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CRIME SCENE DO NOT CROSS

CRIME SCENE

**The investigation of felonious injuries and criminal homicides** can be the most important yet difficult responsibility assigned to a police investigator. First, these crimes are viewed as

being among the most serious offenses committed in our society. The seriousness is reflected in all state statutes, which impose severe penalties for acts resulting in the grave bodily injury or death of a human being. Second, in the beginning stages of some homicide investigations, the inability to identify the decedent greatly complicates the investigative process and prevents it from moving forward. In all homicides, questions such as "Who were the victim's enemies?" and "Who would benefit most from the victim's death?" must be answered before any significant progress can be made in the investigation. Estimating the time of death also needs to be done early in the investigation. Third, criminal homicides, in particular, can generate a lot of media attention and public scrutiny for the department. Pressure to solve the crime from both inside and outside the police agency creates added strain on the criminal investigator.

For these cases, in particular, investigators may need to call on the assistance of experts in the scientific and medical fields. Investigators should create working relationships with specialists such as forensic pathologists, toxicologists, entomologists, and botanists, who can all provide useful assistance to the case. In short, the severity of these crimes warrants that investigators use all available resources in their investigations.

## THE LAW

The various state statutes contain different names for **felonious assault**—such as aggravated assault, assault with intent to commit murder, and felonious battery—but all have one common legal element, namely, that the assault was committed for the purpose of inflicting severe bodily harm or death. In most such assaults, a deadly weapon is employed.

Police officials and members of the public often use the terms "homicide" and "murder" interchangeably. In fact, murder is only a part of the broad category of homicide, and **homicide** is divided into two broad classifications: nonfelonious homicide and felonious homicide. **Nonfelonious homicides** may be justifiable or excusable. **Justifiable homicide** is the necessary killing of another person in performance of a legal duty or the exercise of a legal right when the slayer was not at fault.

**Excusable homicide** differs from justifiable homicide in that one who commits an excusable homicide is to some degree at fault but the degree of fault is not enough to constitute a criminal homicide. There are two fundamental types of excusable homicide. The first involves death that results from misadventure. This is similar to what may be termed "accidental" death at the hands of another. **Misadventure** is death occurring during the commission of a lawful or an unlawful act when the slayer has no intent to hurt and there is not criminal negligence. An example of misadventure is the death of a person who runs in front of a moving automobile whose driver is unable to avoid the collision.

The second type of excusable homicide involves death that results from self-defense when the slayer is not totally without fault, such as someone who gets in a sudden brawl and has to kill to preserve his or her life.<sup>1</sup>

## CHAPTER OUTLINE

Introduction  
 The Law  
 The Medico-Legal Examination  
 The Autopsy  
 Postmortem Changes and Time of Death  
 Forensic Entomology  
 Evidence from Wounds  
 Suicide  
 Fire Deaths  
 Serial Murder

**Felonious homicides** are treated and punished as crimes and typically fall into two categories: murder and manslaughter. **Murder** is defined in common law as the killing of any human being by another with malice aforethought. Most states now provide for varying degrees of murder. **Manslaughter** is a criminal homicide that is committed under circumstances not severe enough to constitute murder but that cannot be classified as either justifiable or excusable homicide.<sup>2</sup>

## THE MEDICO-LEGAL EXAMINATION

The **medico-legal examination** brings medical skill to bear on injury and death investigations. The medical specialist frequently called on to assist in such cases is the forensic pathologist. **Forensic pathology**, a subspecialty of pathology, is the study of how and why people die. To become a forensic pathologist, a physician first attends an approved pathology residency program and then attends three years in a strictly anatomic program or five years in a combined anatomic and clinical program. One or two additional years are devoted to studying the pathology of sudden, unexpected, natural death, as well as violent death, in an approved forensic fellowship training program (there are approximately 30 throughout the country). Most programs are centered in major cities that have a large number of deaths from various causes. The most important area of study for a forensic pathologist is death investigation, but some forensic pathology programs also include examination of the living to determine physical and sexual abuse. Physicians specializing in forensic pathology are ordinarily employed by some unit of government and are not in private practice.<sup>3</sup>

## THE AUTOPSY

All violent and suspicious deaths require an **autopsy** to determine the time and precise cause of death.<sup>4</sup> The autopsy may also answer the following questions:

- What type of weapon was employed?
- If multiple wounds were inflicted, which wound was fatal?
- How long did the victim live after the injury?
- What position was the victim in at the time of the assault?
- From what direction was the force applied?
- Is there any evidence of a struggle or self-defense?
- Is there any evidence of rape or other sex-related acts?
- Was the deceased under the influence of alcohol or any type of drug?<sup>5</sup> (The actual analysis will be done by the toxicologist.)

Answers to all or even some of these questions increase the possibility of bringing the death investigation to a successful conclusion.

## DEAD BODY EVIDENCE CHECKLIST

The following dead body evidence checklist will assist both the investigator and the medical examiner in systematically following all the steps necessary to be certain that no physical evidence is overlooked:

- Thoroughly photograph everything before moving or touching it.
- Collect fragile evidence on the body.
- Remove hair, fingernails and other trace evidence. Use toothpicks to collect evidence that might be under the fingernails if they are short. Place the items in waxed paper, bundle them, and place them in envelopes.
- Brush the head hair and the pubic region (if the body is unclothed). Hold butcher paper under the area being brushed.
- Remove trace evidence from the entire body's skin and clothing, including the face, hands, feet, legs, torso, pubic area, and neck, with Scotch tape or lint rollers. Use only frosted tape.
- Collect samples of pooled blood.
  - Use hemasticks to confirm it is actually blood.
  - Collect control samples (as close to the injured area as possible).
  - Use a cotton swab with one drop of distilled water on it. Place the swab in wax paper loosely, and then place it in an envelope.
- Collect exemplars from the following areas:
  - Environment (vegetation, soil, maggots, other)
  - Residence (carpet fibers, paint, misc. fibers, other)

- Vehicle (carpet fibers, seat fibers, roll the tires, VIN number, wheel base)
- Animals (hairs, bedding)
- Collect blood samples from the victim.
- Swab the bite mark areas.
- Swab the oral cavity.
- Collect exemplar hairs.
- The victim should be fingerprinted even if there is positive proof of identification.
- If circumstances dictate, palm prints and footprints should also be obtained. They may prove useful in matching prints that are later found in the suspect's home, business, car, or other location.
- Collection of the victim's clothing.
  - If the clothing is damaged, the investigator should determine whether the damage is related to the assault or was caused by hospital or emergency personnel giving emergency treatment. When a determination is made of the cause of damage, it should be recorded in the investigation report.<sup>6</sup>

## POSTMORTEM CHANGES AND TIME OF DEATH

A recurring problem in forensic medicine is the need to fix the time of death within the limits of probability. The longer the interval of time between death and the examination of the body, the wider will be the limits of probability. The longer the postmortem interval, the more likely it is that associated or environmental evidence will furnish more reliable data on which to estimate the time of death than will anatomical changes.<sup>7</sup>

It is necessary to be alert to the possibility that the postmortem interval (the time elapsed from death until discovery and medical examination of the body) may be preceded by a significant survival period (the time from injury or onset of the terminal illness or death). The survival interval is best established by evaluating the types, severity, and number of injuries present and the deceased's response to them, taking into account preexisting natural disease.

Establishing the times of an assault and death has a direct bearing on the legal questions of alibi and opportunity. If the suspect is able to prove that he/she was at some other location when the fatal injury was inflicted, then the suspect has an alibi and innocence is implicit. Conversely, if the time of a lethal assault coincides with the time when the suspect was known to be in the vicinity of the victim, then the suspect clearly had an opportunity to commit the crime.

### ESTIMATING TIME OF DEATH

Many physico-chemical changes begin to take place in the body immediately or shortly after death and progress in a fairly orderly fashion until the body is fully decom-

posed. Each change has its own time factor or rate. The rates of development of postmortem changes are strongly influenced by unpredictable changes within the body and environmental factors. Consequently, the longer the postmortem interval, the wider is the range of estimate as to when the death probably occurred. In other words, the longer the postmortem interval, the less precise is the estimate of the time of death.<sup>8</sup>

### ALGOR MORTIS (BODY COOLING)

After death, the body cools from its normal internal temperature of 98.6°F to the surrounding environmental temperature. Many studies have examined this decrease in body temperature, called **algor mortis**, to determine formulas that could predict its consistency. Unfortunately, because of numerous variables, body cooling is an inaccurate method of determining the postmortem interval. In general, however, evaluating a decrease in body temperature is most helpful within the first 10 hours after death. During this time, with a normal body temperature and at an ideal environmental temperature of 70° to 75°F, the body cools at approximately 1.5°F per hour, however the problem with using the 1.5°F-per-hour calculation is based on the assumption that the internal temperature is 98.6°F and the environmental temperature remains at a constant 70°–75°F. If a decedent's body temperature is higher than normal at the time of death because of an infection resulting in a fever, then the body temperature of 98.6°F cannot be used. Furthermore, the outside environment is rarely in the 70°–75°F range, and a body may actually gain heat if an individual expires outdoors during the summer, when temperatures may be greater than 100°F. Conversely, if a person expires in a 25°F environment, rapid cooling takes place.

Nonetheless, if body temperature is measured at a scene, it should be taken by the attending physician on at least two separate occasions before the body is moved. A rectal or liver temperature is the most accurate measurement. The environmental temperature should also be recorded. If these relatively simple procedures are followed, a very crude estimate of the postmortem interval can be made.<sup>9</sup>

Other factors that will affect the rate of cooling include:

- *The size of the body.* The heavier the physique and the greater the obesity of the body, the slower the heat loss.<sup>10</sup>
- *Clothing and coverings.* These insulate the body from the environment and therefore cooling is slower. It has been estimated that cooling of a naked body is half again as fast as when clothed.<sup>11</sup>
- *Movement and humidity of the air.* Air movement accelerates cooling by promoting convection and even the slightest sustained air movement is significant. Cooling is said to be more rapid in a humid rather than a dry atmosphere, because moist air is a better conductor of heat.

• *Immersion in water.* A cadaver cools more rapidly in water than in air, because water is a far better conductor of heat. For a given environmental temperature, cooling in still water is about twice as fast as in air and in flowing water about three times as fast.<sup>12</sup>

## OCULAR CHANGES

In *ocular change*, the cornea becomes cloudy within 2 hours or less if the deceased dies with eyes open. If eyes are closed, it will be 12–24 hours. On the third postmortem day, the corneas become opaque. When gases begin to collect in the body, the eyes may bulge out of the eye socket, but when advanced decomposition sets in, the eyes become endophthalmic, or retracted into the socket.<sup>13</sup>

## STOMACH CONTENTS

After a light meal, food will leave the stomach in 1–2 hours, a medium meal 3–4 hours, and a very heavy meal, 4–6 hours. Examination of the stomach contents may provide information not only about the time of death but also about what the person had eaten just before dying.<sup>14</sup>

## RIGOR MORTIS

After death, the muscles of the body initially become flaccid. Within 1 to 3 hours they become increasingly rigid, and the joints freeze—a condition called **rigor mortis** (or postmortem rigidity or rigor) (Figure 9-1).

Rigor mortis is affected by body temperature and metabolic rate: the higher the body temperature, the more lactic acid produced and the quicker rigor occurs. For

example, a person dying with pneumonia and a fever will develop rigor sooner than a person with normal body temperature. Similarly, if a person's muscles were involved in strenuous physical activity just before death, rigor develops much more quickly. The process is also retarded in cooler environmental temperatures and accelerated in warmer ones.

All muscles of the body begin to stiffen at the same time after death. However, muscle groups may appear to stiffen at different rates because of their different sizes. For example, stiffness is apparent sooner in the jaw than in the knees. Thus, an examiner must check to see if joints are movable in the jaws, arms, and legs.

A body is said to be in complete rigor when the jaw, elbow, and knee joints are immovable. This takes approximately 10–15 hours at an environmental temperature of 70°–75°F. A body remains rigid for 24–36 hours before the muscles begin to relax, apparently in the same order they stiffened.

A body remains rigid until rigor passes or until a joint is physically moved and rigor is broken. Consequently, in addition to indicating an approximate time of death, body position in full rigor can indicate whether or not a body has been moved after death.<sup>15</sup>

## LIVOR MORTIS

**Livor mortis** (lividity, postmortem hypostasis) is a reddish purple coloration in dependent areas of the body due to accumulation of blood in the small vessels of the dependent areas secondary to gravity (Figure 9-2). Postmortem lividity is occasionally misinterpreted as bruising by people unfamiliar with this phenomenon.

Dependent areas resting against a firm surface will appear pale in contrast to the surrounding livor mortis,



◀ **FIGURE 9-1 Rigor mortis**

This individual, who died of natural causes, had been dead for approximately 10 hours. Note the arms in the upright position—the result of rigor mortis. The body will remain rigid for 24–36 hours before the muscles begin to relax.

► **FIGURE 9-2 Livor mortis**

Livor mortis (lividity, postmortem hypostasis) is a reddish purple coloration in dependent areas of the body due to accumulation of blood in the small vessels of the dependent areas secondary to gravity. It is usually evident within 30 minutes to 2 hours after death, typically reaching its maximum coloration at 8–12 hours. Postmortem lividity is occasionally misinterpreted as bruising by people unfamiliar with this phenomenon.



owing to compression of the vessels in this area, which prevents the accumulation of blood. Thus, areas supporting the weight of the body, for example, the shoulder blades, buttocks, and calves in individuals lying on their backs, show no livor mortis but appear as pale or blanched areas. Tight clothing, for example, such as a brassiere, corset, or belt, which compresses soft tissues, may collapse the vessels, also producing pale areas.

Livor mortis is usually evident within 30 minutes to 2 hours after death. In individuals dying a slow, lingering death with terminal cardiac failure, livor mortis may actually appear antemortem (prior to death). Livor mortis develops gradually, usually reaching its maximum coloration at 8–12 hours. At about this time, it is said to become “fixed.” Before becoming fixed, livor mortis will shift if the body is moved. Thus, if an individual dies lying on his/her back, livor mortis develops posteriorly (that is, on the back). If one turns the body on its face, blood will drain to the anterior surface of the body, now the dependent aspect. Livor mortis becomes “fixed” when shifting or drainage of blood no longer occurs, or when blood leaks out of the vessels into the surrounding soft tissue owing to hemolysis and breakdown of the vessels. Fixation can occur before 8–12 hours if decomposition is accelerated, or at 24–36 hours if it is delayed by cool temperatures. Thus, the statement that livor mortis becomes fixed at 8–12 hours is really just a vague generalization. That livor mortis is not fixed can be demonstrated by applying pressure to a dependent discolored area and noting the subsequent blanching at the point of pressure.

Although livor mortis may be confused with bruising, bruising is rarely confused with livor mortis. Application of pressure to an area of bruising will not cause blanching. An incision into an area of contusion or bruising shows diffuse hemorrhage into the soft tissue. In contrast, an incision into an area of livor mortis reveals the blood to be confined to vessels, without

blood in the soft tissue. Livor mortis is extremely important for three reasons:

1. When considered with other factors, it may help estimate the time of death.
2. It may indicate that the body has been moved after death. For example, if a body is found face down with lividity on the back, this would indicate the body has been moved. For this reason, the exact measurements, sketches, and photographs must be made at the scene before and while the body is being recovered.
3. The coloration of the skin may indicate the cause of death, as in the case of carbon monoxide poisoning, certain forms of cyanide poisoning, or extreme cold, when the color of the lividity is not purplish but cherry red.<sup>16</sup>

## CADAVERIC SPASM

**Cadaveric spasm** refers to a kind of instant rigor mortis discussed earlier in this chapter. The same physiological changes occur except at a more accelerated rate. Cadaveric spasm is also commonly called “a death grip.” It typically involves a decedent’s hand tightly clutching a weapon, usually a gun, a knife, or a razor at the moment of death<sup>17</sup> (Figure 9-3).

## DECOMPOSITION

In general, as rigor passes, skin first turns green at the abdomen. As discoloration spreads to the rest of the trunk, the body begins to swell because of bacterial methane-gas formation. The bacteria are normal inhabitants of the body. They proliferate after death, and their overgrowth is promoted in warm weather and retarded in cold weather.

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◀ **FIGURE 9-3 Cadaveric spasm**  
*Cadaveric spasm* is a term used to describe the instantaneous tightening of a hand or other body part at the time of death. Note the weapon clutched tightly in the left hand of this victim of a self-inflicted gunshot wound to the head.



◀ **FIGURE 9-4 Advanced stages of decomposition**  
 The individual shown here had been dead approximately two weeks in an unheated, unventilated room. Note the extreme discoloration and swelling of the facial area as well as the abdomen.

The different rates and types of **decomposition** a body undergoes depend on the environment (Figure 9-4). Bodies buried in earth, submerged in water, left in the hot sun, or placed in a cool basement appear different after the same postmortem interval. When a body is bloated, epidermal sloughing and hemoglobin degradation begin. Moreover, as bloating continues, air is forced from the skin. The increased internal pressure, caused by bacterial gas production, forces decomposed blood and body fluids out of body orifices by a process called *purging*. As the body undergoes skeletonization, the rate of tissue deterioration is dependent on environmental temperature. For example, a body exposed to a 100°F environmental temperature may completely decompose to a skeleton within

a few weeks. In contrast, a body in a temperature of 65°F may not skeletonize for many months. In general, a body decomposing above ground for a week looks similar to a body that has been under water for two weeks or has been buried for six weeks. This generalization should serve as a reminder that an uncovered or naked body decomposes more rapidly than a covered or clothed one.

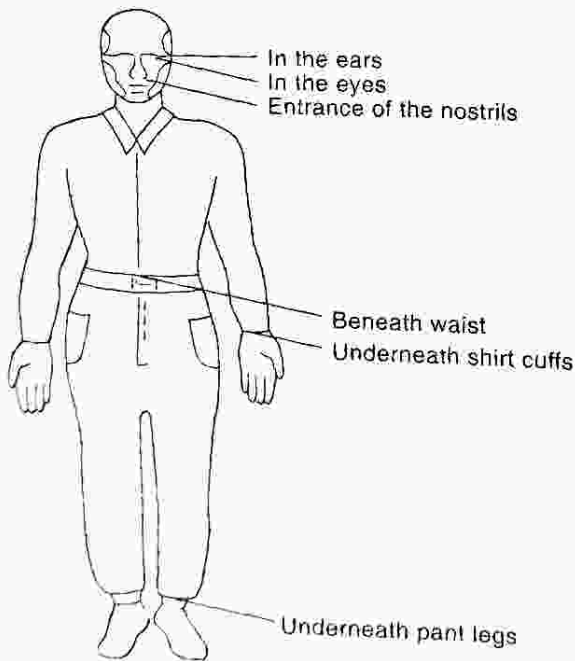
After a body is found, it is usually refrigerated until an autopsy is performed or a final disposition is made. Decomposition slows down or ceases if a body is refrigerated. When the body is exposed to room temperature, decomposition occurs rapidly. Recognition of this accelerated decomposition is particularly important if a person dies in a cold environment and is then moved to a warmer one.

Decomposition may not occur evenly throughout the body. For example, decomposition occurs more rapidly in injured areas. If a person is struck on the head and bleeding occurs only in that area, decomposition may be much more advanced on the head than on the remainder of the body. Fly larvae proliferate during summer, spring, and fall in warm, moist areas of the body such as the eyes, nose, and mouth. Larvae are attracted to injured areas, where they feed on exposed blood proteins and cause accelerated decomposition. Owing to the uneven decomposition, it is common to see skeletonization in only part of the body.<sup>18</sup>

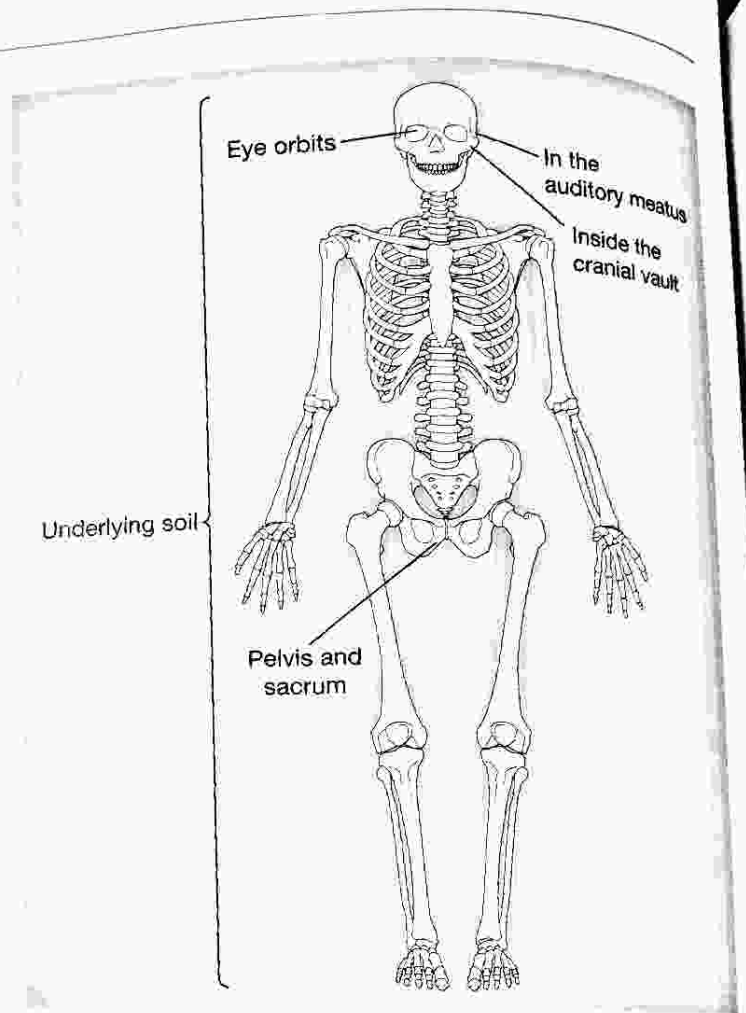
## FORENSIC ENTOMOLOGY

Entomology is the study of insects, and forensic entomology is the study of the insects associated with a dead body, which is used to determine the elapsed time since death. An analysis of the insects found on a homicide victim by a qualified **forensic entomologist** can also tell the investigators whether the body has been moved from one site to another, if it was disturbed after death, or the position and presence of wound sites, long after they are no longer visible as such to the naked eye. Insects can also be used in drug identification and the determination of the length of time of neglect.<sup>19</sup>

Insects are invariably the first witnesses to a crime, arriving within minutes or even seconds after death. There are two ways to use insects to determine time since death. The first method involves using dipteran (blow fly) larval development, and the second involves using insect succession over time (Figures 9-5 and 9-6).



▲ FIGURE 9-5 Body area from which to collect insects



▲ FIGURE 9-6 Areas of skeleton most likely to harbor insects

The first method is used in the first hours, days, or weeks after death and can determine the time of death accurate to a day or less, or a range of days. The insects used in this method are those that arrive first on the corpse, that is, the calliphoridae or blow flies (diptera). These flies are attracted to a corpse very soon after death. They lay their eggs on the corpse, usually in a wound, if present, or in any of the body's natural orifices (Figure 9-7). Their development follows a set, predictable cycle, and each of these developmental stages takes a set, known time. This time period is based on the availability of food and the temperature. In the case of a human corpse, food availability is not usually a limiting factor. Insects are "cold blooded," so their development is extremely temperature-dependent. Their metabolic rate increases with increased temperature, which results in a faster rate of development, so that the duration of development decreases in a linear manner with increased temperature, and vice versa.

An analysis of the oldest stage of insect on the corpse and the temperature of the region in which the body was discovered allows an entomologist to determine the day or the range of days in which the first insects oviposited, or laid eggs, on the corpse. This determination, in turn,



▲FIGURE 9-7 Fly larvae

This individual had been dead for approximately four days. His body was found in the backyard by neighbors. During this period of time, temperatures had reached into the 90s. Note the fly larvae (maggots) in his nose and mouth.

leads to a day or a range of days during which death occurred. For example, if the oldest insects are seven days old, then the decedent has been dead for at least seven days. This method can be used until the first adults begin to emerge, after which it is not possible to determine which generation is present. Therefore, after a single blow fly generation has been completed, the time of death is determined using the second method, that of insect succession.

The highly decomposed and maggot-infested remains of two women were found in a bushy area. Two species of blow fly were collected, and an analysis of the oldest insect stage, together with data from the local

weather station, indicated they had died more than 11 days before discovery. Reluctant eyewitnesses were later brought forward during the police investigation and confirmed the date of death. The eyewitnesses were also able to identify the killer. However, because the eyewitnesses had not come forward earlier, it was possible the jury might doubt their word. This situation became more probable when two other people came forward saying that they had seen the victims alive and well and shopping in the mall only eight days before their bodies were discovered. This statement conflicted with the date of death identified by the two eyewitnesses and meant that the jury would have to make a subjective decision on who was lying and who was telling the truth. However, in this case, there was also the scientific, entomological evidence, which clearly indicated that the victims had died more than 11 days before discovery. This evidence refuted the testimony of the two shoppers and supported that of the two eyewitnesses. Therefore, the jury believed the earlier eyewitnesses, who were able to identify the killer. He was convicted of two counts of first-degree murder.

The second method of using insects to determine time since death is based on the fact that a human corpse, or any kind of carrion, supports a rapidly changing ecosystem. The body decomposes from the fresh state to dry bones in a matter of weeks or months depending on the geographic region. As the body decomposes, it goes through a predictable sequence of biological, chemical, and physical changes. Each of these changes is attractive to a different group of insects. Some insects, such as the blow flies, prefer to feed on the fresh body. Others prefer the remains a few days after death, while still others prefer the remains when they are dry. Some insects are not attracted to the body itself, but arrive to feed on other insects at the scene. Many species are involved at each decompositional stage, and each group of insects somewhat overlaps the ones adjacent to it. The insects that colonize a body are primarily species of flies (diptera) and beetles (coleoptera).

Therefore, with knowledge of the regional insect fauna and times of carrion colonization, the investigator can analyze the insect assemblage associated with the remains to determine a window of time in which death took place. This method is used when the decedent has been dead from a few weeks up to a year, or in some cases several years after death, with the estimated window of time broadening as time since death increases. It can also be used to indicate the season of death (for example, early summer). A knowledge of insect succession, together with regional, seasonal, habitat, and meteorological variations, is required for this method to be successful.

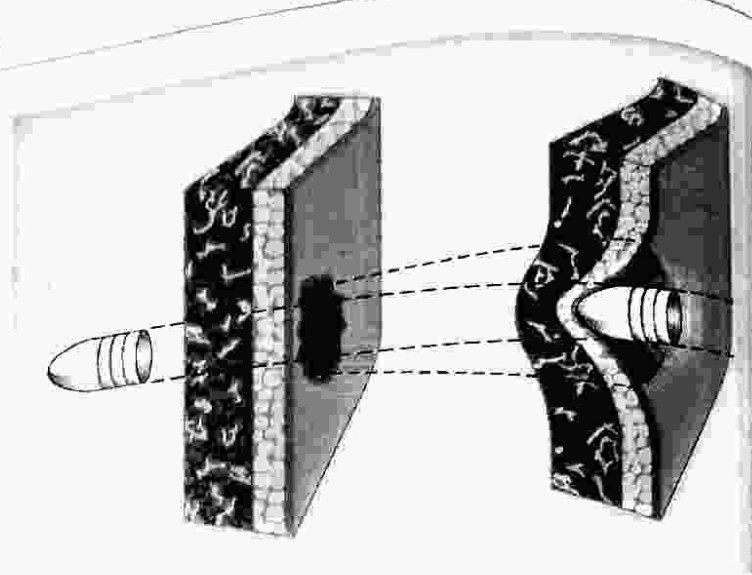
The partially skeletonized remains of a man were found in a wooded area close to a freeway in early spring. A large number of empty blow fly puparia were discovered with the remains, along with several groups of insects that are commonly later colonizers, including piophilidae and fanniidae, as well as a number of beetle adults and larvae. To analyze sequential insect evidence, the entomologist must have local data for the geographical region, habitat, and season, because there can be a great deal of difference between insect arrival and tenure in one region versus another. The species of insects present in this case indicated a minimum elapsed time since death of two months. However, since the body was found in very early spring, death must have occurred earlier than this. Large numbers of empty blow fly puparia indicated the earlier presence of many blow fly larvae, which would have been present only in warm weather. This fact indicated that death must have occurred before the previous fall, when numerous blow flies would have colonized the remains and gone through an entire life cycle, as evidenced by the empty puparia. It would also have allowed for the later colonizers to arrive by March. The onset of cold weather would have prevented additional blow fly colonization in winter, allowing some flesh to remain uneaten, which explained why the remains were only partially skeletonized. If the remains had not been discovered in early spring, blow flies from the upcoming summer would have completed the skeletonization process. Also, if the deceased had died earlier in the previous year, the body would have been entirely skeletonized before discovery. The insects, therefore, indicated that death had occurred in late summer of the previous year.

## EVIDENCE FROM WOUNDS

A basic knowledge of wounds is of great assistance to officers who are responsible for injury and death investigations. It helps them reach preliminary conclusions. The five most common types of wounds encountered by police officers in injury and death investigations are firearm wounds, incised wounds, stab wounds, puncture wounds, and lacerations.

### FIREARM WOUNDS

When a bullet strikes a body, the skin is first pushed in and then perforated while in the stretched state. After the bullet has passed, the skin partially returns to its original position, and the entry opening is drawn together and is thus smaller than the diameter of the bullet. The slower



**FIGURE 9-8 A bullet penetrating the skin**  
The skin is pressed inward, stretched, and perforated in the stretched condition, after which it returns to its original position. The entry opening is smaller than the diameter of the bullet. Immediately around the opening is a contusion ring, because the bullet rubs against this part of the skin and scrapes the external layer of epithelial cells. (Courtesy Nucleus Medical Art Illustration, © 2007, [www.nucleusinc.com](http://www.nucleusinc.com), as depicted in Vernon J. Geberth's *Practical Homicide Investigation*)

the bullet speed, the smaller the entry opening. The bullet passing through the stretched skin forms a so-called contusion ring around the entrance opening as the bullet slips against the skin that is pressed inward and scrapes the external epithelial layers (Figure 9-8). The skin in the contusion ring becomes conspicuous by drying after some hours. In a favorable case, rifling marks on the bullet leave such a distinct mark in the contusion ring that the number of grooves in the rifling can be counted. The combined section of the contusion ring and entrance opening corresponds to the caliber of the bullet or exceeds it slightly. When a bullet strikes the body squarely, the contusion ring is round; when a bullet strikes at an angle, the ring is oval.

Along with the contusion ring, there is another black-colored ring, the "smudge ring," which often entirely covers the contusion ring (Figure 9-8). It does not contain any powder residues or contamination from the bore of the firearm but consists wholly of small particles originating from the surface of the bullet. The smudge ring may be absent in the case of clean-jacketed bullets or a bullet that has passed through clothing.

A bullet passing through the body forms a track that is usually straight but can also be bent at an angle in an unpredictable manner if the bullet meets or passes through a bone. Thus it is not possible to determine with certainty, from observation of the entrance and exit openings, in which direction the weapon was pointed when the shot was fired. The direction must be calculated by the pathologist from the results of the autopsy. The

velocity of the bullet has a great influence on the appearance of the track: straight tracks indicate a high velocity, and bent or angular ones indicate a low velocity.

In gunshot injuries in soft parts of the body, especially in the brain, the bullet can produce a considerable explosive effect, which is greatest with unjacketed or soft-nosed bullets from large-caliber firearms. Such a bullet may split into several parts, each of which forms its own track, and thus there may be several exit wounds. When such a bullet strikes the head, large parts of the cranium can be blown away and the brain scattered around. A soft-nosed bullet that, before hitting the body, is split by striking against a hard object such as a tree branch can produce a number of irregularly shaped entrance holes.

A shot through the head is not always fatal. To be immediately fatal, the bullet must either produce a bursting effect or injure an artery of the brain or a vital brain center. A shot through the brain that is not immediately fatal does not always produce unconsciousness. Even when the heart has been perforated by a bullet, it occasionally happens that the injured person lives for several hours, retaining some capacity of movement.

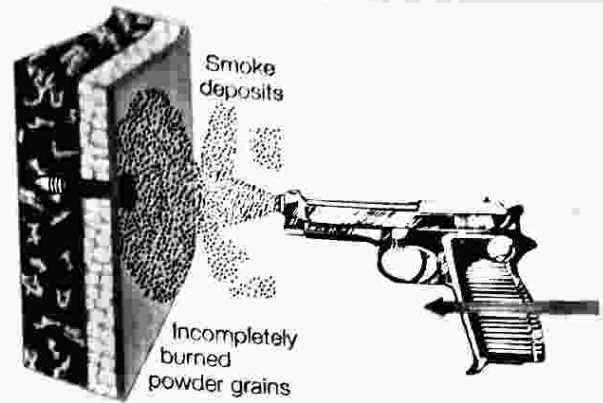
It is often difficult to distinguish the exit wound from the entrance wound, especially from a shot at long range with a metal-jacketed bullet, assuming, of course, that the bullet passes through the body intact. In a favorable case, the exit wound may have a ragged appearance with flaps directed outward. To determine the direction of the shot with certainty in such a case, an autopsy is necessary. If the bullet was damaged by its passage through the body or if there was a bursting effect, it is generally easy to determine the exit wound, which is then considerably larger than the entrance wound and shows a star-shaped, ragged character, with flaps directed outward. Note, however, that in contact shots the entrance wound may be ragged and star-shaped. A bullet that ricochets may strike with its side, or obliquely, and produce a large and characteristic entrance wound.

### Close and Distant Shots

It is very important to be able to estimate the distance from which a shot was fired. In many cases this fact is the only evidence available that can distinguish among suicide, a self-defense killing, manslaughter, or murder.

In practice, a distinction is made among *contact*, *close*, and *distant* shots. A **contact bullet wound** is made when the muzzle of the weapon is pressed against the body when the shot is fired. In a close shot, the distance of the muzzle is less than about 18 inches from the body (Figures 9-9 and 9-10), whereas a distant shot is one fired at a distance greater than 18 inches<sup>20</sup> (Figures 9-11 and 9-12).

In the case of a contact shot against an exposed part of the body, soot, metallic particles, and powder residues are driven into the body and can be found there during the autopsy. Blackening, caused by soot and powder, around the entry opening is often absent. A contact shot

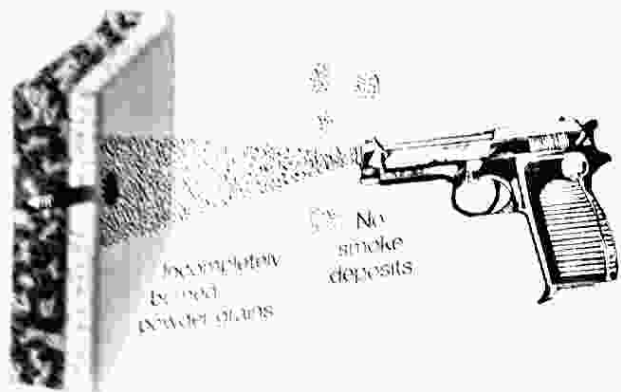


▲ **FIGURE 9-9** Firearm discharge at close range  
Close shot, short distance. The diagram shows both incompletely burned powder grains and smoke deposits in the zone of blackening. The powder grains are concentrated immediately around the entrance hole. (Courtesy Nucleus Medical Art Illustration, © 2007, [www.nucleusinc.com](http://www.nucleusinc.com), as depicted in Vernon J. Geberth's *Practical Homicide Investigation*)

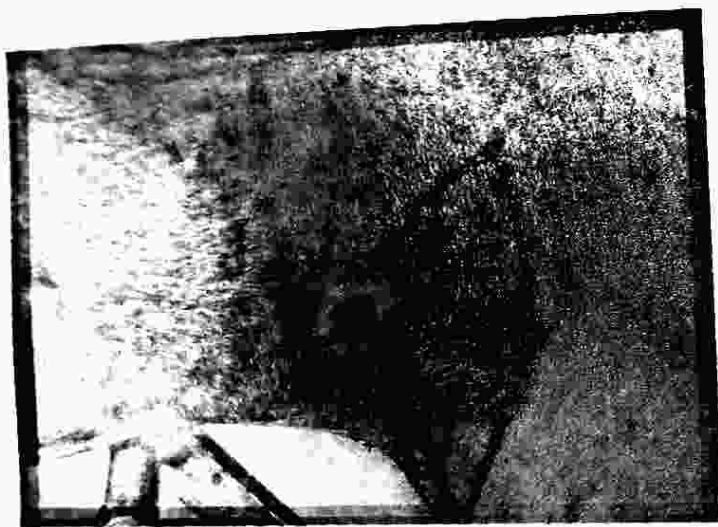


▲ **FIGURE 9-10** Close range gunshot wound  
This victim was first assaulted with a knife and then shot numerous times in the left side of the head. Note the blackened area around the bullet wound indicating direct contact or very close contact with the skin.

against a part of the body protected by clothing often produces a powder zone on the skin or in the clothes, and soot, powder residue, and fragments of clothing are driven into the track. In a contact discharge, the entrance wound differs considerably from an entrance wound in a close shot or a distant shot. When a contact shot is fired, the gases of the explosion are driven into the track but are forced out again and produce a bursting effect on the



▲ **FIGURE 9-11** Firearm discharged from a distance  
 Close shot, greater distance than in Figure 9-9. The diagram shows unburned powder grains, but no smoke deposits in the zone of blackening. (Courtesy Nucleus Medial Art Illustration, © 2007, www.nucleusinc.com, as depicted in Vernon J. Geberth's *Practical Homicide Investigation*)



▲ **FIGURE 9-12** Distant shot  
 When a bullet strikes a body from a distance, the skin is first pushed and then perforated while in the stretched state. After the bullet has passed, the skin partially returns to the original position, and the entry opening is drawn together and is thus smaller than the diameter of the bullet. The bullet passing into the stretched skin forms what is called a *contusion ring* around the entrance as the bullet slips against the skin that is pressed inward and scrapes the external epithelial layers.

skin and clothes. The entrance wound is often star-shaped with flaps directed outward (Figure 9-13).

A close shot produces a zone of blackening around the entrance wound of the track, either on the skin or on the clothes. Sometimes the flame from the muzzle has a singeing action around this opening, with hair and



▲ **FIGURE 9-13** Contact bullet wound  
 Homicidal contact bullet wound to the forehead. Note the charring of the edges and the irregularly shaped tears of the skin owing to the undermining of the scalp. This contact bullet wound was made from a .38-caliber bullet against an exposed part of the body (in this case, the head). Soot, metallic particles, and powder residue are driven into the body and can be found during the autopsy.

textile fibers curled up. The zone of blackening is formed of substances carried along with the explosion gases. When a cartridge is fired, the bullet is forced through the barrel of the weapon by the explosion gases. Only a small amount of the gas passes in front of the bullet. The combustion of the powder is never complete, even with smokeless powder and still less with black powder and the explosion gases therefore carry with them incompletely burned powder residues, the amount of which decreases as the distance increases. Thus, in a close shot a considerable amount of incompletely burned powder residue is found on the target. In addition to carrying this residue, the gases also carry impurities from the inside of the barrel, consisting of rust (iron), oil, and particles rubbed off the bullet. Metallic residues from the percussion cap and cartridge case also occur in the gases of the explosion. If the shot is fired at a right angle to the body, the zone of blackening is practically circular; if it is fired obliquely, the zone is oval. The extent of the zone of blackening is often difficult to determine by direct observation, and it is often better to photograph

it, using infrared-sensitive material, which intensifies the zone of blackening so its extent is more easily determined. The zone of blackening gives valuable information for determining the distance from which a shot was fired, which may be an important factor in deciding between murder and suicide. It is important that comparative test shots be fired with the same weapon and same type of ammunition as those used in the actual crime.

Close shots with black powder show marks of burning up to a distance of 4–6 inches and a distinct deposit of powder smoke up to 10–12 inches. Dispersed grains of powder embedded in the target may be detected even at a distance of 3 feet. In distant shots, none of the characteristics of a close shot can be detected.

Powder residues occur on the object fired at in the form of incompletely and completely burned particles. A careful microscopic examination should precede any chemical examination, as it is often possible to establish in this way the shape and color of unburned powder particles and to distinguish many kinds of powder.

Black powder, which consists of potassium nitrate, sulfur, and charcoal, is identified by the presence of potassium and nitrate in the entrance wound. Smokeless powder consists chiefly of nitrocellulose or of nitrocellulose with nitroglycerine and is identified by the presence of nitrite, which can be detected by various microreactions. The grains of smokeless powder are generally coated with graphite and occur in many forms (for example, round or angular discs, pellets, and cylinders).<sup>21</sup>

### High-Velocity Rifle Wounds

The difference in the size of the wounds and damage done between handgun bullets and rifle bullets, especially those of a large caliber, can be considerable. For example, Figure 9-14 depicts an individual who was shot

in the head one time by a police SWAT team member. The officer was armed with a .308 Remington 700 rifle. The subject had barricaded himself in a motel room while holding a hostage. He was shot in the head after he made the fatal mistake of slightly opening the door to the motel room and pointing his rifle in the direction of a police SWAT team member. The rifle the decedent was holding is depicted on the left side of his body.

### Shotgun Wounds

A shotgun is a smooth-bore, shoulder-fired firearm and is typically used to fire multiple pellets, rather than a single slug. The most common gauges with their corresponding bore diameters are as follows:<sup>22</sup>

- The pellets fired range in size from 0.08 inch for a No. 9 shot to 0.33 inch for 00 Buck.
- A "wad," which may be either paper or plastic, lies between the shot pellets and the powder. Most modern shells use plastic wads.
- A shotgun shell can contain anywhere from a couple of hundred pellets to nine for 00 Buck, to one large lead slug.

**Entrance Wounds.** From contact to 12 inches, there is a single round entrance 0.75–1 inch in diameter. The edge of the wound shows an abrasion ring. As the distance between muzzle and skin increases, powder tattooing appears. Powder blackening is most prominent at less than 12 inches. Powder tattooing is considerably less dense than it is in pistol wounds.

When pellets are discharged at between 3 and 6 feet of range, the single entrance wound widens to 1.5–2 inches in diameter and shows "scalloping" of the edges. At about 6 feet, the pellets begin to separate from the main



◀ **FIGURE 9-14**  
**High-velocity rifle wound**

This individual was shot in the head one time by a police SWAT team member. The officer was armed with a .308 Remington 700 rifle. The subject had barricaded himself in a motel room while holding a hostage. He was shot after he made the mistake of opening the motel room door and pointing his rifle at a member of the police SWAT team.

► **FIGURE 9-15**  
**Close-range wound from a**  
**12-gauge shotgun**

In shotgun entrance wounds, the characteristics of the wound vary based on the distance between the muzzle and the skin. For example, from contact to 12 inches, the edge of the wound shows an abrasion ring. As the distance increases, powder tattooing appears. This photo shows that powder tattooing is considerably less dense than it is in pistol wounds.



mass of pellets. Beyond 10–12 feet, there is great variation in the spread of the pellets (Figure 9-15).

**The Wad.** At close ranges, the wad will be propelled into the body through the large single entrance wound. Beyond 10–15 feet, the wad will have separated from the pellets and will not enter. However, it may mark the body. The gauge of the shotgun and the size of the pellets can be obtained from the wad and pellets, respectively. On occasion, a plastic wad may be marked by the choke or irregularities at the end of the barrel, making ballistic comparison possible.

**Range Determination.** Range determinations can be made later if the size of the shotgun pattern was described at autopsy and duplicated on paper. The same weapon with the same type of ammunition must be used in duplication of the pattern if accurate results are desired. Range formulas do not work.

X-ray patterns of the shot in the body are useless for range determinations, as are patterns on the body in which the shot first struck the target.

The size of the shot pattern on the body depends primarily on the choke of the gun. The type of ammunition and barrel length are secondary factors. The size of the pellet pattern is independent of the gauge of the shotgun, and an increase in gauge just increases the density of the pattern.

**Exit Wounds.** Shotgun pellets rarely exit except when used as instruments of suicide in the region of the head.

### Gunshot Residue (GSR)

**Gunshot residue (GSR)** analysis is used to determine if a subject may have fired a weapon, handled an object—for example, a victim's shirt, with primer residue on it, or been in the vicinity of a firearms discharge.<sup>23</sup> "Primer" is the igni-

tion component of a cartridge. Examination is done by analyzing particles characteristic of primer residues on a subject's hands, face, or clothing. Of primary interest to analysts are antimony, barium, and lead. The Scanning Electronic Microscope (SEM) is commonly used for analysis.

As approximations, GSR remains on hands for 3 hours, on faces for 8 hours, and nasal cavities for 48 hours.<sup>24</sup> If there are multiple exposures to GSR, a determination cannot be made as to which person fired the weapon or his/her relative position to the gun when discharged. Nor does GSR analysis reveal the muzzle to target distance. There is some evidence that a person could enter a room *after* a shot was fired and acquire GSR.<sup>25</sup>

GSP particles dissipate with normal activity and should be collected as quickly as possible, although they are longer lasting on suicide and murder victims because of this lack of activity. Gunshot Residue Collection Kits are commonly used for this purpose.

If safe and otherwise possible to do so, the suspect's hands should not be handcuffed in the rear, because GSR may be wiped off. Visually inspect the suspect's hands for smudges, taking a photograph of any noted. Do not fingerprint the suspect before collecting samples. The investigator should wash his/her hands and wear latex-type gloves.

Open a container and remove the round disc, which is shaped like a shoe polish applicator, except that its bottom has an adhesive surface. Press the adhesive side against one hand in the area of the back of the thumb, rubbing it there, on the web of hand between the thumb and index finger, and down the index finger, extending to the fingertip. Continue rubbing in this area until "stickiness" is lost." The disc is then replaced in the container and sealed and marked in the usual manner. The other hand and both sides of the face are processed using separate discs. The containers are then transmitted to the lab.

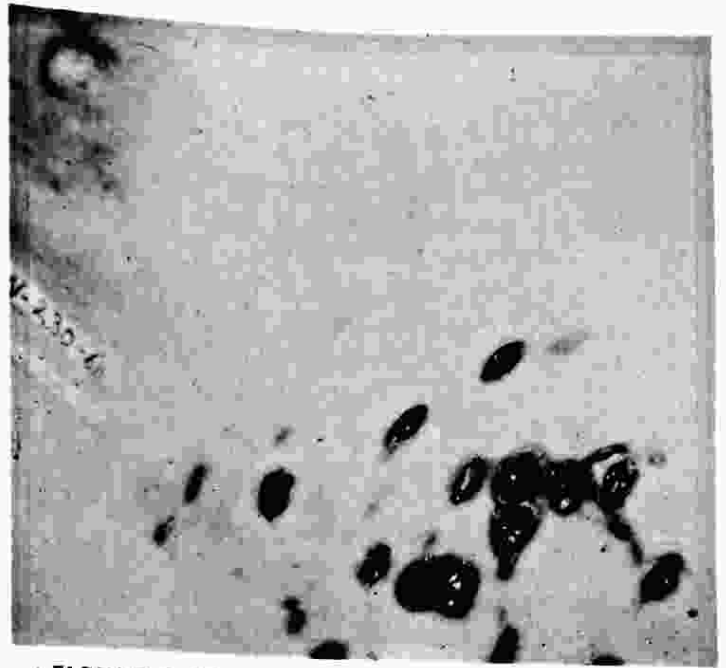


▲ **FIGURE 9-16 Incise wound inflicted with a knife**  
The wound is narrow at the edge and gaping at the middle. Such wounds typically bleed a lot. Incise wounds are often inflicted with a sharp-edged instrument such as a knife or a razor. The wounds are sometimes found on the arms, face, and legs.

## INCISED AND STAB WOUNDS

The **incised wound**—more commonly referred to as a “cutting wound”—is inflicted with a sharp-edged instrument such as a knife or a razor. The weapon typically employed in inflicting both incised and stab wounds is a pocket knife, although kitchen knives are also common. In comparison with shootings, fewer cutting assaults result in death, largely because the perpetrator’s intention was to maim or disfigure rather than kill the victim. Cutting wounds are often found on the arms, face, and legs. Even these “friendly” cuttings, as they are sometimes referred to, can result in death. When the victim does die from a cutting wound, it generally is found around the throat. The severity of most incised wounds is directly related to the shape and sharpness of the weapon, the part of the body being cut, and the amount of force used in striking the victim. The incised wound is typically narrow at the edges and gaping at the center, with considerable bleeding (Figure 9-16). The inexperienced investigator may conclude that a gaping incised wound was inflicted by a large cutting instrument. However, a small knife with a honed blade is capable of causing very severe wounds.

Most frequently, death is caused when a stab results in severe damage to a vital organ, internal bleeding, shock, or secondary infections that develop several days after the attack. Any of these factors may itself be fatal; they often occur in combination. The shape, size, and keenness of the blade all determine a wound’s shape and depth, as does the manner in which the knife is thrust into and pulled out of the body. One noticeable aspect of multiple stab wounds is their different shapes when



▲ **FIGURE 9-17 Multiple stab wounds**  
Death from stab wounds generally results from severe damage to a vital organ, internal bleeding, shock, or secondary infection that may develop several days after the attack. The close proximity of these wounds indicates that the victim was unable to struggle to any sufficient degree. Even wounds inflicted with the same knife as depicted in this figure can be quite different in size and shape.

made with the same knife. The proximity of the wounds in a multiple-stabbing assault may be helpful in determining the actions of the victim before death. If the wounds are concentrated within a small region of the body, then there is a good possibility that the victim was immobilized at the time of the assault—that is, held down, asleep, or intoxicated (Figure 9-17).

## PUNCTURE WOUNDS

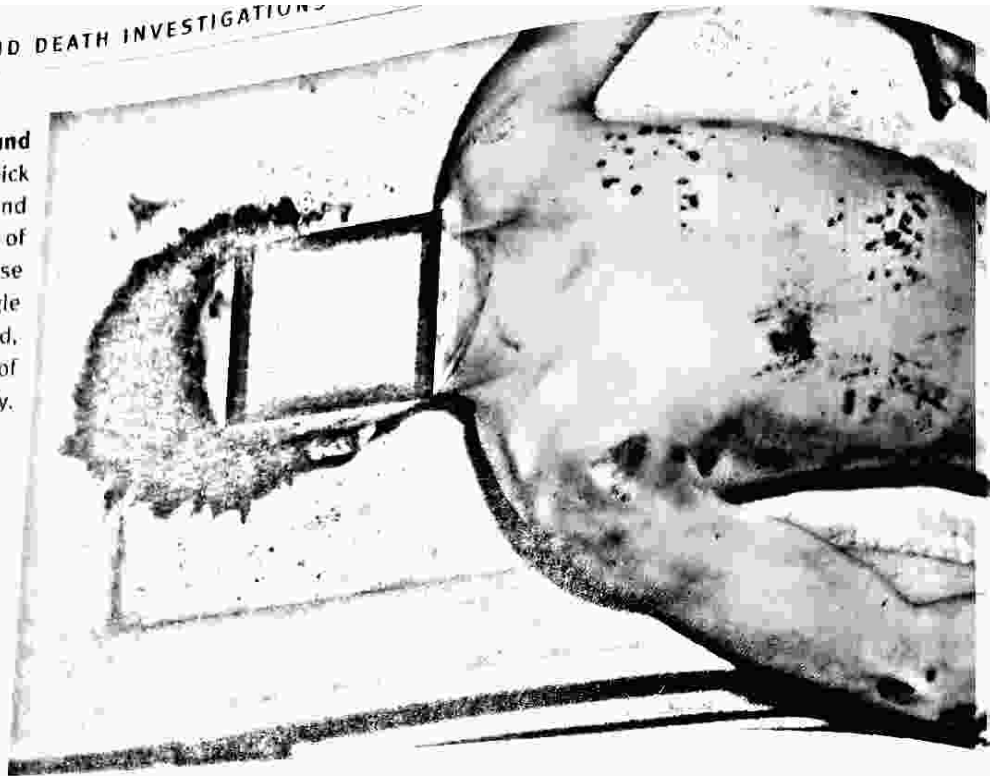
At one time the weapon most frequently used in assaults resulting in **puncture wounds** was the ice pick. However, ice picks are neither used nor as readily available today as they once were. Leather punches and screwdrivers also are capable of producing puncture wounds, which are normally small and have little or no bleeding. Such wounds can be easily overlooked, particularly if they are in hairy parts of the body. Infliction of a puncture wound produces death in the same way as do stab wounds (Figure 9-18).

## LACERATIONS

When used in an assault, clubs, pipes, pistols, or other such blunt objects can produce open, irregularly shaped wounds called **lacerations**. Such wounds bleed freely and characteristically are accompanied by bruising around the edges. There is not necessarily a relationship

► **FIGURE 9-18 Puncture wound**

This victim received multiple ice-pick stab wounds. Leather punches and screwdrivers are all capable of producing puncture wounds. Because there is often little bleeding, a single wound can easily be overlooked, particularly if it is on a hairy part of the body.



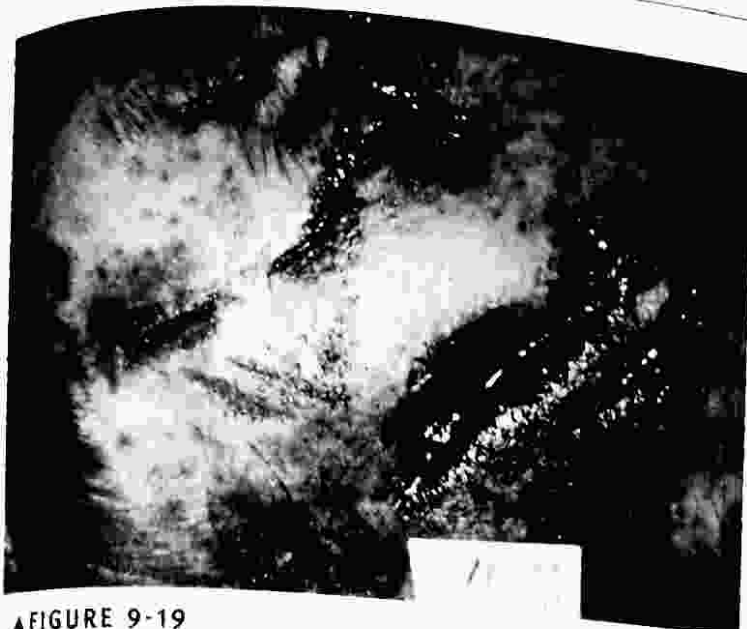
between the shape of the wound and that of the weapon employed. Occasionally, when considerable force is used in an attack, an impression of the weapon is left on the victim's skin. Most frequently, when death results from an assault in which lacerations were inflicted, the cause is severe head injuries. Laceration wounds may be inflicted accidentally, as in the case of an intoxicated person who falls and strikes his/her head against a curb or step. In some instances, circumstances may appear more suspicious:

Checking the back doors of businesses at about 9:30 P.M., an officer found the proprietor of a jewelry store dead at the open rear entrance to his store. He had sustained a large laceration on his forehead and had bled considerably. At first, it appeared that a murder had taken place during a robbery or burglary. Careful processing of the scene yielded traces of blood and one small skin fragment from the brick wall near the rear entrance.

It was established that nothing was missing from the business. The medical examiner found the cause of death to be a heart attack. The head laceration contained minute traces of brick. Thus a reconstruction of events showed that as the owner was closing his business, he suffered a heart attack and convulsions, striking his head against the brick wall. The lacerations he suffered made it look as though he had suffered a fatal head wound.

The severity, extent, and appearance of injuries due to blunt trauma depend on the amount of force delivered to the body, the amount of time over which the force is delivered, the region struck, the amount (extent) of body surface over which the force is delivered, and the nature of the weapon. If a weapon deforms and/or breaks on hitting the body, less energy is delivered to the body to produce injury, since some of the energy is used to deform and/or break the weapon. Thus, the resultant injury is less severe than would have been the case if the weapon did not deform and/or break. If the body moves with the blow, this increases the period of time over which the energy is delivered and decreases the severity of the injury.<sup>26</sup>

For any given amount of force, the greater the area over which it is delivered, the less severe the wound, because the force is dissipated. The size of the area affected by a blow depends on the nature of the weapon and the region of the body. For a blow by a weapon with a flat surface, such as a board, there is a diffusion of the energy and a less severe injury than that caused by a narrow object—for example, a steel rod—delivered with the same amount of energy. If an object projects from the surface of the weapon, then all the force will be delivered to the end of the projection, and a much more severe wound will be produced. If a blow is delivered to a rounded portion of the body, such as the top of the head (Figure 9-19), the wound will be much more severe than would be the case if the same force is delivered to a flat portion of the body, such as the back, where there will be a greater area of contact and more dispersion of force.<sup>27</sup>



**▲ FIGURE 9-19**  
**Lacerations resulting from a pistol whipping**  
 This victim was pistol whipped to death by an armed robber. This assault resulted in numerous lacerations to the head. Such wounds bleed freely and characteristically are accompanied by bruising around the edges. There is not necessarily a relationship between the shape of the wound and that of the weapon employed.



**▲ FIGURE 9-20** **Defense wounds**  
 This victim received severe defense knife wounds on the hands while trying to stop his assailant from stabbing him to death.

**DEFENSE WOUNDS**

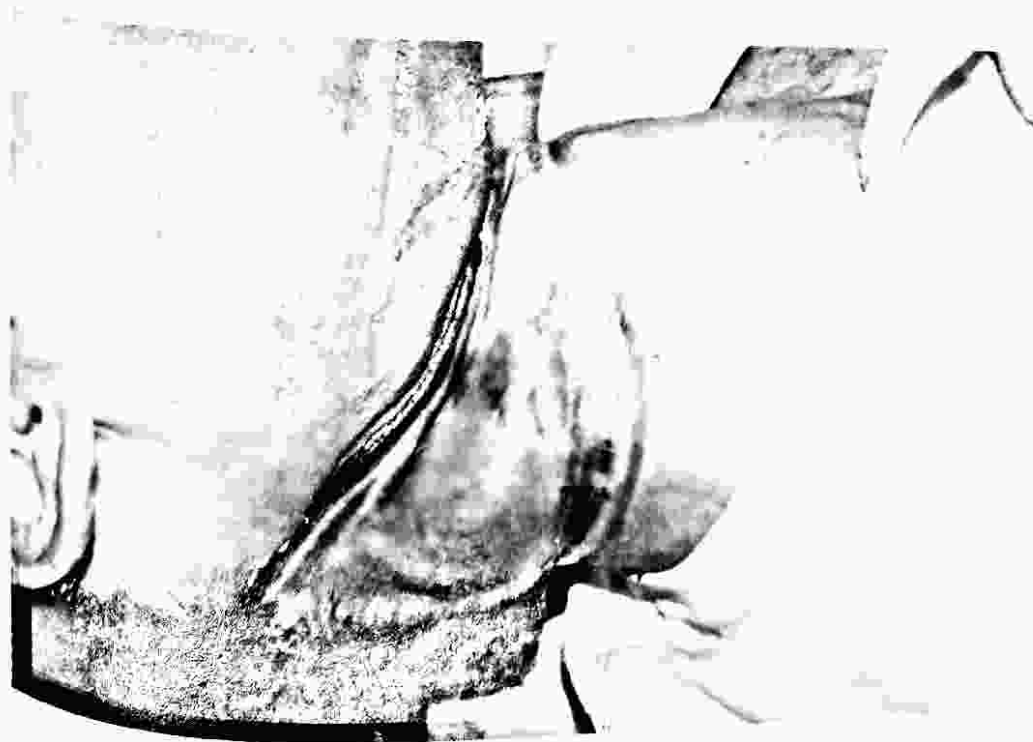
Defense wounds are suffered by victims attempting to protect themselves from an assault, often by a knife or club. These wounds are commonly found on the palms of the hands, the fingers, and the forearms (Figure 9-20). In the most aggravated form, defense wounds resulting from a knife may even result in one or more fingers being severed.

**STRANGULATION WOUNDS**

**Ligature Strangulation**

In **ligature strangulation**, the pressure on the neck is applied by a constricting band that is tightened by a force other than the body weight. Virtually all cases of ligature strangulation are homicides. Females predominate as victims. Suicides and accidents are rare. The mechanism of death is the same as in hanging, namely, occlusion of the vessels that supply blood and thus oxygen to the brain. Consciousness is lost in 10–15 seconds.<sup>28</sup>

Ligatures used range from electric cords (Figure 9-21), neckties, ropes, and telephone cords to sheets, hose, and



**◀ FIGURE 9-21**  
**Ligature strangulation**  
 The pressure on the neck is applied by a constricting band that is tightened by a force other than the body weight. Virtually all cases of ligature strangulation are homicides. The victim in this photo died as a result of strangulation by use of an electric cord.

undergarments. The appearance of a ligature mark on the neck is subject to considerable variation, depending on the nature of the ligature, the amount of resistance offered by the victim, and the amount of force used by the assailant. The ligature mark may be faint, barely visible, or absent in young children or incapacitated adults, especially if the ligature is soft (for example, a towel) and removed immediately after death. If a thin ligature is used, there will be a very prominent deep mark encircling the neck. Initially, it has a yellow parchment-like appearance that later turns dark brown.

In ligature strangulation, in contrast to hangings, the ligature mark usually encircles the neck in a horizontal plane often overlying the larynx or upper trachea. When a wire or cord is used, it usually completely encircles the neck. There may be a break in the furrow, however, usually at the back of the neck, where a hand has grasped the ligature and tightened it at that point. Aside from the ligature mark, abrasions and contusions of the skin of the neck are usually not present. They may occur, however, if the assailant places his/her hands beneath and around the ligature and twists it, tightening it around the neck, or if the victim claws at the neck in an attempt to remove the ligature or relieve the pressure. If there is more than one loop of the ligature around the neck, there may be bruising of the skin if the ligature pinches the skin between two loops.

## Manual Strangulation

**Manual strangulation** is produced by pressure of the hand, forearm, or other limb against the neck, compressing the internal structures of the neck. The mechanism of death is occlusion of the blood vessels that supply blood to the brain. Occlusion of the airway probably plays a minor role in causing death, if any at all.

Virtually all manual strangulations are homicides. One cannot commit suicide by manual strangulation, since as soon as consciousness is lost, pressure is released and consciousness is regained.

In most cases of manual strangulation, the assailant uses more force than is necessary to subdue and kill the victim. Hence, marks of violence are frequently present on the skin of the neck. Usually, there are abrasions, contusions, and fingernail marks on the skin (Figure 9-22).

Although in most manual strangulations, there is evidence of both external and internal injury to the neck, in some cases there is no injury, either externally or internally. For example, one medical examiner reported seeing three women in a three-month period who had been manually strangled. The first woman showed absolutely no evidence either externally or internally; the second showed congestion of the face with fine petechiae of the conjunctivae (discussed later in this chapter) and skin of the face, but no evidence of injury to the neck, either externally or internally; and the third victim showed the classic evidence of injury: abrasions and



▲ **FIGURE 9-22** Death by manual strangulation

This victim died as a result of manual strangulation. Note the crescent-shaped fingernail marks on the center of the throat along with bruising on the sides of the neck, indicating that the assailant attacked from behind.

scratches of the skin with extensive hemorrhaging into the muscles of the neck. All three women were killed by the same individual. All three had blood alcohol levels above 0.30. The modus operandi of the perpetrator was to meet a woman in a bar, buy her liquor until she was extremely intoxicated, and then go off with her and have intercourse. He would then strangle her. At the time he strangled them, the women were unconscious due to acute alcohol intoxication, so a very minimal amount of pressure was necessary. He would place his hand over their necks and push downward, compressing the vessels of the neck. In the last case, the individual regained consciousness and struggled, with the resultant injuries. The perpetrator admitted having killed a number of other women in the same way over previous years in a number of states.

In manual strangulation, the victims are usually female. When they are male, they are often highly intoxicated. In all manual strangulation cases, a complete toxicological screen should be performed.

## SUICIDE

For the investigator, a major concern in an apparent suicide case is to make certain that the death was self-induced and not the result of a homicide. In some cases, the investigator finds overwhelming evidence to this

effect at the scene. In other cases, important information about the victim's behavior before death can be obtained from relatives, friends, coworkers, and employers. **Suicide** is often committed for the following reasons:

- ill health or considerable pain;
- severe marital strife;
- a recent emotionally damaging experience, such as an unhappy love affair, separation, or divorce;
- financial difficulties, including the threat of a much lower standard of living or failure to meet some significant and past-due financial commitments;
- perceived or actual humiliation;
- remorse over the death of a loved one;
- guilt for an act of one's own doing for which he/she cannot forgive him-/herself;
- revenge, frequently by adolescents who have serious difficulties with parents or spurned lovers and want to punish them and make them feel guilty about whatever difficulty preceded their death.<sup>29</sup>

These factors are far from all inclusive, but the investigator will find a significant number of suicides associated with them. Conversely, if there is an apparent suicide and thorough scrutiny fails to produce a solid motive, then the investigator's suspicion should be aroused. Thus, in all apparent suicides the possibility of a criminal homicide should never be lightly discarded.

## METHODS AND EVIDENCE OF SUICIDE

Nine methods are most commonly employed in suicides: shooting, hanging, ingesting sleeping pills and other pharmaceuticals, drowning, cutting and piercing, ingesting of poisons, inhaling gases, jumping from high places, and intentionally crashing an automobile.<sup>30</sup>

Although all of these can be simulated in the commission of murders, there are important differences in physical evidence that distinguish suicides from murders.

### Gunshot Wounds

It is sometimes difficult to determine whether a **gunshot wound** was self-inflicted or resulted from the actions of an assailant. However, there are certain indicators that may be helpful in reaching a conclusion. One of these is the location of the wound and the trajectory of the projectile on entering the body. The most common method of committing suicide with a firearm involves the victim placing a handgun to the temple and firing a shot. If there is no exit wound it will be difficult for the investigator to determine the precise angle at which the projectile entered. This information will eventually be obtained during the autopsy, but it may be several days before one is performed. However, in the meantime, the investigator must make some preliminary determinations. The following case illustrates some of the points discussed thus far.

A man telephoned the police hysterically, reporting that his wife had just shot and killed herself. When the police and an ambulance arrived, the victim was dead of a bullet wound in her upper left temple. The husband was holding the gun with which he alleged his wife had shot herself. He stated that he had arrived home from work just before the incident but that neither his wife nor their three preschool-age children had been there. His wife had arrived home a short while later, and she had been drinking heavily. When he questioned her about the whereabouts of their three children, she told him they were at his mother's home. A heated argument then followed about her neglect of their children, her drinking, and her seeing other men. According to the husband, his wife then slapped him in his face, and he slapped her back. At that point, she walked over to a nearby desk drawer, where he kept a revolver. She removed the revolver from the desk drawer, placed the barrel against her head, fired a single shot, and fell to the floor. No one else was home at the time this incident occurred.

The following set of facts was revealed by the medical examiner's autopsy report:

- The bullet entered the upper left portion of the head, traveled downward through the brain, and continued downward through the victim's body, coming to rest in her chest.
- There were no powder burns present around the gunshot wound.
- Death occurred immediately.
- If the wound had been self-inflicted, the victim would have been holding the weapon in her left hand, at least 2 feet from her head, and would have used her thumb to pull the trigger.

The relatives of both the victim and her husband provided the police with the following information:

- To their knowledge, the victim had not been despondent, nor had she ever previously attempted or discussed suicide.
- The victim and her husband had been having serious domestic difficulties, because she was seeing other men, spending the house money on liquor, and not properly caring for their three young children.
- Both parties were known to have assaulted each other in domestic disputes in the past.
- The victim was right-handed.

These facts tended to indicate the victim's death was not a suicide but a criminal homicide. An interrogation of the husband confirmed what the facts suggested—namely,

► **FIGURE 9-23**  
**Suicide by shotgun**

This individual placed a 12-gauge shotgun against his right temple and pulled the trigger. As can be noted, there are scorch marks around the entry wound near the right ear.

Shotgun wounds to the head, especially those involving large-gauge shotguns, generally result in enormous damage to the head.



that he was not telling the truth. The husband related that he had been truthful about the events leading up to the argument, but after his wife slapped him, he had angrily knocked her to the floor, removed the revolver from the desk drawer, and gone back to his wife, who was now on her knees. Standing over her, he fired a single shot into her head. After shooting her, he became frightened and fabricated the story of his wife's suicide.

This case demonstrates the importance of two factors in the investigation of an alleged suicide. The first is the importance of the location of the wound on the body and its trajectory on entering the body. Second is the presence or absence of evidence indicating that the victim was predisposed to committing suicide.

### **Suicide by Use of a Shotgun**

The use of a shotgun to commit suicide can result in enormous physical damage, especially if the gun is discharged into the head (Figure 9-23).

### **Hanging**

Certain misconceptions associated with suicidal hangings can lead to erroneous conclusions. The first is that the victim's neck gets broken and, second, that the feet are suspended off the floor. Although both of these conditions may occur, they are exceptions rather than the rule. The first misconception is related to the circumstances of legal executions by hanging. In legal executions, the procedures involved in inflicting death are intended to result in the neck being broken. This is accomplished by the use of a specific type of noose and a gallows with a trap door through which the person will drop some predetermined distance before being abruptly stopped. However, in a suicidal hanging, even

when the feet are suspended, the neck is rarely broken, because the fall is not long enough to cause the severe jolt necessary to break the neck (Figure 9-24)

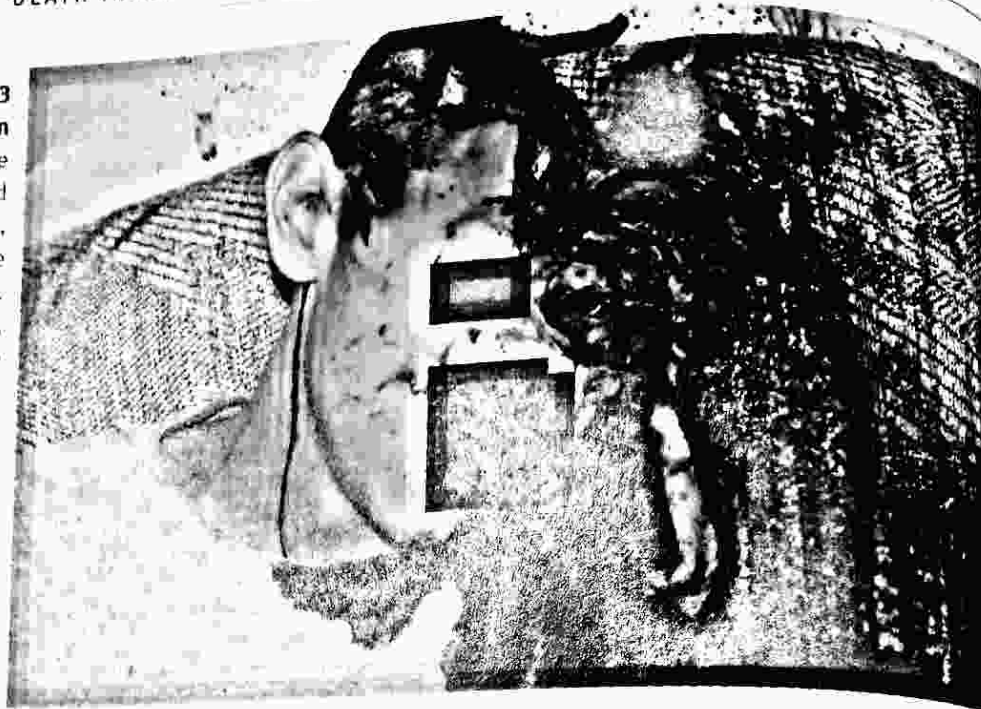
It is also fairly common in suicidal hangings for the victim's feet or even the knees to be touching the ground. Occasionally, the victim is found in a sitting position. Finding victims in these positions often creates suspicion, because it is difficult for inexperienced investigators to understand how anyone could remain in these positions while slowly choking to death. They might improperly conclude the victim first was rendered unconscious or was killed and placed in the hanging position. It is more likely, however, the victim did not slowly choke to death but rather first tied the rope around some supporting device and then around his/her neck. Pressure was then applied by the victim either by crouching down, if in a standing position, or leaning forward, if in a sitting position. This initial pressure painlessly cuts off the flow of blood to the brain, which results in unconsciousness. When unconsciousness does occur, the full weight of the body is then applied to the noose, whereupon all oxygen is cut off to the brain and death follows. There is very little physical pain associated with suicides of this type. If one considers that many suicidal hangings occur in victims' homes, then it is logical to expect the feet not to be suspended above the floor, because few household objects are strong enough to hold the weight of a fully suspended body or one that has fallen several feet from a chair or table.

Livor mortis is most pronounced in the lower portion of the arms and legs and around the face, lips, and jaw. There may be some variations in the location of the discoloration, depending on the position of the body. When death occurs in this manner, one frequently finds petechial hemorrhaging in the eyes, caused when small blood

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▲ **FIGURE 9-24** Suicidal hanging

This suicide victim has been in this hanging position for approximately three weeks. The body is in an advanced stage of decomposition; the mosslike substance on the body is dried body fluids. The victim has used a ligature-type device wrapped around a beam in the attic to suspend his body.



▲ **FIGURE 9-25** Petechial hemorrhaging in the eye

The victim of a suicidal hanging. In suicidal hangings, investigators often find what is referred to as a petechial hemorrhaging in the eyes of the deceased. This is a result of the small vessels in the eye bleeding because of an increase in blood pressure caused by the compression around the neck.

vessels in the eye bleed because blood pressure increases in response to compression around the neck (Figure 9-25).

Occasionally, hangings are accidental, not suicidal. The individual may have himself in a modified hanging position while masturbating and accidentally fall, slip, and knock over the object on which he is standing, resulting in an accidental death, known as autoerotic death or sexual asphyxia; the intent is sexual rather than suicidal. In these cases, the genitals are exposed, and semen may be present. (Chapter 10, "Sex-Related Offenses," provides an in-depth explanation of autoerotic death.) The presence of feces and urine is common because of the total relaxation of the bladder and bowel muscles at the time of death.

### Sleeping Pills and Other Pharmaceuticals

Sleeping pills and other pharmaceuticals have for many years been a common means of committing suicide. However, some deaths resulting from the ingestion of sleeping pills or tranquilizing drugs may be accidental, not suicidal. The investigator has an obligation to determine whether the death was accidental or suicidal. Cer-

tain types of medication, such as barbiturates, when mixed with alcohol have a synergistic effect, which increases the potency of the drug beyond its normal strength. One should not be too quick to decide that the death is a suicide until the investigation is completed and some evidence is available to support this conclusion. In such cases, the investigator should seize as evidence any remaining medication and its container. Frequently, the container identifies the medication, the drugstore dispensing it, and the physician prescribing it. There is always the possibility that the medication was purchased or obtained illegally, thus complicating the investigative process. As in all apparent suicides, the investigator should conduct interviews of relatives, friends, and neighbors who may be able to provide background information about the victim.

### Drowning

The majority of drowning incidents are either accidental or suicidal, but some are homicidal. Three questions must be answered in apparent drowning cases before any final conclusions can be reached: Was the cause of death drowning, or was the victim first killed and then placed in the water? If the cause of death was drowning, did it take place in the water where the body was recovered, or was the victim drowned elsewhere and then placed in the water where found? Was the victim conscious when placed in the water? Answers to these questions can be obtained by external examination of the body by the investigator and an internal investigation of the body by

**FIGURE 9-26 Drowning victim**

This individual died from an accidental drowning. Note the pink foam extruding from his nose and open mouth.



a physician. External signs to indicate that the victim was alive and conscious when entering the water include:

- objects clutched in the hand, such as grass or bottom soil commonly found in water;
- fingernail marks on the palms of the hands;
- white, pink, or red foam extruding from the nose and open mouth (Figure 9-26);
- livor mortis most marked in the head and neck, because the body settled with these parts in a dependent position.<sup>31</sup>

An internal examination by a physician serves to establish whether death occurred by drowning. The following evidence may be found in drowning cases:

- The chest cavity and the lungs are distended and soggy, with fine foam in the trachea and bronchi.
- The heart is flabby, with its right side dilated and filled with dark red fluid. The blood is unclotted and usually hemolyzed owing to the absorption of the drowning fluid into the system.
- The mastoid cells of the ear have hemorrhaged.
- In deep-water drowning, air embolisms may have formed in the blood.
- There may be water in the stomach and duodenum.
- Algae and other marine particles may be found in the stomach and adhering to the sides of the air passages.

In removing the body from the water, the investigator may notice considerable damage to portions of the victim's body, especially around the head and face. This should not cause the investigator to conclude prematurely that the victim was the object of foul play. Some bodies of water contain many rocks and shells; a free-floating body that is subject to strong currents can be

repeatedly slammed into and dragged across such objects, causing severe damage, especially to the forehead, knees, tops of the feet, and backs of the hands. In addition, if the water is rich with fish, crabs, and other marine life, these, too, can cause damage. It is not unusual for the lips, ears, and nose to be at least partially eaten away. The extent of damage from objects or marine life in the water varies; understanding what can result from their presence minimizes the possibility of premature conclusions. But the investigator must also not prematurely conclude that all damage resulted after the body was placed in the water. The medical examiner can help draw conclusions about the actual nature of wounds (Figure 9-27).

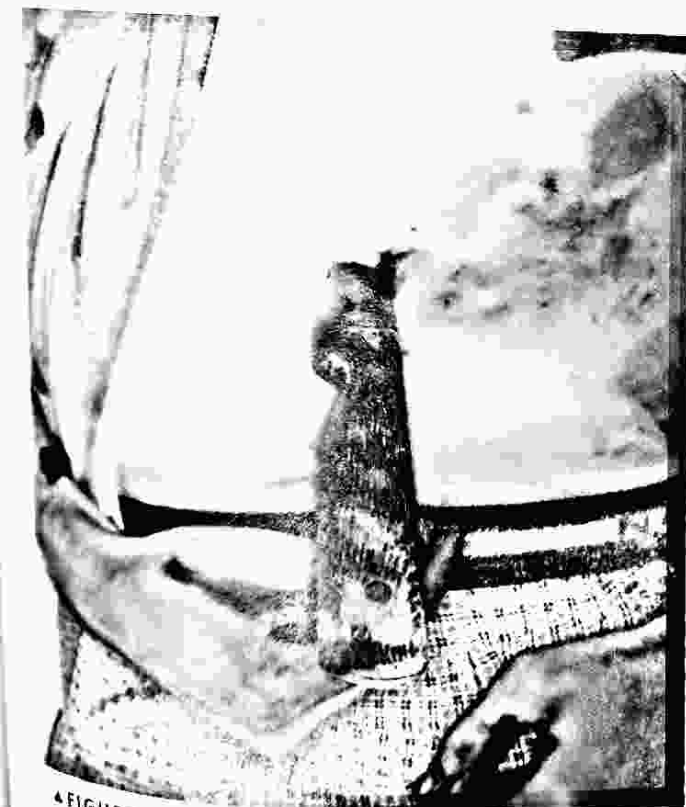
### Cutting and Piercing Instruments

The instruments ordinarily employed in suicides by cutting are razor blades, knives (Figure 9-28), and occasionally glass. One of the common characteristics of suicides inflicted by these instruments is the presence of hesitation marks. Hesitation marks are a series of lesser wounds inflicted by the victim in the general region of the fatal wound, often the wrists, forearms, or throat. In certain throat cuttings, it may be possible to reach a conclusion about whether the injury was self-inflicted or resulted from an assault. If a wound is self-inflicted, it tends to be deep at the point of entry and to shallow out at its terminus, which is near, or slightly past, the midline of the throat. In homicidal throat cutting, the wound appears deep from the start to the terminus. It is not unusual for a victim to inflict a series of severe cuts on different parts of the body to ensure death. The reasons vary, sometimes involving the influence of alcohol or hallucinogenic drugs. The prior ingestion of alcohol or drugs may have been a planned prelude to the act of self-destruction.



**FIGURE 9-27**  
Decomposition and marine life damage to an immersed body

Damage sustained by the victim in this photograph occurred while the victim was immersed in water. Note that the ears and eyelids are completely missing, and there is extensive damage to the nostrils and lips. These areas are among the first parts of the body to be attacked by marine life.



**FIGURE 9-28** Suicide by knife  
This photo depicts an individual who took his life by stabbing himself in the abdomen with a knife.

Self-inflicted wounds can be surprisingly brutal and tend to make people disbelieve they were self-imposed. This is particularly true when mutilation of the sexual parts is involved. In one case, a 28-year-old man used a single-edged razor blade to cut off his penis. When questioned by paramedics, the man said: "It's just been eating away at me for so long, and when I thought about it, I heard voices saying 'Do it, do it.' I was just angry at myself. I had it all planned out and I did it."<sup>32</sup>

## Poisons

The ingestion of liquid **poisons** is sometimes clear from outward signs on the body. Powerful caustic lyes or acids may produce vomiting once the liquid reaches the digestive tract. There is considerable damage to lips, tongue, and mouth, and there may be blood in the vomitus, along with pieces of the esophagus and stomach. Usually, death does not occur rapidly, and victims may employ another means of suicide to stop the excruciating pain (Figure 9-29).

Cases of suspected poisoning frequently pose very difficult problems to the police investigator and to the medical examiner. Many poisons produce symptoms similar to those of certain diseases, a fact that can complicate determination of whether a crime has been committed. However, if there is any reason to suspect poisoning, the investigation must proceed along the lines of a possible homicide, suicide, or accidental death until death due to natural causes is established.<sup>33</sup> To compound the problem, suicides and accidental deaths by poisoning are sometimes very difficult to distinguish from homicide. Alcohol, when consumed with certain medications, may result in an accidental (possibly suicidal) death by respiratory failure. An example is the combination of barbiturates and alcohol; when the alcohol level in the blood reaches about half the lethal dose, most individuals lose consciousness and thus stop breathing. But with the addition of a stimulant, such as an amphetamine, this effect may not occur, and individuals may drink a lethal dose of alcohol before they fall into a coma.

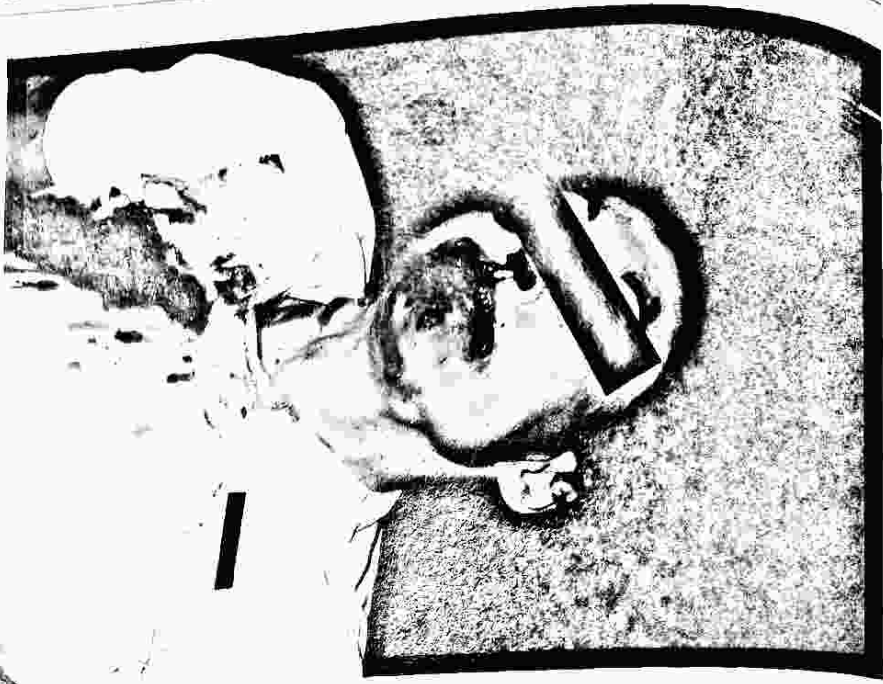
Actually, poisoning is now rarely used in homicides, because modern laboratory techniques can readily detect most poisons, thus unmasking an intended homicide. But when it is the method, a wide variety of poisons may be used (Table 9-1).

**Characteristics of "Ideal" Poisons.** There are certain elements that characterize an "ideal" poison, including:

- *Being odorless, tasteless, and colorless*—This allows for the administration of the poison to the intended victim while providing no warning signs that the victim can detect by the normal bodily senses of smell, taste, and sight.
- *Being readily soluble, preferably in water*—This allows for easy administration in normal foods and drinks that the victims might eat or drink.

**FIGURE 9-29**  
**Ingestion of a caustic drain cleaner**

This victim committed suicide by ingesting a strong caustic drain cleaner. On ingestion, vomiting was induced, thereby causing severe burns to the nose, chin, and chest area.



- *Having a delayed onset of action*—This allows for a time period in which the poisoner can attempt to create an alibi.
- *Being undetectable*—Certainly the more exotic the poison the more likely it will not be detected in more routine toxicological analyses.
- *Having a low-dose lethality*—Less of the toxic material needs to be administered. It is much easier to distribute a pinch of a substance than to distribute a pound.

- *Being easily obtained, but not traceable*—The poison will leave no investigative trail that would lead to the poisoner.
- *Being chemically stable*—This makes it easy to store the poison without loss of potency.<sup>34</sup>

**Role of the Crime Scene Investigator in Suspected Deaths by Poisoning Cases.** Even though the crime scene investigators seldom can identify the chemical compound that caused the death, they should be alert to the

**TABLE 9-1** Poisons and Associated Physical Manifestations

TYPE OF POISON	SYMPTOM OR EVIDENCE
Caustic poison (lye)	Characteristic burns around lips and mouth of victim
Carbon monoxide	Victim's skin takes on an abnormally bright cherry-red color
Sulfuric acid	Black vomit
Hydrochloric acid	Greenish-brown vomit
Nitric acid	Yellow vomit
Silver salts	White vomit turning black in daylight
Copper sulfate	Blue-green vomit
Phosphorus	Coffee-brown vomit with an onion or a garlic odor
Cyanide	Burnt almond odor in air, cherry-red lividity color
Ammonia, vinegar, Lysol, etc.	Characteristic odors
Arsenic, mercury, lead salts	Pronounced diarrhea
Methyl (wood) alcohol, isopropyl (rubbing) alcohol	Nausea and vomiting, unconsciousness, possibly blindness

Source: Richard H. Fox and Carl L. Cunningham, *Crime Scene Search and Physical Evidence Handbook* (Washington, D.C.: Government Printing Office, 1985), p. 126.

general range of possibilities and the potentially hazardous environmental factors that may be connected with a poisoning.

Regardless of the nature of the incident—homicide, suicide, or accident—the symptoms of death by poison are the same. The field investigator should attempt to determine if the victim had any of the symptoms—vomiting, convulsions, diarrhea, paralysis, rapid or slow breathing, contracted or dilated pupils, changes in skin color, or difficulty in swallowing—just before death. These symptoms are general manifestations of systemic poisoning. They do not provide proof of poisoning but can be meaningful in relation to other evidence. Someone who observed the victim just before death provides the best source of information concerning his or her symptoms. If no witness is available, the investigator must rely all the more on physical evidence from the crime scene.

The investigator should collect all available information concerning the activities of the victim during the last three days of life. Information on what types of medication were taken, when the last meal was eaten, and where it was eaten can be very important in determining the type of poison involved. Medical history may indicate that death was due to natural causes.

The **toxicologist** is concerned with the identification and recognition of poisons, with their physiological effects on humans and animals, and with their antidotes. Crime laboratories usually provide some toxicological support but vary considerably in the amount and type that they can furnish. However, full toxicological support is always available through a combination of hospital, medical examiner, coroner, and criminalistics laboratories. Crime laboratories can direct police to local facilities.

If the investigator suspects that poison was ingested, a diligent search should be conducted for the container. In suicides and accidental poisonings, the container frequently is close at hand. Even though a container appears empty, it should be processed for fingerprints, packaged, marked, and forwarded to the laboratory for examination. Additionally, any other object that could reasonably relate to the poisoning should be collected, such as unwashed dishes and glasses, wastebasket contents, envelopes, and medicine containers.

### Opiate-Overdoses

Drugs are classified into different groups based on their origins and effects on the human body. The opiate class of narcotics, which includes morphine, heroin, and oxycodone, are commonly referred to as downers because of their sedative-like effects. With the exception of alcohol, opiates account for the largest portion of drug-related hospital admissions.<sup>35</sup>

Police agencies often identify fatal drug overdoses as accidental deaths, but being aware of and alert to the indicators of a drug overdose before entering a crime scene enables investigators to more effectively conduct their investigation.

Victims of an opiate overdose often exhibit specific characteristics. For example, victims may have a "foam cone," tinged orange or red with blood, around their nostrils and mouth, which is the most common characteristic of such an overdose. Opiates act as a central nervous system depressant, causing a decrease in heart rate and breathing. This slowing causes fluids to gather in the lungs, inhibiting the life sustaining exchange of oxygen and carbon dioxide. Essentially, victims drown in their own pulmonary fluids. As the fluids gather, victims may expel these fluids, mixed with gas bubbles, which then forms the foam cone. Autopsies of opiate overdose victims often reveal that death resulted from pulmonary edema, a swelling of the lungs with a pooling of fluids inside them.<sup>36</sup>

Because of this lack of oxygen, extremities, as well as the lips and tongue, frequently turn blue. Pupils may be constricted to a pinpoint. Many heroin users inject the drug into their body with a needle, a practice known as mainstreaming. Consequently, they also may have needle or track marks, generally found on their arms. Chronic users often damage the blood vessels in their arms to such a degree that they resort to injecting the heroin into their legs, eyelids, or between their toes. Others also attempt to mask the needle marks by injecting into a tattoo.<sup>37</sup> Although only an autopsy can determine the exact cause of death, investigators and first responders can use these characteristics to initially determine that the death likely resulted from an opiate overdose.

### Gases

The gas most frequently involved in medico-legal investigations is carbon monoxide. When a death does result from this gas, it is generally accidental or suicidal. Carbon monoxide is found in automobile exhaust fumes and improperly ventilated space heaters in homes. In a death caused by auto emissions, the individual may have started the engine of the vehicle in the garage after closing the garage door or may have extended a flexible hose from the exhaust pipe into the vehicle and then closed the windows.

When death occurs from carbon monoxide poisoning, the victim's skin takes on an abnormally bright cherry-red color because of the reaction of the red blood cells to the gas. The red blood cells have a very high affinity for carbon monoxide molecules (approximately 250 times greater than for oxygen), absorbing them rapidly, thereby making the red blood cells incapable of absorbing oxygen and rendering them dysfunctional in the life-sustaining process. Death generally occurs when the red blood cells have reached a saturation level usually above 40%, although this varies; the level sometimes goes higher before death results if the victim is asleep, owing to the body's reduced oxygen needs (Figure 9-30).

### Jumping from High Places

The major question to be answered in death resulting from jumping is whether the victim voluntarily leaped or was thrown or pushed. Often, there are suicide notes, witnesses

▶ FIGURE 9-30

**Carbon monoxide death**

This victim died accidentally from carbon monoxide poisoning resulting from an improperly ventilated space heater. Note the abnormally bright cherry-red color resulting from the reaction of the red blood cells to the gas and the pale area in the back region. This results because this area was resting against a firm surface and compressing the vessels in this area, which prevents the accumulation of blood.



who can provide this information, or background information that indicates previous suicide attempts or a predisposition toward suicide.

**The Suicide Note**

Research indicates that suicide notes are not left in most suicides. One study revealed certain facts about persons who do and do not leave notes. Generally, there are no differences between the two groups in age, race, sex, employment, marital status, history of mental illness, place of suicide, reported causes or unusual circumstances preceding the act, medical care and supervision, or history of previous suicide attempts or threats. However, the note-writers differed from the non-note-writers in the methods used to kill themselves. The note-writers used poisons, firearms, and hanging more often as a means of death than did the non-note-writers.<sup>38</sup>

**GENDER DIFFERENCES IN SUICIDAL BEHAVIOR**

Studies of suicide in the United States indicate that the suicide rate is higher for men than for women, whereas the attempted suicide rate is higher for women than men. Some evidence suggests that there are differences between men and women in the methods employed to commit suicide: women prefer barbiturates and poisons; if women do use a firearm, the fatal wound is frequently in the body rather than the head. It has been suggested that these methods are used because they are not disfiguring and because women are often more concerned about their appearance after death than are men. It is not unheard of for a woman to leave a note to her female friends or relatives specifying in detail the clothing and jewelry she wants to wear in her open casket and at her funeral, along with details relating to facial cosmetics.<sup>39</sup>

In contrast, some males kill themselves where their bodies will not be discovered by family members, such as in the woods or some other isolated area. These types of suicides can create investigative problems, especially if a note is not written. For example, if a passerby should come upon the body and steal the gun used in a suicide as well as valuables from the suicide victim, the police may initially believe the death was a murder and robbery rather than suicide.

**FIRE DEATHS**

Frequently, human remains of **fire deaths** are found at the scene of a fire. Properly examined, these remains may provide important data to the investigator about the facts surrounding the fire and the cause of death. Investigators should ask these questions:

- Was the decedent accidentally killed by the fire (whether or not the fire was caused by arson)?
- Was the decedent deliberately killed by the fire?
- Was the decedent already dead when the fire occurred?

To answer these questions, investigators should determine certain facts. These facts are outlined in the remainder of this section.<sup>40</sup>

**COORDINATION AND COOPERATION**

Coordination of, and cooperation between, police and fire investigators are of paramount importance in the successful investigation of any questioned fire. As with other forms of physical evidence at a fire scene, a body should never be moved until fully examined at the scene, unless



◀ **FIGURE 9-31**

**Third-degree burns**

This individual was driving a truck when it caught on fire. He leaped from the truck, but the burn injuries he had sustained would eventually prove fatal. The area of his face, hands, and abdomen are classified as third-degree burns. The cause of his death was listed as thermal injuries.

There is some possibility that the person is still alive or there is danger of further destruction of the body if it remains where it is. Also, because a dead human being is probably the most complex and rapidly changing type of physical evidence at a crime scene, cooperation between medical personnel (preferably forensic pathologists) and investigators is essential. This coordination should extend from the scene of the fire to the medical facility where the postmortem examination is conducted.

### DEGREES OF BURNING

Burns are medically classified into four types. The extent of burns may provide information about the proximity of the body to the point of origin of the fire, the length of time the body was exposed to the fire, and the intensity of the fire.

First-degree burns are superficial and limited to the outer layers of skin. Although the burned area is red and swollen, blisters do not form and peeling may follow. Second-degree burns involve blistering and the destruction of the upper layers of skin. They occasionally cause scarring in living victims. With third-degree burns, the entire thickness of the skin (epidermis and dermis) is destroyed. In living victims with third-degree burns, pain is usually absent as nerve endings are destroyed; scarring results, and skin grafting is usually necessary (Figure 9-31). Fourth-degree burns completely destroy (char) the skin and underlying tissue.

### IDENTIFICATION OF REMAINS

Because fire destroys human tissue, identification of the remains may be especially difficult. Yet because identification of a decedent is a key factor in any questioned

death investigation, an orderly, sequential approach must be used in the identification process. The six means that follow should be considered in sequence, from the "best" identification tools to the "worst":

- Fingerprints
- Dentition
- DNA printing
- Scars, marks, or tattoos on the exterior of the body
- Anatomical abnormalities or artificial appliances used to replace hips or knees inside the body
- Identification, jewelry, and clothing on the body

### SCENE CONSIDERATIONS

As with any physical evidence, burned bodies must be sketched, measured, and photographed in place and in relation to other evidence at the scene of the fire. The actual location of the body may be crucial to the investigation. Determination as to whether the decedent was a smoker is important for establishing what caused the fire and whether he/she was alive at the time of the fire.

### EXAMINATION OF THE EXTERNAL BODY

The body of the deceased should be examined in detail both at the scene and again at the morgue. Significant areas for examination include those discussed next.

### SIGNS OF TRAUMA

Any sign of injury to the external body should be carefully noted, sketched, and photographed. The use of a five-power magnifying glass (as a minimum) is required, because fire obscures signs of injury.

## Skull Fracture

Another factor that may be misconstrued is the discovery that the victim's skull is fractured. Care must be taken to determine whether the fracture is implosive or explosive. An implosive fracture may have been caused by a fall, may be evidence of a previous felonious assault or homicide, or may result from a collapsed structural member. The exact cause will be determined at autopsy and evaluated during the follow-up investigation. An explosive fracture, however, is usually a natural consequence of fire. The extreme heat may cause the fluids in and around the brain to boil and expand. The resulting steam produces pressure sufficient to cause an explosive (pressure-release) reaction. The fracture(s) that result usually follow the natural suture lines of the skull. In extreme cases, the cranium may burst, causing the expelled brain and skull matter to form a circular pattern around the head. This is more common in children than in adults: the fontanel, or membrane-covered opening between the uncompleted parietal bones, is the weakest point in a fetal or young skull. The resulting circular pattern (0-12 inches from the splattering that might result from a shotgun blast or high-order explosion.<sup>41</sup>

## Blistering and Splitting Skin

The inexperienced investigator may be somewhat apprehensive in attempting to evaluate the effects of heat and flame on the skin of the victim. The medical investigator is in the best position to render a judgment in this area.

The formation of blisters (vesicles) is part of the body's natural defense system. The exact distinction between antemortem and postmortem blistering can be made only at autopsy. There are, however, certain signs that a medical investigator can use in developing a hypothesis. Postmortem blisters are generally limited in size and may contain only air or air mixed with a small amount of body fluid. Antemortem blisters are larger in size and contain a complex mix of body fluids. The precise determination of the fluids requires microscopic analysis. A blister surrounded by a pink or red ring can be considered to have occurred before death; the reddish ring is the result of an antemortem inflammatory reaction.

In some instances, temperatures may not have been sufficiently high to produce blistering. Likewise, if the skin is burned off or otherwise heavily damaged, blistering will not be evident.

The heat and flames of the fire also cause the skin to shrink or tighten and ultimately split. The splitting or lesions may be seen on the arms, legs, and torso. At first glance, one could misinterpret this condition, coupled with pugilistic attitude (described shortly), as indicating defense wounds.

In some cases, a seriously burned person survives the fire and is removed to a burn center. In an effort to save

the person, the medical staff at the center may attempt to duplicate the natural splitting of the skin with a surgical technique known as an escharotomy. This technique is used to help foster circulation and to prevent the onset of gangrene. Should the burn victim die some time after the fire, these splits should not be misinterpreted as fire-induced.<sup>42</sup>

## Noncranial Fractures

If enough heat is applied, bones shrink, warp, and fracture. Determining whether fractures were caused by a trauma or heat requires painstaking examination.

## Pugilistic Attitude

The so-called pugilistic attitude of the body is a natural result of the dehydrating effect caused by the heat from the fire and is not related to the cause or manner of death. The arms and legs will be drawn into a posture resembling that of a boxer (Figure 9-32).

More often than not in fire deaths, a forensic pathologist who is an expert on burned bodies may have to be summoned.

## EXAMINATION OF THE INTERNAL BODY

After the body has been closely examined, sketched, and photographed, an internal examination of it should be conducted by a forensic pathologist. Investigators should attend this procedure to get information about the facts, to correct discrepancies in data (such as measurements), and to recover evidence from the body. Significant areas for examination are as follows.

### Soot, Other Debris, or Burning in the Air Passages

These findings may indicate that the decedent was breathing while the fire was burning.

### Pulmonary Edema

A frothy substance in the lungs may result from irritants breathed in during a fire.

### Epidural Hemorrhages

Hemorrhages above the tough membrane covering the brain (the dura mater) and under the skull may occur at the rear of the head due to heat. These hemorrhages should not be mistaken for the hemorrhages associated with blunt-force injuries.<sup>43</sup>

### Internal Injuries

All internal injuries should be closely examined, measured, and photographed, with samples taken by the pathologist for later microscopic examination.

### Foreign Objects

Any foreign objects found in the body, such as bullets, should be recovered as evidence by the investigator.

### Skull Fracture

Another factor that may be misconstrued is the discovery that the victim's skull is fractured. Care must be taken to determine whether the fracture is implosive or explosive. An implosive fracture may have been caused by a fall, may be evidence of a previous felonious assault or homicide, or may result from a collapsed structural member. The exact cause will be determined at autopsy and evaluated during the follow-up investigation. An explosive fracture, however, is usually a natural consequence of fire. The extreme heat may cause the fluids in and around the brain to boil and expand. The resulting steam produces pressure sufficient to cause an explosive (pressure-release) reaction. The fracture(s) that result usually follow the natural suture lines of the skull. In extreme cases, the cranium may burst, causing the expelled brain and skull matter to form a circular pattern around the head. This is more common in children than in adults: the fontanel, or membrane-covered opening between the uncompleted parietal bones, is the weakest point in a fetal or young skull. The resulting circular pattern (0–12 inches from the skull) is significant when compared with the type of splattering that might result from a shotgun blast or high-order explosion.<sup>41</sup>

### Blistering and Splitting Skin

The inexperienced investigator may be somewhat apprehensive in attempting to evaluate the effects of heat and flame on the skin of the victim. The medical investigator is in the best position to render a judgment in this area.

The formation of blisters (vesicles) is part of the body's natural defense system. The exact distinction between antemortem and postmortem blistering can be made only at autopsy. There are, however, certain signs that a medical investigator can use in developing a hypothesis. Postmortem blisters are generally limited in size and may contain only air or air mixed with a small amount of body fluid. Antemortem blisters are larger in size and contain a complex mix of body fluids. The precise determination of the fluids requires microscopic analysis. A blister surrounded by a pink or red ring can be considered to have occurred before death; the red-dish ring is the result of an antemortem inflammatory reaction.

In some instances, temperatures may not have been sufficiently high to produce blistering. Likewise, if the skin is burned off or otherwise heavily damaged, blistering will not be evident.

The heat and flames of the fire also cause the skin to shrink or tighten and ultimately split. The splitting or lesions may be seen on the arms, legs, and torso. At first glance, one could misinterpret this condition, coupled with pugilistic attitude (described shortly), as indicating defense wounds.

In some cases, a seriously burned person survives the fire and is removed to a burn center. In an effort to save

the person, the medical staff at the center may attempt to duplicate the natural splitting of the skin with a surgical technique known as an escharotomy. This technique is used to help foster circulation and to prevent the onset of gangrene. Should the burn victim die some time after the fire, these splits should not be misinterpreted as fire-induced.<sup>42</sup>

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• **FIGURE 9-32**  
Pugilistic attitude

The heat of a fire can result in the arms and legs of the body being drawn up into a posture resembling that of a boxer. That is precisely what happened to this individual, who died in an accidental house fire. The cause of his death was determined to be inhalation of smoke and soot.

Because these objects are frequently small and difficult to locate, X-ray examination of the body before internal examination is recommended.

### Toxicologic Examination

The pathologist should take samples for later examination by a toxicologist. Toxicologic results may be of extreme importance to the investigation.

### Alcohol

Alcohol in blood indicates whether the decedent was incapacitated at the time of the fire and thus unable to escape. A finding of high levels of alcohol raises questions for the investigator about the decedent's habits.

### Other Drugs

Indications of other possibly incapacitating drugs may provide new leads. The possibility of drug interactions—barbiturates with alcohol, for example—should also be considered.

### Carboxyhemoglobin

Carbon monoxide (CO) is an odorless, colorless gas present at hazardous levels in all structural fires. Carbon monoxide asphyxiation (usually above 40% saturation) is probably the most common cause of death in fires. As previously discussed, CO causes the cherry-red color of postmortem lividity (as well as that of internal organs and muscle tissue).

### Presence of Other Chemicals

Chemicals given off by burning materials may indicate the accelerant of the fire, as well as offer evidence that the decedent was breathing them in at the time of the fire.

## MOTIVES IN FIRE DEATHS

In fire deaths, the following motives should be kept in mind by investigators:

- Destruction or mutilation of the body to conceal the identity of the decedent.
- Destruction or mutilation of the body to conceal the true cause or manner of death.
- Incineration of the body with homicidal intent.
- Incineration of the body to collect on an insurance policy. For example, a decedent may have committed suicide but have an insurance policy prohibiting collection after death by suicide. Beneficiaries may burn the body to indicate accidental death by fire.
- Suicide with an accelerant.
- An attempt by a suicide victim to hide the cause of death.
- A victim trapped in a building burned by an arsonist or by accident.

## SERIAL MURDER

In the past 30 years, multiple definitions of **serial murder** have been used by law enforcement, clinicians, academicians, and researchers. Previous definitions of serial murder specified a certain number of murders, varying from two to ten victims.<sup>44</sup>

This quantitative requirement distinguished a serial murder from other categories of murder (that is, single, double, or triple murder).

Most of the definitions also required a period of time between the murders. This break-in-time was necessary to distinguish between a mass murder and a serial murder.

Serial murder required a temporal separation between the different murders, which was described as: separate occasions, cooling-off period, and emotional cooling-off period.

Generally, mass murder was described as a number of murders (four or more) occurring during the same incident, with no distinctive time period between the murders. These events typically involved a single location, where the killer murdered a number of victims in an ongoing incident (for example, the 1984 San Ysidro McDonald's Huberty killing 21 people; the 1991 Luby's Restaurant massacre in Killeen, Texas, where George Jo Hennard killed 23 people; in 2007, the murder of 32 persons at Virginia Tech in Blacksburg, Virginia by Seung-Hui Cho; and the murder of 8 people in Manchester, Connecticut, in 2010 by Omar S. Thornton).

### DEFINING SERIAL MURDER

There has been at least one attempt to formalize a definition of serial murder through legislation. In 1998 a federal law was passed by the United States Congress, titled: Protection for Children from Sexual Predator Act of 1998. This law includes the following definition of serial killings.

The term "serial killings" means a series of three or more killings, not less than one of which was committed within the United States, having common characteristics such as to suggest the reasonable possibility that the crimes were committed by the same actor or actors.

Although the federal law provides a definition of a serial murder, it is limited in its application. The purpose of this definition was to set forth criteria establishing when the FBI could assist local law-enforcement agencies

► **FIGURE 9-33**  
Serial killer Theodore Robert (Ted) Bundy

This photo depicts a forensic dentist obtaining dental impressions from serial killer Theodore Robert (Ted) Bundy in conjunction with the murder of two Florida State University female students. Bundy's dental impressions were compared with bite marks left on the body of one of the victims. The marks were positively identified as his. Bundy, who was suspected of killing as many as 100 women, was subsequently executed in the state of Florida. (Courtesy Sheriff Ken Katsaris, Leon County Sheriff's Office, Tallahassee, Florida)



with their investigation of serial murder cases. It is not intended to be a generic definition for serial murder.

The lay public tends to refer to all multiple murders as serial killers, this however is not correct. For example, if two or more murders are committed by an offender, or offenders at one time without a cooling-off period, this is typically referred to as a "spree murder." According to the definition, a lack of a cooling-off period marks the difference between the spree murder and the serial murder.

Also, unlike serial murderers, spree murderers are generally either killed or seriously wounded by the police at the scene of their multiple homicides or are wounded and taken into custody. It is also fairly common for them to kill themselves at the scene of the crime, generally with a self-inflicted gunshot wound to the head. Thus, although these murderers are every bit as destructive as serial murderers, they do not create the same long-term investigative difficulties as do serial murderers.

Serial murder is a relatively rare event, estimated to constitute less than 1% of all murders committed in any given year. However, there is a macabre interest in the topic that far exceeds its scope and has generated countless articles, books, and movies. This broad-based fascination began in the late 1880s, after a series of unsolved prostitute murders occurred in the Whitechapel area of London. These murders were committed by an unknown individual who named himself "Jack the Ripper" and sent letters to the police claiming to be the killer.

These murders and the *nom de guerre* "Jack the Ripper" have become synonymous with serial murder. This case spawned many legends concerning serial murder and the killers who commit it. In the 1970s and 1980s, serial murder cases such as the Green River Killer, Theodore Robert (Ted) Bundy (Figure 9-33), and BTK sparked a renewed public interest in serial murder,

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which blossomed in the 1990s after the release of films such as *Silence of the Lambs*.

## MYTHS AND MISCONCEPTIONS ABOUT SERIAL KILLERS

The relative rarity of serial murder combined with inaccurate anecdotal information and fictional portrayals of serial killers has resulted in the following common myths and misconceptions regarding serial murder.

### Serial Killers Are All Dysfunctional Loners

The majority of serial killers are not reclusive or social misfits who live alone. They are not monsters and may not appear strange. Many serial killers hide in plain sight within their communities. Serial murderers often have families and homes, are gainfully employed, and appear to be normal members of the community. Because many serial murderers can blend in effortlessly, they are often overlooked by law enforcement and the public as indicated in the following cases:

- *Robert Yates* killed 17 prostitutes in the Spokane, Washington, area, during the 1990s. He was married with five children, lived in a middle-class neighborhood, and was a decorated U.S. Army National Guard helicopter pilot. During the time period of the murders, Yates routinely patronized prostitutes, and several of his victims knew other victims. Yates buried one of the victims in his yard, beneath his bedroom window. Yates was eventually arrested and pled guilty to 13 of the murders.
- *The Green River Killer, Gary Ridgeway*, confessed to killing 48 women over a 20 years in the Seattle, Washington area. He had been married three times and was still married at the time of his arrest. He had been employed as a truck painter for 32 years. He attended church regularly, read the Bible at home and at work, and talked about religion with co-workers. Ridgeway also frequently picked up prostitutes and had sex with them throughout the time period in which he was killing.
- *The BTK killer, Dennis Rader*, killed 10 victims in and around Wichita, Kansas. He sent 16 written communications to the news media over 30-year period, taunting the police and the public. He was married with two children, was a Boy Scout leader, served honorably in the U.S. Air Force, was employed as a local government official, and was president of his church.

### Serial Killers Are All White Males

Contrary to popular belief, serial killers span all racial groups. There are white, African-American, Hispanic, and Asian serial killers. The racial diversification of serial

killers generally mirrors that of the overall U.S. population. For example:

- *Charles Ng*, a native of Hong Kong, China, killed numerous victims in Northern California, in concert with Robert Lake.
- *Derrick Todd Lee*, an African-American, killed at least 6 women in Baton Rouge, Louisiana.
- *Coral Eugene Watts*, an African-American, killed 5 victims in Michigan, fled the state to avoid detection, and murdered another 12 victims in Texas, before being apprehended.
- *Rafael Resendez-Ramirez*, a native of Mexico, murdered 9 people in Kentucky, Texas, and Illinois, before turning himself in.
- *Rory Conde*, a Columbian native, was responsible for killing 6 prostitutes in the Miami, Florida area.

### Serial Killers Are Only Motivated by Sex

All serial murders are not sexually based. There are many other motivations for serial murders including anger, thrill, financial gain, and attention seeking. For example:

- In the Washington, D.C., area serial sniper case, *John Allen Muhammad*, a former U.S. Army Staff Sergeant, and *Lee Boyd Malvo* killed primarily for anger and thrill motivations. They were able to terrorize the greater Washington, D.C., metro area for three weeks, shooting 13 victims, killing 10 of them. They communicated with the police by leaving notes, and they attempted to extort money to stop the shootings. They are suspected in a number of other shootings in 7 other states.
- *Dr. Michael Swango*, a former U.S. Marine, ambulance worker, and physician, was a health care employee. Although he was convicted of only 4 murders in New York and Ohio, he is suspected of having poisoned and killed 35 to 50 people throughout the United States and on the continent of Africa. Swango's motivation for the killings was intrinsic and never fully identified. Increasingly, Swango kept a scrapbook filled with newspaper and magazine clippings about natural disasters, in which many people were killed.
- *Paul Reid* killed at least 7 people during fast-food restaurant robberies in Tennessee. After gaining control of the victims, he either stabbed or shot them. The motivation for the murders was primarily witness elimination. Reid's purpose in committing the robberies was financial gain, and some of the ill-gotten gains were used to purchase a car.

### All Serial Murderers Travel and Operate Interstate

Most serial killers have very defined geographic areas of operation. They conduct their killings with comfort zones that are often defined by an anchor point (for example,

place of residence, employment, or residence of a relative). Serial murderers will, at times, expand their activities outside their comfort zone, when their confidence has grown through experience or to avoid detection. However, very few serial murderers travel interstate to kill.

The few serial killers who do travel interstate to kill fall into a few categories including:

- itinerant individuals who move from place to place;
- homeless individuals who are transients;
- individuals whose employment lends itself to interstate or transnational travel, such as long-distance truck drivers or those in military service.

The difference between these types of offenders and other serial murderers is the nature of their traveling lifestyle, which provides them with *many* zones of comfort in which to operate.

### Serial Killers Cannot Stop Killing

It has been widely believed that once serial killers start killing, they cannot stop. There are, however, some serial killers who stop murdering before being caught. In these instances, there are events or circumstances in the offenders' lives that inhibit them from pursuing more victims. These include increased participation in family activities, sexual substitution, and other diversions. For example:

- *BTK killer, Dennis Rader*, murdered 10 victims from 1974 to 1991. He did not kill any other victims before being captured in 2005. During interviews conducted by law enforcement, Rader admitted to engaging in auto-erotic activities as a substitute for his killings.
- *Jeffrey Gorton* killed his first victim in 1986 and his next victim in 1991. He did not kill another victim and was captured in 2002. Gorton engaged in cross-dressing and masturbatory activities, as well as consensual sex with his wife in the interim.

### All Serial Killers Are Insane or Are Evil Geniuses

Another myth is that serial killers have either a debilitating mental condition, or they are extremely clever and intelligent.

As a group, serial killers suffer from a variety of personality disorders, including psychopathy, antisocial personality, and others. Most, however, are not adjudicated as insane under the law.

The media has created a number of fictional serial killer "geniuses" who outsmart law enforcement at every turn. Like other populations, however, serial killers range in intelligence from borderline to above-average levels.

### Serial Killers Want to Be Caught

Offenders committing a crime for the first time are inexperienced. They gain experience and confidence with

each new offense, eventually succeeding with few mistakes or problems.

While most serial killers plan their offenses more thoroughly than other criminals do, the learning curve is still very steep. They must select, target, approach, control and dispose of their victims. The logistics involved in committing a murder and disposing of the body can become very complex, especially when there are multiple sites involved.

As serial killers continue to offend without being captured, they can become empowered, feeling they will never be identified. As the series continues, the killers may begin to take shortcuts when committing their crimes. This often causes the killers to take more chances, leading to identification by law enforcement. It is not that serial killers *want* to get caught; they feel they *can't* get caught.

## CAUSALITY AND THE SERIAL MURDERER

Following the arrest of a serial killer, the question is always asked: how did this person become a serial killer?<sup>45</sup> The answer lies in the development of the individual from birth to adulthood. Specifically, the behavior a person displays is influenced by life experiences, as well as certain biological factors. Serial murderers, like all human beings, are the product of their heredity, their upbringing, and the choices they make through development.

*Causality* can be defined as a complex process based on biological, social, and environmental factors. In addition to these factors, individuals have the ability to *choose* to engage in certain behaviors. The collective outcome of all of these influences separates individual behavior from generic human behavior. Since it is not possible to identify all the factors that influence normal human behavior, it is not possible to identify all the factors that influence an individual to become a serial murderer.

Human beings are in a constant state of development from the moment of conception until death. Behavior is affected by stimulation received and processed by the central nervous system. Neurobiologists believe that our nervous systems are environmentally sensitive, thereby allowing individual nervous systems to be shaped throughout a lifetime.

The development of social coping mechanisms begins early in life and continues to progress as children learn to interact, negotiate, and compromise with their peers. In some individuals, the failure to develop adequate coping mechanisms results in violent behavior.

Neglect and abuse in childhood have been shown to contribute to an increased risk of future violence. Substance abuse can and does lead to increased aggression and violence. And there are documented cases of people who suffered severe head injuries and ultimately became violent, even when there was no previous history of violence.

It is generally agreed that *there is no single identifiable cause or factor that leads to the development of a serial killer.*

Rather, there are a multitude of factors that contribute to such development. The most significant factor is the serial killer's personal decision in choosing to pursue his/her crimes.

However, the following observations have been made by social scientists who study this particular type of criminal:

- Predisposition to serial killing, much like other violent offenses, is biological, social, and psycho-logical in nature and is not limited to any specific characteristic or trait.
- The development of a serial killer involves a combination of these factors, which co-exist in a rare confluence in certain individuals. They have the appropriate biological predisposition, molded by their psychological makeup, which is present at a critical time in their social development.
- There are no specific combinations of traits or characteristics shown to differentiate serial killers from other violent offenders.
- There is no genetic template for a serial killer.
- Serial killers are driven by their own unique motives or reasons.
- Serial killers are not limited to any specific demographic group, such as sex, age, race, or religion.
- For the majority of serial killers who are sexually motivated by erotized violence during their development, violence and sexual gratification are inextricably intertwined in their psyche.
- More research is needed to identify specific pathways of development that produce serial killers.

## SERIAL MURDER AND THE NCAVC

If a serial murderer confines his/her activities to a single community or a small region, local police are in a good position to see emerging patterns. But because some serial murderers cover many miles in a short period of time, the FBI has developed the **National Center for the Analysis of Violent Crime (NCAVC)**, which is designed to form a partnership among federal, state, and local law-enforcement agencies in the investigation of potentially related, unsolved violent crimes. NCAVC combines law-enforcement techniques, behavioral science principles, and data processing to help any law-enforcement agency confronted with unusual, bizarre, particularly vicious, or repetitive crimes.

Following are the types of offenses and incidents reported to NCAVC for analysis:

- Sexually oriented murder or assault by mutilation or torture, dismemberment, violent sexual trauma, or asphyxiation
- Spree murder (a series of indiscriminate murders or assaults, all committed within hours or days—for example, a series of sniper murders)
- Mass murder (four or more murders in a single incident)

- Robbery murder and nonfatal robbery with extreme violence
- Murder committed during the commission of another felony
- Kidnapping: fatal, with injury, or for ransom
- Murder of a hostage
- Murder for hire, contract murder, syndicate execution
- Murder of a law-enforcement officer
- Political or other assassination
- Terrorist or nationalistic murder
- Drug-related murder
- Gang murder
- Missing person with evidence of foul play
- Unidentified dead body when the manner of death is classified as a homicide<sup>46</sup>

NCAVC can analyze every unsolved murder in the United States, identify the existence of serial patterns, and link cases together. It then notifies the individual local agencies that have similar murders, and they in turn may establish investigative contact among themselves. NCAVC emphasizes that the primary responsibility for investigating cases lies with the state and local authorities.

NCAVC also conducts research on violent crimes and trains local officers in analytic techniques. It is located at the FBI Academy in Quantico, Virginia, where it is administered by the Behavioral Science Unit. The FBI Academy was chosen as the site because it is a national law-enforcement training center with vast resources for research and many capabilities for providing investigative support.

## VICAP CRIME REPORT

When a violent crime remains unsolved for a period of time, the local law-enforcement agency provides details about it on a special **Violent Criminal Apprehension Program (ViCAP)** reporting form.<sup>47</sup> This form is submitted to the nearest FBI field office, which reviews it and forwards it to NCAVC. Following are examples of several murder cases solved with the assistance of ViCAP.

In 2001, a ViCAP crime analyst reviewed a state police publication that mentioned a bag of human bones found by hunters in a seaboard forest of an eastern state. The victim was a white male, about 40–60 years old, and between 5', 7" and 5', 9" tall. His cause of death was blunt-force trauma to the head. Recovered with the remains was a 14-carat gold ring with engraved letters. Authorities had no leads for identification of the remains.

The ViCAP crime analyst searched the database using the physical description of the victim and made