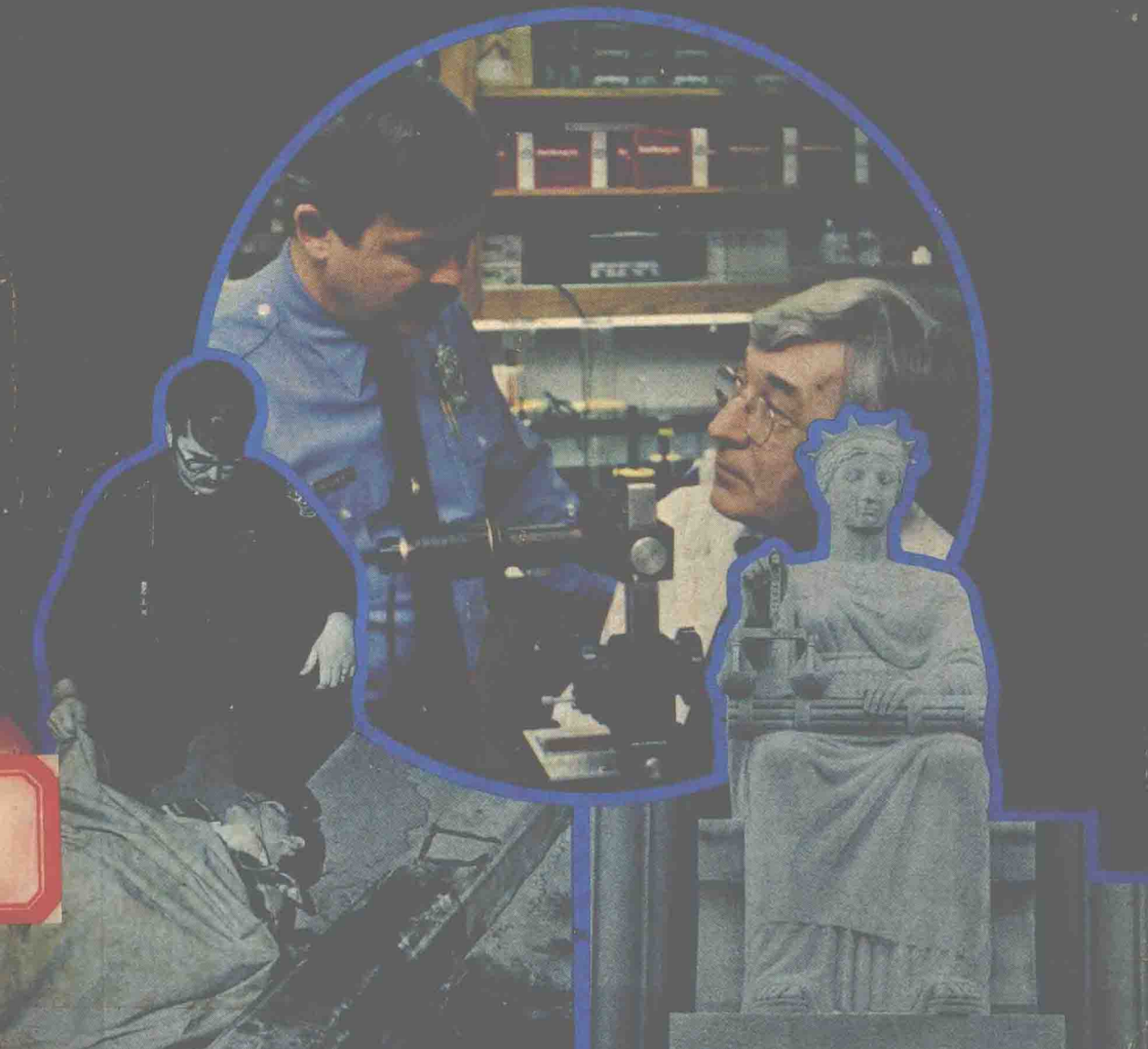


Introduction to  
**FORENSIC  
SCIENCES**

Edited by **WILLIAM G. ECKERT**



# Introduction to **FORENSIC SCIENCES**

*Edited by*

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*with 60 illustrations*

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*To all practitioners in the forensic sciences:  
poorly paid and overworked but  
dedicated to their role as neutral and objective scientists  
in the administration of justice*

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# Foreword

Across the facade of a magnificent western courthouse is carved the inscription, "For what is so important as the administration of justice?" When Alexander Hamilton wrote these words nearly two centuries ago he could not have foreseen the enormous role that medical science was to assume in the judicial process. At that time legal medicine was in its infancy, and the tools it had to work with were few and uncertain.

For four centuries prior to the time that colonists from Britain and Western Europe started to settle in North America in the seventeenth century, the English people had been struggling for democratic government and particularly toward establishing the rights of the individual as against the imperialism of the state. Subsequently, when in large measure the English legal system was adopted in the colonies and the common law became the backbone of our judicial processes, we inherited from Great Britain laws conspicuous for the absence of provisions to apply medical knowledge to the administration of justice. In large measure our laws continue to be hostile to medical jurisprudence. Britain during the nineteenth century made great advances in this field and established chairs of legal medicine in all its leading medical schools. However, in the United States in only a few places have the states yet made any demand for competent medical experts to come to the aid of the law.

From the English we inherited the coroner system of medicolegal examinations, and in most parts of the United States the coroner is still the official who is entrusted with that important function. Possessing neither medical nor legal knowledge, which would seem to be a basic requirement, this official survives solely on political popularity—a qualification that a real medical expert is not likely to possess. Oddly enough, the office of coroner is not a product of the political turmoil and Renaissance of England but has survived almost unchanged from the monarchy of the Middle Ages before the days of the Magna Charta and the crusades.

Another adjunct of this system is the outmoded and antiquated coroner's inquest—a tribunal in which a jury of six persons is charged with the determination of the cause of death and naming the person responsible. Generally the first six persons on the nearest park bench are chosen, and they take a quick glance at

the remains through an open door and listen to what evidence the coroner has at hand. This procedure seems to be founded on the theory that ignorance multiplied by six equals intelligence.

The birth of the modern concept of legal medicine seems to have occurred as a consequence of the Renaissance in Italy, and as this new enlightenment spread to other countries of Western Europe, legal medicine became most deeply rooted in the Germanic countries. Starting in 1532 these nations took steps to establish a sound system of legal medicine and have been predominant in the field ever since.

During the seventeenth and eighteenth centuries the authority of Zacchias was supreme in this field, and it is interesting to take note of the principal problems with which he was concerned. He devoted chapters to such subjects as torture, sorcery, prophecy, and miracles. During this period doctors gravely discussed whether a woman could be got with child by the devil or by a dream, and French judges legitimized an infant when the husband had been separated four years from the mother on the grounds that the child owed its paternity to a dream. It was generally taught that grossly deformed infants had a bestial parentage. The effect on a suspected murderer of touching the body of his supposed victim continued to be a legal expedient within the nineteenth century. Until 1726 cruentation was firmly established in medicolegal practice. It consisted in the belief that in the presence of the murderer the wounds of the corpse, no matter how long dead, would open and bleed afresh. Courts accepted the testimony of medical experts to this miraculous phenomenon.

Medicolegal autopsies were denounced until about 1750, and the work of Morgagni, the father of morbid anatomy, which is a foundation stone of legal medicine, was not published until 1761. So great was the helplessness of the science of legal medicine that a horrible atmosphere of suspicion encompassed the fear of death by poison. On those who were even suspected, the grossest legal abuses were everywhere inflicted, while those who were convicted were boiled alive by the English and burned by the French. The medicolegal authorities Paré, Zacchias, Hoffman, and others taught belief in ghosts, witches, and possession by the devil and united with the clergy in denouncing all disbelievers as heretics and atheists. The distinguished expert Hoffman condemned all those as witches who "vomited nails, hair, wax, glass or leather." Thus did the legal medicine of our ancestors only a few generations removed persecute, drown, and burn thousands of insane persons as "firebrands of hell" who are "moved and seduced by the instigation of the devil."

With the impotence of science to aid the law it adopted miracles as explanations, suspicion as proof, confession as guilt, and "torture as the chief witness"—the medical expert being summoned only to sustain the accused until the rack forced his confession.

In view of this history, *Introduction to Forensic Science* will open up a new

world to those who have occasion to benefit by the wealth of information it contains. Dr. William G. Eckert has performed a masterful service in arranging these facts and presenting them under appropriate headings.

In assembling this material he has wisely chosen to use the services of scientists who are authorities in their respective fields, and their contributions as edited by Dr. Eckert make this book a fresh addition to the literature of forensic science. It constitutes a most valuable reservoir of intelligence to the chief aim of this volume: to identify the guilty and absolve the innocent.

Science has provided the tools; it is up to society to see that the law uses them: "For what is so important as the administration of justice?"

**LeMoyne Snyder, M.D.**



# Preface

The specialized and interrelated fields that constitute the forensic sciences have been studied with growing interest for many years. The need for a broad introductory text dealing with these disciplines of study and professional practice has become increasingly apparent. This text will serve to fill this need by acquainting students pursuing careers in the administration of justice with the several specialty areas that function cooperatively to provide the essential scientific evidence for litigation of criminal and civil cases.

This book presents each of the distinct fields that collectively comprise the forensic sciences. These discussions are contributed by experts in their respective fields. When it is feasible, some of the diverse methods of applying these sciences in different countries are included. For students who need a simple overview, as well as those seeking to learn about available career opportunities, the various ways in which the collective sciences pursue justice at different jurisdictional levels in America and throughout the world will be both useful and interesting.

A consistent effort has been made to acquaint the reader with the vast array of resources and specialized skills that exist within the forensic sciences. The professional organizations, the literature, and significant individual leaders are discussed in every chapter. A historical review identifying experts in each field and their contributions was included to provide students with role models and to motivate them to further the advancement of the forensic sciences.

**William G. Eckert**

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# Introduction to forensic sciences

William G. Eckert

From the earliest times the primary tools in the investigation of forensic cases have been observation and interpretation of physical findings. In the last half of the nineteenth century, science was first applied by the newly advancing fields of chemistry, microscopy, and photography. This revolutionized the manner in which cases were investigated and improved the validity of the conclusions drawn from the investigation of responsible authorities.

A few attempts were made to organize special areas within police departments for processing evidence. Investigating authorities individually obtained scientific information from academic departments of chemistry or pharmacology having knowledgeable scientists and technical instruments such as microscopes. Law enforcement authorities had to locate such resources and deliver the evidence for processing.

In some instances scientific laboratories within the police organizations evolved from identification functions. Bureaus of identification developed because the number of criminals rose with population increases. Law enforcement could no longer depend on the memory of shrewd police officers who knew the felons and their gangs so well that they could determine with accuracy whose handiwork was involved in a particular crime. Initially identification bureaus used the identification method of Bertillon, which was based upon anthropologic measurements supported by photographic documentation. Bertillon's technique of identification was replaced by fingerprint techniques. The processing of fingerprints thus became coupled with new responsibilities for handling physical evidence such as stains, hair, dirt, and other material left at the scene of a crime.

The seeds of modern forensic sciences were sown in the last quarter of the nineteenth century. Progress from that time has been slow but steady. American forensic scientists are now well organized into the American Academy of Forensic Sciences. This organization was established in 1950 by many pioneers in the field who were enthusiastically led by Dr. R. H. Gradwohl of St. Louis, Missouri. The

American Academy of Forensic Sciences includes the following specific areas of expertise: pathology and biology, toxicology, criminalistics, questioned documents, dentistry, anthropology, jurisprudence, psychiatry and a general section. Other sections are developing in such fields as engineering, geology, and microscopy.

### **SPECIAL AREAS OF THE FORENSIC SCIENCES**

#### **Pathology and biology**

The discipline of forensic pathology is a specialty of medicine and a subspecialty of pathology. It was developed to study the problems related to unnatural death and various types of trauma to the living. The pathologist is a doctor of medicine who has had at least four years of training in pathology after medical school and one additional year of activity in handling medicolegal autopsies involving unnatural, suspicious, violent, or unexpected deaths. The forensic pathologist may administer a system of medicolegal investigation. The two systems of medicolegal investigation in the United States are the medical examiner's system and the coroner's system.

The categories of death to be examined are established by statute and classified as to the cause and manner of the death. In the state of New York, deaths occurring during medical treatment, all violent and suspicious deaths occurring to individuals under custody in public or private institutions, or deaths occurring to individuals working in industrial hazards are investigated. The investigation may be followed by a postmortem examination during which the pathologist establishes the cause and manner of death. This often requires on-the-scene investigation before the autopsy is performed. Evidence from the body may be referred to other experts—the toxicologist, serologist, criminalist, dentist, or anthropologist—for further examination.

Biologic testing of evidence includes investigation of blood typing and identification of stains for their content. The comparison of blood types is done in paternity cases. In rape cases saliva and semen, which can be transmitted to another person, may be examined to determine the blood group of the assaulting individual. Distinguishing between human and animal blood is also a part of the pathologist's investigation. Biologic expertise is required in areas and cases involving botanical or entomologic evidence. Plant and insect life become an important concern in establishing how long a body had been in the location where it was found.

#### **Toxicology**

Toxicology deals with the detection of toxic substances in body tissues and fluids. The toxicologist analyzes biologic fluids from victims who are thought to have been poisoned accidentally or purposely. The toxicologist, distinct from the forensic chemist, primarily handles biologic fluids and can detect poisons in blood, urine, spinal fluid, gastric contents, bile and many other body fluids and tissues.

## **Anthropology**

Forensic anthropologists are experts in the identification of bones and skeletal remains. Their studies provide information about sex, race, age, blood type, and time of death. They might also lend support to investigations concerning living cases such as a mix-up of children in a hospital nursery or skeletal identifications of persons involved in immigration problems. The forensic anthropologist may be extremely helpful in mass disasters where there is a considerable number of skeletal remains and in cases where there has been mass burial. A recent application of this expertise has been in reconstructing the face of a skeletonized head.

## **Odontology**

The odontologist or dentist provides information through examination of teeth and dental prostheses. Victims of a disaster or homicide may be identified by a comparison of their dental charts and x-rays to the dental evidence from the victims. Bite mark examination is also an area in which dental expertise is helpful. Bite marks in apples, cheese, fried chicken, chewing gum, and other media as well as on a victim's body may be studied by these scientists. This form of scientific expertise may be used in living cases since the examination of teeth is helpful in cases where there is a possibility of a hospital mix-up of children. Such examinations depend upon the presence of inherited characteristics in teeth.

## **Psychiatry**

The psychiatrist is vital in solving many forensic problems. Psychograms, which analyze behavior, personality, and psychiatric problems, can offer a profile of the assailant to law enforcement officers. Suicides may require a so-called psychological autopsy. Developed by the coroner's office of Los Angeles under Dr. Thomas Noguchi and other forensic scientists in the Los Angeles area, the psychological autopsy consists of a review by psychologists, psychiatrists, and the pathologist of the events and behavior leading up to the death of a person. This in-depth investigation may bring out predisposing behavior, suicidal traits, or financial or alcoholic problems important in establishing causes contributing to the manner of death.

It is extremely important that the accused be properly investigated from a psychiatric standpoint if the cause of his behavior is a medical problem. There are occasions when the psychiatrist may actually evaluate a testifying witness. In the Alger Hiss case, Whitaker Chambers was evaluated by a battery of psychiatrists in the courtroom. Psychiatrists may use thiopental sodium (truth serum) with individuals who have temporary amnesia caused by serious accidents.

## **Questioned documents**

Questioned document examinations were reported as far back as Roman times, with cases of forged documents being described. The use of typewriters has added

significantly to their activities. The Q.D. examiner's work includes examination of handwriting, ink, paper, typewriter impressions, or any other form of writing or printing that may have been used in the case. This expertise includes detection of counterfeiting and examination of various types of fraud involving government paper, forms, money, and credit cards. The investigation of computer fraud examines the validity of print-out material.

### **Criminalistics**

Criminalistics requires several types of expertise. Criminalists in small departments and laboratories handle a general workload. In larger departments they are more specialized. A large criminalistics laboratory will have sections specializing in firearms and explosives examination, toolmark examination, document examination, biologic examination, physical analysis, chemical analysis, soil analysis, and identification.

The firearms section examines bullets from the body of a homicide victim and compares the condition of these bullets to one fired from the weapon used to commit a crime. This is done with a comparison microscope and by weighing and examining the cartridge, bullet, shell, and wadding. Firing pin and ejector marks are also examined. The evidence is documented and recorded for presentation in court. During testimony the firearms expert presents the results of the examination.

Examination of explosives is increasing in volume in large laboratories. The explosives examiner is responsible for the collection of evidence on the scene, examination in the laboratory, and reconstruction of the device and type of explosion. The evidence is often fragmentary and may include a timing device, detonation device, the explosives, and the package in which the explosives were found. Explosives examiners may have to reconstruct the bomb and possibly detonate it in order to demonstrate its similarity to the crime-scene evidence. In fatal explosion cases cooperation with the pathologist is essential as part of the explosive may be embedded in the body of the deceased.

Forensic chemistry is responsible for chemical testing of drugs and other substances found as evidence. This includes illicit drugs, alcohol, accelerants used in arson, and residual explosives after a bombing. This section may be responsible for the testing program of blood alcohol and breath alcohol evidence in drunk driving cases.

In the crime laboratory, technologists in the biology section deal with identification of blood, seminal fluid, and other body fluids. This requires a high degree of expertise and experience in biologic techniques. Soil analysis requires a considerable amount of experience as it includes chemical and physical testing with considerable proficiency in the use of the microscope. Microscopy itself is the mainstay of a crime laboratory. A private organization, the McCrone Institute of Microscopy in Chicago, is a major resource in this specialized field for research and

practical investigation of problems related to soils and other fragmentary trace evidence.

Identification problems provided the impetus for developing scientific laboratories as a section of law enforcement agencies. Identification departments are a mainstay of modern criminalistic laboratories. Their role is applied to the identification of fugitive felons through photographic records, composite drawings, or fingerprint comparison. They may also be utilized in cases of skeletal remains or of fragmented bodies from disasters. Many techniques including x-ray films, photography, fingerprinting, dental comparison, and blood typing may be used in identification laboratories. Voiceprint comparison is a recently developed speciality of crime laboratories.

The application of physics plays a major role in the investigation of minute trace evidence and accident cases in a major crime laboratory. This requires use of instruments that can perform neutron activation analysis, which is a nondestructive method of testing. X-ray diffraction instruments may also be used in a well-equipped laboratory. In the laboratory investigation of an auto accident, tires may be examined for failure. The criminalistics section includes myriad tests and responsibilities for scientists.

## **Jurisprudence**

The expertise of the professional scientist can be of little value unless it is properly presented in a court of law. Consequently the American Academy of Forensic Sciences has developed an area concerned with jurisprudence, which offers the practicing attorney the opportunity to learn what may be obtained from the insight and testimony of an expert. Thus there can be a more definitive preparation and utilization of the expert witness. Annual meetings permit attorneys to attend programs of all areas of the American Academy of Forensic Sciences in order to gain a broader exposure to the knowledge and proficiency of related forensic disciplines.

Medicolegal problems include an infinite number of areas for potential litigation. Basically, legal medicine deals with those areas related to the health care and welfare of a patient. It is extremely important for the attorney to understand the medical problems of any case and to know the type of physician or specialist who can provide pertinent information as well as future testimony to support his case. Cases involving both living and deceased persons are handled under such statutory areas as medical liability, institutional liability, workmen's compensation, products liability, and environmental protection.

The most helpful informational resource in medical areas for the newly graduated lawyer may be the local director of the hospital laboratory. Most hospitals over 150 beds have a pathologist in residence, and laboratories of smaller hospitals are directed or supervised by pathology groups from larger cities so that for the most part pathologists are easily accessible. Pathologists are primary initial

resources because their major activity is dealing with problems presented daily by medical specialists from every medical field. This makes pathologists excellent sources for referral to those specialists who may be needed to clarify and interpret the significance of clinical tests.

## **SPECIAL PROBLEMS OF FORENSIC MEDICINE**

### **Living cases**

Alcohol intoxication is one of the most frequent cases presented. The problems related to this particular area include accuracy of testing, specimen taking, the validity of the results, the problems caused by delay in taking the specimens, and variations in the level of alcohol due to the time the blood sample was taken in relation to the time of the accident. The individual's history of alcoholism, serious disease of the liver or kidneys, and metabolic disease such as diabetes are all important to cases of alcohol use since they have some influence on the metabolism of ethyl alcohol. In possible intoxication cases—a low alcohol measurement and the apparent inability of a person to handle the task of driving—one must consider the possibility of drug use or of a combination of alcohol and medication. The frequency of this occurrence has led to routine procedures of alcohol and drug examination in both living and deceased persons.

Sexual problems in living persons frequently require examination of stains on clothing, bed clothing, rugs, or seat covers for semen. This test is important in cases of incest, carnal knowledge, and rape or sexual assault. In the absence of an available criminalistic laboratory the hospital laboratory tests smears for spermatozoa and performs chemical testing for acid phosphatase, an enzyme in male secretions. The examination of the victim is usually carried out in the emergency room or a doctor's office. In the event of a rape case, advance testing may be done as well on the fluid washings from the victim for the presence of blood from the assailant. The hospital laboratory may also be called upon to determine the gender of a young child where there is immature development or lack of development of any sexual organs. This is done through chromosomal studies and examination of blood for characteristics of gender.

The examination of surgical tissue is a routine activity for pathologists in a hospital laboratory, and the findings may be used as evidence in cases of medical or product liability. Injuries produced by chemical reactions from products implanted in the body such as contraceptive intrauterine devices may also require documentation by the pathologist. The pathology department also has authority over organ transplantation, which may require specific documentation.

The pathologist's experience with examination for injury is beneficial in establishing the possible cause of injuries to living victims. For example, in cases of potential police brutality the age of an injury is important. Also, pathologists may evaluate the injuries of a young child to determine if the child has been abused.

Tissue and chemical analyses of living persons are performed to establish



possible exposure to environmental hazards in industry or the home. Such testing can demonstrate the presence of carbon monoxide, drugs, and harmful metals such as mercury and lead with which the individual may come in contact during regular employment. Chemical complications from an overdose of drugs, either accidentally in a child or due to a suicide attempt in an older person, are also subject to analysis in pathologist-directed laboratories.

Malingering and the demonstration of self-injuries is an extremely interesting and relatively recent area of investigation. Frequency in discovery of self-injury is directly proportional to the degree of suspicion and awareness of the examining emergency room physician and nurse. In one recent case of self-injury an individual put her foot into a lawn mower; in another, an infection was produced requiring amputation. Individuals have produced a bloody cough, bloody vomiting, or hematuria by use of instruments that produced the appearance of an emergency requiring hospitalization. Self-destructive patterns are often focused on a solitary area of the body.

Iatrogenic problems are complications that result directly from the medical treatment. They may derive from drug complications, new forms of therapy, or new medical instrumentation. They add liability to the responsibilities of the health care professionals and the hospital. The pathologist very often is the first to see this type of problem.

## **Examination of the dead**

Part of the pathologist's general responsibility is to deal with examination of deceased persons. In the case of a hospital death this is done at the request and with the permission of the family. A hospital death may be brought to the attention of the pathologist to document the cause of death, the effect of medical treatment, and the presence or absence of unusual complications or unexpected disease processes. An autopsy is a scientific procedure. The dissection is followed by examination of tissue. Chemical or bacteriologic examinations may be required. The results are documented in written and photographic form.

In medicolegal cases, permission for body examination is obtained through the authorization of the coroner, who by statute is required to establish the cause of death. The purpose of the autopsy is to document the identification of the victim, any injuries, and the characteristics of such injuries to determine whether activity might have followed a lethal injury. An autopsy also documents the presence or absence of possible sexual problems related to the case as well as determining the cause and manner of death. This is an extremely important responsibility of the coroner who is aided by the pathologist. The question of whether the death is accidental, homicidal, suicidal, or of undetermined cause must appear on the death certificate. There are occasional cases where disability and workman's compensation claims may add importance to the autopsy investigation. In some instances where an autopsy was not performed a disinterment of the body and an autopsy