calf, a wound of exit which is quadrilateral in shape, .79 inch in length. The bullet entered the patella on the inner side of the median line and passed through the outer condyle, emerging .79 inch from the point of en-

FIG. 2365.—The Specimen Shows Two Perforations of the Right Tibia by the .30 Calibre German-Silver Jacketed Projectile with the Velocity Usually Possessed at 1,200 Yards. The perforation in the middle of the shaft shows two fissures crossing each other in the form of an "×." There is a complete fracture. The lower perforation is attended with less fissuring. There is no solution of continuity.

FIG. 2366.—A Posterior View of Fig. 2365.

trance, splitting the outer tuberosity. A slight outward displacement of the fragments shows a fissure extending upward to the margin of the articular cartilage. The patella is broken into a number of fragments. Passing downward the bullet entered the left tibia, carrying away a portion of the outer cartilage and grazing the top of the fibula. The bullet was flattened laterally along its cylindrical and conical portions on one side, and flattened at the conical end alone on the opposite side.

5. Gunshot injury of the left tibia and fibula near the ankle joint; bullet marked "G," calibre .45. The wound of entrance is over the ankle in front, round, .45 inch in diameter. The wound of exit is just above the external malleolus between the tendo Achillis and the fibula. It is marked by a longitudinal slit, 1.38 inches in length. The bullet entered the tibia 1.18 inches above the ankle joint in the median line; the missile struck the tendon of the tibialis anticus muscle, displacing it to the outer side. The inner portion of the shaft and internal malleolus remain intact. The shaft of the outer side is fissured irregularly; a zigzag line extends between the points of entrance and exit. The fibula is fractured at the same level. The bullet is flattened in the cylindrical portion near the base, and flattened laterally at the conical end, the flattened surface at the latter point being very irregular.

6. Gunshot injury of the right tibia near the ankle; bullet marked "H," calibre .30. The wound of entrance is over the lower part of the leg anteriorly, round, .30 inch in diameter. The wound of exit lies in the same place posteriorly; it presents a punched-out appearance, is triangular in shape, .30 inch in its greatest diameter.

The bullet perforated the tibia on the anterior aspect in the median line, 2.17 inches above the ankle joint. The orifice of entrance has a punched-out appearance; it is .30 inch in the vertical and .24 inch in the horizontal direction. There is a fissure 3.75 inches long, extending upward from the perforation; it is seen through the periosteum, the latter being intact. Posteriorly between the foyer and the wound of exit in the skin many fine splinters of bone are distributed, the fibula is uninjured. The bullet is very little flattened at the conical end.

7. Gunshot injury of the right knee; bullet No. 1, calibre .45. The wound of entrance is .30 inch internal to and above the patella; it is round, .45 inch in diameter; the wound of exit is in the middle of the popliteal space, star-shaped, .59 inch in its greatest diameter. The bullet entered the bone 1.18 inches above the articular surface. The diameter of the perforation corresponds to the diameter of the missile. The orifice of exit posteriorly admits the index finger and is situated in the popliteal space above the trochlear surface of the inner side of the median line. The bullet was recovered, very little dented at the conical end.

8. Gunshot injury of the upper third of the left femur; bullet No. 2, calibre .45. The wound of entrance is round, .45 inch in diameter; the wound of exit is marked by a slit-like opening running longitudinally, 1.18 inches in extent. The projectile entered the anterior aspect of the femur and shattered the bone above its middle. Nine large splinters, from 4 inches to .40 inch in length, are found in the foyer of fracture, and only partially held by the periosteum. The bullet was set up and dented at one side at the conical end.

9. Gunshot injury of the upper third of the right femur; bullet No. 1, calibre .30. The wound of entrance is round, .30 inch in diameter; the wound of exit is in the fleshy portion of the thigh, quadrilateral in shape, .79 inch in its greatest diameter. The bullet entered the bone 5.50 inches below the trochanter major, comminuting the shaft. The largest fragment is 4 by 1.18 inches, and is firmly adherent to the surrounding tissues. The specimen shows an old united fracture of the upper shaft passing obliquely and immediately below the trochanters. The bullet was flattened at the conical end and distorted to one side; the leaden nucleus protrudes from the mantle at the base.

10. Gunshot injury, right tibia, middle of shaft; bullet marked "T," calibre .30. The wound of entrance is round, .30 inch in diameter; the wound of exit is marked by a slit in the calf, .35 inch in its greatest length. The bullet struck the subcutaneous surface of the tibia at its middle, splintering the bone into several large fragments; the largest one, embracing the crest of the tibia, is 5 inches long. Viewed from the inner side the fissures cross at the point of impact, so as to form an "X." The periosteum is intact and binds the fragments together so that, as the dissection would indicate, there is no reason to suppose that the fracture would not unite readily. A large number of fine splinters of bone were found in the muscular tract of the calf, near the seat of fracture. No great laceration of soft parts was observed. The fibula was not injured. The projectile was dented at the conical end.

11. Gunshot injury, right tibia near the ankle joint; bullet marked "C," calibre .30. The wound of entrance is round, .30 inch in diameter; the wound of exit is marked by a slit .30 inch in length. The bullet perforated the shaft 2 inches above the internal malleolus. On

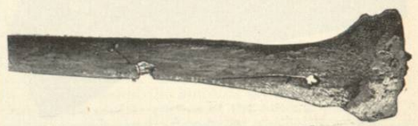

FIG. 2367.—This Specimen Shows a Complete Perforation in the Upper Part of the Shaft of the Left Tibia by the .30 Calibre German-Silver Jacketed Projectile with the Velocity Common at 1,200 Yards. There is also an injury in the middle of the shaft by a .30 calibre projectile at the same range. The bullet struck the crest of the tibia, passing wholly in front of the medullary canal, and producing a gutter in the crest. There is a complete fracture. There is no record of the injury near the ankle.

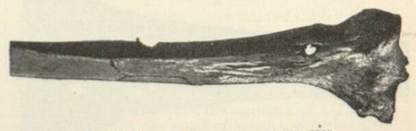

FIG. 2368.—A Posterior View of Fig. 2367.

removing the skin the orifice of entrance in the bone presents sharply cut edges, and it corresponds in size to the diameter of the missile. The bullet passed out at the posterior aspect of the bone, the orifice at this point being irregular in shape and a trifle larger than the orifice of entrance. A few splinters of bone were found in the track of the bullet leading from the bone. The projectile was not deformed.

NOTES ON THE EFFECTS, ON THE HUMAN BODY, OF THE PROJECTILES OF LARGE AND SMALL CALIBRE IMPRESSED BY THE VELOCITY COMMON AT 2,000 YARDS. EXPERIMENTS CONDUCTED AT FRANKFORD ARSENAL, PENNSYLVANIA, MARCH 16TH, 1893.

1. Gunshot injury left tibia, middle third; bullet No. 1, calibre .45. The wound of entrance is oval in shape, .51 inch in its greatest diameter. The projectile re-

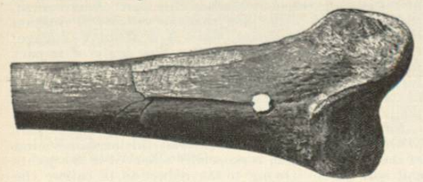

FIG. 2369.—Gunshot Injury, Lower Third, Right Femur, by the .30 Calibre German-Silver Jacketed Projectile Propelled with the Velocity Usual at 2,000 Yards. The projectile entered the bone .79 above the articular surface, making a perforation with long fissures.

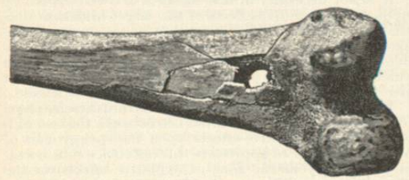

FIG. 2370.—A Posterior View of Fig. 2369.

mained lodged under the skin of the calf. The bullet entered the subcutaneous part of the shaft, 5.50 inches below the knee joint, causing extensive comminution of the bone at the foyer of fracture, including 2 inches of the shaft. Some of the fragments are free whilst others remain attached to the periosteum. The bullet was found under the skin of the calf; it was cleft longitudinally through the conical part, one-half of the cone having become detached from the cylindrical part. The detached fragment was found embedded in the tibialis anticus muscle.

2. Gunshot injury of the right tibia at junction of middle and lower thirds; bullet No. 4, calibre .30. The projectile entered side on, inflicting a wound of entrance which runs obliquely, .98 inch long and .39 inch wide. The bullet lies under the skin posteriorly in the lower part of the calf. The bullet guttered the inner side of the tibia 5.12 inches above the internal malleolus. On removing the skin several spicula of bone are seen in the wound; the outer border and crest of the tibia are uninjured; the posterior surface of the bone is splintered over a distance of 3.15 inches in lines which radiate from the point of emergence. The periosteum is not detached, excepting in the line of the passage of the projectile and over an area adjacent to the posterior margin of the groove, between .20 and .40 inch in diameter. The fibula was not injured. The bullet was embedded in the muscle of the calf with its point resting against the skin and its base presenting in the track through the muscle adjacent to the bone, a distance of .79 inch. The projectile is slightly flattened at the conical end, otherwise it is unaltered.

3. Gunshot injury of the left knee joint; bullet No. 2, calibre .45. The wound of entrance is round, .45 inch in diameter, above and internal to the patella; the wound of exit is in the lower part of the popliteal space, oval, and .59 inch in its greatest diameter. The bullet perforated the tibia 1.18 inches below the articular surface. The orifice of entrance in the bone is sharply defined, irregular in shape, .59 inch in the vertical and .39 inch in the horizontal line; the orifice of exit is also irregular, .59 inch in its greatest diameter. There is a fracture of the shaft marked by a fissure, which runs downward and backward; the compact tissue of the upper and posterior surface of the bone is broken by radiating fissures into six fragments. The muscular track from the bone to the wound of exit contains some fine spicula of bone. The projectile was not recovered.

4. Gunshot injury of the right knee joint; bullet No. 9, calibre .30. The wound of entrance is round, .30 inch in diameter and .39 inch from the internal border of the patella at its middle; the wound of exit is in the upper part of the popliteal space marked by an oblique slit-like opening .39 inch in length. The projectile entered the bone .79 inch above the articular surface, making a perforation of the femur; the missile passed out in the median line in the popliteal space, perforating the popliteal vein, but leaving the artery uninjured. The wound is full of venous blood clots. Very fine spicula of bone were found in the track of the projectile leading to the wound of exit. There is a fissure 4.72 inches in length, which extends from the orifice of entrance in the direction of the shaft, and a number of smaller radiating fissures are observed to start from the orifice of exit. The projectile was recovered from the sawdust very much deformed. The metallic jacket was ruptured at the conical end, having a slit running along the side of the cylindrical portion at the end of which a transverse slit occurs, which includes one-half of the cylindrical part of the envelope; the leaden nucleus has parted entirely from the jacket; it is flattened at the conical end, bent upon itself in the cylindrical portion, and scooped out on one side.

5. Gunshot injury of the left femur, upper third; bullet No. 3, calibre .45. The wound of entrance is round, .45 inch in diameter; the wound of exit is on the outer and posterior aspect of the thigh, marked by a longitudinal slit, .59 inch in length. The projectile made a glancing shot, striking the outer aspect of the shaft of the femur 4.72 inches below the trochanter major, and producing an oblique fracture of the shaft from above downward and inward; the fragments are considerably displaced, the lower shaft lying to the outer side; the periosteum is detached about the point of impact, but the

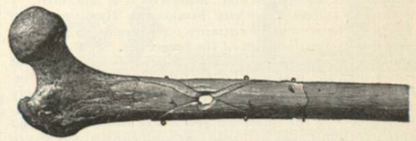

FIG. 2371.—Gunshot Injury of the Right Femur at Junction of Middle and Upper Thirds by the .30 Calibre German-Silver Jacketed Projectile with the Velocity Common at 2,000 Yards. There is a well-marked perforation with extensive fissuring.

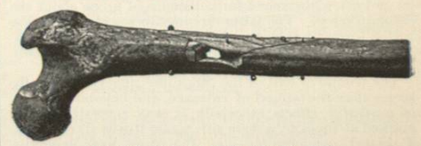

FIG. 2372.—A Posterior View of Fig. 2371.

fragments of bone are not loosened to any very great extent; there is a fissure extending from the trochanter minor downward a distance of 6 inches. Particles of lead were found in the foyer of fracture. The bullet

was seemingly split in two lateral halves nearly equal in weight; the greater half only was recovered.

6. Gunshot injury of the right femur, upper third; bullet No. 0, calibre .30. The wound of entrance is

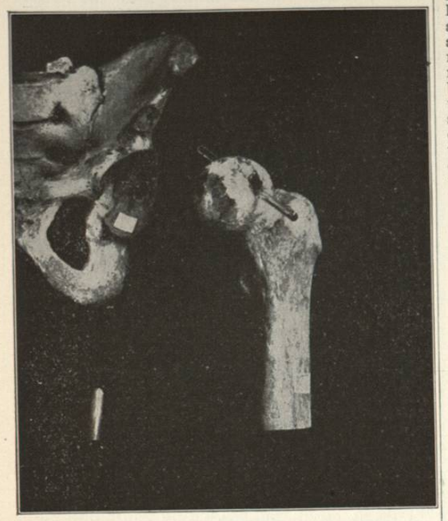

FIG. 2373.—Gunshot Perforation of the Head of Left Femur and Acetabulum by the .30 Calibre German-silver Jacketed Projectile with Velocity Common at 1,200 Yards. The bullet appears in illustration undeformed.

round, .30 inch in diameter; the wound of exit is triangular in shape, .39 inch in its greatest length. The bullet struck the shaft of the femur in the middle line anteriorly, 7 inches below the anterior superior spine of the ilium, comminuting the bone into a number of fragments, which are held by periosteum. The bullet was flattened at the conical end; otherwise it is unaltered.

OBSERVATIONS UPON THE FOREGOING RESULTS.—*Soft Parts.*—The wound of entrance corresponds in diameter as a rule to the diameter of the projectile. In the middle and remote ranges the entrance wound measured less at times than the diameter of the projectile, but the difference was only apparent since the wound invariably admitted a projectile of like calibre to the one having inflicted it. In the short ranges it was often noted that skin overlying bone and resistant aponeurosis was apt to show a wound of entrance actually exceeding in diameter that of the missile. The edges of the wound of entrance were at times clear-cut, but more often they were rolled in, and often blackened for a distance of a line about the circumference. The latter circumstance gave rise to the notion formerly that the discoloration was due to burning, but from experiments to be cited later this fallacy has been forever set at rest.

The wound of exit of the .30 calibre rifle was generally larger than the wound of entrance, and beyond the zone of explosive effects especially, it was generally round, marked at times by a mere slit; again it was star-shaped, T-shaped, semicircular, etc.; the edges were generally turned out. When a wound of exit exceeded in diameter that of the projectile to any extent the circumstance was generally regarded as indicative of bone lesion.

Effects upon the Shafts of Long Bones.—Up to 350 yards the destructive effects of the two projectiles are alike severe. Unless guided by the wound of entrance or other circumstances it is difficult within this range to determine, by the appearance of the injury alone, which of the projectiles has caused the injury. After this range the destructive effects of the smaller projectile become less than those of the larger missile. The fissuring is less, the spicula of bone are larger, and they are more apt to be attached to the periosteum. These differences are especially noticeable from the 500- to the 1,500-yard ranges. At 2,000 yards the smaller bullet again shows rather extensive comminution. This fact has been noted by all observers, and it has been variously explained, though not in a very satisfactory manner. It has been said that the projectile has lost so much of its velocity of translation, when it reaches this part of its course, that it is apt to lodge, and that the velocity of rotation causes such a disturbance, when it is about to engage, that comminution is the result. The angle of impact which is rarely vertical at this range, has been brought forward as a possible cause. Certain it is that a number of the projectiles were observed by us at this range to impinge side on at the moment of impact.

Effects upon Joints.—Before engaging upon this part of the subject it may be stated that the humane wound of the small-bore gun is especially observed in the joints and soft parts. Owing to the reduction in calibre the wounds in the latter partake more of the nature of subcutaneous wounds, and experience shows that they heal very kindly under appropriate treatment.

It is not necessary in this instance to dwell especially upon the destructive effects of the larger leaden projectile upon joints. Suffice it to say that the greater frontage, which it naturally possesses, is made greater still by deformation, and that these facts, in combination with a velocity sufficient to penetrate a joint, serve to convert the .45-calibre projectile into a very destructive missile.

The experiments conducted at Frankford Arsenal show in a striking manner the difference between the two bullets in their destructive effects upon the spongy ends of bones. In order to appreciate this difference it is necessary to go beyond the zone of explosive effects for the .30 calibre projectile, namely 350 yards; even within the latter range perforation with slight fissuring will at times be noticed. From the latter range to the 1,500-yard range perforations and gutterings with little or no fissuring are almost invariably seen. Between 1,500 and 2,000 yards the specimens show perforations still, but there is a tendency to fissuring again, as noted in the shorter ranges (see Figs. 2363 and 2364).

Deformation of Projectiles.—The different kinds of deformation of projectiles represent nearly every form of alteration known. Those of the leaden projectiles are

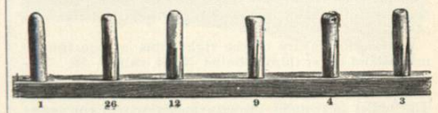

FIG. 2374.—Specimens Showing the More Common Deformations of the .30 Calibre German-silver Jacketed Projectile. No. 1, A normal .30 calibre German-silver jacketed projectile which was never fired. No. 26, A .30 calibre German-silver jacketed projectile showing the deformation sustained upon fracturing the middle of the shaft of the tibia, when propelled with the velocity usual at 1,200 yards. No. 12, A .30 calibre German-silver jacketed projectile showing the deformation sustained upon causing a fracture with slight comminution of the lower half of the humerus, while propelled with the velocity common at 1,500 yards. No. 9, A .30 calibre German-silver jacketed projectile showing deformation after fracture of the middle half of the femur, when propelled with the velocity common at 1,500 yards. No. 4, A .30 calibre German-silver jacketed projectile showing the deformation upon colliding with the upper third of the femur while propelled with the velocity common at 2,000 yards. No. 3, A .30 calibre German-silver projectile showing the deformation sustained upon fracturing the middle third of the tibia when propelled by the velocity usual at 2,000 yards.

sufficiently familiar and require no comment. The deformation of the jacketed projectile is most common at the conical end which consists usually in a slight dent or flattening, and partial separations of the metallic mantle

from the leaden nucleus are occasionally seen; complete separation between the jacket and nucleus is a very rare occurrence. It occurs principally with high velocities

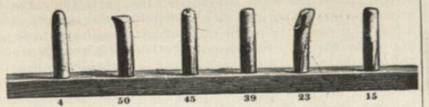

FIG. 2375.—Specimens Showing the More Common Deformations of the .30 Calibre German-silver Jacketed Projectile. No. 4, This is a normal .30 calibre German-silver jacketed projectile which was never fired. No. 50, A .30 calibre German-silver jacketed projectile after inflicting a comminuted fracture of the tibia and fibula with the velocity common at 150 yards. No. 45, A .30 calibre German-silver jacketed projectile which caused perforation of the astragalus with the velocity usual at 350 yards. No. 39, A .30 calibre German-silver mantle projectile which inflicted a perforation of the surgical neck of the humerus with little comminution with the velocity common at 350 yards. No. 23, A .30 calibre German-silver jacketed projectile after inflicting a perforation with slight fissuring of the middle of the shaft of the tibia, when propelled with the velocity usual at 1,200 yards. No. 15, A .30 calibre German-silver jacketed projectile after inflicting a complete fracture with extensive fissures of the middle of the shaft of the femur, while propelled with the velocity usual at 1,500 yards.

at close range, when the projectile encounters resistant bone. Separation of the envelope and nucleus was noticed very seldom in the middle and remote ranges.

Before we leave the subject of the work done by experiments as to the character of gunshot wounds, for the more practical one in the clinical field, it may be well to admit that the deductions of the experimenters have been questioned by a number of surgeons. On the other hand, the experimenters themselves, the great majority of whom have largely dealt with gunshot injuries as actually observed in accidents and in war, are satisfied to believe that the experimental wounds tally in the main with those which we meet in the actual conditions, and that their judgment has been amply confirmed by the accumulated experience in the Spanish-American and South-African wars.

The Heat Imparted to Projectiles.—The heat imparted to projectiles by the ignition of the powder, the resistance in the barrel, etc., has been very much exaggerated. Some have gone so far as to claim that the small jacketed bullets are rendered aseptic thereby. In a series of experiments conducted at the Pathological Laboratory of the Johns Hopkins University and Hospital, and also at Frankford Arsenal some years since, we were able to show that this claim is false. In order to arrive at some definite conclusion in the matter a series* of experiments were undertaken for the purpose of obtaining answers to the two following questions:

(1) Are projectiles from portable hand weapons sterilized by the act of firing?

(2) Can a septic bullet infect a gunshot wound?

As a preliminary to the work of noting the effects of firing bullets that had been previously contaminated it was considered proper to ascertain the condition, bacteriologically speaking, of bullets in their original packages. After a number of observations it was found that fifty-three per cent. of all cartridges in their original packages were absolutely free from germs. This is to be ascribed to the cleanly methods which are necessary in their manufacture.

The literature of gunshot wounds shows that the majority of surgeons of the past and present times believe that the act of firing destroys any infection that might have been accidentally or otherwise placed upon the projectile.

In order to ascertain the facts in the matter we fired projectiles, after they had been sterilized by heat, from revolvers that had been similarly sterilized. The projectiles were recovered from sterilized cotton and dropped into gelatin tubes. The latter revealed no growth.

* N. Y. Med. Journal, vol. lvi., No. 17, p. 458, October 22d, 1892.

Projectiles covered with dust were then fired from sterilized revolvers into sterilized cotton. As each projectile was recovered it was dropped into a gelatin tube. Colonies appeared in every instance.

In a series of experiments with the .22 and .38 calibre revolvers, the .45 calibre Springfield rifle, as well as the .30 calibre Experimental Springfield rifle, whose ballistic qualities correspond to the Krag-Jörgensen, Männlicher, improved Mauser, Lebel, etc., the projectiles were in all instances infected with the germs of anthrax and fired into sterilized materials and into animals. The tables of results show that anthrax bacilli or spores are seldom, if ever, destroyed by the act of firing.

Bullets infected with the streptococcus of erysipelas, with some of the same culture of tetanus mentioned below, and with the bacillus pyogenes soli of Bolton, were fired through the ears of rabbits with a .45 calibre Colt's revolver. The erysipelas coccus was communicated to one animal, and the bacillus pyogenes soli was recovered from the wound of another; tetanus was not communicated.

A bullet infected with a culture of the bacilli of tetanus was fired into a horse with the modified Springfield rifle with negative results; rabbits inoculated with some of the same culture died promptly. At the suggestion of Prof. Meade Bolton, of the Johns Hopkins Hospital, a bag of tetanus earth was placed against the hip of another horse and the projectile of the .30 calibre Experimental Springfield rifle was fired through the earth into the fleshy part of the ham without result.

Later, a series of experiments were conducted to show the effects of firing infected bullets into animals at 300 and 500 yards.*

Whether bacteria might remain on a projectile in transit through the air for such a number of yards had often been questioned, but the evidence at a distance was identical with that obtained at the proximal ranges.

The foregoing results have justified the following conclusions:

(1) The majority of cartridges in original packages are sterile and free from septic germs.

(2) The sterile condition of cartridges is due to the thorough disinfection and absolute cleanliness observed in the process of manufacture.

(3) The majority of gunshot wounds are aseptic because the vast majority of the projectiles inflicting them are either sterile or free from septic germs.

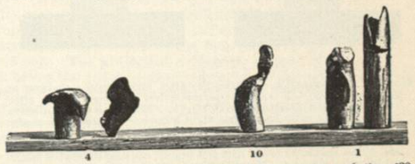

FIG. 2376.—Specimens Showing Unusual Deformations of the .30 Calibre German-silver Jacketed Projectiles. No. 4, A .30 calibre German-silver projectile showing separation of the nucleus from the envelope; the nucleus is badly mushroomed, and only a fragment of the envelope was recovered. The projectile was fired into the arm at 17 yards with the full charge of powder. The humerus was pulverized 3 inches in extent, and the soft parts showed extensive explosive effects. No. 10, A .30 calibre German-silver jacketed projectile showing deformation after causing extensive comminution of the femur, when propelled with the velocity common at 500 yards. The nucleus alone was recovered. No. 1, A .30 calibre German-silver jacketed projectile showing the deformation sustained after perforating the lower shaft of the femur, when propelled with the velocity usual at 2,000 yards. The nucleus has escaped from the envelope through a rent in the conical end. The concavity in the nucleus was probably sustained by colliding with another projectile in the sawdust.

(4) Anthrax spores or bacilli when applied to the projectile of a portable hand weapon are seldom if ever entirely destroyed by the act of firing.

(5) When a gunshot wound is inflicted upon a sus-

* New York Med. Journal, vol. lvi., No. 17.

ceptible animal by a projectile infected with anthrax bacilli the animal becomes infected with anthrax and dies in the vast majority of instances from said infection.

(6) The streptococcus of erysipelas and the bacillus pyogenes soli, when placed upon the projectile of the .45

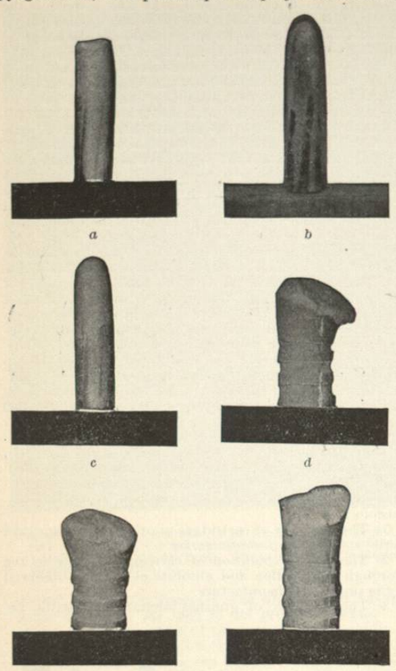

FIG. 2377.—Deformation of Projectiles after Firing into a Cadaver at 150 Yards. *a*, .30 calibre German-silver jacketed bullet after fracturing right tibia, middle third; *b*, .30 calibre German-silver jacketed bullet after fracturing right humerus in middle of shaft; *c*, .30 calibre German-silver jacketed bullet made a perforation, head of right tibia 2 c.c. below articular surface; *d*, .45 calibre lead bullet shattered lower fifth left femur, causing extensive fissuring into the joint; *e*, .45 calibre leaden bullet after fracturing left tibia, middle third; *f*, .45 lead bullet after shattering the upper third of right humerus.

calibre Colt's revolver, are certainly not always destroyed by the act of firing, and they are liable to cause infection.

(7) Projectiles from portable hand weapons are not sterilized by the act of firing.

(8) A septic bullet can infect a gunshot wound.

PRIMARY SYMPTOMS OF GUNSHOT WOUNDS.—The symptoms usually noted in gunshot wounds are (1) pain, (2) shock; (3) primary hemorrhage; (4) thirst; (5) lodgment of the bullet; (6) powder burn, and (7) multiplicity of wounds or, more properly speaking, complications of a primary nature.

(1) *Pain.*—The amount of pain, as an early symptom of gunshot wound, is variable. Indeed it may be said that save in some cases of nerve injury it is not a symptom that reflects the extent or gravity of the injury sustained. The remembrance of the amount and character of the pain at this time of injury is usually vague. Some liken it to a smart tap from a cane, others to a thrill across the tissues, or to a slight sting. During moments of great excitement, in the case of soldiers in battle or of antagonists in duels, the absence of pain is not uncommon. In a certain percentage of cases there is the very opposite of pain, namely a local anæsthesia; the parts about the area of injury have lost their sensibility, the surface is numb to the sense of touch, or to efforts at primary dressing of the wound. Stevenson says that such wounds are apt to give rise to septic discharges. Probably in these cases the vitality of the parts is so lowered that the tissues fall an easy prey to pyogenic micro-organisms. Inquiry among the wounded at Santiago showed that pain was largely related to the idiosyncrasy of the individual. Makin* relates, as a striking instance of absence of entire pain, the case of a man shot through the buttock, the bullet then traversing the abdomen. He was unaware of the fact until he found blood on his trousers on undressing, when he exclaimed, "Why I have got this bloody dysentery." It is related that he died in thirty-six hours.

(2) *Shock.*—Constitutional shock without special tendency to loss of consciousness is generally present. The evidences of shock are most marked in the facial expression. Mr. Harold Schwartz was able by the expression of the face alone to distinguish the cases requiring immediate attention after battle. Before Santiago, in the cases of Mauser wounds from the Spanish rifle, the greatest amount of shock followed hits in the upper part of the femur, the spinal cord, and viscera. Although local shock, as shown by experimental evidence, is much less from reduced-calibre bullets, the assertion on the part of certain observers that men wounded would advance after being hit a number of times was not true of the wounded in Cuba. As a rule to which there were few exceptions, when hit, a man fell back.

(3) *Primary Hemorrhage.*—Primary hemorrhage which threatens life, from gunshot, may be divided into two kinds, internal and external. Of the internal variety, that resulting from injury to blood-vessels in the interior of the trunk, not very readily accessible to surgical aid, is said to cause the majority of deaths on the field of battle, although no one has yet offered statistics to substantiate such claim. Of the external variety, which might be easily stayed by the surgeon in time to save life, the percentage is not so obscure. Doubtless direct injury to a main vessel like the brachial or femoral by a bullet of large calibre, ends fatally in the majority of cases in battle. The cases of this character seen by the surgeon in time are generally acknowledged to be very few compared to the whole number of wounds. According to Longmore they constituted but 3 per cent. in the Crimea. Otis places the number at .05 per cent. in our Civil War. Aside from the internal and external kinds of hemorrhage in which life is immediately threatened, hemorrhage in gunshot wounds is not of special consequence. Much speculation has been indulged in by writers upon the supposed influence of the new high-velocity projectiles in causing additional hemorrhage in wounds hereafter. Happily the apprehensions in this quarter have not been realized. Speaking of the external variety which comes within the opportunity of the surgeon to correct, out of 1,400 wounded in the Santiago campaign the vast majority of which were inflicted by the Mauser bullet, no death took place from this cause nor was a single ligation necessary. The evidence from South Africa is in keeping with our observations in Cuba. Makin† states that hemorrhage was rarely of a dangerous nature except when the larger visceral vessels were involved. From limb wounds the general tendency was to spontaneous cessation of hemorrhage. The English surgeons had ample opportunity to observe this point in over 18,291 wounded exclusive of 4,355 deaths, occurring on the field.‡ Lesion of vessels without tendency to fatal primary hemorrhage from reduced calibre bullets is one of the interesting revelations from this projectile that will be taken up later.

* "Experiences in South Africa," 1901. † *Op. cit.*
‡ American Medicine, vol. ii., No. 6, 1901.

(4) *Thirst.*—This symptom is of no special importance.

(5) *Lodgment of Bullets.*—With low-velocity weapons like pistols, and the old-fashioned smoothbore guns, the lodgment of the missile is very common. The development of higher velocities has done away with this complication very largely except in long range firing and in those instances in which the momentum of a projectile has been lessened by striking or traversing objects in its line of flight. The number of cases of lodgment in the Santiago campaign was surprisingly large, being about ten per cent. on the side of the United States troops. The Spanish surgeons as well had occasion to wonder at the frequency of lodgment of our bullets in their men. Still when the nature of the field was taken into consideration

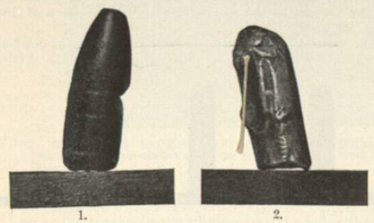

FIG. 2378.—Lodged Bullets. 1, Brass-jacketed .45 cal Remington bullet; 2, Filipino .30 cal. leaden bullet moulded in bamboo stick.

the cause was readily understood. The Americans had to advance through a country rich in jungle-like vegetation so that the remaining velocity of the projectiles of the two armies was very much reduced, thus favoring arrest in the tissues. It is safe to say that a rifle of lower velocity, like the Springfield, would have exhibited a very much higher percentage of lodged balls. This is confirmed by the English surgeons in the Boer War. There were more lodged balls, everything considered, from the large-calibre Martini-Henry and Snider.

(6) *Powder Burn* is one of the complications of gunshot wounds, at close range upon exposed parts of the body. Grains of powder unconsumed at the moment of ignition lodge under the skin causing tattoo marks, and at relatively close range there is superficial burning of the tissues, by the flame of the ignited powder. Powder burn has received special consideration of late in its medico-legal and pathological bearings. Thus the degree of powder burn is very much modified by the distance of the injured part from the muzzle, the calibre and length of barrel, the amount, standard, and variety of powder, the velocity and direction of the wind, etc. Experiments* have shown, as originally pointed out by Dr. D. B. N. Fish, that the burning, scorching, or powder brand as he calls it, is always located on the hammer side of the weapon when the wound has been inflicted by revolvers especially. That is, if the hammer is held up the powder brand will be above the wound of entrance of the bullet; if the weapon is held with the hammer to the left the powder brand will appear to the left of the wound of entrance, if to the right, the powder brand will be to the right of the wound of entrance, etc. The location of the powder brand as described is explained by the action of the recoil upon the point of support, which in the case of a revolver is the hand. This recoil or force tends to cause the weapon to revolve about this point. The ball, which precedes the gases, inflicts the wound of entrance before the barrel has had time to change its direction. By the time the powder gases issue from the muzzle the recoil has partially revolved the weapon, and they necessarily follow the new direction of the barrel which will point above, to the right, or left, as already described. The position of the powder brand has already figured in the courts of justice in distinguishing a suicide from a homicide and vice versa.

* Proceedings of the Association of Military Surgeons, U. S., 1895.

The introduction of certain kinds of smokeless powder which produce neither flash nor burning, as shown by our experiments at Fort Logan, tend to destroy the value of the powder brand in medical jurisprudence. Further, if it is true that a homicide can be recognized in the dark by the flash of the igniting black powder from his weapon, the use of smokeless powder will here again furnish negative evidence.

Of the pathological conditions that may arise from the lodgment of grains of unconsumed powder under the skin, so common in so-called powder burn, it is a fact, ascertained by experimentation,* that such grains of powder when contaminated by septic cocci purposely or otherwise are not purified by the act of firing. Repeated experiments with black powder purposely inoculated with specific micro-organisms, gave positive results when fired into media and lower animals. The results were not so constant with certain brands of smokeless powders; for instance, the Peyton brand used in our service rifle in 1894, when contaminated with the less resistant organisms and fired into media, gave rise to no growth whatever; nevertheless, when it was treated with Bacillus anthracis and fired into media and animals the results were positive. Taken as a whole the evidence thus obtained tends to confirm the opinion that gunpowder may be at times the medium for conveyance of septic influences like tetanus, malignant œdema,† etc. Cases of the former disease reported by H. Nimier of the French Army can hardly be explained otherwise.‡

(7) *Multiplicity of Wounds.*—Multiple wounds from the same bullet are recorded in all works on military surgery more as surgical curiosities. The liability to such occurrences have of course increased with the velocity and penetration of projectiles. Now that the velocity of the present service-rifle projectile has recently been doubled and its penetration trebled, multiple wounds are more frequent than heretofore. Instances of this kind from the Mauser bullet were very frequently seen in the Santiago campaign. Thus a man entered the hospital at Siboney with six wounds inflicted by one Mauser bullet, implicating the right shoulder and both breasts. There were a number of instances in which wounds of the body were associated with wounds of the arm or forearm or both, the latter being in a state of flexion at the time of injury. Wounds of entrance and exit in the lower extremity were several times complicated by wounds of the scrotum or penis by the same bullet. Captain —— 7th Infantry received wounds of the face followed by no disfigurement. The projectile, a Mauser, entered the right cheek below the outer canthus, emerged on the nasal side, entered the nose and again emerged at the left side. The linear scars are noticeable only on close inspection. Had these wounds been inflicted by a leaden bullet of larger calibre, the resulting disfigurement would doubtless have been most distressing.

Poisonous Influence of Projectiles.—The experimental work already alluded to demonstrates that there is liability to infection from an infected bullet. It does not necessarily follow that the gunshot wounds inflicted by dirty bullets will suppurate. The virulence of the micro-organism and the resistance of the patient fix the liability very largely. The danger of infection more often arises from particles of clothing or dirty skin carried into the wound by the bullet. Instances of such infection are seldom seen, not because infected material has not been carried into the wound, but more often because the virulence of the organisms so carried is very weak. Formerly the great source of infection lay in the introduction of dirty fingers and probes into all gunshot wounds, a practice reprehensible to-day even under aseptic conditions.

DIAGNOSIS.—The wound of entrance will nearly always give information of the calibre of the bullet; if elongated, whether the angle of incidence with the surface was a right angle or not. When the bullet's remaining veloc-

* *Ibid.* † *Ibid.*, p. 170.
‡ Archives de Médecine et de Pharmacie Militaires, No. 23, 1894.

ity is reduced from ricochet or extended range, the so-called keyhole character of the wound of entrance will often suggest the fact. A bullet that sustains deformation by colliding with a hard substance like rock and subsequently inflicts a wound will often fail to give definite evidence of its original diameter, and it is apt to upset thereby the calculations made from the size and shape of the wound of entrance. The appearance of the wound of exit and of the area around it often gives evidence of the extent of damage sustained by a resistant bone. When the wound of exit is two or three times as large as the entrance wound, a bone lesion may be taken for granted. With the employment of armored projectiles we sometimes find smaller multiple lacerations around the exit wound. In the case of close shots these may be due either to fragments of the mantle and lead core of the bullet, when these separate, or to small pieces of bone which, having received the transmittal energy from the projectile, have shot forth acting as secondary missiles.

Bullet extractors, detectors, and probes were formerly used to locate balls, estimate bone lesions, and to trace the direction of the channel made by the missile. It is needless to state that these have given way to the more advantageous methods—fluoroscopy and skiagraphy with the Röntgen ray. The experimental evidence already quoted establishes the fact that there is no such a thing as an aseptic gunshot wound. The shreds of clothing, particles of skin, and the bullet itself infect the channel tract at once. That the infection is generally of a low order, unattended with marked systemic disturbance in the vast majority of cases, is due, first, to the state of quietude in the channel tract; second, to absence of virulence on the part of the organism; and third, to the resistance of the individual. If we violate number one by invading the channel tract with probes, or if two and three are not propitious, suppuration is sure to follow. We will revert to this subject under treatment.

Prognosis.—The prognosis of a gunshot wound depends (1) upon the amount of destructive effects sustained, (2) upon the nature of the anatomical parts traversed, (3) upon the environment, (4) upon the management of the case when it falls under the care of the surgeon, and (5) upon the fatality due to different armaments.

1. Destructive effects are proportional to velocity and resistance on impact; that is to say, when a projectile impressed by a maximum velocity collides with a tissue, like the shaft of a long bone, having a maximum amount of resistance, the result is a maximum amount of destruction. On the other hand a projectile travelling at a maximum amount of speed through tissues like muscle having a minimum amount of resistance will not exhibit destructive effects beyond the area of the channel wound; and conversely, in the case of a projectile travelling at a minimum amount of speed, although it may collide with a resistant structure, the destructive effects will be reduced to a minimum. In estimating the probable amount of destructive effects we should also bear the following in mind, viz.: everything being equal, destruction of tissue increases with the sectional area of the projectile, whether natural or whether it be acquired by ricochet or impact. Projectiles of certain manufacture are purposely made to acquire deformation on impact, and they cause extensive mutilation of tissue when they collide with resistant structures. They are used by sportsmen under the name of express bullets, or soft-nose bullets. They have been used in war under the name of explosive bullets although the name is erroneous, since they do not disintegrate by the action of explosives in them as we find in the shells of field guns or cannons. The soft nose bullet is one that has the armored steel jacket covering the lead core except at the point. On impact the absence of the steel envelope at the point invites disintegration of the projectile so that the core and casing break up into many pieces upon striking resistant bone. Wounds caused by such bullets are murderous in the extreme and not permissible in war by the comity of nations. Their use is tantamount to that of an explosive bullet for hand weapons—a thing which was proscribed by the articles of the St. Petersburg Convention of 1868 (Fig. 2379).

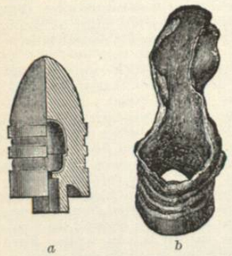

Fig. 2379.—Examples of Explosive Bullets in our Civil War, with Old Calibres. *a*, Gardner's explosive bullet; *b*, fragment of explosive bullet extracted from thigh.

The following illustrations from Dr. Makin's book* are given to show the normal bullets used in South Africa,

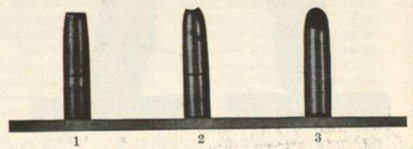

Fig. 2380.—1 and 2 show the steel jacketed projectile with impairment of the steel envelope by filing sufficient to invite deformation on impact; 3, copper-jacketed express bullet, the lead being exposed at the end, used by sportsmen in hunting large game.

those that were deformed by ricochet, and also the appearance of the soft-nose bullet before and after impact. Fig. 2380 shows how jacketed bullets may be filed or otherwise tampered with by the soldier on the field, and 3 on the same figure shows an express bullet used in hunting large game. The result with such bullets on impact against resistant structures is the same as that described for soft-nose bullets (Figs. 2375 to 2377).

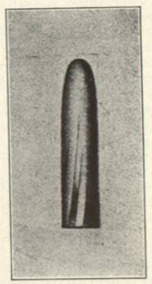

Fig. 2381.—Normal Mauser Bullet.

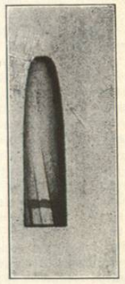

Fig. 2382.—Normal Lee-Metford Bullet. (Makin.)

2. The gravity of gunshot wounds is measured by the nature of the parts traversed. Those of the head, large vessels, spine, and viscera are the most serious.

3. In military practice environment plays a great rôle in the prognosis of gunshot wounds. In the fixed hospitals of civil life, equipped with every necessary appliance, with ample help of the most intelligent kind, the civil surgeon has entire control over his cases at all times; in other words he dominates the environing conditions as they present themselves; whilst, on the other hand, the military surgeon is movable and moving field hospitals

* *Op. cit.*

are ever at the mercy of endless conditions far beyond the surgeon's control. The confusion incident to the turmoil of battle renders it impossible to do more than apply a first-aid dressing to a dirty wound. When the battle waxes fiercely there is as much need for help at the front as at the rear, to say nothing of all the labor that is constantly required of the relief corps in transporting the wounded from the fighting line to the field hospitals, oftentimes several miles to the rear. Under these circumstances it is difficult to provide an adequate amount of help to the three places at the same time. Deficiency in help for the wounded is the result—a fault that has existed in large and sudden engagements in all wars. Again, military necessity compels the movement of the wounded so often that the patient is robbed of needed rest, it is a difficult matter to keep his dressings clean, and the dangers of sepsis are thereby magnified. In spite of the best efforts of the military surgeon in times of peace, when he himself has but few opportunities of treating sick and wounded, it is impossible for him to convert the relief corps under his orders into nurses having the same efficiency that one finds in civil life; so that this valuable adjunct to the care of the wounded is far below the standard. If one undertook to picture the reverse of the conditions that prevail around the civil surgeon he could not do so more aptly than by pointing to the predicament of the military surgeon in active campaign. Hence the influence of environment on prognosis.

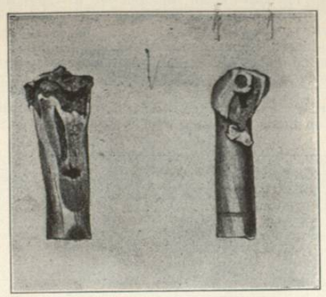

Fig. 2383.—Apical Lee-Metford Ricochets. From Hythe targets. Tendency of cupro-nickel envelope to tear in transverse direction. (Makin.)

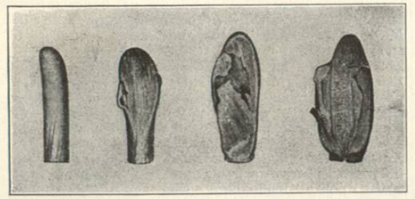

Fig. 2384.—Four Common Types of Lateral Mauser Ricochet Bullets. From left to right. 1, Slipper form; slight broadening and turning of tip. 2, More pronounced degree of form 1, with laceration of the mantle opposite the shoulder of the bullet. This is the weakest spot, for two reasons: the alteration in curve at this position, and the junction of the thickened point of the mantle with the thinner sides. 3, Lateral ricochet involving nearly the whole length of bullet. Rupture of mantle from broadening of core opposite shoulder. 4, Similar lateral ricochet with extensive longitudinal rupture of mantle, the latter being turned out and forming a cutting "flange." (Makin.)

4. The significance of the management of a gunshot wound when it falls under the care of the surgeon was never so thoroughly expressed as by Nussbaum's trite saying: "The fate of the patient with a gunshot wound lies in the hands of the surgeon who applies the first dressing." That this should be done under strict antiseptic precautions goes without saying. More than that, the caution against the unnecessary use of probes should be strictly adhered to. Even in gunshot fractures presenting extensive comminution, there is less danger in a *laissez faire* policy than there is found in an attempt to clear out the wound without adequate preparation. There are certain wounds that need close investigation as soon as possible. This should be thoroughly done, but not before the proper antiseptic precautions are available.

5. The evolution of the military rifle has witnessed some change in the general mortality on the field of battle, but contrary to expectations the mortality has not kept pace with the efficiency in firearms; if anything, it has diminished. This is due partly to the humane character of the armored projectiles, partly to fighting in open order and while lying down. This is well brought out in the subjoined table if we compare the number of killed and wounded to the force engaged in battles with the old armament and in the more recent ones fought with reduced calibres and superior velocities, like the assault on Santiago, and two of the prominent battles of the Kimberley Relief Force, viz.: Belmont and Magersfontein. It should be borne in mind that the armies concerned in the last three engagements were always on the offensive against an enemy well entrenched on heights. The wounds from the artillery arm were less than one per cent. at Santiago, and according to press reports they did not exceed five per cent. at Belmont and Magersfontein, so that the casualties as a whole may be regarded as a fair index of the comparative deadliness of the new military rifle.

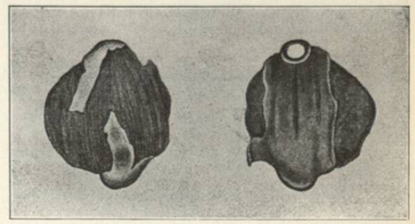

Fig. 2385.—"Disc"-shaped Lateral Ricochet. This form is of little practical importance, as the velocity retained by the bullet is low, and no perforating power would be retained. It is inserted separately in order to complete the series shown in Fig. 2384. (Makin.)

Table III.—Mortality on the Field of Battle from the Old and New Arms.

	Nation.	Strength.	Killed.	Wounded.	Ratio of killed to wounded.
Waterloo, 1815	British, Hanoverians, and German legions	53,284	2,353	7,882	1-3.3
Solferino, 1859	French and Sardinians	135,234	2,313	12,102	1-5.2
	Austrians	163,124	2,386	10,634	1-4.5
Shiloh, 1862	Unionists	63,000	1,735	7,882	1-4.5
	Confederates	40,000	1,728	8,012	1-4.6
Gettysburg, 1863	Unionists	117,350	2,834	13,709	1-4.8
	Confederates	68,352	3,500	14,500	1-4.1
Santiago, 1898	United States forces	11,969	222	1,333	1-6.
	Spaniards	5,140	87	426	1-4.9
Belmont	English	8,693	58	229	1-3.9
Magersfontein	English	11,447	166	717	1-4.3

Occasional Complications.—In former times the complications of gunshot wounds constituted by far the most important clinical picture of this class of wounds; they consisted of inflammation, gangrene, secondary hemorrhage, aneurism, hospital gangrene, pyæmia, tetanus, erysipelas, traumatic delirium, etc. With the exception of those resulting from injury to blood-vessels, the complications that follow gunshot wounds in our day are exceptional. They will be taken up later under the heading of Wounds of the Blood-Vessels, etc.

Fig. 2386.—Ruptured Mauser Mantle, to Illustrate the Tendency to Complete Longitudinal Fissuring. (Makin.)

Remote Effects of Gunshot Wounds.—The ulterior and disabling effects of gunshot wounds as treated by authors have reference to conditions that have remained after the healing of the wound has been accomplished. In the past, the amount of invaliding resulting from the ulterior effects of gunshot wounds among the soldiery has been a cause of great expense to the state, and of much pain and protracted suffering to the wounded. Pain and the ills that ensue after the lodgment of foreign bodies have been a fruitful source of the protracted suffering referred to. As one might suppose, the disabling effects are often correlated with the anatomical structure or bodily region involved. A source of remote effects not hitherto described—plumbism from lodged missiles—has recently been touched upon* by Nimier and Laval. In this article they refer to what seems to be a well-authenticated case by Küster and Lewis in *Arch. für Chir.*, t. xliii., p. 221, 1892. Cases of lead poisoning from this source are seen only when the projectile has divided into many fragments, or when the wound has resulted from fine shot that remains embedded in bone, and preferably in the bone marrow and under the periosteum, both of which possess, to a remarkable degree, the property of

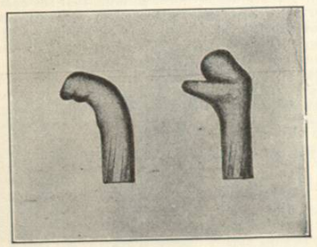

Fig. 2387.—Two retained Mauser bullets which had produced comminuted fractures of the femur of moderate severity. Each has given way at the shoulder, but the mantle developed creases without rupture, and the bullets are correspondingly bent. Both bullets were travelling at a moderate, if not low, degree of velocity. (Makin.)

absorbing materials into the general circulation. In the cases mentioned the symptoms from lead intoxication disappeared as soon as the missiles were removed. Plumbism as a remote effect, already rare, will be very exceptional hereafter in military surgery because of the use of the steel-jacketed bullets, and of the *x*-ray in diagnosis.

* Le Caducée, September 7th, 1901.

The lead core of the latter bullet very seldom separates from its envelope, so that the opportunity for absorption under the most favorable conditions will very seldom occur. The use of the Röntgen ray in diagnosis will point out the location of bullets so exactly that few bullets will be allowed to remain in the tissues long enough to produce any kind of remote effects.

The amount of suffering from remote effects in gunshot wounds diminished very largely with the introduction of clean surgical methods. Again, the use, in war, of hard steel-clad bullets, that seldom deform or disintegrate on impact with hard bone, have materially curtailed

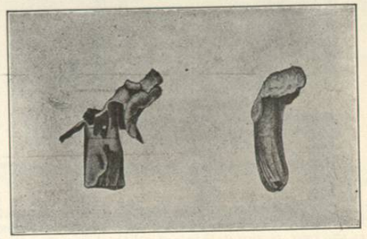

Fig. 2388.—Apical Ricochet Mauser Bullet (see text). The mushrooming of the core is moderate, but the destruction of the anterior part of the mantle very considerable. (Makin.)

the after-effects in wounds. Projectiles of this class seldom lodge, and when they do, their lighter weight and polished exterior favor permanent encystment with few or no symptoms. It may be stated also to the credit of the reduced-calibre projectiles that they seldom carry clothing or pieces of the accoutrement into the wound track, whereas formerly, with the employment of projectiles of larger calibre, this complication was of common occurrence. Lastly, the use of the *x*-ray in localizing projectiles and defining the amount of bone injury has played a prominent part in curtailing the remote effects of gunshot wounds. The following skiagrams explain some remote effects before and after operation (Figs. 2390 to 2398).

General Treatment.—The treatment of gunshot wounds has been very much simplified in late years. The civilian treats them as he would other infected wounds, in accordance with the rules of strict antisepsis. He does not invade the channel tract except for special reasons to be indicated later. In simple uncomplicated gunshot wounds a clean dressing and rest in bed constitute about the necessary measures of treatment. In military practice, when the lack of transport and sudden accessions of large numbers of wounded are thrust upon an inadequate corps of helpers, the medical department resorts to the expedient of furnishing each man, upon going into battle, with a first-aid dressing composed, in our army, of a package five and one-half inches long, one-half inch thick, and two and one-half inches wide. Contents of package: Two antiseptic compresses of sublimated gauze in oiled paper; one antiseptic bandage of sublimated cambric with safety pin; one triangular bandage and a safety pin. The mode of application is illustrated on the bandage. This dressing is

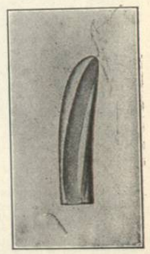

Fig. 2389.—Grooved Mauser Bullet Removed from Anterior Abdominal Wall after Crossing the Ribs. I saw several such removed from the thoracic wall, and am inclined to attribute the grooving to impact with the margin of the ribs. (Makin.)

usually applied by a comrade or officer who has been instructed in first-aid work by the medical department; or by a member of the hospital corps, and less often by a medical officer. The want of water and time seldom permits

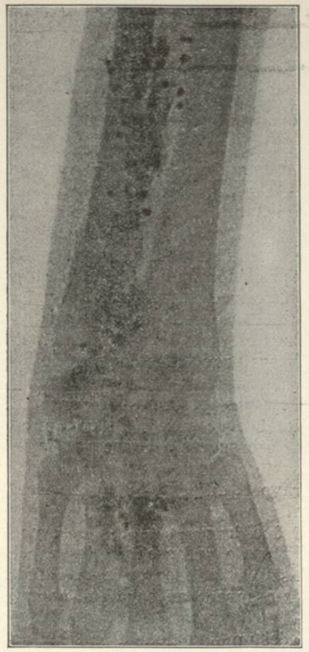

Fig. 2390.—Radiograph. In the case of a marine officer who received a charge of fine shot at close range in the palm of the left hand August, 1900. Wound of exit was on dorsal surface of forearm at junction of lower and middle thirds. During the next four months he had four attacks of lead colic and suffered from plumbism. In December, 1900, the shot was removed. One month later he was free from all symptoms of plumbism. (Nimier.)

more than the application of the dressings without first cleansing the hands of the operator or cleansing the skin about the wound. It is needless to state that a lacerated wound, already infected, dressed in this way will invariably suppurate unless redressed very soon. The fact that the simple wounds, which predominate so largely in war, have heretofore done well under this treatment has caused many observers to attribute the happy results in gunshot wounds to the value of the first-aid dressing. The most that one can say in favor of the practice is that it adds no infection to an already infected wound, which would certainly occur if nothing intervened between the wound and the dirty clothing of the soldier. The simple wounds, and many that included perforations and fractured bones, brought to the Reserve Divisional Hospital, Siboney, from the line near Santiago, exhibited, as a rule, no evidence of suppuration. The loose state in which the dressings were found when they reached us—having oftentimes been imperfectly readjusted by the wounded soldier himself—made it difficult to believe that the happy result was to be ascribed solely to the dressing. These wounds were generally covered by dry blood, and the more reasonable explanation suggested was that healing was taking place under the protective influence of a blood clot. Until we are furnished with something better the military surgeon will have to continue the use of first-aid packages at the dressing stations; later, at the field hospitals, where the appointments are better, wounds are dressed when necessary under such asepsis as field conditions ordinarily permit. Here, also, necessary explorations and surgical operations can be done with some degree of safety. Wounds undergoing suppurative processes can here be thoroughly washed with antiseptic solutions and drained; the dressings can be changed as often as necessary, and with persistence, to the end that suppurative cases shall be kept at the very minimum of number, for once suppuration sets in among the wounded in a hospital the task of preventing its spread becomes doubly difficult, and this is especially true when campaigns are prolonged. The soldiers in prolonged field work lose their normal resistance, while from frequent transmission, pus microbes are ever acquiring virulence as they

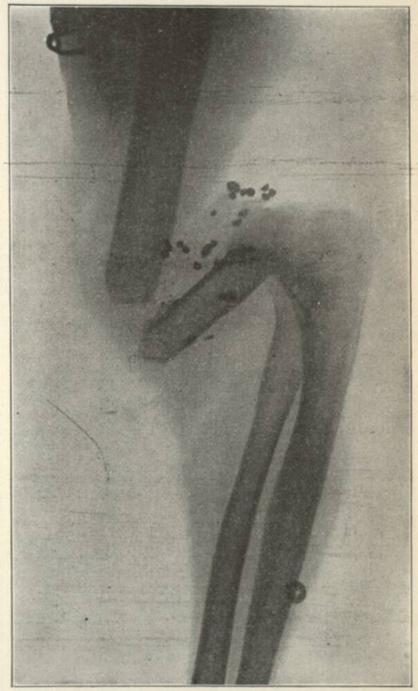

Fig. 2391.—Radiograph. In the case of J. M—— showing ununited fracture of humerus and lodged shot. Wounded June 25th, 1860, by accidental discharge of shotgun within a distance of two feet. Forearm and hand totally paralyzed for three years. Remote effects: flail joint in humerus causing weakness and impairing motion of arm. Radiograph taken October 2d, 1901.

go from host to host. We are speaking here of field conditions where the military surgeon is not always sure of carrying out an aseptic technique.

Lodged Balls.—The questions as to whether it is necessary, in any given case, to remove a lodged ball or other missile, and as to what is the proper time for accomplish-

FIGS. 2392 AND 2393.—Radiographs in the case of C. M——, showing the course of a Mauser bullet through the metatarsal bones. Wounded July 1st, 1898, at a distance of 300 yards. The ball ranged transversely across the foot, grating the metatarsal bones in transit. In the process of healing osseous bridges formed uniting the bones. Remote effects: pain at site of wound and limping due to the bony union. Radiograph taken May, 1900. Operation June, 1900. Excision of fourth and fifth metatarsal bones. Result: no pain; the man walks without limping. The second radiograph was taken in August, 1900.

ing this, call for more than a passing notice, at least in military practice. Save in cases of actual necessity (and they are very rare), when time is a factor as it often is in the rush of field practice, bullets should be let alone. An incision for a bullet requires time and an additional dressing, and it exposes the patient to an additional danger of infection amid doubtful surroundings. The morbid curiosity of the laity to find the ball, the restlessness of the patient, and the lack of resolution on the part of the surgeon are only too often exhibited in this late day. At Siboney it was impossible to restrain the surgeons from the practice of cutting out bullets, notwithstanding the strict orders to the contrary, at a time when the dressings were running short, and military necessity was keeping the wounded almost constantly on the move. The necessity and the time for the extraction of a lodged missile are questions which should as a rule be left to the surgeons who are located at those points on the line of communication where the hospitals are fixed and provided with *x*-ray machines. In time of peace the military surgeon should take occasion to explain to the soldiery the evil effects of probing for bullets, and of haste in operating for balls whose location is not exactly defined, and the utter harmlessness that comes from bullets that lie embedded in tissues. If a bullet is lying immediately under the skin, or has already partially protruded through an exit wound, it should be at once removed. Those lying at the bottom of infected tracts should also be removed, as they are generally met with in the special effort to disinfect the wound by irrigation, etc. Those interfering with function or that cause pain by pressure on a nerve should be removed as soon as definitely located; the same is true of projectiles lodged in joints or in close proximity to the joint structure. An effort should be made to remove all missiles of irregular, sharp contour like those which have been deformed through ricochet or by fragmentation, and also pieces of shells, unless they lie in inaccessible regions very near or in the large cavities. Figs. 2400 to 2404, which give skiagraphic views of the head and thorax, illustrate how bullets can remain

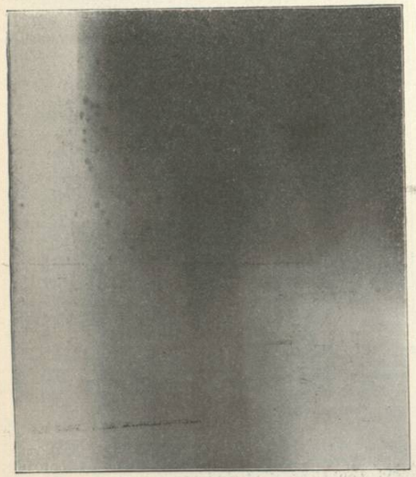

FIG. 2394.—Captain K——, United States Army; lodged bullets from whole charge of No. 6 shot four feet from muzzle, entering outer aspect of upper thigh from below upward. There is a distinct bruit emanating from the external circumflex artery, possibly due to shot lodged in or around arterial coats.

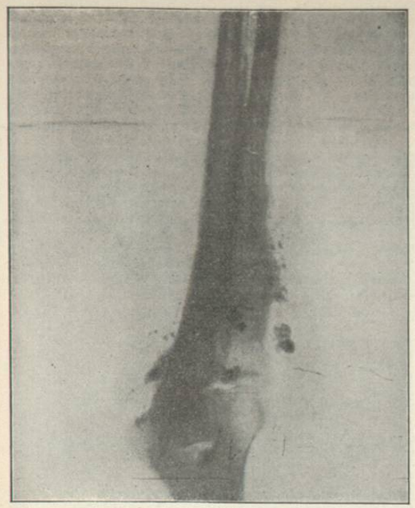

FIG. 2395.

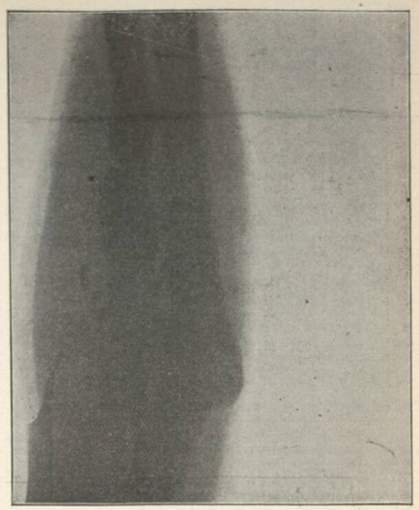

FIG. 2396.

FIGS. 2395 AND 2396.—Radiographs taken from two different directions. Fig. 2395, view at right angles to course of bullet; Fig. 2396, view along course of bullet. In the case of F. F——r, showing explosive effects. Wounded October 8th, 1899, by an unknown bullet at a distance of 100 yards. Remote effects: loss of pronation and supination of forearm; partial paralysis of forearm more marked on the extensor surface. (Radiographs taken May 1st, 1900.)

embedded in regions not accessible and yet cause no special harm.

Wounds of the Blood-Vessels.—Of those injuries of blood-vessels which do not terminate fatally before surgical aid can be obtained, the number in war is very small when compared to the total number wounded. It is re-

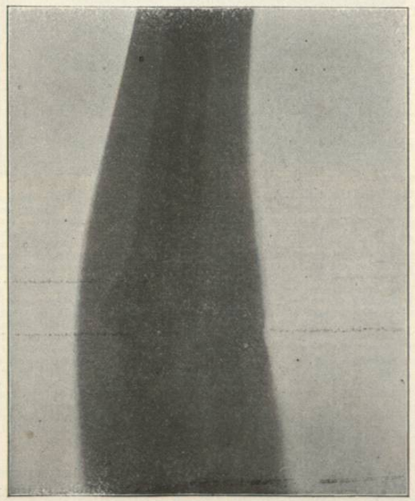

FIG. 2397.

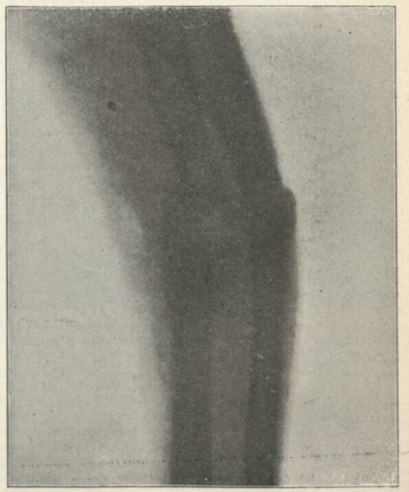

FIG. 2398.

FIGS. 2397 AND 2398.—Radiographs taken from two different directions. Case of D. M——, showing fracture of radius and ulna caused by a large-calibre bullet at a distance of 150 yards. The four fragments united in a solid callus. Remote effects: total paralysis of wrist and hand with loss of sensation over fingers.