Original Articles.

THE EXTERNAL APPEARANCES OF PISTOL-SHOT WOUNDS.

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As by far the greater number of gun-shot wounds that come to the notice of the medical examiner are those caused by pistols or revolvers, I shall confine myself almost exclusively to a consideration of the wounds made by these "weapons of luxury," as they have been so fitly termed.

I have drawn freely from the works of Casper, Ogston, Taylor, Woodman and Tidy, Hofmann, Briand and Chaudé, and others, at times even using their language without always indicating the source from which it is drawn.

When called to view the dead body of a person supposed to have come to his death from gun-shot wounds many questions will present themselves to the medical examiner that may depend for their solution entirely upon the evidence found upon the body itself. He will have to decide whether the death has been accidental, homicidal, or suicidal. If homicidal, it may be important to determine at what distance, with what weapon, and from what direction the fatal shot has been fired.

The trajectory of the bullet through the organic tissues is subject to many and unforeseen variations; it may happen—as it has to so astute an observer as Casper—that the ball cannot be found even at the autopsy, and one may be forced to form an opinion from the external appearances alone of these pistol-shot wounds.

Let us remember at the outset that "death makes disappear many of the phenomena of color, and brings about a relaxation of the parts which may change the dimensions of the wounds, or the situation of the wounded organs."

These wounds, under the force of ever varying conditions, are very different in appearance and extent; their appearances are far from having an absolute value, and "their significance is largely dependent upon the experience and acuteness of the observer."

The resistance of the air, modified, perhaps, by prevailing winds, the difference in length and calibre of the barrel of the weapon, the difference in the quality of its workmanship and even in its condition by reason of proper care or the want of it, the quantity and quality of the powder used, the shape and weight of the missile, all tend to make the problems more difficult of solution.

The wound made by a ball penetrating the body may present an appearance like that of Brauu's "cuts of a lancet," or his "mere scratch," which had healed by first intention; or like Hofmann's wound of the scalp, "so slight, that having escaped detection at the first examination, it was only revealed at the autopsy;" it may be a smooth, round opening,—large or small,—an oval wound, or a valvular one; it may have a starred or a serrated outline, or may be irregular and torn giving to an otherwise simple wound a frightful appearance.

"In general, a bullet preserving its integrity, impinging at ordinary range and at a right angle upon

any portion of the body well covered with soft tissues and not unnaturally put upon the stretch, leaves, as it passes through the skin, an opening more or less regularly rounded in form, often, perhaps, a little less in diameter than the missile, with its edges inverted and livid in hue, due to the contusion and to the discoloration from the burned powder carried upon the missile. A cylindro-conoidal ball will probably cause an irregularly outlined opening either stellate or slit like with serrated edges. If the ball has traversed the body, the wound of exit may closely resemble that of entrance, but is usually larger and more irregular, with everted edges, bearing few evidences of contusion, but often showing greater loss of substance."²

"The wound of entrance is large and irregular when a ball strikes near the extremity of its range."

When a spherical bullet is fired from some distance and has lost but little of its momentum it usually makes a round, well-defined opening, while a conical ball frequently causes a linear incision; this is true especially of revolver-shots, which may produce wounds, very insignificant, similar to knife-cuts. The aperture is made with comparatively little bruising or tearing, and the resilient tissues close upon its track.

As a rule the entrance will be round only when the ball strikes at right angles; it will be oval or valvular when it strikes obliquely, but it sometimes happens that a conical ball from an inferior weapon, even when fired at right angles to the body, strikes wholly or partly upon its side according to the distance from which it is fired, thus always making an oval wound. A revolver in my possession at any distance beyond eighteen inches throws a ball flat-wise; within this distance it strikes partly upon its side, never upon its apex.

"Fired at a moderate distance but so near as to traverse the body, the orifice of entrance will be well-defined, round, or oval according to circumstances,—the skin slightly depressed,—the edges presenting a faintly bruised appearance; but the surrounding parts are neither blackened nor burnt, and they do not present any marks of bleeding. In these cases the orifice of exit is large and irregular, the skin lacerated but free from any appearance of blackening or burning; it is generally three or four times as large as the entrance orifice."³

In regard to the comparative size of these wounds of entrance and exit various and contrary opinions have been held by both surgical and medico-legal writers. On the one hand we have Woodman and Tidy claiming that "the exit wound is invariably the larger," while Casper as positively asserts that "the wound of exit is always smaller than the wound of entrance." It is probably safer to follow the middle path with those writers who teach that, in general:—

In shots fired from a distance the aperture of entrance will be the smaller. [As most gun-shot wounds observed by army surgeons are of this class, this may account for their unanimity of opinion that the orifice of entrance is the smaller.]

In shots from a short distance the two apertures will be alike.

When fired close to the body the wound of entrance will be the larger.

² Otis, Med. and Surg. Hist. War of Rebellion, Surg., vol. iii., p. 711.

³ Taylor's Principles and Practice of Medical Jurisprudence, i., p. 685.

¹ Read at the meeting of the Massachusetts Medico-Legal Society, February 6, 1884.

It must be remembered that these are general rules, subject to many modifications.

Wounds of entrance made by revolvers and pistols will be smaller than those made by weapons of larger calibre; they will also probably be smaller when made by the cylindro-conoidal bullet, now so commonly used, than when made by a spherical ball. Small pocket revolvers, says Hofmann, give rise when they wound the skull only to a small opening whence radiate cracks in different directions.

The bleeding is usually slight, and when it occurs it is more commonly observed from the orifice of exit than from that of entrance.

As a rule the edges of the aperture of entrance will be inverted and those of exit everted, but Casper shows that this is not invariably so. He says: "If the part struck be very fat, the fat soon protrudes from the wound and it — the aperture of entrance — is found to have its edges swollen and anything but inverted. In other cases the putrefactive process causes the edges of both wounds — where two are present — to protrude, and so prevents their being recognized either as apertures of entrance or exit."

Hofmann says: "The assertion that the edges of the aperture of entrance are inverted and those of exit everted is correct in many cases, but not in all. In wounds from shots fired near by, the edges of the aperture of entrance are almost always everted when there happens to be bone beneath the wounded surface, because the gases of explosion are diffused between the skin and the bone beneath; the edges of the wound are crowded outward and may even be lacerated in this manner." [A statement which does not accord with my limited experience in such wounds.] "What proves this method of production of the ragged edges and rents," Hofmann goes on to say, "is this fact: that the edges of the aperture of entrance, whether this be irregular or rounded, are almost always undermined, and the subcutaneous tissues are blackened by powder to an extent corresponding to the parts undermined."

I hope to demonstrate further on that in pistol and revolver shots these gases of explosion, instead of passing with the ball through the skin, expend the greater part of their force upon the tissues at a point outside of the opening made by the ball. I can see that some particles of powder may cling to the ball and explode after passing through the skin. For, in firing a Colt's revolver at twenty-eight inches, several grains of powder passed, probably with the ball, through blotting paper and sprinkled the ash left after burning around the hole made by the ball in a second sheet of paper which was placed four inches behind the first one.

Medical Examiner S. D. Presbrey has furnished me the following notes of an interesting case which appear to demonstrate this possibility more clearly than do my own experiments: "An old man loaded a 'cut-off' musket with powder and shot, — both in large quantities, — put the muzzle to his stomach and fired. The cotton shirt had a hole, with burned edges, irregularly circular, four inches in diameter. Next, a thick woolen shirt had a ragged hole about one inch in diameter. Some few shot-holes to be noticed about the edges of this hole; edges scorched but not burned like cotton shirt. Next, a cotton-wool undershirt with a ragged hole similar to the one last described. Skin blackened with powder for a space of three inches square. In this blackened space were two tears

through the skin, making together an opening somewhat like the letter T, its horizontal measuring two inches, its perpendicular, or rather, oblique, measuring one inch. The stomach with its appendages was hanging through a large hole in his back, blown out, apparently, by an explosion of powder within the body."

Here the burning powder had passed with the small shot through the cotton shirt, setting it on fire; through the other two shirts with little burning, — as woolen burns much less freely than cotton, — and then had exploded in part upon the body, leaving a blackened surface of larger dimensions than the opening made in the second and third shirts. It is probable that the remaining and by far the larger portion of the powder was carried within the body and caused the appearances of explosion.

Ogston says: "The edges of the entrance will be depressed and contused, the edges of the exit projecting and torn. The entrance will be dry and dark colored, the exit one raw and bloody. There will be loss of substance in the former case, but none in the latter."

The blackened and burned appearance of the edges of wounds of entrance has been variously explained. Otis, as already stated, ascribes it to the contusion and to the discoloration from the burned powder carried upon the missile. Taylor says it arises from the heat and flame of the gunpowder at the moment of explosion. Hofmann declares that it is due less to a burn than to a contusion and excoriation of the edges of the aperture of entrance, for it may be found, although less defined, in shots fired from a distance. Ogston asserts that it may result from a contusion of the wound causing an ecchymosis, or, when the piece is fired close by, from the burning of the powder.

On the other hand, Briand and Chaudé, alone of all the authorities consulted, speak of "the cauterization of the lips of the wound by the heated projectile." They quote Gosselin as describing "furrowed wounds, which present a surface, so to speak, cauterized by the projectile;" also, "cul-de-sac wounds — bleeding more freely, for the projectile, losing in proportion to its penetration of the tissues a notable amount of its momentum and heat, divides the tissues without cauterizing them." Such a heating of the projectile by the flame of the powder and by the friction of its passage seems impossible, as the time of exposure to such influences is too short. A rifle ball travels, on the average, about six hundred and sixty feet a second, and it takes only a few one hundredths of a second to burn over one hundred and fifty grains of powder. Capt. John E. Greer, now chief ordnance officer of the Department of Missouri, who was selected by the War Department, at the request of the Attorney General of New York, to make experiments in firing for use in the famous Billings murder trial in Saratoga County, has stated to me that at no range is the bullet heated sufficiently to burn the skin. His experiments were made with rifles, carbines, and revolvers on paper and on glass. [We probably shall not err greatly if we continue to speak of "a dose of cold lead."] Ogston has said that "as the blackened and scorched appearance of the edges of the entrance wound may be caused in more than one way, its presence or absence has to be accounted for by the history of the case, and is not found to be invariable in its occurrence. Where, as is frequently the fact, the blackening is due to ecchymosis being produced, the production or non-production of

this ecchymosis will account for the extent or absence of the blackening."

Dr. F. H. Hamilton relates the case of a soldier shot in the chest by a sentinel, in which the wound of exit was larger by one half than the wound of entrance, its edges not everted but looking discolored as though blackened by powder. This discoloration he found to be due to a slight extravasation of blood into the tissues under the skin.

"Small shot, fired at a distance," says Dr. Lachese, "of not over ten or twelve inches, may produce a round opening somewhat resembling that made by a bullet; from twelve to eighteen inches the opening was irregular and the borders were much lacerated; at thirty-six inches the central opening was entirely lost and the surface much covered with shot." Briand Chaudé say small shot begin to scatter at thirteen inches, while Dr. Lowe is said to have fired a new gun with the result of a round aperture resembling that of a bullet at a much greater distance than that given by Dr. Lachese.

Grains of powder may act as projectiles when fired at short distances, even penetrating the organs which they reach.

The wadding of a gun, paper pellets, a ball of wax or cork, may make holes like shot or like a bullet when fired from a gun with a large charge of powder at a distance of two or three yards.

The explosion of powder alone, without ball or wadding, is capable of causing very serious wounds, especially when fired into the mouth. When wadding has been used in like circumstances, it is known to have caused extensive laceration of the soft parts with fracture of the bones of the face and the base of the skull. So a pistol fired close to the abdomen, without a ball, has produced a fatal wound from the entrance of wadding alone. A pistol, loaded with powder and ball, may be fired with the muzzle pressed closely against the flesh without the ball touching the body. The weapon will either burst or recoil, and the bullet drop to the ground leaving only a contusion or a slightly contused wound, caused, not by the ball, but by the air within the weapon.

The aperture in the clothing made by the projectile is worthy of consideration. Dupuytren says it is always smaller than the ball; Taylor, that it is smaller when the clothing is of an elastic material. In comparing the size of the aperture and that of the ball, it must be remembered that the bullet may have struck upon its side and not upon its apex, also that the powder may have burned a portion of the clothing around the opening. Ogston says: "At the entrance of the ball, the tissue of whatever kind exhibits a more or less ragged and irregular opening along with loss of substance, while the injury to the stuff caused by the exit of the projectile is not so much a hole as a rent, either straight or shreddy, which will admit the tissue to be so replaced as readily to show that there has been no part of its texture destroyed or carried away. The opening made by the ball in entering is always smaller in the clothes than in the skin."

In firing at several thicknesses of cloth placed against a hard or a soft backing one may often get as many varieties of openings as there are layers of cloth.

Although foreign to the subject, it may be of interest to note the statement of Briand and Chaudé that "when the ball presses the clothing into the wound,

taking several superimposed layers of clothing, we frequently find the layers in the inverse order in which we should expect them; for example, we find a shred of the shirt before that of the coat, which can be explained only by a rotary motion, if not forward at least laterally, of the projectile."

Before passing to the appearance of the powder marks let me call your attention to the following facts:—

"Two wounds nearly in a line may both be wounds of entrance, made by two distinct balls, both of which have lodged."

"The wound of entrance and of exit may be side by side, as when the bullet has passed around the body, or there may be only one wound through which the bullet has entered and also escaped."

"A plurality of openings does not necessarily imply a plurality of bullets, for one bullet has been known to make five wounds,—two of entrance and three of exit."

When the weapon has been fired at a distance, for ordinary pistols or revolvers, of probably not more than twelve to fourteen inches, the hair and skin may be singed, burned, or blackened from the burning powder; and at a distance, even for the larger weapons of this class, of probably not over forty-eight inches, unburned and partly burned particles of powder may be imbedded in the flesh.

These powder marks may, within certain limits, aid in estimating the distance at which the pistol has been fired, and the position in which it has been held. In some cases they may even show, with some degree of certainty, whether the weapon has been fired by one's own hand or by the hand of another.

They arise from the smoke, from the heat and flame of the burning gases, from partly burned powder, from the residue or ash of the wholly burned powder, and from partly burned and unburned grains of powder driven into the tissues.

The larger the charge of powder, the longer the barrel of the weapon, and the more finished its workmanship, the more marked will be these appearances; but with a large calibre and short barrel the powder marks will cover a greater extent of surface. Pistols will show these markings, and brandings of powder at greater distances than revolvers of the same calibre, for, having a continuous barrel, there is not that escape of the gases of explosion and of the unburned powder that occurs between the cylinder and the barrel of the revolver.

The most of my experiments have been made with revolvers, because it seems, in these days, when very fair revolvers can be bought for eighteen dollars a dozen, that by far the greater part of the murders and suicides are committed with revolvers using metallic cartridges.

Before detailing my own experiments, let me call your attention to what has been said of these marks of powder by others.

"Dr. Dumesnil," I quote from Hofmann, "found, in firing at pieces of white kid, that at thirteen centimetres (five inches) the tattooing and even the burning produced by the powder will remain, easily to be shown even after washing. It is very probable it will most always be the same"—upon white kid I suppose him to mean—"at twenty centimetres (7.87 inches). At thirty centimetres (11.8 inches) the traces diminished considerably; they nearly disappear at fifty centime-

tres (19.7 inches); and at eighty centimetres (31.5 inches) hardly a trace is to be seen.

"What disappears in the first place — passing from near shots to those fired at a distance — is the immediate action of the gases of explosion, which, even at short distances, are absent, and this in proportion as the charge is smaller; sooner for revolvers than for pistols, sooner for pistols than for guns.

"Tourdes, with a holster pistol" [the French holster or cavalry pistol is said to be of .45 of an inch calibre], "set on fire a piece of paper at one half a metre (19.7 inches), and we have observed burning of hair from a revolver nine millimetres in diameter (.35 of an inch calibre) fired from a distance of ten to fifteen centimetres (four to six inches). He also found an incrustation of grains of powder from a holster pistol at two metres (78.5 inches); from a great American revolver at one and one half metres (fifty-nine inches); from an ordinary revolver at forty centimetres (15.7 inches)."

Briand and Chaudé say: "Powder blackens the surroundings of the wound to an extent of several centimetres, and grains of powder incrust themselves in the circumference of the wound. Powder driven from a barrel burns on leaving it at a distance equal to the length of the barrel of the weapon; the burning was carried much further."

My own experiments do not accord with this statement, as a cheap revolver, with a four-inch length of barrel and cylinder, calibre .32 long, will burn cotton-batting at a distance of seven and one half feet, the burned spots appearing at a little distance from the entrance of the ball. It will scorch cotton cloth at a distance of five feet; bibulous paper at six feet. In certain other experiments the paper was set on fire at three feet, and several grains of powder had penetrated six layers of the paper; at thirty inches two holes were burned through the six thicknesses.

A Colt's revolver, old style, .32 calibre, six-inch barrel, with thirteen grains of "Duck powder, No. 4," burned cotton-batting at a spot two and one half inches from the entrance of the ball at eight feet. At two feet the batting was all on fire. Fired at seven feet it burned two holes the size of the ball through tissue paper. These holes were at some distance from and above the opening made by the bullet.

Resuming the extract from Briand and Chaudé, — "Experiments made with a holster pistol fired at hair on a sheet of paper have shown, at one metre, the paper blackened by some grains of powder; some had penetrated the paper. The hair had no trace of burning. Contour of holes made by the balls not blackened. At sixty-five to forty-eight centimetres (25.5 to 19 inches) the hair had not been burned nor the paper blackened at the entrance of the ball, but the black points and little holes made by the grains of powder were numerous. Ten shots at sixteen centimetres (6.3 inches), edges of hole extensively blackened to width of thirty-five to forty millimetres (1.38 to 1.57 inches). Several times the paper took fire. The hair always burned more or less completely."

Casper says: "These scorplings and brandings with powder only prove that the shot has not come from any great distance, that is, . . . from a distance not greater than from three to four feet."

The most explicit statement that I have seen appears in *The New Dictionary of Medicine and Surgery*, Paris, 1866, in which it is said that "The charring and

burning of the vicinity of the wound, seen only at entrance, are always seen in shots at sixteen centimetres (6.3 inches); very nearly always from sixteen to thirty-two centimetres. Beyond this up to one metre there is no longer burning, but we may still find black grains incrustated around the wound. At sixteen centimetres paper takes fire frequently, hair always."

In regard to the blackening of the edges of the aperture of entrance in paper and cloth as well as in the flesh, experiment leads me to conclude that a part at least of this is due to the smut of the barrel — which even in the best revolvers becomes very great after repeated firing — and to the powder which clings to the ball because the latter is greased before firing. With a perfectly clean bullet fired from a clean and dry barrel the hole in the paper appeared free from any blackening; with a clean ball and an oiled but otherwise clean barrel there appeared slight smutting; with a greased ball, and especially after the piece had become foul, the blackening of the edges of the hole was very marked.

Nearly three years ago, while making some experiments in firing at short range, I noticed, in addition to the smutting of the paper by smoke, and to the marks of the partly burned and the unburned grains of powder distributed around the bullet hole, one spot, blacker and more burned than the rest. I found this was caused by the flame of the gases, by the burning powder, and by the residue, or ash, of the burned powder striking and resting upon this place. I also noticed that this burned and blackened spot held a most constant position directly above, or above and a little to one side of the bullet hole. Asking for the reason of this, I was told by an officer of the United States Ordnance Department that "as the velocity of the powder gases was greater than that of the ball, powder stains are found above rather than below the bullet hole." Thinking this might give some indication of the direction from which the shot was fired, I tried in later experiments to vary its position by firing at different angles, but with little or no effect.

Firing the pistol from either side, from above or from below the paper, the mark was still above the bullet hole, though its lower border sometimes came down to the level of the lower border of the opening made by the ball. After wasting much paper and ammunition it occurred to me to turn my pistol hammer down, that is, bottom side up. Now this spot appeared directly below the bullet hole, and I had a most pleasing solution of what had so long perplexed me.

I could put this spot on any spoke of the wheel of which the bullet hole represented the hub, simply by holding the pistol so that its hammer and sight were on a line with that spoke. Turning the pistol flat upon its side, with the hammer to the right, the spot appeared upon the right of the bullet hole; turning it hammer left, the mark was at the left of the hole.

The position of this burned or burned and blackened spot, varying constantly and varying exactly as the top or hammer of the pistol is turned on the long axis of its barrel, is due neither to the kind of weapon nor to the kind of ammunition used. Over two hundred experiments with seventeen different pistols and revolvers — rifled and smooth-bore of various calibres — fired with "loose ammunition," that is, powder and ball separate, or with rim-fire or centre-fire metallic cartridges, have failed to show any deviation from this result. It is due solely to the recoil of the muzzle of the weapon

This plate shows four shots made on dressed sheepskin from a Smith and Wesson new revolver, calibre 32, short, 6-inch range, with four positions of the hammer. The shot at the top was made with the hammer up, that at the bottom with the hammer down, those at the right and left sides with the hammer respectively right and left. Three fourths full size.

in the direction of its sight. When this recoil is prevented by fixing the weapon firmly in a vise the bullet hole will appear at or near the centre of the spot instead of at one side of it. This is well shown by the results of some seventy-two experiments kindly made for me, with the permission of the commanding officer of the National Armory at Springfield, Mass., by Mr. J. F. Cranston, an expert at the Armory. Of the seventy-two shots with three different weapons thirty-six were made with the pistols in a vise; each pistol was fired in four positions of the hammer — up, down, to the right, and to the left — at ranges of four, ten, and twelve inches; in no case did the mark appear at one side of the bullet hole. Of the thirty-six shots with the three weapons held in the same positions as before but held in the hand, at the same ranges, none that showed the mark plainly failed to show it at one side of the bullet hole and on a line with the hammer and sight.

It is barely possible that a pistol will be found in which the centre of gravity or of mass is so far forward on the line of its barrel that the recoil will be

downward when held in the usual position for firing, but I am assured by gun dealers and manufacturers that, though rifles are sometimes so weighted at the muzzle, by brazing on a piece of iron, as to prevent the recoil upward, no pistols are made that do not thus recoil.

I have seen no allusion to the appearance and position of this spot in any work I have consulted, and have met no one who has ever noticed it.

I offer you, then, what I believe to be a new and almost infallible rule for determining the position of the weapon:—

Whenever this burned, or burned and smutted, spot is found, either upon the skin, the hair, or the clothing, at one side of the wound made by the bullet, by placing the muzzle of the weapon upon the wound so that the line of the hammer and sight will meet a line drawn from the centre of the wound through the centre of the spot of burning, or of burning and smutting, you will have the exact position of the weapon when it was fired. By position of the weapon I do not mean the distance at which it was fired, nor its angle to the body; the latter does not

seem to modify the rule I have given. As some revolvers of large calibre and short barrel will sometimes produce the greatest smutting opposite the point of greatest burning, the latter must be understood in such cases as the spot to which this rule is to be applied.

It will occur to you that there are many positions in which a suicide could not, or would not, hold a weapon for the purpose of shooting himself, because he could not hold it firmly enough to be sure of inflicting a mortal wound. If this *brand*, if I may so designate it, is found either upon the skin, the hair, or the clothing, showing one of these positions of the weapon impossible or improbable for a suicide, it is reasonably certain that the case is one of homicide and not of suicide. No suicide, for instance, would hold a pistol to either the side or back of his head with the hammer and sight pointing forward, or forward and downward, nor would he hold it to his heart with the hammer pointing downward and inward, or downward and outward; nor to his side pointing backward.

Moreover, if this *brand* is found in certain positions relative to the bullet wound, — such as forward and downward at the back of the head, or downward on the back, or downward and inward on the chest, — we may feel sure that the victim has not only been shot by another, but has been shot while lying down, or at least while in a reclining position; for no man who intends to shoot another holds his weapon upside down. While standing over the prostrate body he may easily fire so as to leave the *brand* of the powder upon any side of the bullet wound.

It is possible that in a struggle for the possession of a pistol it may be accidentally fired in one of these unnatural positions, but even then the very fact of its being held in such a position might be of importance in corroborating a claim that it was fired accidentally.

In testing for impossible or improbable positions of the weapon it should be cocked, as the hammer will thus interfere with positions that might otherwise appear possible.

Let me say here that among the illustrations of the rule given some will be found which apparently do not exactly conform to the given position of the hammer; this is due solely to the fact that in firing at such short range it is difficult to hold the weapon in just the position intended on account of the great sense of danger to the eyes from the rebounding grains of powder.

For the better preservation of these illustrations

Smith and Wesson 32, 6 in., hammer right.

Mr. Charles O. Lovell, of Lovell's Photographic Gallery, has generously enabled me to present herewith

excellent photographs of some of the best of them. The illustrations which accompany this article are photographic reproductions of the original shots, reduced in size.

From the few experiments I have made, I believe

Union 38, 6 in. range, hammer left.

that the statement already quoted that "the charring and burning of the vicinity of the wound are always seen in shots at sixteen centimetres (6.3 inches), very nearly always from sixteen to thirty-two centimetres,"

Smith and Wesson 32, 8 in., hammer down.

will be found true in the case of shots fired from revolvers and pistols. One of .22 of an inch calibre, short, will probably show the powder brand plainly at four to six inches; a .32, short, at six to eight inches; a

Union 38, 36 inch range.

.38 at eight to ten inches; and a .44 at ten to twelve or thirteen inches. These figures are, of course, to be taken with a great deal of caution, as further observation may prove them to be erroneous.

As the distance of this *brand* — which always follows the line of the hammer and sight — from the entrance wound of the bullet will vary with the “kick” of the pistol and with the degree of firmness with which it is held, it is not probable that anything can be learned from this of the distance at which the shot has been fired. Neither have I been able, as yet, to draw any inference from the size of these powder marks as to the distance of the weapon.

Hair, unless it is wet or very oily, will show marks of burning at six inches with even the smaller revolvers and pistols; at eight to ten inches with a .38, and at twelve to thirteen inches with a long barreled .44 revolver.

The powder marks upon the clothing will, by comparison with the results of experiments upon the same material made with the weapon and with ammunition similar to that used, furnish the criteria by which the distance may be judged.

I have found that upon broadcloth the spot or *brand* can be distinguished with care at fourteen inches with a .44 revolver; at nine to twelve inches with a short barreled .38; at eight inches with a .32 long; and at six to eight inches with a .22 and .32 short.

White flannel cloth will be scorched and singed so as to define the position of the hammer at twelve inches with a .32 long; at fourteen inches with the same weapon this could not be detected.

On cotton cloth at twelve inches with a Smith and Wesson .32 short this powder brand was plainly visible even after vigorous rubbing; with a Robin Hood, fired with a .32 short cartridge, the scorching and smutting were much less marked, the latter being an inferior weapon with corroded barrel. At fourteen inches with a Colt's army .44 the *brand* was well defined.

It will be seen that I have placed the tissues upon which this powder brand will appear in the following order: first — at the longest range — cotton and woolen cloth; next, the skin; and last, the hair. It is possible that when the skin is moist it may not show the *brand* even when the hair is burned.

Of the marks left by the powder upon the skin there remains for consideration the tattooing caused by the unburned particles of powder driven into the flesh. The proportion of powder wasted varies with the character of the weapon and with the kind of powder used; even in metallic cartridges of the same size it varies with the degree of compression used in fixing the ball. For heavy artillery this waste is over sixty per cent., and from my own experiments I know it to be very great with small arms, especially with the cheaper revolvers. In revolvers a part of the unburned powder escapes between the cylinder and the barrel; in all fire-arms a part of it may never reach the target; of that which does reach it a part rebounds; how much will imbed itself in the skin is so much a matter of uncertainty that it is difficult to determine at what distance a given weapon will present a certain definite degree of tattooing of the skin.

After various and unsatisfactory experiments, none of which were upon the cadaver, I can do no better than to refer again to the statement found in The New Dictionary of Medicine and Surgery, that “beyond .32 centimetres (12.5 inches) up to one metre there is no longer burning, but we may still find black grains incrusting around the wound.” Whether the tattooing of the skin can be produced at this distance by

pistols and revolvers is not stated; it seems to me very doubtful except in the case of the larger weapons of this class, having a long barrel and carrying a heavy charge of powder.

Neither can I give any definite estimate of the extent of surface covered by the tattooing at different distances. It is possible that in some cases an approximate estimate can be formed by experiments similar to the following made with a weapon with which a homicide had been committed:—

A boy was shot in the forehead with a “Standard” revolver, calibre .32 long. The tattooing measured two inches in diameter. The hair was considerably burned directly above the wound. Experiments with this pistol, and with cartridges similar to the one used, showed that to produce the amount of burning of the hair the weapon must have been held at a distance of six inches or less. Firing at two thicknesses of blotting paper placed upon a hard backing, as many grains of powder perforated the first layer of paper at six inches as at four inches, but to reduce the diameter of the surface perforated to the two inches of the tattooing of the skin the pistol had to be fired at a distance of four inches.

The fact that in very near shots clothing may be set on fire by the deflagration of the powder or by the burning wad is worthy of consideration.

Ogston says: “As to the question of a fire-arm discharged close to the body setting fire to the clothes, and extending from this to any distance along the dress of the party, the French Academy decided after several experimental trials that though the clothing may be set on fire in this way, and the fire spread to a limited extent, yet the burning is usually confined to the borders of the orifice in the dress.”

Briand and Chaudé state that “the burning clothing may burn the parts with which it is in contact, but the point of departure of the combustion is always upon one of the points of the circumference of the hole made by the ball. It will not burn to any great extent.”

In my opinion it is safe to say that, usually, this combustion will start from that point at the edge of the hole in the clothing which is in a line with the hammer and sight of the weapon, although if this is below the entrance of the ball the greater amount of burning may be above, as the flame would naturally pass upward.

Experimenting upon a worn, light weight broadcloth coat, I have not been able to set it on fire at any range even up to two inches with a .38 revolver; at eight inches several fibres of a cotton pocket were burned in the track of the ball. At seven inches with a Robin Hood .32, the pocket was somewhat burned; at nine inches a .38 Union set on fire the padding of the coat in the track of the ball.

Firing at an old and well-worn box cover, which was stuffed with excelsior and cotton batting and covered with a sleazy curtain damask, a Hood .32, at twelve inches, charred the covering to an extent of one half inch in diameter about the bullet hole; at ten inches five holes were burned in the covering above the bullet hole; at nine inches cotton batting set on fire in the track of the ball; a Colt's .32, at nine inches, fired hammer up, with rifle powder, set fire to the cloth at the upper edge of the hole; this fire burned until it had to be put out to save the target; fired hammer down, it set fire to the lower edge; at eight inches neither Smith and

Wesson's revolver, .22, nor Stevens' pistol, same calibre, produced any burning; at seven inches the Hood, and at five inches the Smith and Wesson's, .22, would always start a vigorous fire.

Such a target as this will give a fine illustration of the fact that the greater part of the flame follows the line of the hammer and sight. After exposing the cotton batting by making an opening in the cloth covering, and then firing shots about the circumference of this opening, with the sight pointed towards it, one can see the burning powder strike in the opening and set fire to the batting, while if the sight is turned away from the opening the flame will very rarely touch it.

In experiments on cotton cloth, at ten inches, with a Hood, .32 short, powder passed with the ball through four thicknesses of cloth, and set fire to the cotton batting in the box cover. At five inches a Whitney, .32 long, set the edge of the hole on fire. A Smith and Wesson, .32 short, set the cloth on fire, and burned a hole six inches in diameter.

Flannel did not burn at five inches.

It has been said that a pistol fired into the mouth has set fire to the portion of the clothing touching the neck, and burned the neck, chest, and chin. The fire extended to the furniture of the room. Such a burning, starting from a point below the entrance of the bullet, would seem very improbable, and would lead to the suspicion that the fire originated from some source other than the discharge of the weapon.

Devergie has stated that at 2.25 inches the shot can set fire to the clothing at the level of the hole made by the bullet, and the combustion may spread to a certain extent.

How shall we decide from these traces left by the projectile and by the powder upon the body and upon the clothing whether death has resulted from accident, from suicide, or from homicide?

It will not be necessary to recapitulate the evidences left by the projectile.

Accidental pistol-shot wounds cannot be distinguished from homicidal wounds when both are inflicted from a distance. In shots fired near by, when one is known to have been shot by another, and to have been shot while standing, an unnatural position of the weapon, as shown by the relative location of the *brand*, will tend to corroborate a claim of accidental shooting. So if one is known to have shot himself an unnatural position of the weapon will show that the shot was probably accidental. The location of the wound and the course taken by the ball may also characterize the wound as accidental.

Homicidal wounds may be far or near, and will be determined by the exclusion of accident or suicide. If there are several wounds upon the body the case is probably one of murder, but both barrels of a two-barreled pistol, or even more barrels of a revolver, may be accidentally discharged at the same time. One bullet, as has been said, may make five wounds, and a would-be suicide has been known to fire five shots into his own body. Suicides generally shoot at the head, — often directing the pistol into the mouth, — less frequently at the heart or lungs, more rarely at the abdomen; yet they sometimes fire at the back of the head. "The murderer more often, unless furious with passion, fires at the back or side of his victim."

If the wound be upon such a part of the body that a suicide would not be likely to inflict it upon himself,

or if, as has been stated, the relative location of the aperture of the bullet to the burning of the hair, or of the burning or burning and blackening of the skin or of the clothing, shows that the pistol has been held in a position unnatural for a suicide, it is probable that a homicide has been committed.

If there is entire absence of these scorplings and brandings of powder it will also generally prove that the case is homicidal, but it must be remembered that suicides sometimes arrange contrivances, by means of cords attached to the trigger of the weapon, for shooting themselves from a distance, and that certain "chemical powders" do not leave any stains of the powder.

Casper relates the case of a man who undoubtedly shot himself through the heart, but not a single grain of powder was found on the edges of the wound, the neck, or the face. A like instance has come under my own observation in which a suicide held a pistol, loaded with the ordinary metallic cartridge, so closely to the temple that the blood spurted into the barrel of the weapon, yet there was only the burning of the hair, and a stain of powder smoke just back of the wound, an illustration of the rule already given governing the location of the powder brand.

Briand and Chaudé say that in the case of a suicide by a revolver it is very rare that the muzzle of the weapon, directed towards the head, can be more than twenty centimetres (7.87 inches) distant. Though this distance can be easily increased to even twelve inches by any one with average length of the arms, yet just as the suicide would not hold a pistol in any unnatural position of the hammer and sight of the weapon lest he should fail to inflict a mortal wound, so he will not be likely to exceed this limit of twenty centimetres.

If the bullet is found, its weight should be ascertained, as thereby it may be possible to show that although deprived of a part of its substance it still weighs more than the ball apparently used.

The external appearances of every pistol-shot wound should be studied with care. Then by experiments with the same weapon, and with ammunition similar to that used, it may be possible to determine many points otherwise doubtful, but of vital importance.

I do not know of any substance that has been proved to offer resistance to the impact of powder similar to that presented by the living human skin, and I am forced to leave this for some more fortunate member of our Society to discover. I will, however, venture the opinion that we have in blotting paper, of average thickness, a material of value for comparative experiments. With a target of two thicknesses of this fastened against a board, the surface covered by projections or elevations and perforations appearing upon the posterior surface of the outer sheet, will, I am inclined to believe, show the extent of surface marked upon the skin by powder grains when fired from the same distance. It may also be found that the number of these projections or elevations together with the number of these perforations will be equal to the number of grains of powder imbedded in the skin.

My experiments have been made upon sheep skin, chamois skin, upon the skin of a young calf, and upon the skin of a living cat; also upon blotting paper of various thicknesses, rubber, cotton and woolen cloth.

SUMMARY. The distance at which a pistol-shot has been fired may be estimated by the following general rules:—

(1.) From a great distance the entrance wound will

usually be large and irregular; there will be absence of any great degree of lividity of its edges, and absence of the marks of powder. The wound of exit, if one is present, will usually be larger than the wound of entrance. At any distance the edges of wounds of entrance will usually be inverted, those of exit everted.

(2.) From a short distance the entrance and exit wounds will generally be nearly equal in size; the edges of the former will be blackened, and powder grains will be imbedded in the skin, but there will be absence of the scorchings and brandings of powder.

(3.) Close to the body the entrance wound will generally be larger than the exit. There will often be, in addition to the tattooing of the skin by unburned grains of powder, a mark or *brand* made by the flame of the gases and of the burning powder, by the soot of the partly burned powder, and by the residue or ash of the wholly burned powder. As a rule this *brand*, which may consist of a burning alone of the hair, the skin, or the clothing, or of a burning and blackening of the skin or clothing, will appear at one side of the bullet hole.

The *direction* of a shot will be shown in part by the trajectory of the ball,—a subject of which this paper does not treat,—and by the location of the wound of entrance. The character of the opening, whether rounded or oval, may give some indication of the angle at which the weapon has been held.

The *position of the weapon* (and whenever this term is used I wish to be understood to mean not its angle to or distance from the body, but the manner or position in which it is held; that is, whether it is held with its hammer and sight above the barrel, as in the usual position for firing, or with the hammer and sight below the barrel, as when the weapon is turned upside down, or in any other position of the hammer and sight relative to the barrel of the weapon) the *position of the weapon* is to be determined by the following rule: When the *brand* appears upon the hair, the skin, or the clothing at one side of the bullet hole, hold the weapon with its muzzle to the bullet hole so that the line of its hammer and sight will meet a line drawn from the centre of the bullet hole through the centre of the *brand*, and it will show the exact position of the weapon when fired.

This rule is deduced from the newly-discovered fact that, owing to the recoil of the muzzle of the weapon in the direction of its sight, this *brand*, when it appears at one side of the bullet hole, will appear upon that side which corresponds to the side of the hammer and sight in their position relative to the bore or barrel of the weapon. That is, if the weapon is held upside down the *brand* will appear below the bullet hole.

Accidental wounds are generally near wounds. When inflicted from a distance they cannot be distinguished from homicidal wounds. In shots fired near by, when a person is known to have been shot while standing, an unnatural position of the weapon, as shown by the location of the *brand*, will tend to corroborate a claim of accidental shooting. So, if one is known to have shot himself, an unnatural position of the weapon will show that the shot was probably accidental. The location of the wound and the course taken by the ball may also characterize the wound as accidental.

Homicidal wounds inflicted within the suicide limit have heretofore been distinguished from suicidal wounds alone by the location of the wound and by the uncertain evidence presented by the trajectory of the ball.

When the location of the wound has been such that a person might easily have inflicted it upon himself there have been no means of determining from its character whether it was homicidal or suicidal. To aid in distinguishing between such wounds I offer the following rule: When the location of the *brand*, relative to the bullet hole, shows that the weapon has been held in a position of its hammer and sight impossible or improbable for a suicide it is probable that a murder has been committed. Certain relative locations of this *brand* may also indicate that the victim has been shot while in a reclining position.

Multiple wounds are usually homicidal, but may be either accidental or suicidal.

Shots fired beyond the usual suicide limit are probably homicidal.

Suicidal wounds. It is said that the suicide rarely holds the muzzle of his pistol at more than eight inches from the body. Suicides generally fire at the side or front of the head, next at the heart; they sometimes fire at the back of the head.

The distance from the body at which the weapon must be held to show the *brand* plainly is probably very nearly as follows: for small pistols and revolvers not over four to six inches; for large weapons of this class not over twelve to fourteen inches.

A CASE OF IMPETIGO HERPETIFORMIS.¹

BY W. E. BOARDMAN, M. D.

MAGGIE D., single, twenty-six years of age, healthy, was confined at the Boston Lying-In Hospital March 11, 1884, after a labor which was normal in all respects, except that the placenta was extracted, expression having failed to cause its expulsion, and this procedure was followed by a slight hæmorrhage, which, however, was easily controlled.

March 14th, on account of the continued rise in temperature and pulse and offensive lochia, in spite of the usual care and treatment pursued at the hospital in all cases, she was given an intra-uterine injection of corrosive sublimate solution, one to 2000.

Upon the following day this was repeated, morning and evening, and each injection was followed by the insufflation of powdered iodoform within the uterus. The chart indicates a fall in the temperature and pulse beat on the succeeding day, but at evening the injection of the sublimate solution and the insufflation of iodoform were repeated, and the next day gave a morning record of temperature 100.8° F., pulse 95.

Upon the next day (the 18th) the record shows another rise, and the patient complained considerably of pain in the right side and below the breast. Nothing was discovered upon physical examination to explain this, and fearing a renewal of the septic process the former treatment was employed at evening of that day. Upon the following day the chart shows a slight rise, there was continued complaint of the pain in the right side, and an erythematous blush was observed between the thighs and upon the labia. March 20th these parts became the seat of a vesiculo-papular pustular eruption, and the erythema was noticed on the buttocks, upper thighs, lower abdomen, and breasts, rapidly becoming papular, and in some portions, particularly upon the breasts and adjacent portions of the trunk, vesic-

¹ Read before the Society for Medical Observation, May 5, 1884.