

Forensic medicine

The branch of medicine concerned with the resolution of legal issues by the application of scientific medical knowledge. The issues may be of criminal or civil nature. The specialty of forensic medicine is often referred to as legal medicine in Europe and in Spanish-speaking countries. The development of forensic medicine began in Europe in the early nineteenth century. Although forensic medicine has its basis in the specialty of pathology, physicians in other specialties, such as psychiatry, orthopedics, cardiology, and neurology as well as specialists in other disciplines, may be called on to resolve legal questions posed by judges, attorneys, investigators, and hearing boards.

In death investigations, a number of forensic specialists may work together. A forensic odontologist may be called in to identify the deceased person through dental examination, or the perpetrator of bite marks left on the deceased's body. A forensic anthropologist may be needed to identify skeletal remains; a forensic toxicologist for the identification of poisons or drugs; and a criminalist for investigation at the scene and collection of evidence, or for study of trace evidence such as blood stains, hair, paints, and seminal fluid. In cases of equivocal suicides, forensic psychiatrists and psychologists may be called in. Recently the biomechanical engineer has been added to the roster of forensic specialists, to test and study injury patterns to determine how the injury came about. The forensic medical specialist may express an opinion in writing or may be required to testify in person in the courtroom. As with all legal proceedings, the physician witness must be cognizant of issues such as the degree of proof, the chain of custody of specimens or evidence, competency of the witness, and court procedures. See also: Forensic anthropology; Forensic evidence

Medicolegal investigative system

In many countries other than Canada and the United States, medical schools have departments of forensic or legal medicine, and medical students take courses in forensic medicine. In these countries, in cases of medicolegal disputes, the professor of legal medicine at the local medical school is asked to examine the patient or conduct the forensic autopsy, and to offer opinion to the courts, attorneys, or investigators. In the United States, in earlier times, the autopsy service was provided by a local physician hired by the coroner's office, which handled the investigation and determined the cause of death. In many of the states and larger metropolitan areas, beginning with the Commonwealth of Massachusetts and New York City, this system evolved into the medical examiner's system. The medical examiner's office has jurisdiction either statewide or countywide. A federal medical examiner's office has been established in Washington, DC. The American Board of Pathology sets the standards, establishes the qualifications, and certifies the competency of the forensic pathologists.

Most board-certified forensic pathologists work as medical examiners for a state or county. Their work involves death investigation, conducting forensic autopsy to determine the cause and manner of death, and often testifying in court. Few maintain full-time private consultation service. A well-staffed medical examiner's office has toxicological and forensic laboratories; a team of investigators; consultants in such forensic specialties as odontology, anthropology, and entomology; and medical consultants in radiology and psychiatry.

Clinical forensic medicine

Forensic medical specialists also deal with medicolegal issues involving living persons. Psychiatrists may assist with the evaluation of insanity pleas by defendants; a cardiologist may deal with a worker's claim for disability due to heart disease; and an orthopedic surgeon may evaluate the degree of a patient's disability for a court or for attorneys prior to settlement. In the United Kingdom and former commonwealth countries, and in the Far East, a system of police surgeons is set up to provide medical advice to the local police. A physician appointed as police surgeon is called on to visit the jail to examine a detainee, or is called to the scene of death. In the United States, clinical evaluation of jail inmates is provided by individual practicing physicians, and the setup varies with the locality.

Authority and practice

In the United States, deaths that are sudden and unexpected or violent are usually investigated by the medical examiner's office, except in areas where the coroner still has jurisdiction. Even in those jurisdictions, most autopsies are conducted by board-certified forensic pathologists. Throughout the world, such deaths are investigated by an official agency. In continental Europe and the Far East, the police conduct the investigation, with an autopsy authorized by a magistrate. In

the United Kingdom and former commonwealth countries, the coroner, who is also the magistrate, conducts the inquest. The medical examiner in the United States is a board–certified forensic pathologist, who serves as an appointed rather than an elected official. In all states there are state or countywide medical examiner's offices. Their purpose is to determine by investigation the cause and manner of death. Typical cases include gunshot wounds, stab wounds, blunt–force injuries, traffic accidents, drowning, hanging, asphyxiation, and drug and alcohol abuse. Any death suspected of being an accident, suicide, or homicide is investigated.

The medical examiner's authority has been expanded to cover such incidents as death in nursing homes, sudden and unexpected death during surgery, or death of a prisoner in custody. Furthermore, the medical examiner's office usually takes jurisdiction over cases of undiagnosed epidemic diseases that constitute a public hazard. In some jurisdictions, any proposed cremation of the remains is usually subjected to inquiry by the medical examiner's office prior to the cremation.

The medical examiner's office not only certifies the cause and the manner of death, but also helps prevent accidental, suicidal, and homicidal deaths by maintaining and disseminating biomedical information and by participating in professional and public education. See also: Public health

With the advent of transplants as therapeutic procedures, some medical examiners have become involved in the administration of organ and tissue donation programs and related ethical matters. This necessitated a new legal definition of death. Moreover, ethical problems have arisen concerning the patient's right to refuse certain kinds of care. When a patient is dying or irreversibly comatose, such decision–making is a troubling matter. In some states, a surrogate can be authorized to make decisions about the patient's care (power of attorney for health care). Forensic medicine plays a vital role in the enactment of appropriate legislation to handle these and other ethical matters. See also: Death

Drug and poison detection

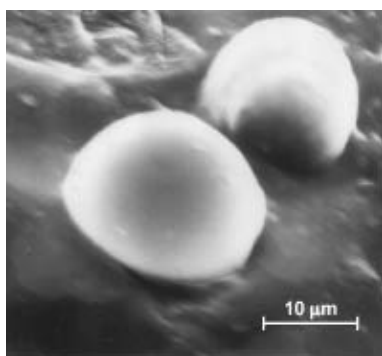
Drug and alcohol abuse have been social problems for centuries. Before World War II, alcohol, barbiturates, heroin, aspirin, cyanide, and arsenic were the chemicals most commonly causing death. In the 1960s, stimulants and hallucinogenic drugs arrived. In the 1970s, phencyclidine (PCP) and lysergic acid diethylamide (LSD) caused major problems and deaths, and in the 1980s cocaine became the most widely publicized illegal drug involving fatalities. The medical examiner determines the cause and manner of death due to drugs and alcohol, but also assesses drug and alcohol involvement in deaths due to traffic accidents, homicides, and suicides, and maternal and perinatal deaths.

The rapid improvement in the accuracy and sensitivity of analytical instrumentation, coupled with the availability of sophisticated computers, now makes it possible to detect drugs, poisons, and their metabolites in samples as small as 10^{-12} g. Although the incidence of drug overdose leading to deaths has declined, alcohol, multiple therapeutic drugs, and illegal substances continue to plague society. See also: Forensic chemistry; Forensic toxicology

Scanning electron microscope

As part of the medicolegal investigation, the medical examiner performs microscopic examination of tissues. The analysis of trace materials, including gunshot residue, fibers, glass, and serological material, may greatly add to the understanding of the circumstances surrounding death. Microscopic examination, in particular with the scanning electron microscope (Fig. 1), which permits viewing of minute objects with magnifications up to 100,000 times, is useful for the analysis and identification of minute fragments of objects left on human bone, cartilage, and soft tissue, such as the crushing marks of an assault tool on the skin and serrated markings on bone in the case of stabbing. Another example is electrocution, where the skin may show the burn of the electric wire and a deposit of copper. Scanning electron microscopy coupled with energy–dispersive x–ray spectroscopy can effectively identify chemicals deposited on the wound and may be used to identify gunshot residues, which are composed principally of lead, antimony, and barium. Atomic absorption spectroscopy and neutron activation analysis are also used for this purpose. See also: Analytical chemistry; Scanning electron microscope

Fig. 1 Scanning electron microscopic image. The two round objects represent molten primer compound emitted from a recently fired cartridge. Energy–dispersive x–ray spectroscopy produced the spectrum characteristic of gunshot residue. (*Office of Chief Medical Examiner–Coroner, County of Los Angeles*)



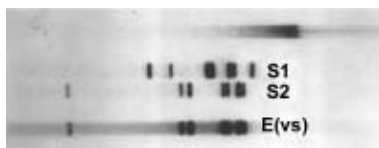
Identification of bite marks

During the investigation of a death, a forensic pathologist looks for bruises and marking on the victim's skin. The assailant may leave a bite mark on the skin, which can be used to identify the person. Bite marks are second only to fingerprints in their forensic value for identifying murderers, particularly serial killers.

Genetic analysis

Another important development is the forensic application of genetic analysis. Every individual has a unique genetic content determined by deoxyribonucleic acid (DNA) sequences. The DNA present in forensic samples such as hair, bloodstains, and seminal fluid can identify a suspect. One analysis technique is called DNA fingerprinting; it can be used to compare the DNA sequence of a suspect or a defendant with material evidence at the crime scene. The DNA is broken into unique fragments by restriction endonucleases and then separated by electrophoresis. The pattern seen after hybridization with specific probes is called the DNA fingerprint, and like an ordinary fingerprint is characteristic of the individual (Fig. 2). DNA analysis is also used in identification of an unknown person or of parts of a human body. Paternity exclusion by ABO blood typing has been replaced by DNA fingerprinting. See also: Deoxyribonucleic acid (DNA)

Fig. 2 DNA sequence of two rape–murder suspects, S1 and S2, are compared with the DNA sequence of the seminal fluid found in the vaginal smear from the victim. Suspect sample S2 matches the DNA sequence of the seminal fluid E(vs). A guilty verdict was rendered against suspect S2. (*Cellmark Diagnostics, Division of ICI Americas Inc.*)



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Topic Page: >> Medicine: >> Medical science – general

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Additional Readings

- National Association of Medical Examiners



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