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THE MANAGEMENT OF BURNS*

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CINCINNATI

To attempt to establish a line of management of all burns *a priori* is somewhat preposterous. Following the doctrines of Hebra, and accepting his division of burns into three degrees, we find that the pathologic process in each is different. In burns of the first and second degree there is an inflammatory reaction of the skin, while in the third degree there is primary necrosis. The degree of the burn, the medium producing the burn, the depth of the injury in the tissues, the extent of skin burned and the condition of the nervous system of the patient, all influence the treatment of such important injuries. In general we can state that the best treatment is that which favors the sloughing of the burned skin, which maintains the sterility of the resulting wound and promotes granulation and the newly forming epidermis, so that a regular soft cicatrix may be obtained.

A burn is always a serious injury in view of the resulting shock, and of the action of poisonous substances arising from the burned skin. The treatment of the local lesion is only a part of that necessary, for the results on the general system have to be taken under consideration.

In 1902 I reported 88 cases of burns, of which 56 were in men and 32 in women.

The burns seen in that year were: of the first degree, 8; second degree, 54; of the third degree, 26.

The results of that year were: recovery in 61; death in 24, while 3 left the hospital.

Last year we had 49 cases of burns: in men, 34; in women, 7; in children, 8.

The results were: of the 34 men, 32 recovered, 2 died. Of the 7 women, 5 recovered, 2 died. Of the 8 children, 6 recovered, 2 died.

In severe burns the patients when taken to the hospital are greatly excited, crying and screaming with pain. As soon as the wounds are dressed and the patient is placed in bed an injection of morphin, $\frac{1}{4}$ grain, produces quiet. Some so regain their normal power as to furnish details of the accident and ask questions about their relatives. After a severe burn, the patients as a rule do not void urine, and when they do it is scanty and contains either blood or a quantity of albumin.

A woman suffering from a slight epileptic attack fell while carrying a coal-oil lamp, her clothes being set on fire. When taken to the hospital nearly two thirds of the body was burned to a crisp, from the feet to the chest. Both legs were just baked, the whole surface brown, hard and insensible (Fig. 1). She received an injection of morphin, $\frac{1}{4}$ grain, and was placed in a water bed in which a handful of sodium borate had been dissolved to remove the burned clothes adherent to the skin. After cleansing the burned surface she was placed in bed, and compresses were applied moistened with a 2 per cent. solution of aluminum subacetate. The patient lay in apathy and began to vomit bilious and bloody matter. This continued for two days. The urine was scanty and contained albumin. The following day she received a subcutaneous injection of normal salt solution, and also strychnin, $\frac{1}{30}$ grain. The stupor passed away and the pulse improved considerably. She lived twenty-four days. The eschar was detaching, but it was a difficult matter to remove it, because the muscles were becoming detached and exhaling an offensive odor. The patient grew very weak, became delirious, fell into stupor and died.

Death was due to sepsis. Although the action of the fire or of different mediums at an elevated temperature is limited to the skin, yet general disease follows. The burn has a remarkable influence on the organism. The severe symptoms following an extensive burn of the skin are in relation with the entity of the lesion. At times, even in consequence of an apparently light combustion, severe symptoms endanger the life of the patient. For this reason the burns have a general as well as a local treatment.

The treatment of burns¹ by forcibly removing the burned skin and deep blisters is risky, unnecessary, and will not accomplish the purpose. This was proposed by Sneve² and summarized by W. A. Jack, Jr.,³ and Brazer⁴ recommended that as much as possible of the burned skin be removed, and the surface then washed with gasoline, while Lieber,⁵ advocating the same process, advises washing the bleeding surface with benzin. Although this operation is carried on under an anesthetic, and is followed by an injection of morphin, it is to be avoided. The shock is so severe that the patient may not recover from it.

According to my experience, time is necessary to give the burned tissues a chance to detach from the

* Read before the Section on Dermatology at the Sixty-Sixth Annual Session of the American Medical Association, San Francisco, June, 1915.

1. The Treatment of Burns, New York Med. Jour., March 14, 1914, p. 541.

2. Sneve, Haldor: Treatment of Burns, THE JOURNAL A. M. A., July 1, 1905, p. 1.

3. Jack, W. A., Jr.: Washington Med. Ann., May, 1912.

4. Brazer, Louis: New York Med. Jour., Aug. 2, 1913.

5. Lieber, M.: Beitr. z. klin. Chir., 1912, lxxxi; Die Verbrennungen und ihre Behandlung, Dermat. Wehnschr., 1913, No. 23, p. 657.

normal nonburned structures. Even in the second-degree burns, when large blisters are formed, it is better to puncture the blisters in several places to allow the serum to exude, leaving the old epidermis for some time to cover and protect the denuded papillae of the derma. Some blisters are superficial, the serum is contained only in the stratum corneum, and when punctured the whole contents ooze out. Other blisters are deep, they affect the entire thickness of the corpus mucosum, and when opened very little or no serum escapes. The corpus mucosum is thick and has the appearance of grayish pulp.

The histologic changes of the skin in the second degree burn are characterized by an enlargement of the papillae, enlargement and congestion of the capillary blood vessels, swelling and infiltration of the collagenous tissues of the derma. The corpus mucosum is swollen, and a layer of small leukocytes lies on the papillae and beneath the epidermis, which forms the vault of the bulla. According to Kaposi⁶ the papillae appear like a reticular tissue whose meshes contain serum and white cells, epithelium and fibrinous masses. The blister, either breaking of itself by the pressure of the serum or artificially broken, undergoes a regressive process. When exposed to the air the cuticle dries up, the fibrinous contents form a thick crust under which the epithelium is reproduced, which covers the papillae. When a deep blister is opened the disorganized tissues of the mucous layer gradually slough off. The inflammatory process diminishes in intensity, the epithelial cells underneath become more coherent, cover the papillae and form a new epithelial layer which completes the epidermization without leaving a scar.

The burns at the time they occur cause great pain; a few hours later fever follows. In the same way when the burned tissues begin to slough off, a high temperature shows the general systemic reaction. Although a second degree burn is not so dangerous, yet, according to the extension and the age of the patient, it can have fatal results.

In a third degree burn the skin has been disorganized; there is mortification of the tissues. The eschar involves the derma, and may reach to the subcutaneous tissue. When the skin has been burned to such a degree by flame it appears dark brown (Fig. 2) and dry like leather; when burned by steam at high pressure, it looks white like marble, hard and coriaceous, and is insensible to the touch. In the skin so burned

the blood circulation is destroyed, and the vitality also. Together with the disorganization of the skin (Fig. 3), coagulation and decomposition of the proteic substances takes place. The products of the disorganized albuminous tissues then arising from the burned skin are poisonous and according to Ferrarini⁷ cause the systemic symptoms, and even death. Spietschka⁸ found that these poisonous elements are excreted by the kidneys. The urines of men and of animals affected with extended burns are poisonous. To the coagulated albuminous matters and to the

burned blood corpuscles these poisonous elements may be traced.

In the beginning it is difficult to establish whether a burn is of the second or of the third degree, especially when it has been produced by steam. After two or three days the burned skin assumes a dead appearance, and at the edges the elimination process begins, separating the burned

Fig. 1.—Burn of third degree. Leg baked. Surface hard and insensible.

from the healthy skin.

Figure 2 shows a third degree burn, caused by flame. It was taken the second day after the occurrence. The skin is baked brown, dry and hard, and is insensible to the touch. The whole surface is swollen; in some parts the cuticle has been removed, in others it is forming blisters. It was treated with continuous moist compresses with 2 per cent. solution of aluminum subacetate. Figure 4 shows the same burn one week later. Toward the periphery where the blisters were situated the epidermization is well advanced. Where the eschar sloughed out the granulations are forming. In the center where the burn was still deeper, the eschar is still hanging on. The eschar is removed without forcing, the shreds which are detached are seized with a thumb forceps and taken off with scissors. In this way we avoid pain, and still better, the bleeding. When the blood vessels are broken the door is opened for infection. The burned skin in the tissues is so adherent that it is

Fig. 2.—Burn of third degree caused by flame. Skin dark brown and dry like leather.

impossible to remove it without producing trauma. Nature removes the burned from the healthy tissues, and it is our duty to help this process and not to disturb it. In many cases when we believe we have a very deep eschar we are surprised in a few days to see that the shreds of burned skin are sloughed off and there remains underneath a clean healthy granulating surface, which soon shows islands of epithelium and in a short time heals. The elimination of the eschar begins between the third and the fifth day.

7. Ferrarini, Guido: Die toxische Lehre in der Pathogenese des Verbrennungstodes, *Dermat. Wehnschr.*, 1913, No. 12, p. 335.

8. Spietschka: Ueber verbrennungen und Verbrennungstod, *Arch. f. Dermat. u. Syph.*, ciii, Nos. 1 to 3.

6. Kaposi, M.: *Pathologie et traitement des maladies de la peau*, translation by Besnier and Dayon, Paris, 1891, i, 492.

An inflammatory process starts around the eschar by way of a groove which separates it from the healthy tissues. The separation is effected in from eight to twelve days. The resulting granulating wound has an uneven bottom and irregular edges, on account of the irregularity of the mortification of the tissues. After the elimination of the disorganized tissues, abundant granulations come up to replace the loss of substance of the skin. From the edges of the granulating wounds the epithelium is concentrically reformed and, furthermore, islands of epithelium appear in a round form in different places in the middle and these, gradually growing, peripherically cover the newly formed tissues. This is the process of cicatrization. Scar substitutes the lost skin; it has no papillae and no hair follicles. The difficulty of the cicatrization is the reproduction of the horny layer. The granulations sometimes are irregular, luxurious and abundant, and if not watched and kept under control, the resulting scar may become irregular, uneven, inelastic, contracted, distorted, protuberant and disfiguring. Figure 5 shows a burn of the leg and thigh, which came under my service twenty days after the occurrence. The patient had remained in his house treating himself. It was covered with crusts and was infected with *Bacillus pyocyaneus*. The dressing in a few hours turned blue. Compresses moist with 1:2,000 solution of mercuric chlorid cleared the surface of infection. In Figures 6 and 7 burns of both hands and feet of the second and third degree are well illustrated. On the hands deep blisters formed, which in a few days were removed and in a short time the burn healed. It took nearly two weeks for the eschar to slough off the feet with a third degree burn, and nearly four weeks for complete recovery.

LOCAL TREATMENT

In a first degree burn the application of dry powders such as talcum powder, bismuth, or alum is the best treatment. Rosslinger⁹ has already recommended the exclusion of salves and of baths in these burns in order to avoid maceration and excoriations of the epidermis, which often constitute open doors for infection. In case of severe pain I recommend application of compresses moistened with a solution of aluminum subacetate of from 2 to 5 per cent., which will calm the burning pain. As soon as the patient is eased the dry powder is applied. In a few days the redness and swelling disappears, and under a superficial desquamation the skin returns to its normal condition.

9. Rosslinger: Die erste Behandlung bei Verbrennungen und Verbrennungen, Intern. Med. Kong. in Wien, September, 1892.

In second degree burns I apply moist compresses of a solution of aluminum subacetate. When the blisters are distended with serum they are opened, draining the fluid and leaving the epidermis in place to protect the denuded papillary layer.

The application of compresses moistened with a 1 per cent. solution of picric acid has been highly recommended, especially by Boland¹⁰ of Atlanta, Ga., and a 3:4,000 solution of potassium permanganate has been recommended by Beck.¹¹ In my service I could find no advantage that the picric acid or potassium permanganate had over the aluminum subacetate. It has been found disagreeable to handle on account of the staining. Compresses of sterile gauze are applied on the burned surface and kept continually moist with the aluminum solution, and the whole is bound with a piece of oiled silk, so cut as to hold the dressing in place.

Oily substances as carron oil, oleum lini and aqua calcis, so much recommended by Kaposi¹² and Wert-

Fig. 3.—Section of burned skin. From photomicrograph. Epidermis missing; no papillary layer. Lymph spaces filled with coagulated albuminous matter. Blood vessels shown as streaks of dark granules, the upper surface infiltrated with black granules. Collagenous tissues hardened and shrunk.

heimer,¹² according to our experience must be avoided. We must agree with Verney¹³ that carron oil in many cases is dangerous, on account of infecting wounds.

When the shreds of epidermis forming the blisters are easily detached all are cut off by means of a pair of scissors and a thumb forceps and the whole surface is gradually cleared. The papillae are already covered by a newly formed epithelium, the surface is red, and a little oozing can be noticed. At this point the Sneve² treatment, exposing the surface to plain air is very useful. In the beginning the patient complains of the burning and wishes to have it covered, but after a while he does not experience much discomfort. The

10. Boland, Frank K.: New York Med. Jour., Aug. 2, 1913.

11. Beck: Treatment of Severe Burns in Children, Therap. Monatsh., No. 8, 1913.

12. Wertheimer: Zur Behandlung der Verbrennungen in Kinderalter, München. med. Wchnschr., 1892, No. 31.

13. Verney, A. E.: Ueber Behandlungen von Brandwunden, Deutsch. med. Ztg., No. 100, 1894.

surface is left exposed to the air for one hour at first, later for two or three hours. The surface is then dusted with powder and covered with sterile gauze. A second degree burn can recover in the course of one week or ten days. Some little points may remain which ooze and granulate; these may be touched up with 3 per cent. nitrate of silver, and to prevent the formation of crusts at night can be covered with 2 per cent. boric acid in petrolatum.

The treatment for a third degree burn is nearly the same. I mostly use compresses moistened with aluminum subacetate solution for the purpose of softening the eschar and helping the process of elimination. In the skin burned to the third degree, there is no more life, no more circulation, the proteic elements are decomposed, and it has to be eliminated from the living tissues. This is done by nature herself. Between the third and the fifth day a groove is formed by inflammatory process around the eschar which is gently detached, and gradually eliminated. With scissors I cut away all the shreds of the eschar which hang on the surface, without forcing. When the eschars are removed by force the tissues tear and bleeding follows. Bleeding means the opening of the blood vessels, and causing them to absorb the putrid material, which is derived from the burned tissues which form the eschar. This is the time when the patient has more intense fever due to the entrance of the poisonous substances into the system. When fever is high and pus is formed on the surface, compresses moistened with 1:2,000 solution of mercuric chlorid have given me the most satisfactory results.

When the eschar has been completely eliminated, the resulting wound is rose red, clean, and slightly uneven on account of the different depths of the burn. On the whole surface healthy granulations form a substitute for the lost skin. From the epidermis at the edges an epidermic layer gradually tends to cover the granulating surface as a whitish thin cover. In different places in the center of the granulating wound, islands of epidermis are seen, which

look like epidermic grafts, and, in a round shape, keep reforming the epidermic layer. We believe with Hebra and Kaposi that these epithelial islands are the results of preexisting epithelium emanating from portions of the mucous layer, or from hair follicles which escaped destruction.

Recovery is therefore obtained through cicatrization, from newly formed connective tissue in which papillae, hair and glands are missing, and which is covered by a thin, slowly produced epidermis.

In order not to disturb the process of epidermization, the Sneve method is useful. It has been pointed out that the direct application of the gauze on the granulating area tends to delay the healing of the burns. The adhesion of the gauze to the surface has been considered as interrupting the

process of repair, and as causing unnecessary pain and drain of nervous energy each time that the dressing is removed.

As I have already said, the exposing of the granulating wound to clean plain air is advisable at this time, and the surface is improved by its drying action. So long as parts of the eschar, necrotic particles and infectious detritus are still on the surface, moist dressings with mercuric chlorid must be used, in order to clean the surface and favor their sloughing off.

The open-air treatment and the direct application of the sun's rays to ulcers and wounds has been advised for many years. Recently attention was called to this by Wagner¹⁴ and Oscar Barnard,¹⁵ the latter claiming it to be a disinfecting and a healing power. In minor burns, open-air treatment had been used by W. P. Copeland,¹⁶ protecting the wound by means of a pasteboard box, and by Reid,¹⁷ who protected the surface with a wire cage.

As stated, we expose the granulating surface to the

Fig. 4.—Same burn shown in Figure 2, one week later.

Fig. 5.—Burn from hot water, fourth week.

14. Wagner, H.: Quoted by Sneve, Note 2, *Zentralbl. f. Chir.*, December, 1903.
15. Barnard, Oscar: *München. med. Wchnschr.*, Jan. 5, 1904, quoted by Sneve, Note 2.
16. Copeland, W. P.: *New York Med. Rec.*, 1887, quoted by Sneve, Note 2.
17. Reid, G. Archdall: *Lancet*, London, March, 1898, quoted by Sneve, Note 2.

air only for a certain time, from one to three hours. More than that inconveniences the patient, the secretion begins to form crusts, and we prefer to cover the surface again after this length of exposure.

It seems that the plain air acts by stimulating the granulating surface from which clear serum is oozing. The serum dries up when exposed to the air and forms an homogeneous film, which covers the granulating papillae. From the edges the epithelial cells underneath keep extending their whitish layer which covers the granulating surface. When exposed directly to the sunlight the action is much stronger, and if the surface is not sterile, vesicles are formed at the edges, which easily break and form crusts which are soon removed with compresses moistened in a 1:2,000 solution of mercuric chlorid.

It must not be forgotten that the granulations need to be touched with a solution of silver nitrate every other day to prevent irregular, or keloidal scar.

The wound after being exposed for from two to three hours, must be covered with a suitable dressing as 2 per cent. borated petrolatum on English lint. When the granulations are pale and show a tendency to the formation of pus the application of a mixture of castor oil and Peruvian balsam also gives good results. This dressing, however, cannot be used for a long time on account of producing irritation. Kuss¹⁸ advocates covering the burned surface with a piece of caoutchouc paper as a protective, cut exactly to fit the wound, having holes to drain the serum, and allowing moistening in salt solution. This is covered with patches of gauze also moistened with salt solution. When a burn involves a joint, the scar has to be watched so that it does not cause contracture of the limb. The fingers, eyelids, and lips, must be kept separated with lint, so that no adhesions may occur.

In a burned area of a large size, without a tendency to the formation of epidermis, a few grafts of epidermis after the method of Reverdin, will help to produce the epidermization.

SYSTEMIC TREATMENT

An extensive burn, no matter of what degree, causes always a general systemic reaction. In the beginning the patient may suffer primarily from the shock. Klauder¹⁹ calls attention to this condition, and advises injections of morphin or strychnin in the very beginning to prevent this condition. In my service cases of shock have been rare. More often I have seen gastroduodenal ulceration, with continuous vomiting,

sometimes nephritis, and pneumonia. In nephritis the intravenous injection of Fisher's solution with the internal administration of digitalis has greatly helped, and in a few days the urine was clear of albumin. The fever following the burn rises and falls somewhat resembling that of typhoid fever. In all my cases the administration of chinin has been very beneficial, and I consider it one of the most useful antiseptics. Gradually as the patient improves, when the fever is gone, a substantial diet must be given with some tonic iron preparation to improve the general condition of the patient.

ABSTRACT OF DISCUSSION

DR. W. A. PUSEY, Chicago: It is not my experience to see many cases of burns, but I have a strong impression that burns are not, as a rule, well treated. I think the most useful part of Dr. Ravogli's paper is that in which he emphasizes the value of wet dressings, and particularly of wet dressings of aluminum acetate solution. There is, I

believe, an open field for the writing of a book on "old and useful remedies which have been forgotten." In that book I would put among the first subjects, aluminum acetate solution, with which dermatologists are all familiar, but whose value is apparently unknown to the great majority of the profession. If Dr. Ravogli's paper does no more than call to the attention of the profession the value of dilute aluminum acetate solution as a bland antiseptic dressing it will have served an excellent purpose.

DR. JOSEPH ZEISLER, Chicago: In the case of a burn we should always endeavor to make a prognosis at the beginning.

People easily misjudge the nature and the importance of burns from the local evidence presented. I have seen severe burns in which I pronounced a fatal ending in a few hours or days, when the parents were utterly amazed. When they looked at the skin and failed to see blisters or injuries, they could not understand that it was a serious case. The general public does not know of the apparently harmless appearance of the skin in burns of the third degree. In one case in which

a child was burned by a gasoline fire, the skin had a peculiarly waxy appearance; and the parents did not realize the serious case they had before them until the child died.

DR. ERNEST DWIGHT CHIPMAN, San Francisco: I would like to amplify the remarks of Dr. Pusey concerning the application of wet dressings. There comes a time in the treatment of most, or many burns—as in cases of some eczemas—when the particular therapeutic indication is for something slightly astringent and something which promotes epidermization—in some cases an application of acetate of aluminum; but I like 1 or 2 per cent. of resorcin or salicylic acid. Resorcin is my favorite. Its effect many times is magical; and there are many burns in which that condition must be fulfilled. I think it is an ideal application.

DR. A. RAVOGLI, Cincinnati: I thank Dr. Pusey for his remarks on the utility of the acetate of aluminum solution, which I prefer to any other thing, on account of its action.

Fig. 6.—Burn of second degree. One week after occurrence.

Fig. 7.—Burn of third degree. Four weeks required for full recovery.

18. Kuss, Georges: *The Treatment of Burns*, Med. Standard, April, 1914, No. 4, p. 157.

19. Klauder, Joseph V.: *New York Med. Jour.*, Aug. 2, 1913.

It quiets the pain, diminishes the hyperemia and does not give any trouble through discoloration, such as occurs with picric acid and permanganate of potassium, which have no other beneficial effect than to soil the clothes and the attendant's hands. Early prognosis is extremely interesting, as Dr. Zeisler has said. I have seen cases in which it was thought the patient would rapidly recover, but he died, and vice versa. In the matter of resorcin, I prefer mercuric chlorid for this reason: I have shown the illustration of a leg and thigh burned after twenty days which came under my service, and when the patient was taken to the hospital the lesion was infected with the *Bacillus pyocyaneus*. I must say I am afraid of *Bacillus pyocyaneus*. The use of mercuric chlorid 1 or 2 per thousand by continuous bathing I think is the best way to get rid of the *Bacillus pyocyaneus*. The Sneve treatment is very good. Expose the resulting wound, when granulating, to the plain air for one hour, and no more, as after one hour the patient feels such discomfort that he cannot stand any more; for this reason very seldom do I extend that to two or three hours. In the same way I use the direct rays of the sun. I treated a case of very severe burn in a boy of 12 with a large granulating surface infected with pus germs; the exposure to the sun had an antiseptic effect on that suppurating surface and epidermization began. But the boy could stand hardly one hour's exposure to the rays of the sun.

EXPERIENCES IN MILITARY SURGERY *

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The ideas presented here were gained during a service at the American Ambulance Hospital at Paris during the latter part of 1914 and the early part of 1915. Hence the point of view is that of the surgeon at a large base hospital.

In any discussion of military surgery, the questions of shock and physical fitness naturally occupy a prominent place. Surgeons at the first-aid stations say that the degree of shock exhibited by wounded soldiers is much less than that seen in civilians sustaining similar injuries. It is remarkable how little shock is shown by men received at the base hospitals suffering from grave injuries 24 to 48 hours after being wounded. There can be no doubt that the mental attitude plays a considerable part in this. The wounded soldier, while discouraged and suffering, sees visions of a comfortable bed and pleasant surroundings, feels himself somewhat of a hero, and escapes at the same time from the ever present specter of impending death. In the mind of a civilian similarly injured, the mental picture is entirely different. He begins immediately to grieve over a multitude of troubles, loss of wages or position, and in civil life, gunshot injuries are not infrequently attended with shame and chagrin to the sufferer. The physical condition of the French and English soldiers

speaks well for those in charge of the commissary. They were uniformly well nourished and healthy in appearance, facts which go far toward minimizing shock.

The modern sharp-pointed, steel-jacketed, so-called humane rifle ball, despite all claims to the contrary, is remarkable for its severe and mutilating trauma. The point of entrance may be a small slit, or round wound, but the wound of exit is quite often large and ugly, with herniated muscles, giving it a mushroom, or explosive, appearance. In our Spanish war, the high velocity rifles, shooting balls of the Mauser type—that is with an oval end and with the center of gravity near the middle of the mass—made wounds which were, comparatively speaking, quite humane. The effects of the modern rifle bullets are usually classified according as they occur in one of four zones. These are:

First zone (0 to 500 yards) explosive effects.

Second zone (500 to 1,000 yards) penetrating effects.

Third zone (1,000 to 2,000 yards) simple wounding effects.

Fourth zone (2,000 to 2,500 yards) contusive wounding effects.

It is no exaggeration to say that the modern sharp-pointed bullets are all potentially dumdums, for it is the rule rather than the exception that the ball, after striking, pivots and turns sidewise. This is explained by the fact that the center of gravity is situated far back, near the base, so that the slightest deflection of the point from the line of flight is an instantaneous command for the base to swing forward. From such balls picked up on the battlefields, and some extracted from the wounded, it is seen that not infrequently the

base of the bullet is deformed in consequence of striking first, while the sharp point is in nowise altered. From this, it would seem that these bullets often possess a wobbling motion, and even rotate on their transverse axis, particularly toward the end of their flight.

Modern field artillery consists, for the most part, of 3-inch field guns and 6-inch howitzers. The extreme ranges of these guns vary from 5,600 to 6,700 yards. The projectiles weigh from 15 to 20 pounds. The German shrapnel contains from 300 to 500 round lead bullets,

hardened with antimony, which vary from 1 to 1.5 cm. in diameter, and in weight from 10 to 16 grams. In the present war more than 80 per cent. of the ammunition used by field guns is in the form of shrapnel. A 3-inch shrapnel shell may be described as a steel or brass tube with a solid base and a detachable head in which there is a time fuse. At the base, there is a charge of about 3 ounces of black powder, and in the center of the tube is a core of gun cotton to assist in the explosion. Surrounding this core are placed lead balls, which are, in turn, surrounded by the smoke-producing matrix. This latter serves as an index to the gunner to locate the point of explosion. Shrapnel will kill at 6,500 yards, at which distance it

Fig. 1.—Showing type of ambulance body used on Ford chassis.

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