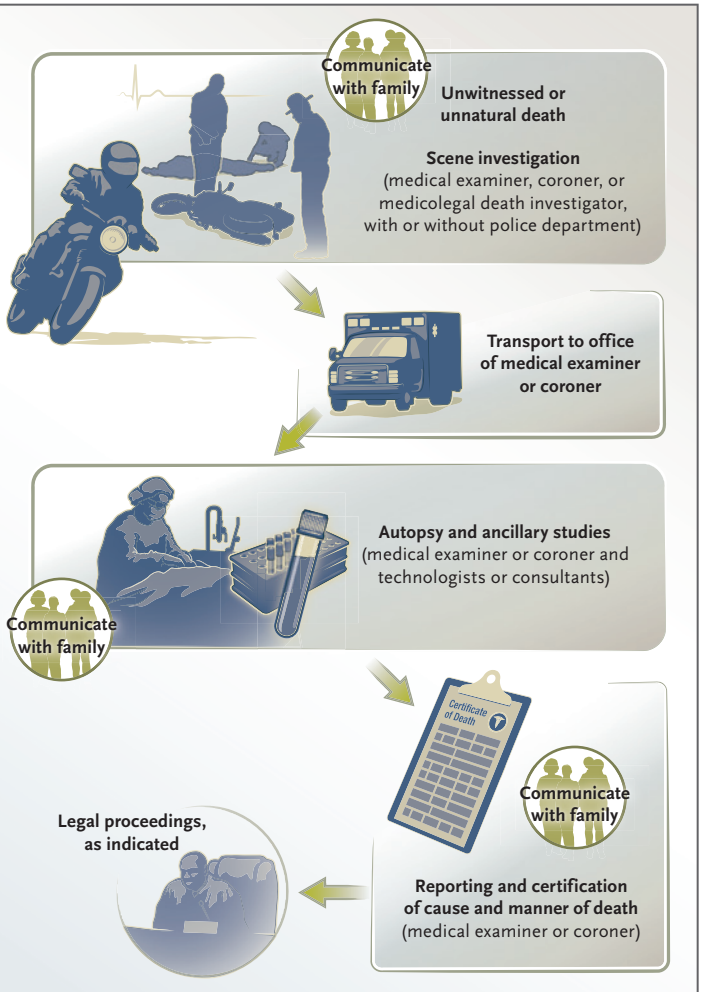

Figure 2. Usual Sequence of Events after Deaths Falling under the Jurisdiction of a Medical Examiner or Coroner.

Scene investigations may be undertaken by specially trained medicolegal death investigators under the authority of the medical examiner or coroner and may or may not be accompanied by investigation by the police department. Technologists or consultants include forensic experts such as mortuary technicians, toxicologists, anthropologists, molecular geneticists, neuropathologists, and cardiac pathologists. A death certificate is generally filed within 24 hours after death, which allows for the release of the body to funeral personnel. The final certification may take 30 to 90 days, depending on the complexity of the case and whether criminality is known or suspected. The medical examiner or coroner office has many opportunities to communicate with the family.

diseases in his locale, eschewing the then-prevailing belief that human suffering represented visitations from gods or magical forces:

> "During winter began paralyses which attacked many, a few of whom quickly died. In fact, the disease was generally epidemic. In other respects the public health continued good. Early in spring began ardent fevers which continued until the equinox and on to summer. Now those who began to be ill at once, in spring or the beginning of summer, in most cases got well, though a few died; but when autumn and the rains came the cases were dangerous, and more died."[22]

For an example of the role of medical examiners in our own *De Morbis Popularibus*, we point to the public health emergency events associated with Covid-19 in the winter of 2019–2020 C.E. Alongside the essential role of first responders in emergency, outpatient, and inpatient care of the living, many large medical examiner or coroner offices in urban areas, including the New York City Office of Chief Medical Examiner, served as first responders with a different focus — that of the city mortuary. We were pressed into serving a population of 8.8 million as deaths from Covid-19 climbed and overwhelmed hospitals, funeral homes, cemeteries, and crematoria and required us to house the bodies of thousands of decedents, some for many months, until funeral services could be arranged for their families (Fig. S1 in the Supplementary Appendix, available with the full text of this article at NEJM.org). This sudden increase in "excess deaths" (i.e., deaths exceeding the usual baseline number) stretched resources in a way not seen since the influenza pandemic 100 years earlier, in which the case fatality rate in the United States was 1%, essentially identical to that during the first 2 years of the Covid-19 pandemic.[23,24] We, along with other medical examiner and coroner offices throughout the world, continued not only to safeguard the deceased members of affected families but also to learn crucial details about this new disease outbreak,[25-29] which was characterized by the Global Burden of Disease consortium as the largest natural mass fatality event since data collection began in 1990.[30]

RESPONSE TO THE OPIOID CRISIS

The recent crisis of opioid overdose deaths in the United States and elsewhere represents a substantial threat to public health and safety. Responsibility for the investigation of deaths that are possibly drug-related[31] places medical examiners and coroners on the front lines of this

outbreak, which has claimed more than 100,000 American lives annually since 2021.[32] This statistic is driven by the illicit opioid fentanyl and its analogues, now ubiquitous in the street drug supply and involved in more than 80% of opioid overdose deaths.[33] Drug intoxications are considered chemical or toxicologic injuries, and in adjudicating deaths attributable to these drugs, medical examiners and coroners place the results of postmortem toxicologic testing in the context of the autopsy, scene investigation, and other laboratory findings to determine whether persons have simply died with the drug (or drugs) present in their body or have died from the drug (or drugs). These circumstances inform decisions about both the cause and manner of death, with the latter requiring distinctions among accident, suicide (if the drug overdose was intentional), and homicide (if the overdose was administered by another person).

Furthermore, epidemiologic data derived from death certificates that are generated by medical examiners and coroners are used to gauge overall trends involving drug-related deaths and detail the specific drugs and combinations causing these deaths, including new and emerging threats beyond the familiar fentanyl, cocaine, and heroin; examples are xylazine, medetomidine, nitazenes, and "designer" benzodiazepines. Medical examiners and coroners not only provide answers to families who have lost loved ones to a drug overdose but also serve as important sources of data to direct policy and programmatic decisions at the local, state, and federal levels, which can be applied in real time to prevent additional overdose deaths, particularly when temporal or geographic clustering of cases is identified.

Although medical examiners work closely with law enforcement, they are neither police nor prosecutor. Medical examiners must be impartial arbiters of the cause and manner of death, and this independent role is recognized by families, friends, and others in the social network of each decedent whose death is being investigated. The trust established with those who have lost a loved one suddenly, unexpectedly, or violently, including loss to a drug overdose, affords the medical examiner, as the last physician to see their loved one, particular investigative advantages, such as a willingness to share details that they might not reveal to the police.

We offer a few observations from our roles in New York City, where someone dies on average every 3 hours as the result of an unintentional drug overdose. Such deaths in the city peaked at more than 3000 per year in 2023.[33] Nationwide, more than one in eight adults have been directly or indirectly affected by a drug overdose death.[34] The New York City Office of Chief Medical Examiner established the Drug Intelligence and Intervention Group (Fig. S2) as an outgrowth of the city's RxStat initiative, which has been presented as a cross-sector partnership that other jurisdictions may adopt.[35] This multiagency consortium uses real-time data from reviews of drug overdose deaths to rapidly inform public health and justice partners, to reach out to the overdose victim's associates (who are themselves at risk for fatal overdose) as a preventive measure, and to connect family or social network members with bereavement and other support services. This mission enlists epidemiologists, data analysts, and social workers to leverage the medical examiner's or coroner's engagement with families from the moment a death has occurred. Implementation of this approach has led to considerable success in reaching persons imminently at risk for overdose.[36-39] A similar approach has been advocated in other public health agencies confronting the opioid crisis,[40-45] and it offers a proof of concept that may be applied beyond overdose deaths as an example of how medical examiners can expand their care for the living and directly help save lives.

SUPPORT TO FAMILIES

One aspect of forensic pathology that is often misunderstood is that a decedent's loved ones are also our patients. In essence, what we do, we do for the living. This principle is manifested in many ways. Our perspective is that people can live with the truth, but they have difficulty with uncertainty. The medical examiner provides them with medically and scientifically sound answers about what happened to their loved one in a professional and sensitive manner. Often, the conversation with families begins at the scene investigation performed by medicolegal death investigators affiliated with the medical examiner or coroner. Soon afterward, the medical examiner or coroner contacts the family by telephone to ask about the family's wishes concerning the autopsy.

On completion of the autopsy, the family is contacted again, with at least preliminary information and a projected timeline for the results of ancillary studies, as necessary (Fig. 2). In many cases, repeated communications with the family occur, with abundant opportunity for the medical examiner to provide both answers to any questions and comfort. Some articles have framed this aspect of the job as "family physician of the bereaved."[46]

An often-unrecognized example of this role, albeit a singular example and perhaps not generalizable, is the continuing effort to identify persons who were killed in the attacks on the World Trade Center on September 11, 2001, the largest homicide in U.S. history. To date, 60% of those who perished that day have been identified, either through an iterative process for specimens that were initially uninformative or on new testing of more recently discovered remains. As DNA technology has advanced, it has been incorporated to extend the original promise by the New York City Office of Chief Medical Examiner to identify as many persons as possible.[47-49] We meet annually with families to update them on our progress and over the past two decades have developed relationships extending to the next generation. A forensic anthropology team member maintains a permanent office at the 9/11 Memorial. Moreover, the advances in analysis of mass fatality sites, especially those with commingled remains, that were driven by our response to 9/11 have led to the use of a similar approach for identification of missing persons in other contexts, bringing closure for families with lost loved ones.[48,50,51]

Another example of the role the medical examiner or coroner plays in supporting families is in the use of molecular genetics, the so-called molecular autopsy. When a healthy baby, child, or young adult dies suddenly, questions abound. Occasionally, the autopsy and ancillary studies (e.g., histologic, toxicologic, and microbiologic assessments) fail to reveal a cause of death. In such cases, molecular genetic testing for cardiac channelopathies, aortopathies, coagulopathies, hemoglobinopathies, and genes associated with epilepsy may provide information that not only reveals the cause of death but is also relevant to the health of relatives and to future pregnancies.[52,53] Some medical examiner or coroner offices have referral mechanisms in place for the family to consult experts regarding risk analysis and preventive care options or — as in New York City — they employ a genetic counselor for that purpose.[54]

INTERFACE WITH THE JUSTICE SYSTEM

The role of medical examiners and coroners that is most familiar to the average U.S. citizen is the one depicted, often with much artistic license, on television. In the classic *Quincy, ME* series, the plucky Dr. Quincy performed (and solved) all aspects of the investigation himself, topping off each episode with a righteous and fiery court appearance. (We acknowledge the influence of this series on our own interest in forensic pathology.) More contemporary examples include *Bones* and *CSI: Crime Scene Investigation*, which also portray charismatic stars in dramatic scenarios. Although accurate in some respects, the television formula is much too simplistic to reflect the demands on medical examiners and coroners. Currently, the burdens of "solving" a case are shared among experts in various specialties (medicolegal death investigators, toxicologists, forensic anthropologists, neuropathologists, and cardiac pathologists, each with specific training and certification requirements). The medical examiner or coroner synthesizes the findings in the death certificate, which is available to law enforcement or other authorities with legitimate standing (Fig. 2 and Table 1). The determinations of the medical examiners and coroners are thus independent of the police, a status that is essential to the integrity of both forensic pathology and the justice system.

Medical examiners and coroners play important roles in criminal and civil legal proceedings, such as testimony in criminal court regarding the findings in homicides or deaths in custody and appearances in family court regarding unexpected deaths of children or older adults that arouse concern about care in the home. In such circumstances, the medical examiner or coroner is speaking for the decedent by bringing to light the patterns of injury, underlying natural disease, and environmental factors that would otherwise remain unidentified.

ROLE IN INFORMING THE PUBLIC

In recent politically charged and polarized times, many Americans have followed trials associated with civil protests across the country.[55] The role of the medical examiner has been on display, permitting the layperson to see directly the importance of an independent death investigation by physicians dedicated to speaking accurately, despite threats from defendants, politicians, law enforcement personnel, or partisan supporters. Forensic pathologists can explain to the public the way in which autopsy results reflect the sometimes complex interplay of traumatic, toxicologic, and natural disease leading to death in criminal settings.

CONTRIBUTION TO RESEARCH

Medical examiners and coroners have an additional obligation to collaborate with medical researchers in studying disorders that are highly represented in forensic settings. In addition to infections and mass fatality events, other subjects that require research are acute and long-term sequelae of traumatic brain injury, including homicides resulting from intimate partner violence and child abuse; repetitive traumatic exposures in athletes, military personnel, and civilians, sometimes leading to suicide or a drug overdose, with familial concern about chronic traumatic encephalopathy; autism and other developmental disorders resulting in epilepsy or disability and requiring institutional care; and sudden, unexpected death in infancy and childhood — all of which are nearly impossible to study in a hospital setting.[56-58] Examples of these cooperative institutional efforts are the University of Washington Autopsy and After Death Services and the Mayo Clinic Office of Decedent Affairs.[59] Such efforts are facilitated through liaisons with local organ procurement agencies, which often interact with medical examiners and coroners in the process of arranging for organ harvest. Beginning in the 1990s, the legislature in some jurisdictions, such as the State of California, started approving statutory language that permits research in sudden infant death syndrome (SIDS) without specific parental consent.[60] This statute, resulting from lobbying by the families of infants who have died from SIDS, has allowed for advances in the understanding of many aspects of infant development, particularly through the sharing of brain tissue from the San Diego County Department of the Medical Examiner with researchers.[61-64]

Efforts to include medical examiners and coroners as resources for the donation of research tissue must overcome many obstacles. As government employees or appointees, medical examiners and coroners face resource limitations that are unfamiliar to many of those working in academic or community hospital practices.[6,13] In addition, institutional conflict-of-interest policies may be misconstrued to apply to medical examiners or coroners who are complying with family wishes and consent to donate tissues to qualified research laboratories. These limitations have had the effect of blunting enthusiasm for scholarly research pursuits on the part of some medical examiners and coroners.

SUMMARY AND FUTURE DIRECTIONS

Forensic pathologists play a unique role in monitoring and responding to myriad public health threats. As with all laboratory-based physicians, forensic pathologists' work is not visible to the public and is consequently susceptible to misunderstanding and sometimes fanciful renderings in the media. Forensic pathologists are dedicated to implementing extensive laboratory analyses in order to provide answers for families at times of loss and fear, supplying objective facts for use in the justice system and for public health purposes, and assisting in research that continues to advance our understanding of human disease and injury.

Disclosure forms provided by the authors are available with the full text of this article at NEJM.org.

We thank the dedicated personnel of the New York City Office of Chief Medical Examiner, especially for their professionalism during the recent Covid-19 pandemic, and the many caring members of the Drug Intelligence and Intervention Group in New York City.

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REFERENCES

1. Jones D, Milne R. The coronial system: a short history. Int J Foren Sci 2023; 8:1-5.
2. Kidenda S, Muchai R, Green L, McHale T, Mishori R, Nelson BD. Evaluating the effectiveness of a mobile application to improve the quality, collection, and usability of forensic documentation of sexual violence. PLoS One 2022;17(12): e0278312.
3. Hanzlick R, Combs D. Medical examiner and coroner systems: history and trends. JAMA 1998;279:870-4.
4. Institute of Medicine (US) Committee for the Workshop on the Medicolegal Death Investigation System. Medicolegal death investigation system: workshop summary. Washington, DC: National Academies Press, 2003 (https://www.ncbi.nlm.nih.gov/books/NBK221919/).
5. Collaborating Office for Medical Examiners and Coroners. Medicolegal death investigation systems, by county. December 2023 (https://www.cdc.gov/nchs/comec/Medical-Death-Investigation-System-by-County.pdf).
6. Smiley-McDonald HM, Keyes KA, Wire S, Greenwell K, Santos NA, Ropero-Miller JD. The impacts of governing agency: a comparison of resources in the patchwork of medicolegal death investigation systems. Forensic Sci Int Synerg 2024;8: 100467.
7. 2022 Medical examiner and coroner survey report. Springfield, VA: Drug Enforcement Administration, September 2023 (https://www.nflis.deadiversion.usdoj.gov/nflisdata/docs/12028NFLIS2022MECShortReport.pdf).
8. The Match. Results and data: 2024 main residency match. Washington, DC: National Resident Matching Program, June 28, 2024 (https://www.nrmp.org/match-data/2024/06/results-and-data-2024-main-residency-match/).
9. Accreditation Council for Graduate Medical Education. Advanced program search, 2025 (https://apps.acgme.org/ads/Public/Programs/Search).
10. The Match. Pathology fellowship match. Washington, DC: National Resident Matching Program (https://www.nrmp.org/fellowship-applicants/participating-fellowships/pathology-fellowship-match).
11. ABPath Examiner. Spring 2025;47(1). Washington, DC: American Board of Pathology (https://abpath.org/wp-content/uploads/2025/03/2025_ABPathNewsletter_Spring_.pdf).
12. Robboy SJ, Weintraub S, Horvath AE, et al. Pathologist workforce in the United States. I. Development of a predictive model to examine factors influencing supply. Arch Pathol Lab Med 2013;137:1723-32.
13. Report to Congress: needs assessment of forensic laboratories and medical examiner/coroner offices. Washington, DC: National Institute of Justice, 2019 (https://www.justice.gov/olp/page/file/1228306/dl?inline/).
14. Rueckert J. Elimination of the autopsy requirement by CMS. N Engl J Med 2020; 382:683-4.
15. De Cock KM, Zielinski-Gutiérrez E, Lucas SB. Learning from the dead. N Engl J Med 2019;381:1889-91.
16. Weedn VW, Menendez MJ. Reclaiming the autopsy as the practice of medicine: a pathway to remediation of the forensic pathology workforce shortage? Am J Forensic Med Pathol 2020;41:242-8.
17. McCloskey CB, Johnson K, Brissette M, et al. Factors influencing US allopathic medical students to choose pathology as a specialty. Acad Pathol 2020; 7:2374289520951924.
18. Borbat A, Novikova T, Yaroslavtsev M, Bychkov A. Not choosing pathology: an essay-based survey of first-year clinical residents. Am J Clin Pathol 2023;160:593-8.
19. Pape A, Scherpelz KP. Frequency and types of errors in clinician-composed death certificates for patients with or without autopsy in a hospital population. J Public Health (Oxf) 2024;46:83-6.
20. Schuppener LM, Olson K, Brooks EG. Death certification: errors and interventions. Clin Med Res 2020;18:21-6.
21. Ely SF, Gill JR. The pathophysiology of death and death certification. In: Ely SF, Gill JR, eds. Principles of forensic pathology: from investigation to certification. London: Elsevier, 2023:31-64.
22. Hippocrates. Epidemics I. W.H.S. Jones, ed., trans. Cambridge, MA: Harvard University Press, 1923 (https://scaife.perseus.org/library/urn:cts:greekLit:tlg0627.tlg006/).
23. Cunha BA. Influenza: historical aspects of epidemics and pandemics. Infect Dis Clin North Am 2004;18:141-55.
24. Morens DM, Taubenberger JK, Fauci AS. A centenary tale of two pandemics: the 1918 influenza pandemic and COVID-19, Part I. Am J Public Health 2021;111:1086-94.
25. Lee MH, Perl DP, Steiner J, et al. Neurovascular injury with complement activation and inflammation in COVID-19. Brain 2022;145:2555-68.
26. Fernández-Castañeda A, Lu P, Geraghty AC, et al. Mild respiratory COVID can cause multi-lineage neural cell and myelin dysregulation. Cell 2022;185(14): 2452-2468.e16.
27. Stram MN, Seifert AC, Cortes E, et al. Neuropathology of pediatric SARS-CoV-2 infection in the forensic setting: novel application of ex vivo imaging in analysis of brain microvasculature. Front Neurol 2022;13:894565.
28. Lee M-H, Perl DP, Nair G, et al. Microvascular injury in the brains of patients with Covid-19. N Engl J Med 2021;384: 481-3.
29. Bradley BT, Maioli H, Johnston R, et al. Histopathology and ultrastructural findings of fatal COVID-19 infections in Washington State: a case series. Lancet 2020;396: 320-32.
30. GBD 2021 Diseases and Injuries Collaborators. Global incidence, prevalence, years lived with disability (YLDs), disability-adjusted life-years (DALYs), and healthy life expectancy (HALE) for 371 diseases and injuries in 204 countries and territories and 811 subnational locations, 1990–2021: a systematic analysis for the global burden of disease study 2021. Lancet 2024; 403:2133-61.
31. Davis GG, Cadwallader AB, Fligner CL, et al. Recommendations for the investigation, diagnosis, and certification of deaths related to opioid and other drugs, December 17, 2019–December 17, 2024 (https://www.thename.org/assets/docs/Opioid%20position%20paper%20Final%2012-17-2019.pdf).
32. Ahmad FB, Cisewski JA, Rossen LM, Sutton P. Provisional drug overdose death counts. Washington, DC: National Center for Health Statistics, 2025 (https://www.cdc.gov/nchs/nvss/vsrr/drug-overdose-data.htm).
33. NYC Health. Health department issues commissioner's advisory as overdose crisis reaches historic levels. September 25, 2023(https://www.nyc.gov/site/doh/about/press/pr2023/commissioner-advisory-overdose-crisis-reaches-historic-levels.page).
34. Athey A, Kilmer B, Cerel J. An overlooked emergency: more than one in eight US adults have had their lives disrupted by drug overdose deaths. Am J Public Health 2024;114:276-9.
35. Allen B, Urmanche A. NYC RxStat: stakeholder perspectives on a national model public health and public safety partnership to reduce overdose deaths. Eval Program Plann 2023;98:102275.
36. Bottomley JS, Feigelman WT, Rheingold AA. Exploring the mental health correlates of overdose loss. Stress Health 2022; 38:350-63.
37. Feigelman W, Bottomley JS, Titlestad KB. Examining grieving problem correlates of anticipation of the death vs. shock among overdose death and suicide bereaved adults. Death Stud 2023;47:400-9.
38. Macmadu A, Frueh L, Collins AB, et al. Drug use behaviors, trauma, and emotional affect following the overdose of a social network member: a qualitative investigation. Int J Drug Policy 2022;107: 103792.
39. Kenny KS, Kolla G, Firestone M, et al. Frequency of fatal and non-fatal overdoses and response to grief and loss among people who inject drugs: an unexplored dimension of the opioid overdose crisis. Drug Alcohol Depend 2022;237:109539.
40. Marshall BDL, Alexander-Scott N, Yedinak JL, et al. Preventing overdose using

information and data from the environment (PROVIDENT): protocol for a randomized, population-based, community intervention trial. Addiction 2022;117:1152-62.
41. Allen B, Schell RC, Jent VA, et al. PROVIDENT: development and validation of a machine learning model to predict neighborhood-level overdose risk in Rhode Island. Epidemiology 2024;35:232-40.
42. Haas E, Truong C, Bartolomei-Hill L, Baier M, Bazron B, Rebbert-Franklin K. Local overdose fatality review team recommendations for overdose death prevention. Health Promot Pract 2019;20:553-64.
43. Lloyd D, George N, Grove D, Goldberg R, Clear A. How post overdose response efforts can address social determinants of health among people who use drugs: perspectives from the New York State Department of Health (NYSDOH) Post Overdose Response Team (PORT). Harm Reduct J 2024;21:180.
44. Cherico-Hsii S, Bankoski A, Singal P, et al. Sharing overdose data across state agencies to inform public health strategies: a case study. Public Health Rep 2016;131:258-63.
45. Wolff J, Gitukui S, O'Brien M, Mital S, Noonan RK. The overdose response strategy: reducing drug overdose deaths through strategic partnership between public health and public safety. J Public Health Manag Pract 2022;28:Suppl 6:S359-S366.
46. Hirsch CS. Talking to the family after an autopsy. Arch Pathol Lab Med 1984;108:513-4.
47. Holland MM, Cave CA, Holland CA, Bille TW. Development of a quality, high throughput DNA analysis procedure for skeletal samples to assist with the identification of victims from the World Trade Center attacks. Croat Med J 2003;44:264-72.
48. Gill JR, Desire M, Dickerson T, Adams BJ. The 9/11 attacks: the medicolegal investigation of the World Trade Center fatalities. In: E.E. Turk, ed. Forensic pathology reviews. Berlin: Springer, 2011:181-95.
49. Adams B, Warnke-Sommer J, Odien J, Soler A, Damann F. Victim identification from the September 11, 2001 attack on the World Trade Center: past trends and future projections. Forensic Sci Int 2022;340:111463.
50. Hanson I, Fenn J. A review of the contributions of forensic archaeology and anthropology to the process of disaster victim identification. J Forensic Sci 2024;69:1637-57.
51. de Boer HH, Blau S, Delabarde T, Hackman L. The role of forensic anthropology in disaster victim identification (DVI): recent developments and future prospects. Forensic Sci Res 2018;4:303-15.
52. Davis GG, Cadwallader AB, Fligner CL, et al. Position paper: recommendations for the investigation, diagnosis, and certification of deaths related to opioid and other drugs. Am J Forensic Med Pathol 2020;41:152-9.
53. Webster G, Puckelwartz MJ, Pesce LL, et al. Genomic autopsy of sudden deaths in young individuals. JAMA Cardiol 2021;6:1247-56.
54. Saxton S, Kontorovich AR, Wang D, et al. Cardiac genetic test yields and genotype-phenotype correlations from large cohort investigated by medical examiner's office. Cardiovasc Pathol 2024;72:107654.
55. Medical examiner testifies he wasn't pressured when making George Floyd autopsy report. CBS News. February 1, 2022 (https://www.cbsnews.com/minnesota/news/medical-examiner-on-stand-at-officers-trial-in-george-floyd-death/).
56. Danner B, Gonzalez AD, Corbett WC, et al. Brain banking in the United States and Europe: importance, challenges, and future trends. J Neuropathol Exp Neurol 2024;83:219-29.
57. Smith DH, Dollé J-P, Ameen-Ali KE, et al. COllaborative Neuropathology NEtwork Characterizing ouTcomes of TBI (CONNECT-TBI). Acta Neuropathol Commun 2021;9:32.
58. Dams-O'Connor K, Seifert AC, Crary JF, et al. The neuropathology of intimate partner violence. Acta Neuropathol 2023;146:803-15.
59. Mayo Clinic. Office of decedent affairs (https://www.mayoclinic.org/office-decedent-affairs).
60. FindLaw.com. California Code, Government Code - GOV § 27491.41. January 1, 2023 (https://codes.findlaw.com/ca/government-code/gov-sect-27491-41/).
61. Kinney HC, Thach BT. The sudden infant death syndrome. N Engl J Med 2009;361:795-805.
62. Kinney HC, Haynes RL. The serotonin brainstem hypothesis for the sudden infant death syndrome. J Neuropathol Exp Neurol 2019;78:765-79.
63. Haynes RL, Trachtenberg F, Darnall R, et al. Altered 5-HT2A/C receptor binding in the medulla oblongata in the sudden infant death syndrome (SIDS): tissue-based evidence for serotonin receptor signaling abnormalities in cardiorespiratory- and arousal-related circuits. J Neuropathol Exp Neurol 2023;82:467-82.
64. Cummings KJ, Leiter JC, Trachtenberg FL, et al. Altered 5-HT2A/C receptor binding in the medulla oblongata in the sudden infant death syndrome (SIDS): age-associated alterations in serotonin receptor binding profiles within medullary nuclei supporting cardiorespiratory homeostasis. J Neuropathol Exp Neurol 2024;83:144-60.