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INTRODUCTION

In no type of death by violence is a painstaking search for scientific evidence likely to be as richly rewarded as it is in a case of fatal injury by gunfire. The finding of the body of a person dead of an unwitnessed or unreliably witnessed shooting invariably raises a host of pressing questions. It is essential that the truth be learned as quickly as possible. Did death result from homicide, was it suicide, or could it have been an accident? From what kind of a weapon was the fatal shot fired and from what distance and from what direction? What kind of ammunition was used? What can be learned regarding the individual characteristics of the gun that was used? If multiple wounds are present, in what sequence were they incurred and how many different weapons or different bullets were responsible for their production? How long did the victim survive the injury and how soon was he incapacitated?

Almost invariably the answers to many of these questions are to be found in, on, or near the body of the decedent. Because of the ease with which critical objective evidence may be destroyed or lost, no police officer, medical examiner, or coroner's physician should undertake to investigate the scene of a shooting or the body of a person dead of gunfire unless he knows what to look for and how to preserve its evidential value.

The purpose of this chapter is to call attention to the principal sources of objective evidence in cases of gunshot injury and to indicate the potential value of such evidence in the administration of justice. To appreciate the significance of such evidence it is necessary that the reader be familiar with certain of the basic characteristics of firearms and ammunition.

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FIREARMS

Rifled and smooth-bore: Firearms may be divided into two main classes according to whether the inner surface of the barrel is rifled or smooth. In the former, spiral ridges engage the surface of the bullet as it passes through the barrel and give it a centrifugal rotation that increases the accuracy of its flight. Smooth-bore weapons do not contain such ridges and depend on the dispersion of multiple simultaneously discharged projectiles for their effectiveness rather than on the accuracy of an individual bullet. The barrels of rifles and pistols are rifled whereas those of shotguns are smooth.

Single-shot and repeating guns: Both rifled and smooth-bore weapons are in turn divided into two main sub-groups according to whether they can be fired repeatedly or only once without reloading. A single-shot weapon is one that has no magazine or other device for holding extra cartridges. It must be reloaded after each firing and the new cartridge must be placed in the gun by hand. A variant of the single-shot type of firearm is one with a double barrel. Such a weapon is in reality two single-shot guns in one and although it can be fired twice without reloading each barrel must be loaded manually before it can be fired again. The double barrel shotgun is the only modern example of such a weapon.

There are two principal types of repeating rifles and shotguns. In each the gun is equipped with a magazine for holding extra cartridges. The type of gun convenentionally described as a "repeater" is one having a manually operated device in the form of a sleeve, bolt, or lever for ejecting the empty case of the fired cartridge and reloading the barrel with a fresh one. The type of gun conventionally described as "automatic" is in reality semi-automatic. In weapons of this type the force of the backward thrust of the exploding cartridge is used to eject the empty shell case and to reload the barrel. Semi-automatic repeaters differ from those that are truly automatic in that the trigger of the former must be pulled each time the gun is fired. Fully automatic weapons such as the machine gun continue to fire as long as pressure is maintained on the trigger.

One form of pistol has a unique type of repeating mechanism. It is called a revolver because the magazine in which the extra cartridges are kept is a revolving cylinder which is constructed in such a manner that each of its bullet-containing compartments becomes an integral part of the barrel when rotated into the firing position. There are no truly automatic pistols. Semi-automatic pistols commonly designated as "automatic" operate on the same principle as do the semi-automatic rifles and shotguns.

Caliber: The caliber or internal diameter of the barrel of rifled weapons is usually expressed in hundredths of an inch. The calibers of the most commonly used firearms in the United States are .22, .25, .32, .38, and .45. The calibers of the more commonly used shotguns are ordinarily designated by a gauge number which is actually a rough reciprocal of the weight of a lead ball having a diameter equal to that of the barrel. The internal diameters of the more commonly used shotguns expressed in one-hundredths of an inch together with their gauge equivalents are as follows: .775 (10 gauge), .729 (12 gauge), .662 (16 gauge), .615 (20 gauge). One small caliber shotgun having an internal barrel diameter of .410 is not ordinarily designated by its gauge equivalent.

AMMUNITION

Although there are major differences between ammunition for rifled and smooth-bore weapons, and minor differences within each class of ammunition, cartridges for modern weapons have certain basic similarities. A cartridge consists of one or more projectiles and a powder charge contained in a case or shell which keeps charge and projectile together and protects them against loss or deterioration. In addition to these three basic components most cartridges also have a primer or cap. The cap is a soft metal cup containing a highly explosive mixture and is incorporated into the center of the base of the shell. Its construction is such that when it is struck by the firing pin or hammer of the gun, its contents are exploded. This explosion of the cap ignites the main powder charge.

The rapidly expanding gases which emanate from the burning powder propel the projectile through the barrel and emerge from the muzzle. Some smoke may escape from the breech in the case of revolvers in which the fit between cylinder and barrel is loose.

Powder charge: Different kinds of explosive mixtures are used in different kinds of ammuntion. Some contain black powder, some smokeless, and some a combination of black and smokeless called "semi-smokeless." Because smokeless is a better propellant than black powder it is used more frequently. Ammunition for revolvers, shotguns, and small caliber rifles is occasionally charged with black or semi-smokeless powder. Ammunition for semi-automatic pistols and high velocity rifles is almost invariably charged with smokeless powder. Although any one of the three types of powder may be used in ammunition for shotguns smokeless is probably most commonly encountered.

Black powder is a mixture of potassium nitrate, sulfur, and charcoal. Smokeless consists of cellulose nitrate alone or in combination with nitroglycerine. With each type of powder both burned and un-

burned components of the charge may be discharged from the muzzle and may be recognized on the target by their distinctive physical and/or chemical characteristics.

Primers: Since the combustion products of the primer mixture are also discharged from the muzzle a knowledge of their chemical composition is desirable. Formerly mercury fulminate, stibnite, potassium chloride, and powdered glass were used almost exclusively. Recently this mixture has been supplanted in some ammunition by a combination of lead azide, lead styphnate, and barium nitrate. Stibnite is still used occasionally and to some primers zirconium has been added.

Projectiles: Projectiles vary as to shape, size, composition, and number per cartridge according to the type of gun and use for which they are intended. Cartridges for rifled firearms contain a single projectile or bullet which is characteristically enlongated with a rounded or tapered forward end. The diameter of the bullet corresponds to the bore of the weapon for which it is intended. Bullets for revolvers and low velocity rifles are ordinarily comprised of lead which may or may not be alloyed with antimony and/or tin. Some lead bullets have a thin plating of cadium, copper, tin, or zinc. Bullets for most rifles greater than .22 caliber and for semi-automatic pistols are usually jacketed. The core of such a bullet is lead and the jacket is usually comprised of cupronickel, steel and cupronickel, or brass and cupronickel. Lead bullets are frequently lubricated with vaseline or graphite.

Cartridges for shotguns are usually loaded with multiple lead spheres. They fall into three main groups according to the size of the individual pellets. Birdshot starts with spheres so small that they are characterized as dust (.04 inches in diameter) and increases to spheres measuring .23 inches in diameter. The diameter of buckshot varies from .24 inches to .36 inches. The diameter of lead balls varies from .51 inches to .71 inches. A type of shotgun cartridge intended for deer hunting contains a single large, spherical or elongated projectile. In some ammunition of this type, longitudinal grooves have been cut in the projectiles in such a manner that the friction between them and the barrel will tend to give them a rotary motion.

Shell cases: The shell case of a cartridge for use in a rifled weapon is metal and has either a projecting rim or a groove at the margin of the base to facilitate its extraction from the barrel. Cartridges for single-shot guns, for manually operated repeaters, and for revolvers have a projecting rim, and cartridges for semi-automatic rifled weapons have a circumferential groove. The name of the firm that manufactured the ammunition and the caliber of the gun for which it is intended is

sometimes imprinted on the base of the case. Cases for use in shotguns are usually made partly of metal and partly of cardboard.

Wads: In addition to the components already described, cartridges for shotguns contain discs of cardboard and felt. One disc of cardboard closes the forward end of the shell case and keeps the shot from spilling out. Additional discs of cardboard and felt separate the shot from the powder charge. These discs are discharged from the muzzle when the gun is fired.

Sources of Evidence

Table 1 shows the kind of information that is usually desired and the principal sources from which it may be obtained.

Table 1

Information desired	Where information may be obtained										
	Empty Shell Case				Spent Bullet				Powder Residue		Wounds
	Location of	Number of	Marks on	Contents of	Location of	Number of	Marks on	Traces of	Pattern of	Composition of	
Individual peculiarities of gun			X				X				
Make and model of gun			X				X				
Kind of ammunition			X					X		X	
Range of fire	X								X		
Direction of fire	X				X				X		X
Number of shots fired		X				X		X	X		X
When did shooting occur				X							
How soon was injury disabling or fatal											X

Empty cartridge cases: Obviously the finding of an empty cartridge case in the vicinity of a person dead of gunfire does not necessarily indicate that it is the case from which the fatal shot was fired. However, it may become an exhibit of great importance. If the gun that

was used was a single-shot, a manually operated repeater, or a revolver, an empty cartridge case or cases may or may not be found at the place. If, however, a semi-automatic weapon was used the empty cases will usually be found near the place where the shooting occurred and within a few feet of the place where the gun was operated.

The distance between the place where the gun was fired and the place where the body was found may be such as to exclude the possibility of suicide. The location of the empty shell cases may indicate that testimony purporting to show that the gun was fired in self-defense is probably false. The number of empty shell cases may fail to agree with the number of shots that were said to have been fired and may indicate that what originally appeared to be an accident is actually a murder.

An examination of a recovered shell case will not only indicate the kind of ammunition that was used but it may also show the kind and caliber of gun from which it was fired. Empty shell cases often bear imprints or abrasions of such a highly individual character as to consitute a personal signature of the weapon from which they were fired.

Such individual characteristics are derived from several sources. The most important of these is the breech face. When a gun is fired the base of the cartridge is expanded backward against the breech face with great force. Whatever irregularities there are on this surface are likely to be imprinted in the base of the cartridge and particularly in the ductile metal that comprises the primer cap. Individual peculiarities in breech faces may consist of the file or machine marks that were left when the surface of the breech face received its last finishing or they may be caused by wear and tear.

Other individual marks on the base of the shell case may be derived from the firing pin or hammer. Irregularities of the surface or of the alignment of either, whether they be original or acquired, may leave distinctive impressions on the primer cap. Peculiarities in the extractor or ejector mechanism may also lead to characteristic abrasions on the edge of the base of the shell case. If the individual characteristics of a shell case from the scene of the crime are identical with those of a shell case known to have been fired from a certain gun it can be assumed that the case from the scene of the crime was fired in that gun.

In favorable circumstances chemical analysis of the combustion residues remaining in the empty cartridge case may provide information regarding the time that elapsed between firing and examination. Certain chemical changes in the burned powder that has been left in the case may occur as a result of exposure to air. These changes are usually completed within a few hours and if they have not yet reached

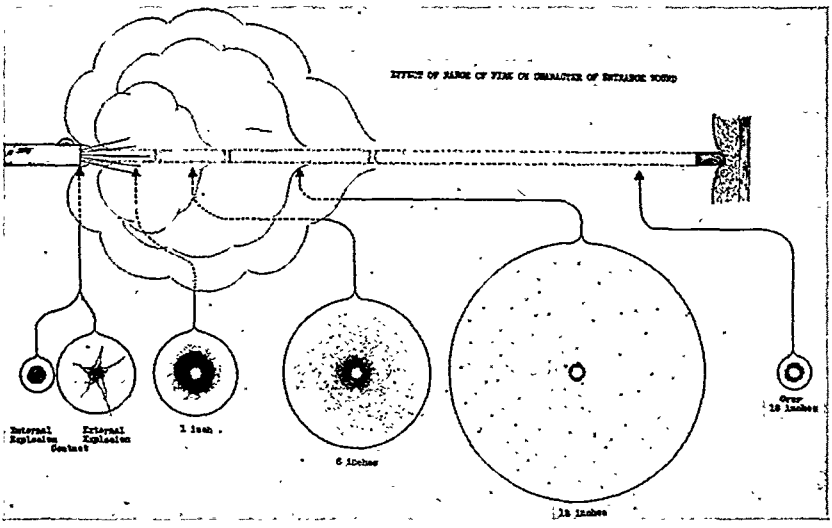

FIGURE 1

Diagrammatic illustration of the muzzle discharge of a firearm and the effect of its various components on targets at different ranges of fire.

Marks to be Looked for on Cartridge and Bullet

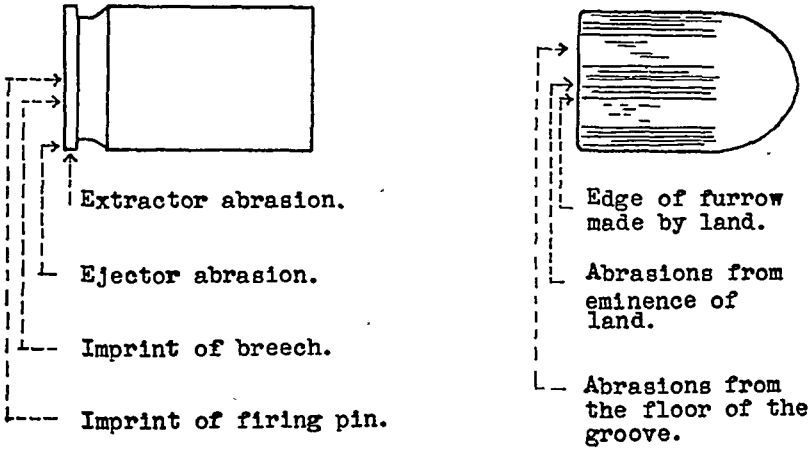

FIGURE 2

Diagrammatic representation of empty cartridge and fired bullet showing principal sources of imprints and abrasions likely to be useful in establishing the identity of the gun from which they came.

FIGURE 3

Composite Photograph: The left half is the test bullet and the right half is the bullet under investigation. The number, width, and pitch of the lands indicate that they came from the same make and model of gun and the similarity of secondary abrasions produced by irregularities in the bases of the grooves indicate that they came from the same gun. (Courtesy Capt. Charles J. Van Amburg.)

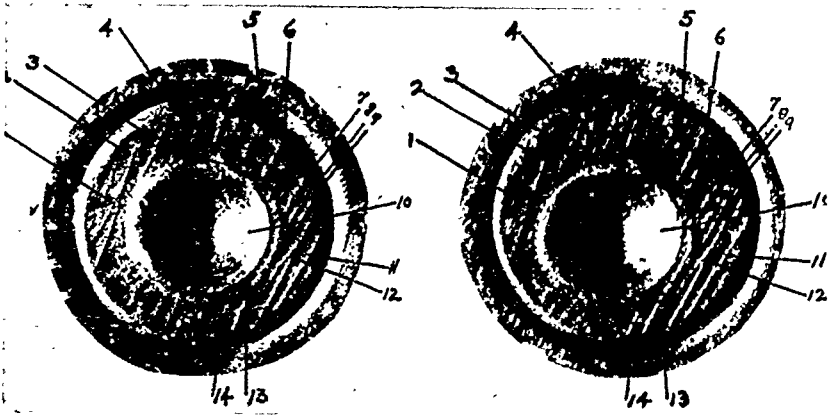

FIGURE 4

Photograph of the bases of the primers of two empty cartridge cases which were fired from the same weapon. Similarities in the imprints of breech face and firing pin are indicated by numbers. (Courtesy Capt. Charles J. Van Amburg.)

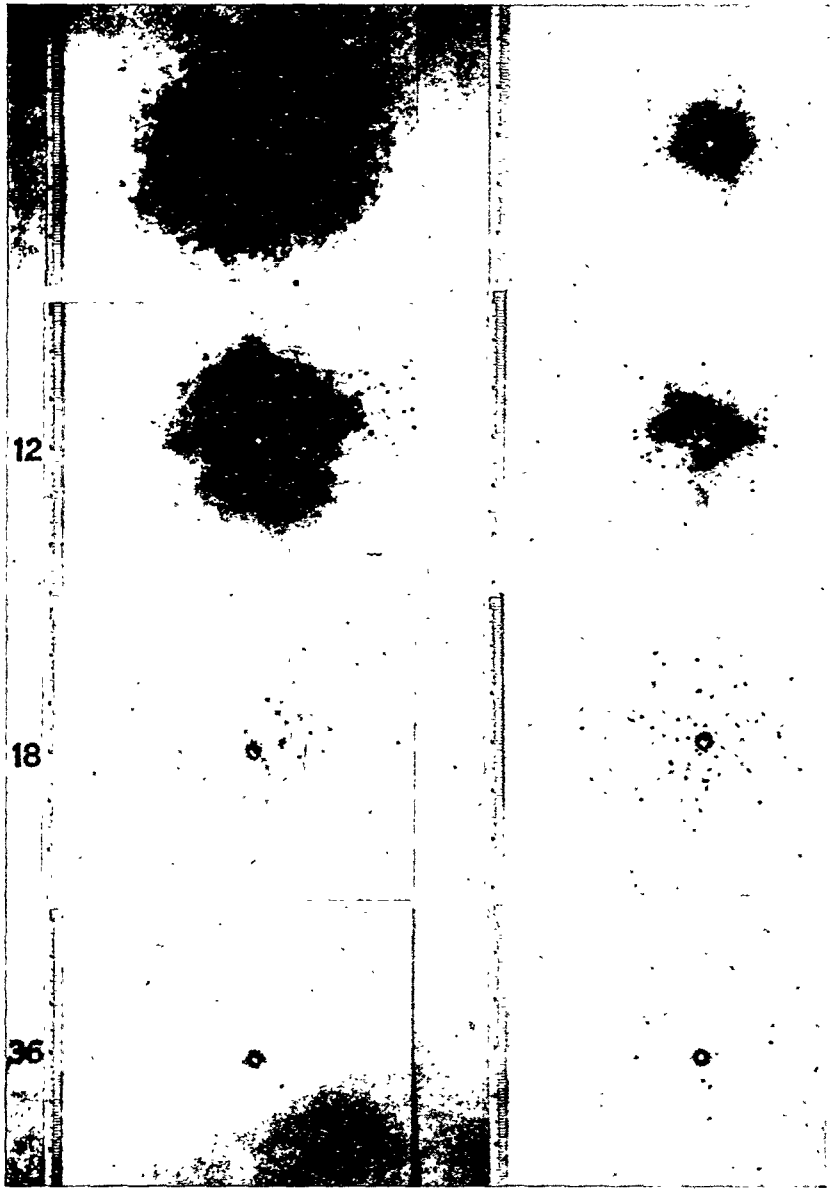

FIGURE 5

Two series of targets prepared at 6, 12, 18, and 36 inches with the same gun. In the series at the left, the ammunition was charged with black powder and in the series at the right, with a mixture of black and smokeless powder. The photographs show the necessity of making test targets with the same kind of ammunition if any inferences are to be drawn regarding the range of fire.

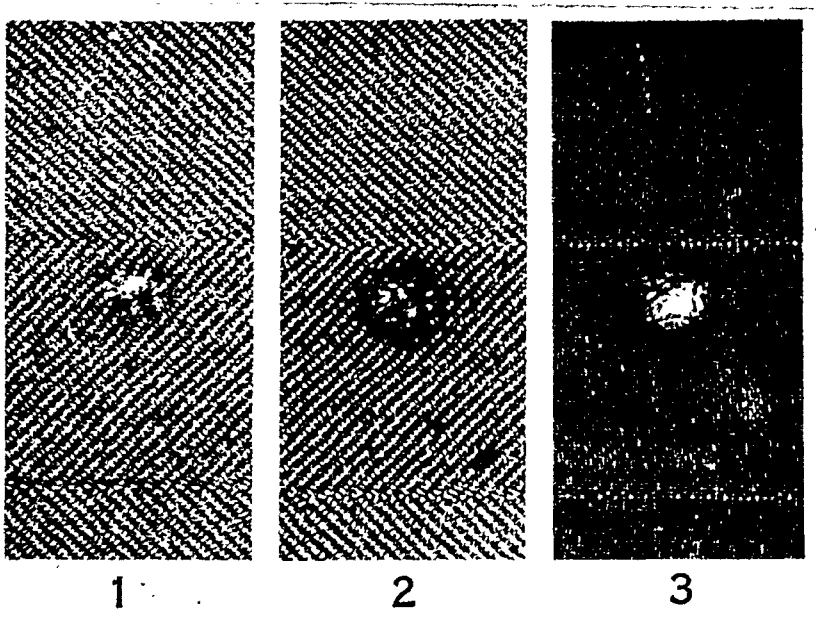

FIGURE 6

Three photographs of the same entrance hole of a bullet in a piece of clothing. No. 1 was photographed on orthochromatic film and shows the hole and the surrounding cloth as it appeared to the naked eye. No. 2 shows its appearance when photographed on infra-red film. The contact ring round the hole and soiling of the surrounding fabric by combustion residue can now be seen. No. 3 is a print from a soft X-ray film and shows the distribution of metallic material in the edges of the hole and in the surrounding fabric. (Courtesy Dr. Joseph T. Walker.)

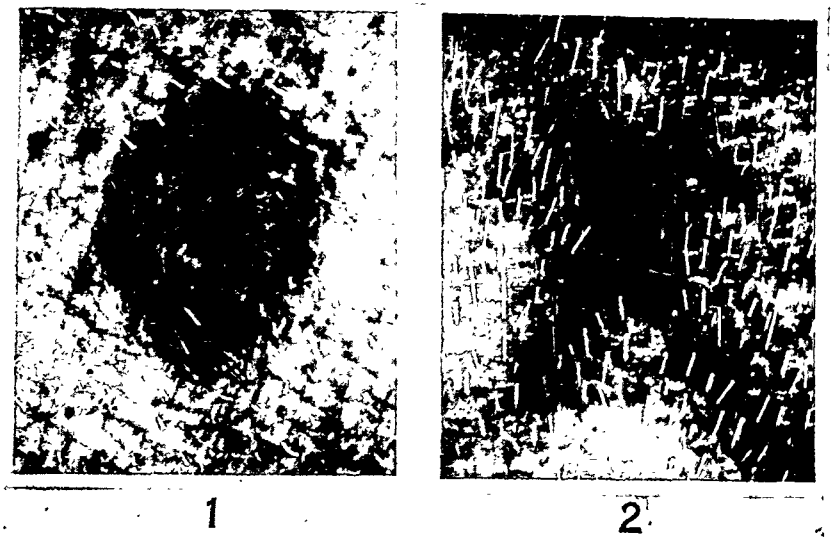

FIGURE 7

Photographs of the entrance (1) and exit (2) wounds in skin produced by the passage of the same .32 caliber lead bullet through the body. The diameter of the bullet was approximately the same as the diameter of the circular area of abrasion and blackening that surrounds the entrance hole. That the range of fire was close is indicated by the presence of powder grains embedded in the epidermis in the region of the wound. The exit wound is stellate and larger than the bullet and does not show the marginal abrasion and soiling that was present around the entrance wound.

completion when the shell is examined it may be possible to state that the cartridge was recently fired.

Thus to summarize the information that may be gained from an examination of empty cartridge cases it may be possible to establish: (1) the place (range and direction) of gunfire; (2) the number of shots fired; (3) the kind of gun that was used; (4) the individual characteristics of the gun; (5) the kind of ammunition that was used; (6) the length of time that elapsed between the firing of the gun and the finding of the empty shell.

Bullets: In no instance of fatal gunshot injury can the search for evidence be regarded as complete until all of the bullets that were fired, including those that missed the target, have either been found or the possibility of finding them exhausted.

It is obvious that information regarding the direction of fire will often be disclosed by the projection of a line between the place where the bullet first struck the target and the place where it finally came to rest. It is essential, of course, that proper allowance be made for deflection and secondary migration.

The importance of determining the location of a bullet that has passed through the body may be illustrated by a case in which homicide was suspected by reason of the fact that the victim was shot from in front and from a distancs that was too great for suicide. It was known that there had been an altercation between victim and suspect. The finding of the spent bullet in the ceiling directly above the victim's body lent support to the allegation that the injury was accidental and occurred when a revolver carried by the decedent in his inside coat pocket fell to the floor and was discharged when the latter bent over to pick something up that he had dropped. If the bullet had not been located it is reasonable to assume that the suspect would have been charged with murder.

Reliable information concerning the total number of shots that were fired is always desirable and can frequently be obtained by a careful examination of the scene of a shooting. The finding that a single shot was fired sometimes points to suicide or accident whereas the finding that multiple shots were fired may justify a suspicion of murder. If, for example, in a case of fatal gunshot injury it is determined that only one shot was fired, it might be concluded on a basis of collateral evidence that the manner of death was accidental. However, the finding of evidence that several shots had been fired and that only one had hit the target might easily point to the probability of murder.

A case in point is that of a woman who was found dead of a through-and-through gunshot injury of the head. Bilateral temporal

wounds were regarded to be the entrance and exit holes of a single bullet. In view of the fact that there was blackening of the wound of the rigth temple, that a gun was found beside the body, and that the victim was known to have been predisposed to suicide, it was assumed that the fatal injury had been self-inflicted. However, the finding at autopsy of a bullet in the brain indicated that more than one shot had been fired. The bullet found in the skull had produced the entrance wound in the right temple but the bullet that had produced the entrance wound in the left temple was not immediately found. It was subsequently found in a window sill in a place that indicated that it had been fired from the victim's left side, had passed through the head, and emerged through the hole that the first bullet had made in the right temple. The location of the two bullets in this case provided evidence that the manner of the woman's death was homicide and not suicide.

Even though only small traces of a bullet can be found, as may be the case when the bullet has passed through the body and come to rest in some unknown location, appropriate chemical or spectroscopic examination may provide important information regarding the kind of ammunition that was used. In passing through the skin both at the place of entrance and of exit small fragments of metal will frequently be sheared or abraded from the bullet. Such fragments may constitute the only source of evidence regarding the nature of the ammunition that was used.

The potential importance of this kind of evidence may be illustrated by a case in which the body of a woman dead of a through-and-through gunshot wound of the chest was found in a field. The bullet could not be located. Traces of metal recovered from the margins of the wound disclosed it to be lead heavily alloyed with tin. It was shown that the only ammunition possessed by a suspect who had been charged with the crime was of an entirely different composition. Not only was the composition of the bullet that killed the woman different from that of the ammunition in possession of the suspect but it was also different from that of any standard brand of ammunition. It was subsequently concluded that the bullet that killed the woman was one that had been cast from soldering metal by a person who manufactured his own ammunition.

The evidentary value of the marks imparted to a bullet from the barrel through which it has passed are well known. Differences in the number, direction, pitch, and width of the grooves and ridges that have been cut in the inner surface of the barrel make it possible to identify the make and model of a firearm by the marks that have been left on a bullet.

In addition to the marks that indicate the make and model of the

gun, a bullet will frequently bear marks of a highly individual character. As a result of wear and tear, barrels acquire certain irregularities that will not be present in an identical fashion in any other firearm. If these individual irregularities are sufficiently prominent they will produce corresponding marks on bullets. It is apparent then that when it can be demonstrated that a bullet found in a body and a test bullet fired in the laboratory have identical marks, and that the marks could only have been produced by the irregularities of a single barrel, the gun from which the test bullet was fired is the same one that was responsible for the bullet in the body.

In recapitulation the following facts deserve emphasis. So far as possible all bullets should be recovered and the location of each should be accurately recorded. Even when it appears that the entire truth regarding the circumstances and manner of death is already known, an attempt should be made to confirm the facts by objective evidence. In every case of fatal gunshot injury there should be sufficient study of the physical and chemical characteristics of bullets or traces of bullets to determine whether the bullet was, could have been, or could not have been fired from the suspect gun. Great care should be exercised in the marking of bullets for identification purposes. If a bullet is to be marked for identification a fine steel point should be used and the mark should be placed in the center of the base.

Powder residues: Attention has already been called to the fact that different kinds of powder have different chemical and physical properties and that the traces of powder that emerge from the muzzle of a gun with the bullet may be deposited on the target if the distance between target and gun is not too great. The blast of particulate matter and gas that emerges from the muzzle tends to assume the shape of a cone and the greater the distance between target and muzzle the greater will be the area of fouling on the surface of the target. The heaviest elements of the blast are carried the farthest. The wads of a shotgun shell may be carried ten yards or more. Droplets of mercury from the primer or bits of metal that have been sheared or melted from the bullet may travel three or four feet in a relatively straight line. Ordinarily it is difficult to see much fouling with the naked eye if the distance between target and muzzle was more than 24 inches. No exact estimate of distance can be made unless test targets are prepared with the gun and ammunition that was used and are compared with the target that is being investigated.

The importance of preparing test targets with the same gun and ammunition that were used in the shooting being investigated is illustrated by the case of a hunter who was found dead in the woods with

a shotgun wound of the chest. It was obvious that the gun had been fired at close range and because the decedent was in financial difficulty and because the circumstances were at first considered not to be consistent with accident, the manner of death was certified as suicide. Several insurance policies were invalidated by this finding. A reinvestigation of the case threw doubt on the official verdict because of evidence that the range of fire was greater than is usually the case in suicide. A series of test shots were made with the same gun and ammunition in which cloth identical to that of the hunting jacket of the deceased was used for the target. Repeated experiments showed that the powder residue pattern around the hole in the decedent's hunting jacket was characteristic of a range of fire not less than 12 and not more than 18 inches. A re-examination of all of the evidence indicated that the decedent had probably rested the barrel of his gun on a fallen log with the butt on the ground on the other side of the log. When he picked the gun up by the barrel the trigger was caught by a projecting dead branch and the gun discharged. This reconstruction of the circumstances was in accord with the objective evidence bearing on the range of fire and the insurance claims were paid.

The following characteristics of powder residues on targets should be investigated. The first have to do with the size and shape of the pattern and its relation to the bullet hole. The second concern the physical and the third the chemical nature of the residue.

As already indicated, when the same gun and ammunition are used the size of the powder pattern tends to increase with the range of fire. However, this is not invariably the case. If the muzzle of the gun is fired in tight contact with the target the gases and residue of the explosion may be so completely blown into the wound as to be invisible by external examination. If the contact between muzzle and target is loose the combustion products may be blown radially over the surface in such a manner as to produce a wider area of soiling than would occur if the muzzle had been several inches away. When the distance between muzzle and target is less than an inch the pattern of the soiling is likely to be characterized by radiating bands of intense discoloration disposed around the bullet hole like the spokes of a wheel.

Generally speaking a powder residue pattern is likely to be more homogeneous and to show less stippling when the range of fire is between 1 and 6 inches than when it is over 6 inches. It should be remembered that black powder produces more combustion residue and is more likely to produce prominent stippling and punctate burning on the surface of the target than is smokeless powder.

The position of the bullet hole in relation to the powder pattern may

provide information as to the direction of fire. Other things being equal the presence of the bullet hole in the center of the powder pattern indicates that the barrel was directed approximately at right angles to the surface of the target at the moment of firing. When the long axis of the barrel is not at right angles to the target the bullet hole will be eccentric and close to the near edge of the pattern.

Recognition of the physical characteristics of powder residue so often provides useful information that every target, whether it be skin or cloth, should be routinely examined with a magnifying glass. Burning of the surface of the target invariably means close range fire. The amount of burning that will occur and the range at which burning may take place varies according to the ammunition and the gun. Black powder causes more burning than smokeless. Cloth which burns more readily than skin and hair is likely to show the effects of heat better than the epidermis. The presence of microscopic bubbles in the hair shafts may provide the only objective evidence that the muzzle was within a few inches of the target when fired.

In residues produced by black powder relatively large amorphous granules are likely to be identified. Residues produced by smokeless powder frequently contain unburned elements of highly characteristic appearance. Smokeless powder is usually comprised of uniform particles of geometric contour. The contours of such unburned particles may be so characteristic that the firearms expert may be able to identify the type of ammunition that was used by the size and shape of single unburned particles of the powder.

Not infrequently the target is such that even though powder residues are present they cannot be recognized by ordinary inspection. This is particularly true when the target is a piece of dark cloth. Several physical methods are available to the investigator in such circumstances. One is the employment of infra-red photography. Powder residues on cloth that are not visible to the naked eye frequently can be identified in an infra-red photograph. Invisible residues can also be demonstrated by soft x-ray.

Appropriate chemical examination of a target may disclose the presence of unsuspected powder residue. Even though the presence of powder residue has been recognized visually chemical tests to determine its exact composition may disclose the kind of ammunition that was used. A comprehensive review of the various chemical procedures that may be used to identify the composition and distribution of powder residues has been published by Walker.[1]

Thus to summarize the information to be gained from the recog-

[1] Walker, Joseph T., *Bullet Holes and Chemical Residues in Shooting Cases* (1940) 31 JOUR. CRIM. LAW & CRIMINOLOGY 497.

nition of the nature and distribution of powder residues on skin or clothing it may be possible to determine (1) the range of fire, (2) the direction of fire, (3) the number of shots fired, (4) the kind of ammunition used.

Bullet holes: The most impressive evidence of the fact that a given hole was produced by gunfire is the finding of a bullet in the wound. Under appropriate conditions any small hard missile or any rigid pointed object may produce a defect in the skin which may be similar in many respects to a bullet hole. It is a fact, however, that the velocity and composition of a bullet usually imparts certain physical and chemical characteristics to a wound whereby the manner of its production can be recognized if it be subjected to competent investigation.

Multiple wounds do not necessarily indicate that the victim was struck by a corresponding number of bullets. It is not unusual to find that a single projectile has produced several different sets of entrance and exit wounds. In a case in point seen by the author the victim of a shooting affray was leaning forward and running toward his assailant when the fatal shot was fired. The latter was standing on an eminence and the bullet first struck the top of the victim's shoulder, emerged from the front of his chest, grazed the abdomen, passed through the inner aspect of the left thigh, and emerged from the thigh to enter the calf of the leg where it shattered the tibia and produced four exit wounds, at least one of which was caused by a fragment of bone rather than by the bullet. Thus, one bullet was responsible for 10 separate defects in the skin.

The fact that no wound is visible on external examination does not always exclude the possibility of injury by gunfire. The senior author has seen two instances of murder by gunfire in each of which the skin of the victim was intact. In one a screaming woman was shot in the mouth. Her lips, tongue, and soft palate escaped injury and the entrance wound occurred at the back of the pharynx. The shooting was unwitnessed and bleeding from the mouth was at first ascribed to natural causes. In another instance at the conclusion of a sexual assault the muzzle of a revolver was introduced into the vagina and fired.

When a bullet strikes skin or cloth it indents the surface so that the hole is made through a stretched target. After such a target has been penetrated it usually contracts and the hole becomes smaller. Thus an entrance wound is frequently smaller than the bullet that produced it.

During the time that the skin or cloth is being stretched over the nose of the bullet it is bruised, abraded, and soiled over an area that is considerably larger than the hole itself. It is usually possible to identify the direction in which the bullet was traveling by an examination

of the margins of the hole. In cloth, the side of the fabric which shows soiling at the margin of the hole will be the surface that was first struck by the bullet. In skin, the marginal soiling, contusion, and abrasion will be external and readily visible at the site of the entrance wound, while it will be internal and more difficult to recognize at the site of an exit wound. An entrance wound in cloth is shown in Figure 6. The contrast between the entrance and exit holes produced by the same bullet in skin is shown in Figure 7.

The amount of marginal soiling around an entrance wound varies according to the kind of projectile that produced it. Lubricated lead bullets cause more soiling than unlubricated jacketed projectiles. If the bullet has already passed through several layers of cloth there will be less fouling of the edges of the skin wound than is the case when an unclothed part of the body has been struck.

Bullets traveling at high velocity and bullets that are tumbling as a result of having struck something else before hitting the skin may produce extremely large and irregular entrance wounds. Another circumstance in which a large entrance wound may be produced is when the muzzle of the gun is pressed so tightly against the skin that the entire blast of expanding gas is carried into the tissues. In such a circumstance it is not unusual to find an enormous explosive type of injury.

Not only are exit wounds characteristically larger than their corresponding entrance wounds but it is not uncommon to find multiple exits associated with a single entrance. Multiple exit defects may result from the fragmentation of a bullet within the body or from fragments of bone.

In some instances it is possible to reconstruct the direction of fire by projecting a line between the entrance and the exit wound. No significance should be attached to such a line, however, unless the full tract of the wound through the body has been explored in order to determine the extent to which the original direction may have been altered by deflection.

Even though the bullet has passed entirely through the body and even though the surface of the body has been destroyed by putrefaction or fire, it is frequently possible to determine both the direction in which the bullet was traveling and its chemical composition. When a bullet strikes a bone, pieces of the bone are displaced in the direction of the bullet's flight. Not only does the manner in which such fragments are dispersed indicate the direction of flight but information in this regard may also be obtained from the contour of the bony defect. When a bullet passes through a bone it will usually be found that the hole on the side of entrance is considerably smaller than the hole on the side

of exit. Information concerning the composition of the bullet can be derived from chemical or spectroscopic analysis of the fragments of metal that are almost invariably found on the broken edges of a bone.

Occasionally as is the case when a bullet has destroyed the brain stem or the spinal cord it can be asserted with confidence that the victim could not have moved himself from the place where the injury was incurred. In other circumstances great caution must be exercised in expressing an opinion as to the extent to which the victim may have been capable of locomotion. Thus it is by no means uncommon for a through-and-through wound of the brain to be survived without loss of consciousness or ability to move about. Persons with fatal bullet wounds of the heart or aorta are sometimes capable of astonishing physical feats before collapsing. Multiple wounds, any one of which might seemingly have been instantly fatal, are sometimes self-inflicted.

Conclusions

In no instance of fatal gunshot injury should the circumstances of the shooting or the identity of the firearm that was used be regarded as established until due consideration has been given to all available objective evidence. The principal sources of such evidence are the wounds, the spent bullets, the empty shell cases, and the powder residues. Organized society can ill-afford to take the risk of allowing a criminal to escape apprehension or an innocent person to be prosecuted because of the failure of the police or the medical investigator to acquire all of the information from these sources that may be relevant to the case.