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THE GENERAL SURGEON'S APPROACH TO THE PROBLEMS PRESENTED BY FRACTURES AND OTHER TRAUMAS

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PROBABLY many question the need for a discussion of a subject which seems to have been settled for some time by the orthopedists and the patients. In urban, most suburban, and even in the rural districts, the patients themselves are consulting the orthopedists directly for the treatment of fractures, thus short circuiting the traditional route via the general practitioner, the general surgeon, while, for the correction of resulting permanent deformities, the orthopedist has a clear field.

This is a general statement, and the practice varies in different parts of the United States and Canada, but it would seem fair to say that it is only in the older parts of our land, in the regions where one finds the litter of antiques and traditions persisting, the general surgeon still has the undisputed privilege of treating fractures. If this is the trend of the times, is it right or wrong; and if wrong, what should or could be done about it by the general surgeon?

Is the specialization of surgery rational, necessary, or in the best interests of the patient? I feel sure we are on common ground when claiming that irrespective of our personal interests it will be the welfare of the individual patient which will, and should, govern the practice of medicine and surgery in the future.

Some years ago I discussed this subject with Dr. Meeker, then dean of the Graduate School of Medicine of the University of Pennsylvania, and from what I have already said you will understand my side of the argument. I was not convincing him by any means, and finally, a little heatedly, I asked if he would define a specialist. He quickly and positively replied, as he usually does, "a specialist is a surgeon or an internist who can and does one thing well, and does it better than any one else." Again upon my request for his definition of a general surgeon, his answer came just as promptly as before, "a general surgeon is one who does not do any one thing particularly well."

The passing of time has softened to some extent my immediate resentment, so much so that I am offering his definition as a text for our consideration.

You will note that Dr. Meeker said "*does not* do any one thing particularly well." But he *did not say* "*cannot.*" This seems to me to open the way for our discussion.

Is it true that the lay public (for Dr. Meeker is not a doctor of medicine, but a doctor of philosophy in biochemistry) agree that general surgeons do not do any one thing particularly well; and if so, why? Is this attitude toward fractures much different from that which they have toward other specialties including: obstetrics and gynecology; genitourinary surgery; neurosurgery; facial maxillary surgery; plastic; thoracic; and one of the latest diseases of the peripheral vascular systems?

In many of the medical schools at the present time all these fields of surgery are being taught by specialists, not by the general surgeons, and is it any wonder that the graduate medical student, when he becomes a practitioner, refers his traumatic surgery, or at least his fractures, to the orthopedist? This being so, and if the orthopedist does not give as good service to the patient as the general surgeon, will this practice continue for long? I doubt it, for sooner or later the patient, or his family doctor, will properly evaluate the services received.

By this indirect approach we come, to the crux of the situation, as expressed by Dr. Meeker. *Does* the general surgeon give to the fracture patient as good or better service than the orthopedist? I shall deliberately avoid

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giving my answer to that question for the time being.

The next question then: *can* he provide, as a result of his training and experience in general surgery, as good or better service than the orthopedist? I am positive that he can and should.

My thesis, then, is: that the general surgeon, because of his broad surgical training, should be able to compete successfully with the orthopedist in the care of trauma of the soft tissues, bones, and joints, but I have a feeling that he is not holding his own at the present time.

Recently a new specialty has been developing, that of traumatic surgery, composed of general surgeons who are interested in fractures, and orthopedists who are interested in the general problems of trauma. This may be the answer to the dilemma, for in such a group we find surgeons who are particularly interested in the treatment of traumatic conditions, and orthopedists who are willing to admit that they need a much broader training in the care of trauma than is provided by a limited experience in the regional field of bones and joints. It may be that the surgeons of South America have already solved this quandary, for during a recent conversation with Dr. Juan M. Allende, professor of clinical surgery in the University of Cordoba, Argentina, he told me that the surgery of trauma in South America is carried on exclusively by specialists, and the specialty is known as the surgery of traumatologia and orthopedia.

My effort tonight will be to call your attention to these changing conditions in the surgery of trauma in this changing world, and try to interpret them from the viewpoint of the general surgeon.

Interest in major trauma is being constantly stimulated in these days by military, industrial, and automobile catastrophes. During a similar crisis, under the pressure of the first World War, improved methods of fracture and wound treatment were instituted. Some of these methods, in the original or modified form, were promptly incorporated into the accepted lore of surgical treatment, while others have been discarded long since, for example, at the present time the elimination of Dakin's solution from the United States Pharmacopeia is being discussed seriously.

1. We are now faced with the probability of having to care for large numbers of war casualties, and it is apparent that in this war the surgical problems will be more complex than in the previous wars. The absence of well defined battle lines, and the use of air armadas and panzer units, which attack the civilian population over large areas of a country, spreads the casualties to the noncombatant population. In the present European struggle it is reported that civilian casualties have been ten times more numerous than have military, as a result of the bombing and shelling of cities. There are new types of injuries, and the wounds caused by the modern high explosive shells and bombs, whose fragments have terrific velocity, tend to be massive and more devastating than the wounds of former wars. The blast injuries resulting from bombs of this type require attention which was not even suspected in the last war (Fig. 1). They result from a high pressure wave, which is immediately followed by a low pressure one, and the injuries usually take the form of capillary hemorrhages of the lungs (Figs. 2 and 3), the liver, the spleen, intestines, adrenals, and kidneys.

2. A second reason for particular interest in the problems of fractures and trauma at this time is the increasing pressure being exerted by the economic front of the workmen's compensation legislation. Methods of treatment which will insure the ultimate restoration of function in the minimum length of time are now demanded by the compensation boards and insurance companies. This has led to higher standards of reduction, fixation, and after-treatment of fractures. This trend is also directly responsible for more widespread employment of open reduction and internal fixation. Though internal fixation was strongly advocated many years ago by Arbuthnot Lane, the difficulties of the technique and the meticulous equipment in personnel and material incident to the proper attainment of this type of fixation discouraged its general use. Only recently have we realized the vital importance of the rigidity provided by internal fixation, which makes possible active motion

Fig. 1. Wounds of the face resulting from high explosive bombs. (Courtesy of Mr. Broster.)

of the affected extremity immediately after the operation. This ideal can now be obtained through the employment of the biplane fixation which was devised by Clay Ray Murray of New York.

As internal fixation became more generally practiced, it was quite evident that improvement was necessary in the type of metals used. The plates and screws became eroded and would lie loosely on the bone fragments. It was Venable and Stuck who demonstrated that this erosion was due to the electrolytic action of tissue fluids upon the metals. They claim that when any two dissimilar metals are used as fixatives in the same wound, an electrolytic process is set up between these metals in accordance with the laws of electromotive force. Vitallium was proposed by them as a metal entirely inert to the effects of body fluids when not associated with any other metallic substance. As a result of this research vanadium has been discarded as the standard metal for plates and screws, and in its place vitallium, or high-chrome low-nickel steel, or tantalum are now in vogue.

3. Motor accidents provide the third need for increased interest in fractures and traumatic wounds. More stringent traffic regulations of all kinds are needed to stop this terrible waste. It is without question the responsibility of the medical profession, and surgeons in particular, to see that this evil is corrected. Legislation, publicity, and the direct fostering of organizations such as the Red Cross, together with the guidance of state highway commissions in instructing laymen in the proper methods of administering intelligent first aid care to the victims of industrial and automobile accidents, are necessary to promote the interest of the laity in the subject.

A sign encountered this summer while motoring through New England indicates the responsibilities which motor accidents are bringing to the rural physician and surgeon, and the economic burden being thrust upon communities, many of which are unequipped and financially unable to bear them. A large billboard, was found at the entrance to the town, which read: "This town does not maintain a hospital, and motorists are warned that they should take every precaution to avoid accidents while driving through, for we are not equipped to take care of them." This may be the easiest way out, but I am sure it will not be the final answer, even in that town. Nor should it be.

During September, 1941, 3,777 persons met death as a result of motor accidents in this country. This was an increase of 14 per cent over the same period last year, and marks the fourteenth successive month to show an increase over 1939 and 1940. With 1941 three-quarters gone, the total killings have been 27,860, which is a rise of 17 per cent over the fatality list for the same period of 9 months in 1940.

After this brief consideration of some of the many special fields of knowledge which must be mastered in order to cope with the changing problems in the treatment of traumatic wounds and fractures, one might think that we had forgotten our original promise. On the contrary, it is exactly because of the complexity of these problems that we believe that a general surgeon, employing the basic knowledge of the principles of surgery, should be better

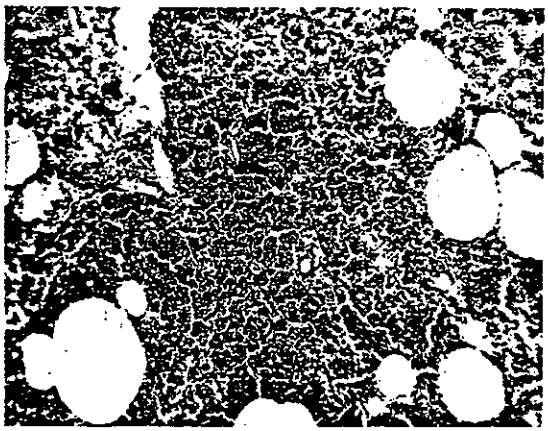

Fig. 2. Low power view of lung of a woman killed in a steel shelter as the result of a "near miss." There was massive hemorrhage throughout the left lung. × 58. (H.L. 3). (Courtesy of Mr. Broster.)

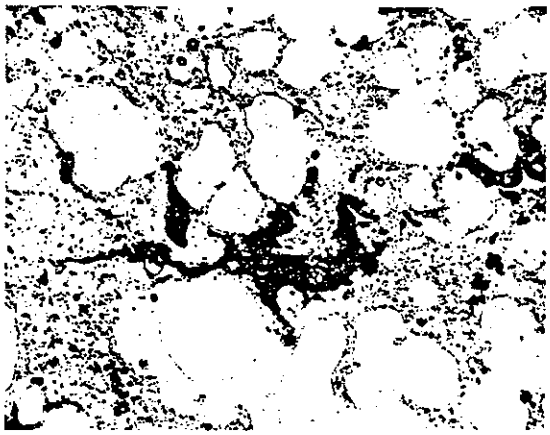

Fig. 3. Section of the lungs of a woman killed in an air raid. The casualty was extricated from the remains of her house, and autopsy revealed numerous hemorrhages in both lungs. The specimen has been stained with scharlach R (black regions) to demonstrate fat. × 58. (H.L. 5). (Courtesy of Mr. Broster.)

fitted to arrive at a complete solution of them than are his more highly specialized colleagues.

FIRST AID

I feel sure no one will disagree with the statement that the first essential in treating a patient suffering from a fracture or trauma is to try to evaluate the condition of the patient as a whole, and not to concentrate entirely on the local wound or deformity, immediate or final. Age, sex, physical development, nutrition, emotional status, all of these elements and many more must be grasped at the same time as one prepares to administer proper first aid care. I say proper first aid care because —while the beneficial effects of such aid as immediate splinting of fractures or dressing of wounds is unquestioned—the methods of carrying out this first aid may be far from ideal.

May I offer here the slogan which we advocated and taught to the lay public during the last war, and to Red Cross groups during the interval between the two wars, namely, when in doubt as to what you are dealing with, do nothing, and when you are not sure about what should be done, even though you know the indications, do nothing. Those of us who do not see these patients until after the administration of well intentioned first aiders know too well that the patient too often would have been in better condition if he had been left alone and had not received the treatment given to so many of them. Dr. William Darrach has expressed this in a more scholarly way: "In our early examination and treatment we should be guided and restrained by our realization of the pathology, by the mental picture of what has actually occurred beneath the skin, and what may occur as a result of our first aid efforts."

Gentleness is unquestionably the keynote of first aid care and must be rated above all other considerations in the management of severe accident cases.

Hemostasis. In dealing with traumatic wounds it is frequently necessary to control hemorrhage. This is accomplished most easily and with the greatest safety by applying a pressure dressing. The latter should be firm, but not excessively so. Tourniquets are sometimes required to control more severe hemorrhage, but only as a last resort, and one must not forget that periods of release are required if the band remains in place for more than 30 minutes. Gangrene is still too often the result of the application of tourniquets by conscientious first aiders.

Asepsis is secondary only to the control of hemorrhage in the primary treatment of open wounds. As a first aid measure the application of a sterile or mechanically clean dressing is the best safeguard against infection. Anti-

TABLE 1.—SHOCK

Cause	Treatment
Hemorrhage	Transfusion
Dehydration	Fluids
Pain	Morphine
Cold	Warmth
Fear	Reassurance
Asphyxia	Oxygen
Exhaustion	Rest

(Courtesy of Dr. Norman E. Freeman.)

septics probably do more harm than good when introduced into a potentially infected wound. Cleansing of the skin area around the wound should be left for the operating room inasmuch as proper solutions and the facilities for using them will probably not be available at the locus of the injury.

Simple methods. There is a tendency among general surgeons who treat many traumatic wounds to utilize relatively simple and conservative methods. Soap and water cleansing of the skin surrounding a wound and irrigation of the wound proper with normal saline solution or sterile water should be used more often than complicated antiseptic skin preparations and antiseptic irrigants. Wounds of soft parts of the extremities should be splinted, not only to prevent pain and hemorrhage, but also to discourage the spread of contaminating bacteria.

What appears now to be an epochal contribution in the control of infection in traumatic wounds is the experimental work of Trueta, which was undertaken with the object of explaining the localization of wound infection when the traumatized tissues were primarily immobilized in plaster. In two series of dogs, one being used for control and the other for experiment, the extremities in both groups were traumatized, the soft tissues lacerated, and the bones fractured. The injured tissues were then inoculated with the Bacillus welchii perfringens and hemolytic streptococci. Following this the wounds were filled with sulfanilamide powder and packed open with vaseline gauze. In the control group the traumatized extremities were not immobilized, while in the other group they were encased in plaster casts.

In the control group every animal died from a gas bacillus infection within 3 days, while in the other group no deaths occurred. Trueta explained this by the fact that the immobilization of the soft tissues resulted in stagnation of the lymphatic circulation. In the tissues of the animals examined after death he found, in the group with freely moving extremities, the previously injected bacteria or their offspring had entered the blood stream within 24 hours after receipt of the injury. In the group in which the tissues had been immobilized, the organisms remained within a short distance of the traumatized tissues but had not entered the lumen of the blood vessels.

FRACTURES

In the treatment of fractures the simplest technique which will afford adequate reduction and complete immobilization should be chosen. Open reduction with internal fixation is recognized as an ideal procedure for the treatment of simple fractures, but should be reserved for exceptional cases. Furthermore, unless one has occasion to practice open reduction with internal fixation frequently, we believe it is better not to attempt this procedure. It is usually not performed successfully by the occasional operator.

In summary we will repeat that our endeavor in treating traumatic wounds is to avoid intricate or cumbersome techniques and to adhere carefully to the fundamental principles of gentleness, hemostasis, asepsis, and immobilization.

It may be well to insert at this point a word about one phase of the treatment of fractures and traumatic wounds which has troubled the surgeons who form the Fracture Committee of the American College of Surgeons, namely, the need for an *educational program* aimed at improvement in the care of trauma of all kinds.

Such a program must have its origin in the *medical schools*, where more emphasis should be placed upon the recognition and management of various types of fractures and traumatic wounds. Furthermore, medical students should be taught to recognize the types of cases which *they will not be qualified* to handle as general practitioners and which should be referred to one specially trained in surgery. In order to accomplish these aims

more time must be allowed by the schools for the teaching of traumatic surgery, and fresh material of this sort should be made available to the students. As far as we know, Dr. Gallie of the University of Toronto was among the first to recognize this need and to make an effort to meet it.

The important elements of this subject cannot be learned in lectures and in dry clinics by viewing the bandaged wounds and splinted extremities. Students must see, and participate, if possible, in the whole procedure from the time the patient enters the hospital until his wound or fracture has been treated and he has been put to bed on the ward. In hospitals, internes and residents require special instruction in this field, and this can be made possible by spending a specified time on a traumatic service. The special value of a traumatic service has been proved to our satisfaction, and in such a plan the traumatic cases are segregated into special wards and cared for by a group of nurses and attendants specially trained in handling the equipment and problems incident to fractures and major injuries. Probably this ideal cannot be achieved generally because of the financial outlay which it entails. However, it is usually possible, at least, to practice a modified version of the idea by having traumatic cases under the care of the same surgeon or group of surgeons continuously for a period of 6 months, or preferably a year. In this way the plan of treatment undertaken is not as likely to be interrupted as when the direction of the service is changed at shorter intervals. Upon discharge from the hospital it is also advantageous to have the same team to carry on in the out-patient department. Both fractures and major traumatic wounds are treated intelligently only if they are followed carefully for prolonged periods after discharge from the hospital. The results of epiphyseal injuries, shortening or tilting of long bones, restoration of joint function, and contraction of scars, to mention only a few instances, cannot be evaluated fully until at least one year after the actual treatment has ceased. Such an organization may seem cumbersome and unwarranted to those who have not seen it in action. This may be true for a short time after its inception, but once established the results are so greatly improved that the satisfaction to both the patient and the surgeon is a sufficient stimulus and compensation to keep it running smoothly.

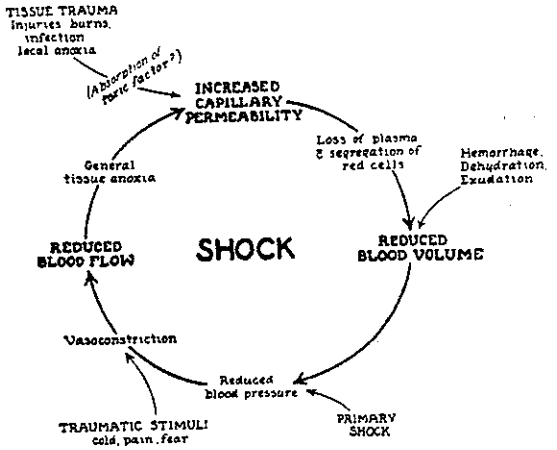

Fig. 4. Courtesy of Dr. Norman E. Freeman.

Undoubtedly one of the most perfect demonstrations, not only of the possibilities but also of the efficiency that can be obtained by the specialization of the surgery of trauma and fractures, is to be seen in the fracture service of Darrach and Murray at the Medical Center of Columbia University in New York. In referring to such an ambitious plan for the teaching of undergraduate, graduate, and postgraduate surgery of this type, one must pay homage to this contribution to the problems of traumatology.

Time will not permit of an exhaustive discussion of the many interesting phases of this subject. However, we have chosen three, namely, shock, burns, and compound fractures, for more detailed consideration.

SHOCK

In the discussion of shock the general surgeon must always define his understanding of the pathology of the process in order to justify the type of treatment used (Table I, Fig. 4). We subscribe to the now generally accepted theory that shock is caused by one, or several, or all of a group of factors operative at the time of the injury. These factors are hemorrhage, dehydration, pain, cold, fear, asphyx-

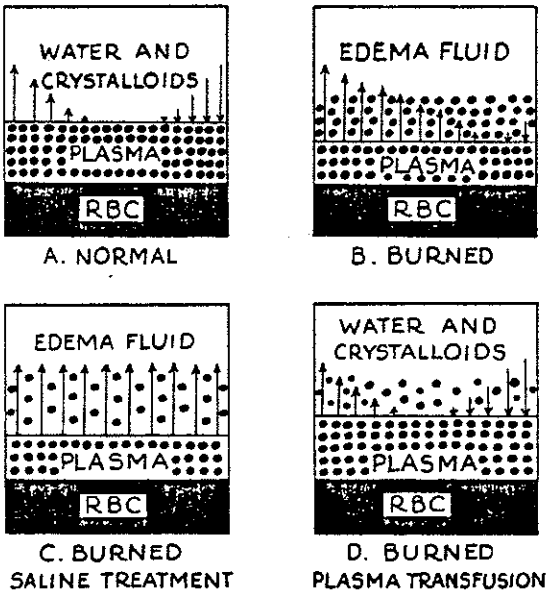

Fig. 5. Distribution of fluid between the capillary and tissue spaces.

ia, and exhaustion, as outlined by Freeman. The total effect of this phenomenon is to produce tissue anoxia which gives rise to abnormal capillary permeability. Consequently there follows a loss of blood plasma, a diminished blood volume, lowered blood flow, blood stasis in the capillaries, and finally, a greater degree of anoxia of the tissues. In this manner a vicious circle is established which can be broken only when the proper treatment is administered.

Treatment of this condition, up to very recent times, consisted of relieving the objective symptoms by means of well known methods.

About 10 years ago the intravenous infusion of saline and glucose was added to the armamentarium. This resulted in a temporary rise in the blood volume and blood pressure which was not sustained because the fluid left the leaking capillaries almost as fast as it was introduced, and carried with it the vital serum protein, so that the harm which was done was not only passive but was likewise active (Fig. 5).

Following this routine use of saline and glucose, whole blood was infused into veins in order to raise and maintain for a length of time the flagging blood pressure. It is true there are definite indications for the use of whole blood in shock, particularly when it is associated with hemorrhage, but the difficulty in performing transfusion into the collapsed veins of the shocked state have been experienced by every surgeon. In this connection we wish to call attention to the recent work of Tocantins, in Philadelphia. During

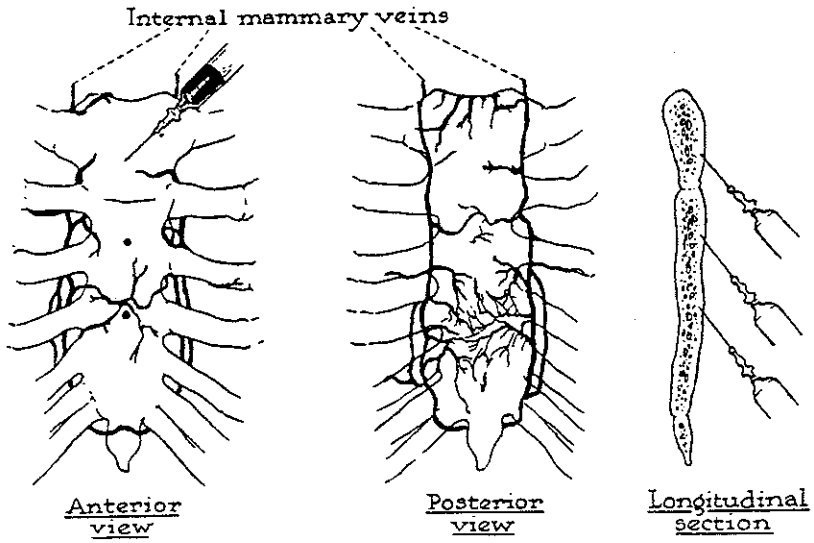

Fig. 6. Illustration of the distribution of the dye in theretrosternal veins, and the location of the needle during the injection. (Courtesy of Dr. L. M. Tocantins.)

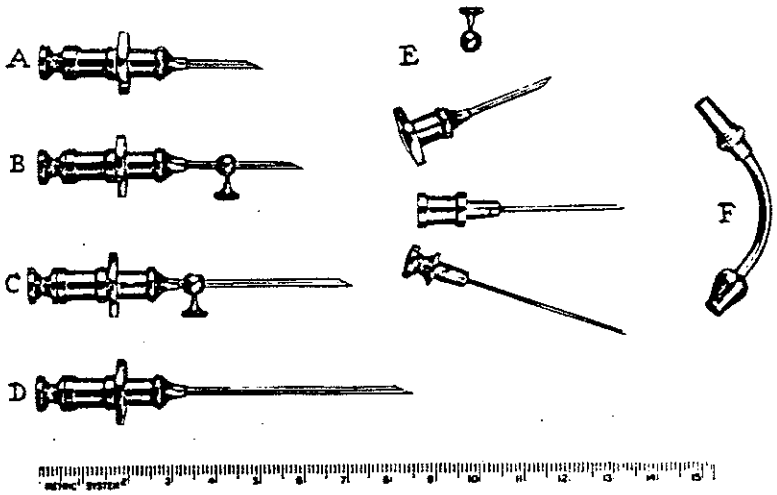

Fig. 7. *A*, *B*, *C*, *D*, infusion needles of various lengths. *E*, component parts of a needle, from top to bottom: needle guard, external needle gage 15, internal needle gage 18, solid stylet. *F*, curved adapter. (Needles made by the George Pilling Co., Philadelphia.)

the stage when fluids are most urgently needed, the physician is left without ready access to the central portion of the circulation because of the collapse of the peripheral veins as a result of shock. It occurred to Tocantins that under such conditions the bone marrow offered the ideal site for the introduction of fluids until the patient reaches such a stage that the peripheral circulation is restored and access to the veins is again possible. Since the marrow veins are surrounded by a rigid envelope, they are less likely to collapse, and probably can withstand forcible injection, without overdistention and leakage, better than the poorly supported peripheral veins. Further, substances injected into the bone marrow cavity are taken up almost immediately into the venous circulation and apparently unchanged (Fig. 6).

"We have experimentally demonstrated this by the injection of dye into the marrow of the sternum of a cadaver and found that it rapidly appeared in the right auricle. The comparatively short distance between the sternal marrow and the right side of the heart makes this possible. The rapid introduction of fluid into this side of the heart may, therefore, help to restore the cardiac output during the phase of acute peripheral failure, by increasing the volume of the blood returning to the central portion of the circulation."

Tocantins needle (Fig. 7). After the needle has been inserted through the cortex and the marrow has been obtained by aspiration, the syringe containing the material to be administered is connected with the needle and the material is injected as fast as the resistance offered to it will allow. In conscious patients, if the fluid is injected at a rate greater than 10 cubic centimeters a minute, there is usually a feeling of fullness in the sternum which, however, passes off immediately upon cessation of the injection. By using a two-way valve, one side connected by rubber tubing to the container of the fluid and the other leading from the valve into the sternal needle, it becomes unnecessary to remove the syringe from the sternal needle every time it has to be filled. In some instances, in which a more rapid rate of injection is desirable, two needles can be introduced into the sternum, one at either end, and since the marrow cavity of the manubrium and the marrow cavity of the sternum seldom communicate, it is possible to inject material through one orifice without it coming out of the other. This method can be used for the administration of any type of medicaments to patients with acute circulatory fail-

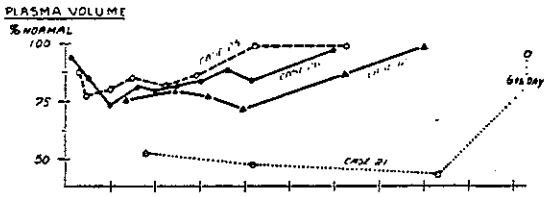

Fig. 8. Illustration of the shifting of the plasma volume in a series of burns which received local treatment only.

ure, and it has been found to be much more efficient than when the material is injected by other routes.

In the 72 cases in which this method was used by Tocantins, no untoward reactions of any kind were experienced.

But there are definite contraindications to the use of whole blood transfusion to combat shock which are readily understandable if one accepts the etiology of shock as outlined here. Whole blood infusions will provide an increase in blood volume, but they also supply an element which is detrimental in shock; the red cells which when added to the circulation serve to increase the viscosity of the blood and thus cause greater capillary stasis. This in turn brings about a greater degree of anoxia and increases the capillary permeability. To put it briefly, whole blood transfusions are contraindicated in shock because they tend to exaggerate the existing hemoconcentration. Hemoconcentration, however, may be absent and not marked when shock is associated as the result of hemorrhage.

The search for a substitute for whole blood, which would raise the blood pressure by increasing the blood volume without increasing hemoconcentration, was terminated happily when the use of blood plasma was suggested. As early as 1927 Strumia first advocated the use of blood serum in shock treatment, but adverse reactions, since found to be due to the absence of the fibrin fraction, caused serum to fall into disrepute. Then in 1929 he found that plasma was equally effective in combatting shock and did not give rise to reactions. Ten years were to pass before the plasma transfusion was widely accepted and employed in shock treatment, but now this therapy is well established. It has stood the test of the demands of war surgery and answers the physiological requirements of the damaged

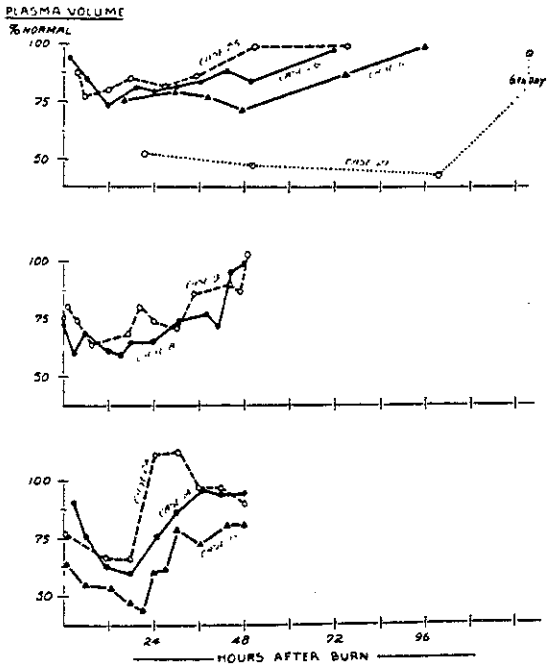

Fig. 9. Comparison of the duration of the shifting of the plasma into the perivascular tissues. Above, When local treatment only was used. Middle, when local treatment and blood transfusions were used. Below, when local treatment, blood transfusions, and adrenal cortical extract were used.

tissue. Plasma dilutes the concentrated blood of the capillaries and tends to remain in the vascular bed better than any other material thus far used.

The history of the production of plasma for infusion in shock states is interesting but too lengthy for consideration here. The preparation of plasma from citrated blood is now accomplished both by centrifuging and by the simpler natural settling process. After preparation the plasma is probably best used in its liquid form, although dried and frozen types of plasma are available. One other interesting development has arisen from this plasma industry. Plasma, once an incidental dividend of the blood bank system, has now become the capital of that system. The demand which is made for plasma is now commonly stated as being four times that for whole blood.

When the use of plasma in the treatment of shock was generally established, it became necessary to discover some way of testing

Fig. 10. Interference with the circulation of the hands and digits following the use of tannic acid in the local treatment of severe burns.

clinically for the presence and degree of shock in order to determine the dosage. The laboratory tests devised for this purpose consist of the usual hemoglobin and hematocrit determination and red blood cell counts. From a consideration of these figures the state of hemoconcentration may be determined.

More recently these values have assumed added importance in that with them one can compute by means of a simple formula the amount of plasma lost. Thus replacement of plasma is removed from the realms of uncertainty and carried out on a definite volume basis. An example of such a formula is that of Black which is given as follows:

$$\frac{HB}{100} \qquad \frac{5}{5\text{-}X}$$

HB is the observed hemoglobin
X is the plasma lost in liters.

This formula has been criticized from the point of view that it fails to take into account the fact that the hemoglobin may be very low in shock associated with hemorrhage in which there occurs a compensatory dilution of the blood. However, the formula has been of great value in emergencies and especially in war conditions when one cannot wait for or obtain more complicated tests. If the formula cannot be recalled it is a safe rule to give plasma to any patient in a shock state when the hemoglobin is found to be above 100 per cent.

When laboratory facilities are available for determining the hematocrit and plasma protein concentrations, we have found the following formula devised by Elkinton, Wolff, and Lee to be more accurate than that of Black.

For calculating this quantity, the authors have proposed the following formula:

$$\text{Plasma protein requirement in grams} = 3.5\ W - \frac{W\ (100\text{-}Ho)\ Hn\ Po}{2\ (100\text{-}Hn)\ Ho}$$

W = body weight in kilograms.
Hn = normal hematocrit value, per cent cells.
Ho = observed hematocrit.
Po = observed plasma protein.

If the plasma protein requirement in grams is multiplied by 14 the required volume in milliliters of plasma is obtained.

Fig. 11. Second and third degree severe burns of the forearms and hands, treated with tannic acid, on the right, and with triple dye, on the left.

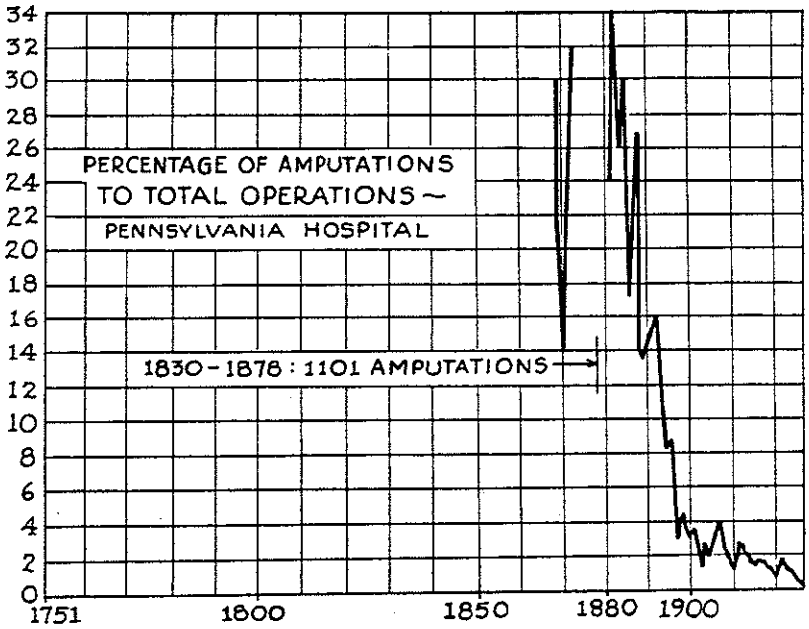

Fig. 12. Illustration of the total number of amputations performed yearly at the Pennsylvania Hospital before and after the introduction of Listerism.

Our final thought regarding shock concerns the use of adrenal cortical hormone in shock therapy. The work of Wolff, Rhoads and Lee suggests that cortin in the form of eschatin has a beneficial effect in combatting the secondary shock encountered in severe burns. This effect is experienced only when adequate plasma is given by infusion at the same time. It is believed that the eschatin does not increase the plasma volume per se, but that it acts by reducing the permeability of the capillaries so that plasma leaks from them less rapidly. Since this therapy is effective in shock produced by burns, we believe that it would also be beneficial in secondary shock caused by other trauma. We plan to use eschatin along with plasma in all cases of traumatic shock encountered henceforth.

BURNS

Extensive superficial burns present an especially complicated problem for the traumatic surgeon. Usually the patient is suffering from secondary shock when he is first seen. As the great majority of burn deaths are still due to this cause, treatment must first be directed toward the prevention and replacement of plasma volume. In the past it was estimated that 80 per cent of the mortality from burns occurred during the first 7 days. The fact that but 1 of 40 consecutive patients, in whom we used plasma and cortical extract, has died in this period would seem to suggest the former mortality rate is now unjustifiable. However, as the later course of the patient will be largely conditioned by the amount of infection which develops, it is also of vital importance to protect the patient from contamination by the immediate use of aseptic precautions (Fig. 8).

Experience has shown that large transfusions of plasma in the early stages accelerate the rate of plasma loss so that a slow infusion is mandated during the early stages. Without the administration of adrenal cortical extract, large infusions were for the most part passed into the perivascular tissues of the patients studied at the Pennsylvania Hospital during and up to the 40th hour after receipt of burn. In the recent cases that were treated with adrenal cortical extract in addition to plasma it was possible to use large infusions effectively between the 18th and 24th hours so that the hematocrit could be restored to normal at this early time (Fig. 9).

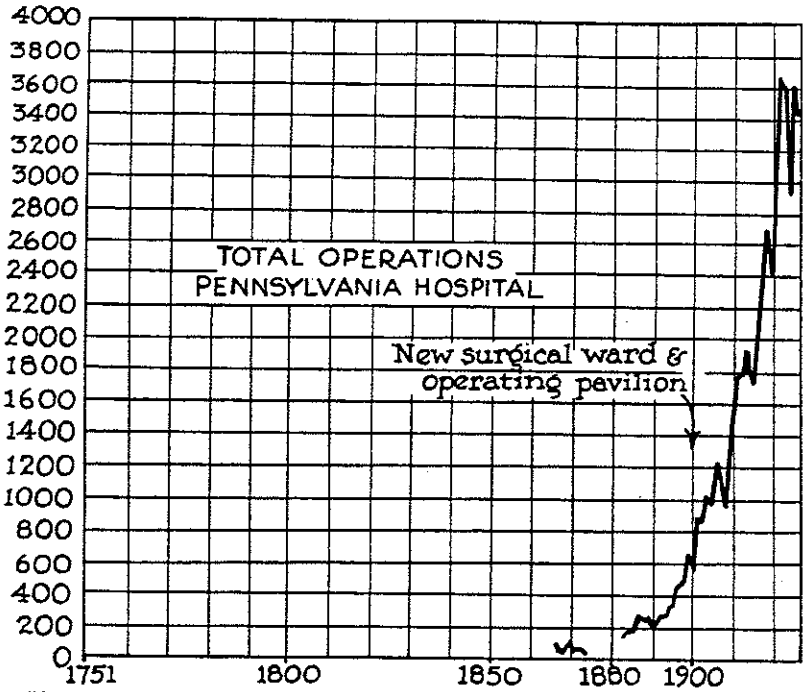

Fig. 13. Illustration of the influence of antisepsis and asepsis and the total number of operations performed at the Pennsylvania Hospital before and after the introduction of Listerism.

The local treatment of burns, after a long period of standardization with tannic acid, is again in a state of flux. Current opinion suggests that tannic acid is satisfactory for burns of flat, relatively immobile surfaces, but that it should not be used on the face, hands, or feet because of the danger of circulatory interference if the eschar completely encircles the digits or extremities (Fig. 10). On the latter gauze packs saturated with normal saline solution, well padded and held in place by circular pressure bandages, seem to be more satisfactory, according to Koch and Mason. In our experience powdered sulfonamides have proved of value in controlling infection of granulating surfaces preparatory to grafting (Fig. 11).

Regarding skin grafting we would like to emphasize the necessity for early grafting. Whether the skin defect has resulted from a burn, or another traumatizing agent, every effort must be made to replace the lost skin as soon as possible; that is, as soon as the granulating tissue base is surgically clean, but not necessarily aseptic.

The best type of graft for general use is the split graft provided by the Padgett dermatome. This ingenious machine demands careful attention to details in its manipulation, but when its use has been mastered the grafts obtained warrant the time required to acquire the technique. Its chief advantages are the ability to deliver a graft of the exact thickness and size required, and also to deliver grafts of uniform thickness throughout. These are attributes not achieved by the most expert advocates of razor grafts. In cases in which it is difficult to obtain sufficient skin to cover the entire area, we are inclined to use pinch grafts, usually of the type suggested by Staige Davis. This type of graft will invariably grow almost uniformly, and thus hasten the epithelization of an infected field. But these grafts usually are not followed by as good cosmetic results as are the split grafts of Padgett.

When one has a clean base, and when the thickness of skin is important, the full thickness graft is ideal. This type of graft when used as a free transplant is the most difficult

to apply successfully, and, when applied, as one of the various pedicle or flap grafts, the procedure is lengthy, but the chances of success are improved. From a cosmetic standpoint the full thickness skin graft cannot be surpassed.

COMPOUND FRACTURES

Every compound fracture is potentially infected and, therefore, must be treated as though actually infected. This statement will not be questioned as regards grossly dirty wounds, but in cases of wounds with no external evidence of contamination there is disagreement from some quarters. Without being certain of the cleanliness and asepsis of the buried fragments it is too often assumed that the innocuous looking wound of the skin will heal satisfactorily and the lesion is treated as a simply fracture. The occasional wound of this type which becomes infected is responsible for the bad reputation of compound fractures. Tinker, quoted by Kennedy, stated the problem very aptly in 1909—"The most important consideration in the management of compound fractures is still the wound of the soft parts. If our wound is aseptic, tetanus and blood poisoning are impossible; bony union and a movable joint are favored; osteomyelitis will not develop; and a useful, if not perfectly normal extremity will usually be saved."

As a diversion for a few minutes perhaps you will allow me to offer two illustrations which will help to date the period to which Tinker and Kennedy make reference in the previous statement.

I was asked by the late Dr. Astley P. C. Ashhurst, during the year of the bicentennary of the introduction of Listerism into surgical technique, to determine, if possible, and to illustrate by means of graphs, the effect of asepsis and of antisepsis upon the surgical practice of the Pennsylvania Hospital in Philadelphia.

At the Pennsylvania Hospital we have continuous records of every patient from the time of its opening, in 1751, to the present. This is not even possible in the Royal Infirmary at Glasgow, where the work of Lister was first carried out. The records of his work in their wards have been destroyed.

With this type of record, and fairly constant factors, before and after statistics obtained from such a source should be of peculiar value.

Figure 12 shows the influence of antisepsis and asepsis on the number of amputations performed at the Pennsylvania Hospital before and after the introduction of Listerism. Figure 13 shows the influence of these two surgical principles on the total number of operations in the hospital during these periods.

Could a better statistical experiment be provided to demonstrate that the prophylaxis of wound infection is the prime concern of the general surgeon in the treatment of compound fractures. The best method of prophylaxis is thorough débridement before contaminating organisms establish infection which means that débridement should be performed within 6 hours after the time of injury. In a few selected cases it may be possible to débride successfully as late as 10 hours after contamination occurs but every minute saved is added insurance against infection. We must impress upon our colleagues that minutes spent in the hospital preparing for operation are just as precious as those that were spent in transportation of the patient from the site of accident to the hospital. Therefore, we should strive to organize the various hospital services so that the care of compound fractures will be given priority over that of all other operative cases.

The methods of débridement are well known, but a few remarks to emphasize certain points of technique may not be amiss.

The use of antiseptics, regardless of their innocuousness, should be confined to the skin surrounding the wound. Antiseptics should never be applied to the wound proper. Normal salt solution is the strongest solution which should be allowed to touch the exposed tissues.

Cultures of the wound, both aerobic and anaerobic, should be taken routinely at the time of the débridement if laboratory facilities exist. In addition some surgeons advocate taking smears to be examined during the course of the débridement for the immediate detection of gas bacilli.

All compound wounds should be irrigated thoroughly with normal salt solution during

and after débridement. After the final irrigation they should be dusted evenly with one of the sulfonamide powders. Recently we have used sulfanilamide for this purpose and no ill effects in the local lesion have been noted although several patients have shown rather marked toxic effects of a systemic nature. It is claimed that sulfadiazine can be administered in much larger does than any others of the group without causing toxic manifestations. It is excreted slowly and consequently we have unintentionally achieved higher concentrations in the blood than needed. In one case in which the concentration reached 21 milligrams per cent there were slight toxic symptoms which ceased when the blood level fell to 10 milligrams per cent. Whichever drug is used in the wound it should also be given by mouth as soon as the patient is able to take oral nourishment, in order to maintain the concentration in the blood at the optimum level.

On the question of wound closure we stand firmly with the conservatives. The soft tissue wounds of all compound fractures are packed wide open with vaseline gauze. Primary suture would doubtless succeed in many cases. However, because of the horrible results—osteomyelitis, amputation, or death—which may occur in wounds which become infected after primary closure, it is our opinion that it is not fair to expose the patient to a risk such as this.

Accurate reduction and complete immobilization are important. The time for reduction of compound fractures is at the time of the débridement. Most reductions can be accomplished under direct visualization and instrumental manipulation of the fragments while the soft part wound is open. There is thus no excuse for inaccurate reduction.

Fixation of compound fractures is possible by several methods.

When a nonpadded plaster casing will hold the fragments adequately this is probably the best and safest type of fixation. It introduces no foreign material into the field of operation or into the proximal or distal portions of the affected extremity. Because no special equipment or techniques are required this type of fixation is the one best suited to the occasional operator.

A more positive scheme for maintaining rigid fixation is the two pin transfixion method advocated by H. Winnett Orr. A pin or wire is driven through the proximal fragment and another through the distal fragment. By means of traction and countertraction on an orthopedic table, or on one of the special distraction apparatuses, the length and rotation of the affected bone are restored. Then while the pins or wires maintain the reduced position a plaster casing is applied which incorporates the pins or wires by means of which a more rigid fixation than can be attained with simple plaster casing is effected.

Perhaps the ideal method for maintaining reduction in compound fractures as well as in simple fractures is by means of biplane internal fixation performed simultaneously with débridement. This type of fixation must be in two planes to be effective. Frequently, the plates or screws must be removed before healing of the fracture has occurred because of infection. However, in many cases it is possible to succeed in avoiding infection as a result of the rigidity afforded by internal fixation, and the fragments will unite just as rapidly as do simple fractures which are treated in a similar manner.

We cannot leave this subject without mentioning the excellent work of Trueta in the recent Spanish War in his treatment of compound fractures by the Orr method. His monograph we recommend to every surgeon practicing in the field of traumatology. The theme which he emphasizes is that for war wounds the needs are débridement and complete rest of the tissues immediately following operation and during transportation, and infrequent dressings. The best way to afford such conditions is by means of a plaster casing. He treated 1,072 cases of open fractures of limbs by the typical Orr method. There were 6 deaths and 976 good results. This is the most convincing evidence which has as yet been offered for the excellence of this type of treatment.

CONCLUSION

In conclusion, we feel sure that most general surgeons will claim that they are fully able to provide such service as we have out-

lined, and the majority will feel that they do give such service. But do they carry this service as far as the orthopedists in their routine care of fractures? I refer to the painstaking, personal follow-up, not only in the hospital, but for months and years after the patient leaves. Is the general surgeon's aim—once a patient, always a patient? In other words, does he feel the responsibility for complete, or as nearly complete, rehabilitation as can be provided through the routine use of multiple operations, gymnastics, the swimming pool, physical therapy, and above all, occupational therapy? Is he as interested in the surgery of trauma as in that of the abdomen? If not, I am sure that patients in the future will not choose him in preference to the surgeon or an orthopedist who is. The question is not whether he *can* give the best service to such patients, but as Dr. Meeker queried, *will he?*