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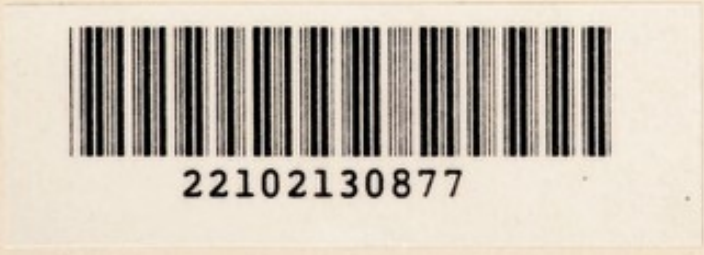
REPORT
ON
MEDICAL AND SURGICAL DEVELOPMENTS OF THE WAR

BY

WILLIAM SEAMAN BAINBRIDGE
LIEUTENANT COMMANDER, MEDICAL CORPS
UNITED STATES NAVAL RESERVE FORCE

1918

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REPORT ON MEDICAL AND SURGICAL DEVELOPMENTS OF THE WAR

BY

WILLIAM SEAMAN BAINBRIDGE
LIEUTENANT COMMANDER, MEDICAL CORPS
UNITED STATES NAVAL RESERVE FORCE

WASHINGTON
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JANUARY, 1919

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NAVY DEPARTMENT,
Washington, March 20, 1907.

This UNITED STATES NAVAL MEDICAL BULLETIN is published by direction of the department for the timely information of the Medical and Hospital Corps of the Navy.

TRUMAN H. NEWBERRY,
Acting Secretary.

NOTE.

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PREFACE.

The publication and issue of a quarterly bulletin by the Bureau of Medicine and Surgery contemplates the timely distribution of such information as is deemed of value to the personnel of the Medical Department of the Navy in the performance of their duties, with the ultimate object that they may continue to advance in proficiency in respect to all of their responsibilities.

It is proposed that the NAVAL MEDICAL BULLETIN shall embody matters relating to hygiene, tropical and preventive medicine, pathology, laboratory suggestions, chemistry and pharmacy, advanced therapeutics, surgery, dentistry, medical department organization for battle, and all other matters of more or less professional interest and importance under the conditions peculiar to the service and pertaining to the physical welfare of the naval personnel.

It is believed that the corps as a whole should profit, to the good of the service, out of the experience and observations of the individual. There are many excellent special reports and notes beyond the scope of my annual report being sent in from stations and ships, and by communicating the information they contain (either in their entirety or in part as extracts) throughout the service, not only will they be employed to some purpose as merited, but all medical officers will thus be brought into closer professional intercourse and be offered a means to keep abreast of the times.

Reviews of advances in medical sciences of special professional interest to the service, as published in foreign and home journals, will be given particular attention. While certain medical officers will regularly contribute to this work, it is urged that all others cooperate by submitting such abstracts from the literature as they may at any time deem appropriate.

Information received from all sources will be used, and the bureau extends an invitation to all officers to prepare and forward, with a view to publication, contributions on subjects relating to the profession in any of its allied branches. But it is to be understood that the bureau does not necessarily undertake to indorse all views and opinions expressed in these pages.

W. C. BRAISTED,
Surgeon General United States Navy.

FOREWORD.

This report comprises observations on the western front and in England during December, 1917, and the first six months of 1918, made pursuant to the instructions of the Surgeon General, United States Navy. For purposes of comparison, there have been added certain data obtained while in Germany during the autumn of 1915.

In making the survey, the following objects were kept constantly in mind:

1. To record the surgical lessons of the present war based on the experience of our allies.

2. To secure anything likely to be of value to the United States Naval Medical School, Washington, D. C., or helpful in the preparation of medical men and hospital corpsmen for active service.

The United States Navy is justly proud of its efficiency and foresighted policy of preparedness. Accordingly, it desires to have its medical corps fully abreast of the Army in learning the lessons being taught by this world war. The medical service of the Navy has not only the usual duty of caring for the incidental casualties in the Navy and of being constantly ready for sea warfare on a large scale, but is responsible for the marines fighting on land, maintains its own base hospitals abroad, some of which at times are used exclusively for the Army wounded, sends forward operating teams to aid in times of crisis, and is entrusted with the care of the sick and wounded from all branches of the Army as well as of the Navy, on their way home. Our troop transports going over are ambulance transports on the return trip.

As the men return to this side, the great questions of aftercare, restoration of function, plastic surgery, reeducation, and the like become matters of great importance. While the Army with its enormous numbers is most deeply concerned, it is just as vital from the standpoint of the needs of the individual that the naval personnel should be thoroughly equipped to deal with the same problems, although they may be called upon to care for fewer cases.

In harmony with the policy of making ready, and in order to supplement the individual reports which from time to time have come from various sources to the Bureau of Medicine and Surgery, Surgeon A. M. Fauntleroy, United States Navy, was sent abroad in

1915 and upon his return made a report on the medico-military aspects of the European war. His observations have proved of much value and have helped to a larger knowledge of many matters connected with the war on the part of the medical officers of the Navy, as well as of surgeons in civil life. As indicated above, a somewhat different field is covered in the present survey.

In writing a report of this kind, where the material gathered is so exhaustive and illuminating, there is a strong temptation to go into detail. An effort has been made to combat this temptation and to cover only such points as seem to have a practical bearing on the objects for which the survey was made.

Every source of information which could be reached in the time at my disposal has been utilized. The experiences of the British, the French, the Belgians, and of those American surgeons who were in active war service with our allies before we entered the conflict, were unreservedly placed at my disposal. To all who so materially assisted me I am most grateful.

In both of my preliminary reports (April 27, 1918, and July 10, 1918) to the Bureau of Medicine and Surgery I mentioned some of those who aided me with advice and with information. Here and there in the text which follows will be found the names of some who furnished special data or contributed material for exhibits to accompany this report. If space permitted there are others to whom a special word of thanks should be given for their cordial cooporation and assistance. Particularly am I indebted to the American Red Cross, through Major J. H. Perkins, Major Alexander Lambert, Mr. Homer Folks, and their staffs; to the British Red Cross, through Colonel Sir Arthur Lawley, Q. C. S. I.; to the French authorities, through M. Jean de Piessac, Prof. Theodore Tuffier, General Gourard, and Major Alexis Carrel; to the British Army, through Lieutenant General Sir Beauvon de Lisle and many others, for the many opportunities and hospitalities extended to me at the request of Director General Thomas H. Goodwin; to the Colony of Strangers, through M. Lawrence V. Binnet and Dr. Ernest H. Lines. Without their aid, and that of Commander W. R. Sayles, United States Navy, late naval attaché at Paris; Dr. Herbert Adams Gibbons, of the American Committee on Public Information, and General A. E. Bradley, until recently chief of the Medical Corps, American Expeditionary Force, this survey could not have been made.

W. S. B.

New York, September 14, 1918.

REPORT ON MEDICAL AND SURGICAL DEVELOPMENTS OF THE WAR.

TREATMENT OF WAR WOUNDS BY THE ALLIES.

In the many hospitals and casualty clearing stations visited, the method of treating war wounds varied greatly. There were those who believed in the use of the strongest antiseptics, as at the Grand Palais, where phenolization was employed, while others favored incising freely with drainage and practically no antiseptics. More and more, the two extremes are being emphasized; on the one hand, the Carrel treatment with its scientific laboratory control and systematic use of strong antiseptic solutions, and on the other, débridement and immediate closure.

Late in September, 1915, after having spent considerable time in the hospitals of both the German and French armies, Prof. Kocher, of Berne, said to me: "The great lesson of the war so far is, back to antiseptic surgery. Asepsis is not enough."

In contrast with this, three years later (in June, 1918) Major A. L. Lockwood, D. S. O., who has had one of the largest experiences in acute war surgery in the present conflict, said when I was at casualty clearing station No. 36, behind the British front: "One of the greatest lessons of this war is that aseptic surgery and not antiseptic surgery should be practiced, the former in all cases, the latter associated with it in selected cases."

Between the two extremes of the Carrel-Dakin treatment and primary suture, both of which are described in detail hereinafter, there are many other methods and agents employed with more or less satisfactory results. These are also taken up somewhat briefly. Their classification is arbitrary for there is overlapping all along the line.

After going from hospital to hospital and station to station and hearing each of these many methods acclaimed or criticized, it becomes convincingly apparent that the obtaining of satisfactory results depends far more upon the surgeon himself than upon the agent which he employs. The lesson to be learned from all this diversity of opinion is that those who are to be given charge of this surgical work should have first, a thorough knowledge of surgery, second, sufficient

experience to give them an adequate technique, and third, the necessary judgment to select and employ such of these methods or agents as seem best for the particular case at the given time.

From the purely therapeutic viewpoint, the surgery of wounds in the present war may be grouped under fairly approximate chronological headings, as follows:

1. The period of ordinary antiseptic agents; second half of 1914 and first half of 1915.
2. The period of wound drainage combined with antiseptics, 1915.
3. Introduction of hypochlorites; later in 1915.
4. Evolution of the Carrel technique of intermittent wound instillation; early in 1916.
5. Ascendency of Bipp method; 1916.
6. Period of approximately equal use of the Morison and Carrel methods; 1916–17.
7. Prominence of flavine and colored wound pastes, such as brilliant green; 1917.
8. Progressive general adoption of wound-excision method (which had its beginnings early in 1916); late in 1917.
9. Period of primary wound suture, immediate or delayed; 1917–18.
10. Period of attempted selection, adaptation and standardization; late 1918.

I. WOUND SUTURE.

In the recent remarkable advance of the science and art of surgery, with its exacting demands upon the time and energy of modern operators, its modest beginnings are sometimes overlooked, but a rich vintage is in store for the investigator of medical records of the past.

After visits to the front and observing much of primary and delayed suture, I determined to secure the memoirs of Paré and the life of Larrey, with a view to learning if any of the modern war wound treatments was foreshadowed by those two great surgeons who lived so much in advance of their times, and who, many years ago, fought over northern France and southern Flanders much as we are now doing. Neither in Paris nor London was I successful. Finally, by advertising, both volumes were obtained from the North of England.

There, in the last of the sixteenth century was described immediate closure; and in the days of Napoleon, molded splints and early primary amputation, much as we know them to-day, except for the phraseology of the time.

The pioneer in the proper treatment of gunshot wounds, and perhaps the forerunner of ultramodern methods of treating fractures and other war wounds, was Ambroise Paré, the father of French

surgery, who was enabled to add the surgical observations of many years of warfare to his early experience as an army surgeon in the Piedmont campaign. Later on he became the premier chirurgien of the French kings, Charles IX and Henry III. The first English translation of his works appeared in London in 1578. In Book IX of his "Chirurgery" he devoted to wound suture a chapter enriched by illustrations showing "The figures of pipes with fenestels in them, and needles fit for sutures," and introduces his subject as follows:

> When wounds are made alongst the thighs, legs, and arms, they may easily want sutures, because the solution of continuity is easily restored by ligatures, but when they are made overthwart, they require a suture, because the flesh and all such like parts being cut are drawn towards the sound parts; whereby it comes to pass that they part the further each from other; wherefore that they may be jointed and so kept, they must be sewed, and if the wound be deep you must take up much flesh with your needle; for if you only take hold of the upper part, the wound is only superficially healed; but the matter shut up, and gathered together in the bottom of the wound, will cause abscesses and hollow ulcers; wherefore now we must treat of making sutures.

As to the first dressings to be used in "wounds made by gunshot, other fiery engines, and all sorts of weapons, after the strange bodies are plucked or drawn out of the wound," Paré laid stress on the importance of tight binding up and rolling the part; "for it doth not a little conduce to the cure to bind it so fitly up as it may be without pain." The presence of Paré in Metz during the attack of Charles V, was regarded as a providential dispensation, for the garrisons saw, to their dismay, that death followed on practically all wounds.

Modern methods of war-wound treatment are distinctly foreshadowed in the writing of some of Paré's pupils, for example in the little known, but most interesting Sclopotarie of Josephus Quercetanus, Phisition, or his booke containing the cure of wounds received by shot of gunne or such like engines of warre (published in English in London in 1590). In the third chapter, speaking of wounds in which the bones of the arms and legs are broken, he differs from some of his contemporaries who favor open-wound treatment, in that, in his judgment, he thinks it best "that the bones by and by before inflammation be engendered be brought in their seat and natural form, with as little pain as may be to the patient, and then to use such medicines as are profitable to both intentions—that is, for the wound and fracture. Moreover, you must see that the wounded part be rightly placed, and if need be, rolled in a plate of lead, bowed to the fashion of a leg or an arm, or else with sodden leather fastened together with buckles, whereby the bones which were broken, may be surer be holden together, which ought not (as little as may be) be shaken and moved, until he is cured, and the bands loosed * * * by which only I have seen fractures cured, the bones being rightly placed," etc.

The originator of much modern military surgery was Baron Larrey, surgeon in chief of the first Napoleon's Grande Armée, who has been called the father of military surgery. It is interesting to note that he was nominated surgeon of the Royal Navy in 1787, and took part in a cruising expedition in North American waters. Although no mention of immediate closure of war wounds occurs in his writings, a surgical memoir read by him at the Royal Academy of Medicine in Paris on February 19, 1819, describes at length an extensive operation for the removal of a large glandular mass from the neck of a man 40 years of age, the edges of whose wound were at once drawn together and united by a series of sutures. All the stitches held well, and the large wound healed promptly, the patient being cured on the thirty-first day after the operation and leaving for his home in excellent condition on the forty-first day.

Practically the identical words which, in the present war have been pronounced in connection with the progressive danger of infection of all war wounds, were spoken a century ago by Larrey, in commenting upon the utility of immediate amputations: An hour's delay is often responsible for the death of the patient. This is doubly interesting and remarkable in view of the fact that a large part of Larrey's work was done on Flemish soil, made familiar to us by the events of the world war; for we read of his being sent to Louvain and Brussels, or of his visiting the military hospitals of Great Britain, like contemporaneous army surgeons. The brilliant career of Baron Larrey brings us close to the present day, when war surgery has perhaps reached its zenith, the operator standing at the head of the medical profession just as the man in uniform represents the dominating factor in both the Eastern and the Western Hemispheres.

IMMEDIATE, DELAYED, AND SECONDARY SUTURE.

Under favorable conditions, primary union by immediate or delayed suture of war wounds which have been operated upon and properly purified, is now the last word in this branch of surgery. Experience in the world war has taught entirely new lessons to the surgeons who found themselves confronted with unprecedented conditions both in regard to the masses and classes of war wounds they were expected to handle. Perhaps the most important lesson of all, with the closest bearing on wound treatment in general, consists in the recognition of the fact that antiseptics are inefficient without the most careful and thorough mechanical purification of the wound, including the complete removal of all dead or nonviable tissue. Certain phases of antiseptic wound treatment are passed in review in "An Address on Primary Suture of Wounds at the Front in France," by Surgeon General Sir Anthony Bowlby, delivered at a meeting of the Royal Society of Medicine on February 13, 1918, and

published in the British Medical Journal, Volume I, March 23, 1918. page 333.

Strong antiseptics, such as were used early in the war, in the expectation of arresting sepsis, were foredoomed to failure, as a result of the unprecedented bacterial contamination of war wounds sustained in the germ-laden battle fields of Flanders. The prompt discarding of these antiseptics involved the abandonment of primary union by suture of war wounds, followed as it was at first by discouraging results. On the other hand, the opposite method of leaving the wounds wide open and maintaining a free discharge of the wound secretions, in its turn proved disappointing. A successful outcome was found to depend upon the performance of excision before the infectious bacteria have had time to penetrate far into the depth or surroundings of the wound. The period which has elapsed since the infliction of the wound thus becomes a factor of great prognostic importance. In a general way, and with certain reservations, "delay means danger" (Bowlby). According to the report of Duval, at the allied surgical conference in November, 1917, 80 per cent of the lightly wounded cases, without fracture, were successfully sutured within 8 to 12 hours after the injury.

By "delayed primary suture" is meant a wound suture which is applied at the end of a day or two after the infliction of the wound. Even after three or four days' delay, the wound may be sutured with the same favorable results as obtained by immediate suture. The experience of French operators, who are the pioneers in this field, shows that such delay, of 48 or more hours, is advantageous rather than otherwise in a large number of cases. The observations at the front on the part of Sir Anthony Bowlby are in conformity with this experience. According to him, "no definite rule can be laid down as to the lapse of time after which suture should not be done, but the sooner the wound can be operated upon, the greater is the probability of success. It can be sutured later." As a matter of fact, it is not advisable to close at once war wounds involving extensive lacerations, or complicated fracture cases, for all oozing from the wound must have ceased before a successful suture can be applied. Circumstances alter cases, and the best treatment for a given wound rests with the surgeon in charge. Doubtful wounds are preferably left open, after excision of all dead or dying tissue, until conditions permit of a decision. It goes without saying that the ever present contingencies of infection and suppuration are materially lessened by the early performance of complete wound closure.

Scrupulous asepsis is the imperative condition of primary wound suture, immediate or delayed. While thorough in the removal of all hopelessly damaged tissue, the excision should be as conservative and restricted as possible. No part of the wounded region must be

neglected or slighted, the greatest care being especially required in all deep wounds and in open or compound fractures. The performance of primary suture transforms the latter into simple or closed fractures, and thereby greatly lessens not only the danger of sepsis but also the soldiers' enforced rest in bed or in hospital.

Certain limitations of primary suture of war wounds, emphasized by Doval, are that the procedure can not be used in emergencies, and also that its performance is not advisable unless the patient can be kept in the hospital for at least a fortnight, under the care of the same surgeon.

There are certain cases of relatively old wounds, not yet operated upon and clinically noninfected, or very mildly infected, capable of being closed by suture, which under these conditions must be described as delayed primary suture, for the reason that the operation is performed after the first 12 hours, namely, after the usual stage of bacteriological latency of war wounds. Such sutures differ essentially from the purposely delayed sutures in cases where the cleansed and surgically sterilized wound is left open and covered with aseptic dressings in the first aid stations, being united by sutures later on at a greater distance from the front. According to Chalier (Le Progrès Médical, No. 27, 1918), this delay can often be advantageously utilized, for instance, for the radiological localization of a projectile, the removal of which is essential to the success of a complete operation terminated by wound suture.

The desirability of extending the benefit of primary suture to all wounded soldiers, in time of attack, provided that operative and hospital facilities permit, is emphasized by recent French writers (such as Marquis, Descazals, Luquet, and Morlot; Bull. et Mém. d. l. Soc. de Chir. de Paris, 43, 2, 1917, p. 2281). In their experience, primary suture proved apparently most advantageous in wounds of the joints, where very accurate union was obtained; the method at the time of the report had been utilized in nearly 450 cases, including wounds of the bones, joints, and soft parts. Wounds of the skull, the thorax, and the abdomen were likewise sutured with favorable results. The mortality for all suture cases amounted to 21 deaths or 4.7 per cent.

That primary suture is at present the rational and as it were the obligatory treatment for war wounds is the declaration of Gross, Tissier, Houdard, Di Chiara, and Grimault (ibid.). From being exceptional, primary wound suture has become a common procedure, largely through the work of Tissier, who first showed that all war wounds which are not infected by the streptococcus will heal after suitable surgical treatment followed by the performance of primary suture.

In the surgical automobile ambulance No. 12, which takes charge of the gravest injuries, such as extensive destruction of soft parts, long seton wounds, shattering and crushing of entire limbs, etc., 430 of 549 wounded men were sutured (78.8 per cent). Altogether, 759 sutures were applied in these 430 cases, and in 675 instances led to healing by first intention, which is equivalent to a successful outcome in 88.8 per cent of the cases. There were 209 fracture cases with a favorable result. It is noteworthy that even conditions of such gravity as amputation of shattered extremities (22 cases), fractures of the vertebræ, lesions of large blood vessels, deeply embedded projectiles in the cervical region, and other severe injuries of war are amenable to primary suture.

The routine application of primary sutures is advocated by Gross and Tissier whenever the removal of the projectile and the excision of the necrotic tissue is practicable. Unless streptococci be detected in the early wound discharge, the sutures should not be disturbed, but the appearance of the streptococcus is an indication for removal of the sutures and the performance of radical excision, in order to check the putrefactive process. Secondary wound suture is recommended at the earliest possible date, where primary suture could not be applied. Only those war wounds are now left open in which there is an association of anaerobic and streptococcic infection. The vast field of opportunity for the application of wound suture is illustrated by figures such as the 880 cases of Potherat, in Delbet's service, with 221 primary sutures, 209 of which proved successful, and 459 secondary sutures. Perfect union after primary suture is reported by Picot in 25 of 30 cases of complicated diaphyseal fractures.

Barnsby (Revue Internationale de Médecine et de Chirurgie, No. 2, 1917, p. 26), in a series of primary sutures of soft-part wounds, observed healing by first intention in 160 of 172 cases. In the remaining 12 cases, the stitches had to be removed, the wounds healing by second intention, without harm to the patient. The application of primary suture of war wounds is advocated by him in the 10 hours following the traumatism, in injuries of the following description: Simple articular wounds, or lesions of joints combined with slight bony lesions; wounds of soft parts (supra-aponeurotic); superficial glancing subaponeurotic wounds, the floor of which can be plainly seen after incising. All such wounds should be sutured, provided a reliable asepsis and sufficient surgical cleansing can be secured. When the asepsis is uncertain, however, or when the wound is of more than 20 hours' standing, especially when it is obviously infected, or in serious injuries such as deep subaponeurotic wounds, large muscular seton wounds, extensive bone shattering (diaphysis or epiphysis) and, finally, when there is any doubt, even in appa-

rently simple wounds, primary suture should be omitted, and the wound be treated according to Carrel's method of intermittent instillation, the proper time for the performance of delayed suture being determined by the daily bacteriological control of the wound.

In justice to the method of primary suture, it should not be attempted in very large wounds with irregular tracks, where there is extensive shattering of bone, or in injuries dating back more than half a day or so (12 to 18 hours at most). In fracture cases, the importance of complete fixation and immobilization from the earliest possible moment can not be overestimated.

The advent of primary wound suture, representing as it does a wonderful economy in time, money, and material, has brought about a striking change in war surgery. Formerly, even after the deplorable stage of overwhelming septic wound contamination was past, a long time was required for the repair and cicatrization of wounds which healed but slowly under laborious aseptic dressings. Before the application of at least secondary wound suture had become a reality, large numbers of wounded soldiers had to be evacuated before their wounds were properly closed. The introduction of primary suture has greatly simplified modern wound treatment, which now consists essentially in passive supervision of the repair process, without dressings. The suture threads are removed on the tenth to fifteenth day. At the end of three weeks, the patient is evacuated to the base hospital, or discharged on leave, according to the gravity of the condition.

Credit must be given, especially in these days of precarious inter-allied communication, to War Medicine, published by the American Red Cross Society in France, for giving in the English language a review of the notable reports on primary wound suture published in the Bulletins et Mémoires de la Société de Chirurgie de Paris. The March number (1918) of this Red Cross bulletin also brings in full several papers on this subject, by English surgeons and bacteriologists, indorsing the treatment of war wounds by primary and especially by delayed primary suture (the secondary suture of French writers). Colonel Gask emphasizes the nonoccurrence of deaths in a series so treated, though many of the cases were severe; no bad results were attributable to the early suture; the comfort and well-being of the patients were noteworthy.

In conclusion, it may be said that this procedure has come to stay, and that with the reservation of its three requirements—namely, an experienced operator, a convenient locality, and sufficient time—the adoption of primary wound suture will steadily extend. It is imperative that the operator be one who knows how much tissue to remove. If too little be removed death may result; if too much, a mutilation which is sometimes worse than death.

Aside from the benefit accruing to the severely wounded, primary wound suture involves the enormous advantage of restoring to activity, at the earliest possible moment, the hosts of men with minor wounds which, without this new technique, necessarily constituted a serious handicap for the armies in the past. In striking contrast with this prolonged disablement, Pierre Duval reports, after primary suture of flesh wounds, seven days' leave and return to service in more than half the cases; and after delayed primary suture, seven days' leave and return to the regiment in 32 per cent of the cases; one month's convalescence in 30 per cent of the cases,

The overabundant clinical material is being constantly replenished by the casualties of the war, as illustrated for example by the report of Lemaitre, in whose experience since July, 1915, when the use of antiseptics was definitely abandoned in favor of operative surgery, 2,664 (of 4,072) wounds were united by primary suture, 231 by delayed primary suture, and 324 by secondary suture, for the most part between the seventh and fifteenth day after the infliction of the injury, with a very small number of failures. Med. Bull. (Red Cross), March Supplement, 1918.

Although prior to the European war the closure of contaminated wounds by suture would have been regarded as foredoomed to failure, and no such procedure at first entered the minds of Army surgeons, this method of wound treatment is not strictly speaking novel, nor is it incident to the current war. Far from being new, the combined surgical acts which culminate in primary wound suture have been in use for many years, and as stated before, the closure of gaping war wounds by sutures with specially devised needles is described at length in the Chirurgery of Ambroise Paré. Observation and experience have matured and improved the technique of the procedure, which at the present writing seems to have reached a stationary degree of perfection.

The most extensive available statistics of primary suture of war wounds (2,537 cases) were published in this year by Lemaitre of the V Army (Lyon Chirurgical, Tome XV, 1918, p. 65) and show that 79 per cent of injuries can be treated successfully by primary closure, immediate or delayed, without excision of scar tissue. The statitstics comprise:

Two thousand and thirty wounds of the soft parts; (1,060 very serious, and 250 associated with bony, vascular, or nervous injuries); 87 injuries of large joints; 263 wounds with diaphyseal fractures; 110 wounds of hand and foot, with injured tendons, bones or joints; 40 injuries of the skull and brain; 7 injuries of the thorax.

The method proved unsuccessful in only 0.84 per cent of cases. There were only four subsequent deaths, including three brain injuries and one penetrating wound of the thorax. Contraindications

are: Spreading infection, gas gangrene, a bad general condition, shock, shattered limbs necessitating amputation, association with vascular lesions of large blood-vessels.

The suture method was gradually reached by Lemaitre in July, 1915, after successive phases of nonintervention, free exposure and surgical purification, complete excision of the entire wound track, fixation of microbes by means of iodine, and Carrel's method of multiple instillation. The original technique of wound suture has been considerably improved in the last three years. Filiform drainage by means of silkworm gut, removed in three or four days, is recommended on the basis of favorable experience. Minute asepsis, and scrupulous hemostasis are indispensable, and radioscopy or operating on the radioscopic table, are helpful adjuncts. When performed by experienced surgeons, primary closure by suture constitutes the ideal modern treatment of war wounds. The method needs no defense, for it is its own best vindication. Lemaitre aptly calls it a worthy daughter of French surgery, destined to live and prosper.

II. CARREL METHOD.

CARREL-DAKIN TREATMENT.

None of the procedures devised to meet the exigencies of the world war has aroused so great an amount of controversy in surgical circles as the Carrel-Dakin method of treating infected war wounds. Even among those who have used it there are bitter critics as well as earnest advocates. The result is that a decision for or against its employment can hardly be arrived at by the surgeon without personal experience and observation of its results.

After visiting scores of military hospitals abroad, and obtaining at first hand the views of the acknowledged leaders in war surgery, I have attempted to describe impartially the method and its application. It was first put to the test in the Compiègne Hospital, early in 1915, where the surgeons associated with Major Carrel became its ardent supporters. Although professional opinion is still divided regarding the value of wound treatment by continuous instillation of a special antiseptic fluid, the method has undoubtedly attained popular fame and favor. It has been accepted by the United States Government for its military medical services; and even behind the enemy's lines there is a tendency to regard sodium hypochlorite as the turning point in the treatment of infected war wounds and the answer to the puzzle of chemical wound disinfection. I have been so fortunate as to witness much of its development, having seen it employed in Compiègne in the fall of 1915; at the War Demonstration Hospital, New York, in the summer and fall of 1917; again in Compiègne late in 1917; and forward of Soissons, in the advanced

U. S. S. GEORGE WASHINGTON

No. 1.

BACTERIOLOGICAL CHART

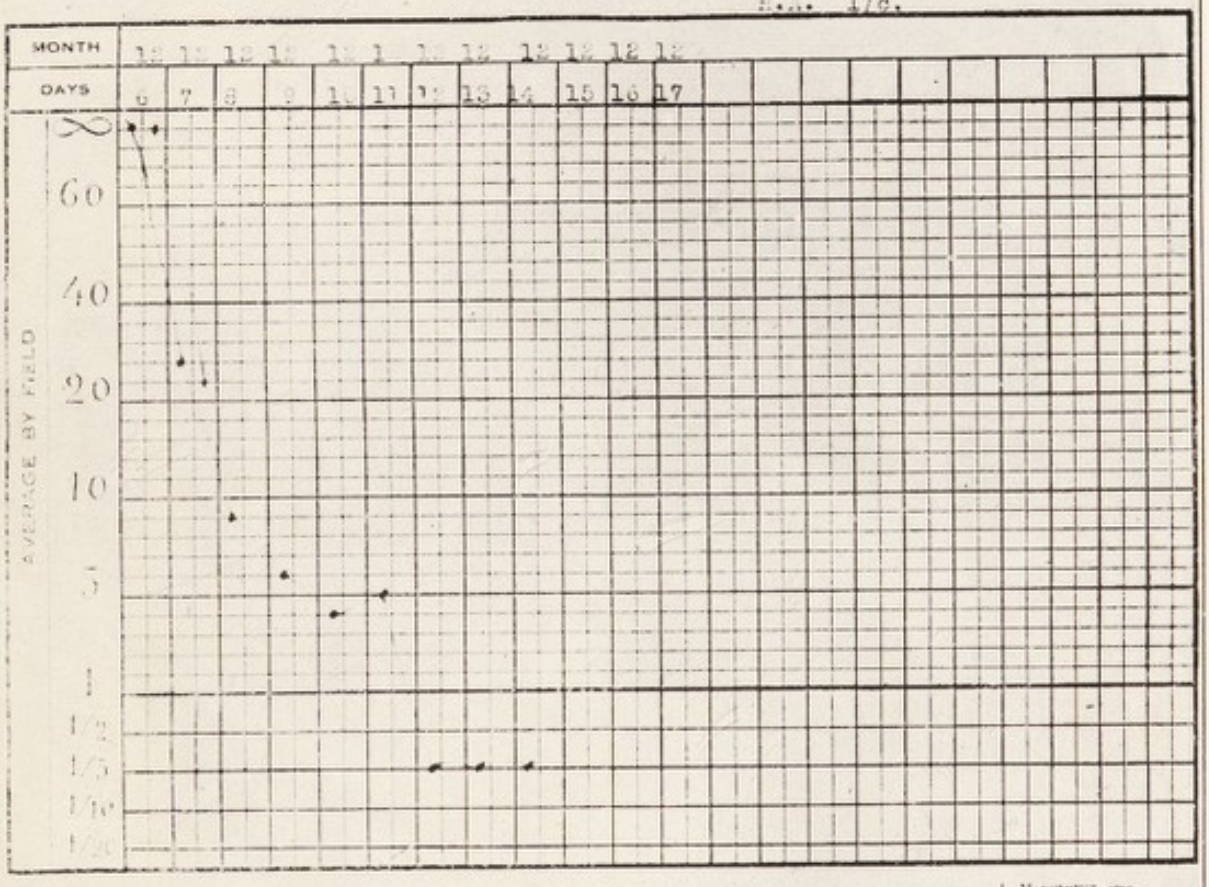
Name: Clarke, F.E. *Ward:* Surg. *No.* 1.

Nature of the wound Infected Brush Burns, Left Leg.

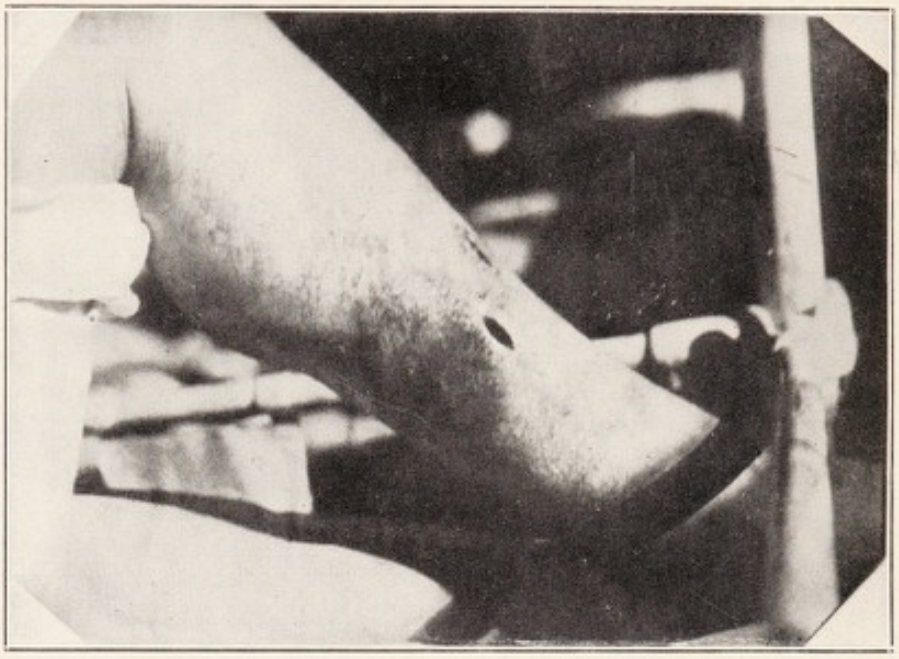
Anterior
Middle

James Albert Doren.

U.S. 1/c.



L. Mauthner, imp.



F. E. C. Picture taken December 5, 1917.



F. E. C. Picture taken December 20, 1917.

Carrel Hospital, in December, 1917. In November, 1917, on my recommendation, this method of treatment was put into operation on the U. S. S. *George Washington*, including the Carrel-Dakin treatment proper and various modifications of it. Major Carrel and others of the staff of the Rockefeller War Demonstration Hospital and Rockefeller Institute personally aided in the establishment of this floating war demonstration hospital, fully equipped with adequate laboratory facilities, special splints, X-ray apparatus, and photographic plant. Preparation was made for the treatment of 200 cases by the Carrel-Dakin method for one month without the necessity of renewing supplies. We have had most gratifying results where it has been employed. Charts, etc., of two typical cases are included herein.

U. S. S. *George Washington.*

Carrel case No. 1.—Surgeon, Bainbridge, Wm. S.; date, December 6, 1917; name C., F. E.; rate, Sea., 2c.; age, 26.

Date and nature of wound: November 15, 1917. Loop of rope caught left leg and cut into flesh. It was dressed with a saturated sol. mag. sulph. Worked but became worse. Seemingly well for three days; became worse, glands in groin became swollen and painful, back to sick bay.

Date and nature of operation: December 3, 1917. Picture of leg taken. Condition, cellulitis of leg. Wounds discharging pus, leg swollen. Wet dressing of mag. sulph. December 5, 1917, incision of leg over shin.

Treatment.

Date.	Condition of wound.	Temp.	B. count.
1917 Dec. 6	Three wounds; 2 burns, 1 incision as above; 1 tube; No. 3 covered; Dakin's sol. 30 c. c. q2h.	Normal....	Inf. all types.
7	Patient states that he has no more pain or throbbing; leg less swollen, almost no discharge; 3 tubes applied; Dakin's sol. 30 c. c. q2h.	.....do....	Middle 26, anterior 22.
8	Looking better, less pus; 3 tubes; Dakin's sol. 30 c. c. q2h.	.....do....	Middle 9; anterior dry, no smear.
9	Anterior wound cured; middle looking better; 1 tube; Dakin's sol. 30 c. c. q2h.	.....do....	Middle 6.
10	Looking better, no pus; 1 tube; Dakin's sol. 30 c. c. q2h.	.....do....	Middle 4.
11	Condition about the same; 1 tube; Dakin's sol. 30 c. c. q2h.	.....do....	Middle 5.
12	Wound looking better; a clean bright red color; no pus; 1 tube; Dakin's sol. 30 c. c. q2h.	.....do....	Middle 1-5.
13	Condition of wound much better; Dakin's sol. discontinued; chlorazene cream applied.	.....do....	Do.
14	Much better; chlorazene cream applied.	.....do....	Do.
15	Condition of wound much better; chlorazene cream discontinued; thymol iodid applied.	.....do....	

Treatment—Continued.

Date	Condition of wound.	Temp.	B. count.
1917			
Dec. 16	Wound much better; thymol iodid applied.	Normal ..	
17	Wound sterile and healing rapidly; dusted with thymol iodid.	.....do....	
18	Looking well; thymol iodid applied...	.....do....	
19	Wound practically healed; dusted with thymol iodid; discharged to duty.	.....do....	
20	Picture taken.....	.....	

Carrel case No. 10.—Surgeon, Bainbridge, Wm. S.; date, January 5, 1918; name, M., P. F.; rate, SF–2; age, 25.

Date and nature of wound: November 15, 1917, while standing watch in a lookout aboard the U. S. S. *De Kalb*, he got a sudden pain in his right side so bad that he had to be relieved from duty. Next morning he was admitted to the sick bay.

Date and nature of operation: November 17, 1917. An aspirating set was used to draw off about a liter of milky pus; this relieved the pain for a time. November 18, 1918, transferred to base hospital No. 5 at Brest. December 1, 1917, a second puncture was made, this time drawing off about the same amount of milky pus. Two weeks later an incision was made postero-laterally in the region of the seventh rib of the right side. About three-fourths of an inch of the seventh rib was extracted. Two liters of a milky pus evacuated at this time.

Treatment: Dichloramine–T. Slight improvement. Patient had practically no temperature at any time. Patient had been up and about for two weeks prior to his transfer to the U. S. S. *George Washington* on January 5, 1918. Treatment changed to the Carrel-Dakin sol. every two hours. Patient improving rapidly under new treatment.

Treatment.

Date.	Condition of wound.	Temp.	B. Count.
1918			
Jan. 5	A. M. Dressed at Brest, where D. T. was used.....	.....	
5	Great loss of flesh; right chest contracted; right lung collapsed; regular diet; a tube 8 inches long and 14 cm. in diameter was removed from cavity, followed by about 250 c. c. of a dark, slimy pus; irrigated with Dakin's sol. 6; No. 1 tubes inserted; Dakin's sol. 120 c. c. q2h.	Normal...	Cavity, pus, granulation, inf. all types.
6	Condition a little better, 1 pint of pus evacuated; irrigated well with Dakin's sol.; return well bleached. 6 tubes; Dakin's sol. 120 c. c. q2h.	...do.....	Cavity 40, pus 16, gran. 18.
7	Condition much better, irrigated out with Dakin's sol.; return normal color; 5 tubes; Dakin's sol. 120 c. c. q2h.	...do.....	Cavity 6, pus 10, gran 9.
8	Looking much better, much less pus, much less contraction of the chest; irrigated with Dakin's sol.; 6 tubes; Dakin's sol. 120 c. c. q2h.	...do.....	Cavity 4, pus 5, gran. 6.
9	Looking much better, practically no pus; 4 tubes; Dakin's sol. 90 c. c. q2h.	...do.....	Cavity 2, pus 3, gran. 4.

U. S. S. GEORGE WASHINGTON

No. 10.

BACTERIOLOGICAL CHART

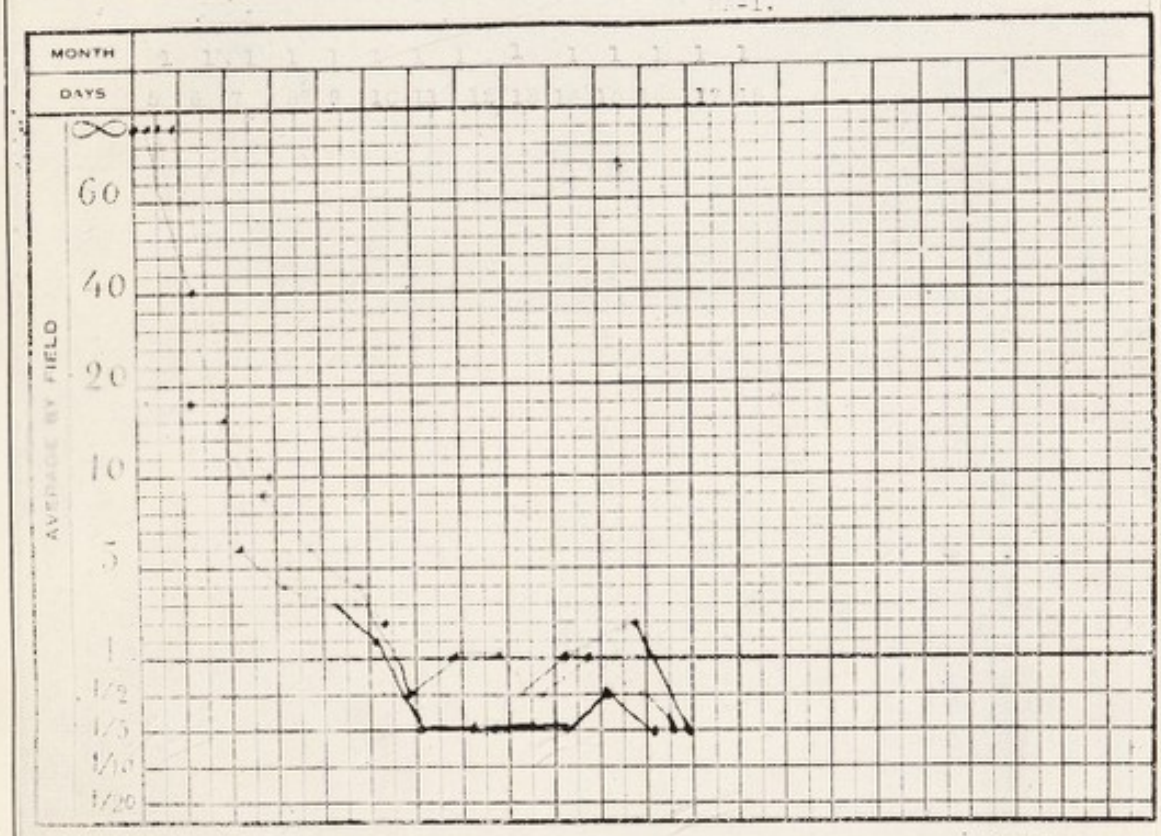
Name: [illegible], . . *Ward:* [illegible] *No.* 10.

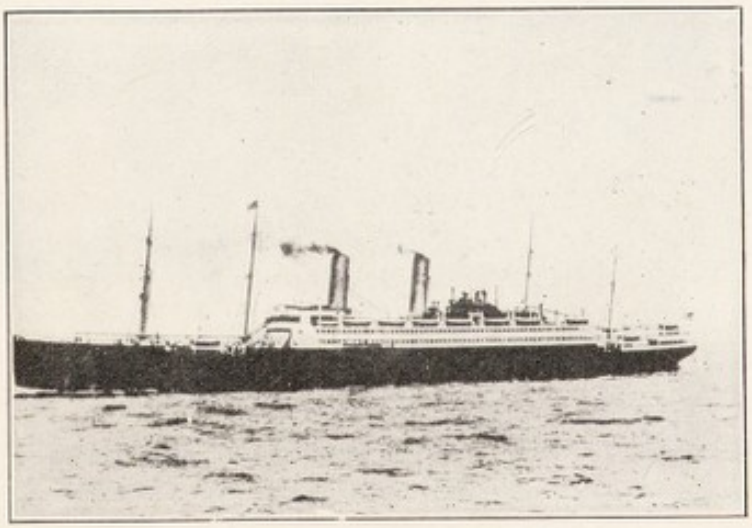
Nature of the wound [illegible] Chest

Discharge
Gunshot wound
Breast of Cuba
Times Hill of Santy.

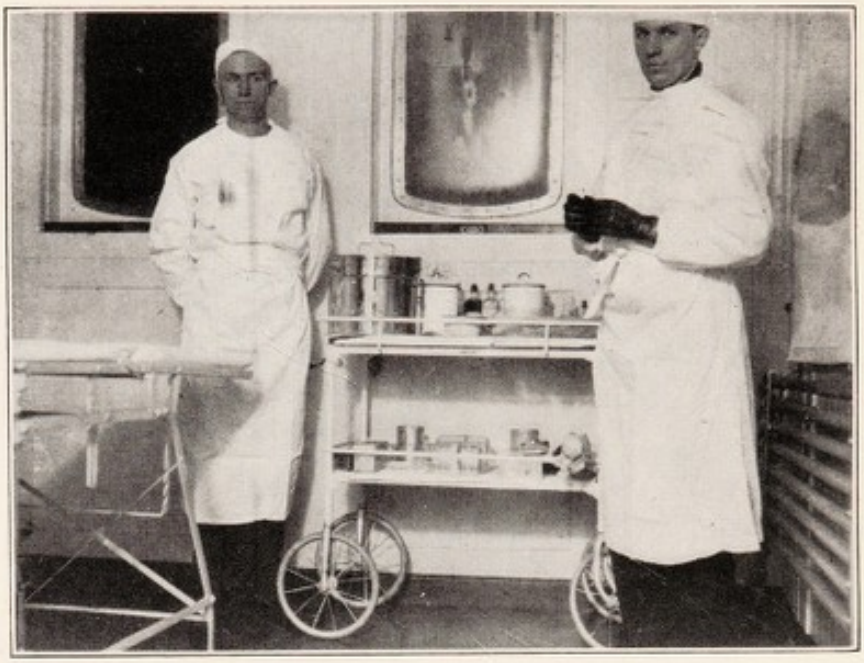
[illegible]

-1.

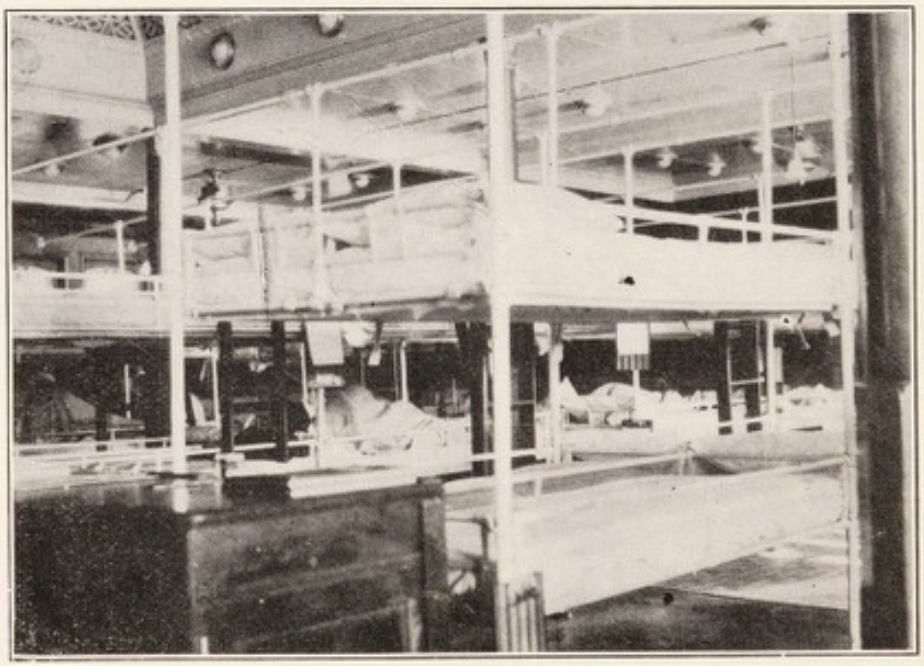




U. S. S. George Washington.



Preparing to give Carrel-Dakin treatment on U. S. S. George Washington.



Sick bay on U. S. S. George Washington

Treatment—Continued.

Date.	Condition of wound.	Temp.	B. count.
1918			
Jan. 10	Looking much better, less pus, practically no pain; 3 tubes; Dakin's sol. 90 c. c. q2h.	Normal...	Cavity 1, pus 2, gran. 2.
11	Much better, no pain, no pus; 2 tubes; Dakin's sol. 50 c. c. q2h.	...do.....	Cavity 1–5, pus 0, gran. 1.
12	Looking much better, small amount of pus, less contraction; patient up and about; great change in strength; putting on weight; blow bottle b. i. d.	...do.....	Cavity 1, pus 1–5, gran. 1–5.
13	Looking much better, less pus; blow bottle b. i. d.; 2 tubes; Dakin's sol. 50 c. c. q2h.	...do.....	Cavity 1–5, pus 1–2, gran. 1–2.
14	Patient feeling much better, less pus, no pain; blow bottle bid; 2 tubes; Dakin's sol. 50 c. c. q2h.	...do.....	Cavity 1–5, pus 1, gran: 1.
15	Patient feeling well, is putting on weight rapidly, practically no pus; blow bottle b. i. d; 2 tubes; Dakin's sol. 50 c. c. q2h.	...do.....	Cavity 1–5, pus 1, gran. 1.
16	Continued gain both general and local. About ready to permit of closure.	...do.....	Cavity, pus, granulation.
17	Arrived at Norfolk, Va., to be transferred to hospital for treatment.....	.....	

Carrel-Dakin titrations during voyage from December 4, 1917, to December 21, 1917

Stock solution showing effects of time.

Dec. 4, 1917	12.1
Dec. 6, 1917	11.9
Dec. 8, 1917	11.3
Dec. 10, 1917	11.0
Dec. 12, 1917	10.7
Dec. 15, 1917	10.1
Dec. 18, 1917	9.2
Dec. 21, 1917	8.6

Solution used.			Solution used.		
Dec. 4, 1917	12.1	0.45	Dec. 13, 1917	12.1	0.45
Dec. 5, 1917	12.1	.45	Dec. 14, 1917	12.1	.45
Dec. 6, 1917	12.1	.45	Dec. 15, 1917	12.1	.45
Dec. 7, 1917	12.1	.45	Dec. 16, 1917	12.1	.45
Dec. 8, 1917	12.1	.45	Dec. 17, 1917	12.1	.45
Dec. 9, 1917	12.1	.45	Dec. 18, 1917	12.1	.45
Dec. 10, 1917	12.1	.45	Dec. 19, 1917	12.1	.45
Dec. 11, 1917	12.1	.45	Dec. 20, 1917	12.1	.45
Dec. 12, 1917	12.1	.45	Dec. 21, 1917	12.1	.45

The novelty of this method of wound treatment consists in its providing a close and protracted contact between the solution used and the infected wound surface. In order to maintain an unchanged concentration of the antiseptic, a special technique is required for

the constant renewal of Dakin's fluid, which is very unstable and easily decomposed. The treatment requires as a preliminary the earliest possible thorough cleansing of the infected wound, within the first six hours, with free incisions, removal of foreign bodies, and excision of all dead or dying tissue. This surgical purification is then supplemented by the Carrel instillation method of wound sterilization by chemical means, more particularly in the form of Dakin's fluid, which is claimed to be approximately isotonic with blood serum.

The point emphasized by Carrel in his treatment is the principle of its application; which is a direct reversal of the accepted principle of gravity drainage and a revival of the doctrine of antisepsis, not as opposed but as subservient to asepsis. The old Listerian teaching has thus been vindicated, and antisepsis has been developed into a practicable therapeutic procedure. In view of the fact that sepsis is responsible for the loss of countless lives and limbs after recovery from the immediate effects of the traumatism, efficient antisepsis seems to offer a more hopeful outlook for the wounded. A most important feature of this treatment is that it permits of early closure of the disinfected wounds by suture, thereby preventing tedious convalescence, threatened septicemia, and more or less loss of function.

Under this method, all war wounds are treated as suspects, which means that under no circumstances may such a wound be closed without sterilization under bacteriological control. Clinical appearances, no matter how favorable, must be corroborated by microscopical examination. On coming under treatment within 24 hours after the infliction of the wound, the patient is placed on the operating table and the affected region is freely exposed by incisions, bringing all wound corners and recesses into view. In conformity with modern conservative principles, all vascular, nervous, or tendinous structures are respected as far as practicable. At the same time, an effort is made to convert an irregular angular wound into one large open chamber or cavity. Aside from the radical removal of all foreign bodies and other contaminations, the fleshy tracts of projectiles and the like must be excised as completely as possible, this being the only way to accomplish absolute wound purification. Sacrifice of muscular tissue under such circumstances is more apparent than real, as extensive sloughing of the walls of seton wounds is sure to occur. Hemorrhage is to be controlled by means of plain catgut or linen ligatures, which alone are capable of resisting the action of the antiseptic fluid. It is essential that all oozing be checked with hot saline solution, for the presence of blood not only interferes with proper sterilization, but prevents the taking of satisfactory smears for determining the microbic content. Hidden foreign bodies

in the depth of the wound are best located by the X-rays, which are also useful for ascertaining the presence or absence of bone fractures. Neutral oleate of soda is employed for the preliminary cleansing and again for washing the skin around the sterilized wound, to prevent reinfection.

The next stage of the treatment consists in the introduction of hypochlorite solution into the prepared wound by means of one or several red rubber instillation tubes, with a lumen of 4 mm.; thickness of wall, 1 mm. When destined to flush a single large cavity, the tubes are open at both ends, whereas tubes which supply several smaller cavities are closed at one end and perforated at the sides. Not the tubes, but the solution must be renewed every two hours, because by that time its efficiency has been greatly lessened by the loss of concentration due to the union of the chlorine with the protein elements of the bacteria and tissues. The renewal of solution is effected without removing the dressings, by the simple expedient of allowing more of the fluid to flow in through the instillation tubes.

The dressing is carried out as follows: Compresses soaked in Dakin's solution are applied to the wound in such manner as to hold the tubes in position and prevent kinking or other obstruction to the flow. Small squares of gauze, smeared with sterilized vaseline, are placed over the skin around the wound to prevent cutaneous irritation which otherwise might follow on prolonged exposure of the skin to the solution. In addition the dressing comprises another layer of gauze, a sheet of absorbent cotton wool, a second sheet of nonabsorbent cotton wool, and still another layer of gauze. These four layers come ready made in pads, so that they can be quickly applied and easily retained with safety pins or wooden clothespins. The dressing is applied with the absorbent cotton wool nearest the wound in order to absorb secretions, while the nonabsorbent layer prevents these from escaping and soaking the bed. The perforated portion of the tubes is all beneath the dressing; either upon the wound, if superficial, or inside of its cavity. The nonperforated part is connected with the distributing tubes, which are divided so as to provide as many outlets as may be needed. These distributing tubes are of glass and come either in the form of a Y or a three to four-toothed comb; their lumen is about 7 mm. They are connected with the instillation tube (same lumen) from the reservoir, which is a flask holding 1 liter, with a diameter of 7 mm. at the outlet. This instillation tube is fitted with a pinch cock to control the flow when intermittent instillation is used, and with a drop counter and screw pinch cock to serve in continuous instillation. The latter method is employed only in cases where one tube open at the end is placed in or on a wound.

Where two or more tubes with lateral perforations are used, the intermittent method alone is practicable. Every two hours the nurse presses on the pinch cock for a few seconds and permits the inflow of enough fluid approximately to fill the cavity. The overflow is caught by the absorbent gauze of the dressing and when properly managed will not wet the patient. Protective pads may be placed underneath, but waterproof wound dressings are prohibited. Chutro uses a shallow metal pan under the dressing with a tube connecting it with a receptable beneath the bed for possible overflow.

The hypochlorite solution in the reservoir is colored pink with potassium permanganate in order to distinguish it from other irrigating fluids and also to shelter it from the decomposing effects of light. It is a rather unstable solution.

The aim and object of the Carrel method of wound treatment is the continuous contact of injured parts with an efficient nonirritating antiseptic, which is, moreover, a solvent of necrotic tissue. Otherwise, this dead or dying tissue would maintain infection in spite of the bactericidal power of the instillation. A further most essential feature of the method is the scientific control by way of bacteriological examination, usually on alternate days, of smears from various parts of the wound to determine its progress toward asepsis. The time for closure of the wound by suture is governed by the laboratory reports, and has not arrived until the proportion of bacteria under the microscope is as low as one to five or six fields. The smears are taken by the surgeon himself after the instillation has been discontinued for two hours. When closure under these conditions is followed by a rise of temperature and evidences of local disturbance, the wound must be reopened without delay and search made for an undetected foreign body. If such be discovered and successfully removed, the wound may be closed again after a second period of observation. Sometimes in long-standing cases bacteria are imprisoned in cicatrices and set free when an attempt is made to close the parts. More or less incomplete sterilization is indicated by pain and rise of temperature and calls for an immediate repetition of the course of instillation.

Regarding the composition of the antiseptic agent used in this method, the neutral hypochlorite of soda was selected by Dakin, after considerable experimentation, as the most advantageous and nonirritant to the interior of the wound, although slightly attacking the skin. The latter can be simply and effectively protected by means of vaseline. Soda hypochlorite in a concentration between 0.45 and 0.5 per cent destroys all bacteria without distinction. Below 0.45 it loses its bactericidal powers; while above 0.5 the tissues will not tolerate it. Between these two extremes it will disintegrate pus-cells and dissolve necrotic tissue, being superior in this respect

to chloramine, a better antiseptic, but without the power of dissolving necrotic tissue. Moreover, chloramine decomposes more rapidly on contact with the tissues and must therefore be used in larger amounts than soda hypochlorite, which after exhaustive experimentation under identical conditions is advocated by Carrel as the best available. It is cheap and readily made up, provided care be taken to secure the correct ingredients and to make the proper combinations.

Dakin's fluid is prepared according to two formulas, one with and the other without the addition of boric acid, the latter having proven most acceptable in practical experience. The process of making the solution is described as follows:

Neutral hypochlorite prepared without boric acid is best made according to the formula given by Daufresne, and at the present time is perhaps more generally used than any of the other modifications. Two hundred grams of good bleaching powder are put in a 12-liter bottle with 5 liters of tap water. The solution is shaken vigorously and allowed to stand for at least six hours, unless a mechanical shaker is used, when half an hour's shaking will be found sufficient. In another vessel, 100 grams of dry sodium carbonate and 80 grams of sodium bicarbonate are dissolved in 5 liters of cold water and then added to the bleaching powder mixture. The whole is shaken vigorously for a few minutes, and the precipitate allowed to settle. At the end of half an hour the clear solution is siphoned out and then filtered through paper. The proportions given above for the carbonate and bicarbonate of soda are those given by Daufresne. It is our experience, however, that with most brands of American bleaching powder it is better to use 90 grams of each salt. This solution must invariably be tested for neutrality by adding a pinch of solid phenolphthalein to a little of the solution. If the solution should give an alkaline reaction, one of three methods must be employed to correct it, otherwise skin irritation will surely result.

(*a*) Pass carbon dioxide gas into the solution until a sample shows no alkalinity when tested as described. This is perhaps the best method.

(*b*) A neutral hypochlorite may be secured by reducing the proportion of carbonate of soda and increasing the bicarbonate.

(*c*) Boric acid may be added until neutrality is secured. An advantage of the carbonate preparation is that it possesses greater stability and can be kept for several weeks without much deterioration. On the other hand, with varying qualities of bleaching powder, containing different amounts of free lime, it is more difficult to adjust the proportion so as to obtain a neutral solution directly. Probably those having adequate laboratory facilities will prefer the carbonate-bicarbonate solution, while the mixture containing boric acid is readily made under less favorable circumstances.

Titration of the solution.—Measure 10 c. c. of the solution, add 20 c. c. of 1 : 10 iodin solution and 20 c. c. of acetic acid. Pour into this mixture a decinormal solution (2.48 per cent) of sodium thiosulphate (hyposulphite) until decoloration. Let N equal the number of cubic centimeters of thiosulphate employed. Then the quantity of sodium hypochlorite for 100 c. c. of the solution would be given by the equation: $T=N\times0.03725$.

Precautions.—Never heat the solution. If, in case of an emergency, it is necessary to titrate the chlorinated lime, use only water, never with the solution of soda salts.

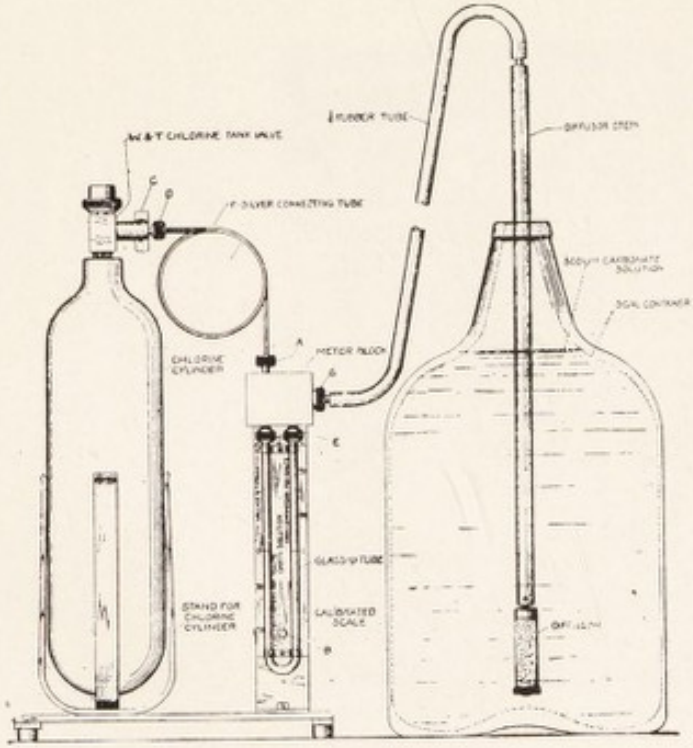
Other means of preparing the hypochlorite solution by passing chlorine gas into soda solutions are coming into favor, because of the readiness of obtaining an exact chlorine concentration without the trouble and delay of titrating the lime. Transportation of the chlorine tanks is as easy as that of the lime outfit. We have found the chlorine gas method very satisfactory on one of our largest transports. Thousands of these gas tanks have been ordered for the United States Army.

The apparatus for making Dakin's solution directly from liquid chlorine (designed and manufactured by Wallace & Tiernan Co., New York, tested and indorsed by the Rockefeller Institute, and shown in the illustration) consists of a seamless steel cylinder of chlorine with a special regulating valve, connections from the cylinder to a meter, connections from the meter to a diffusor stem and diffusor for distributing chlorine in the sodium carbonate solution.

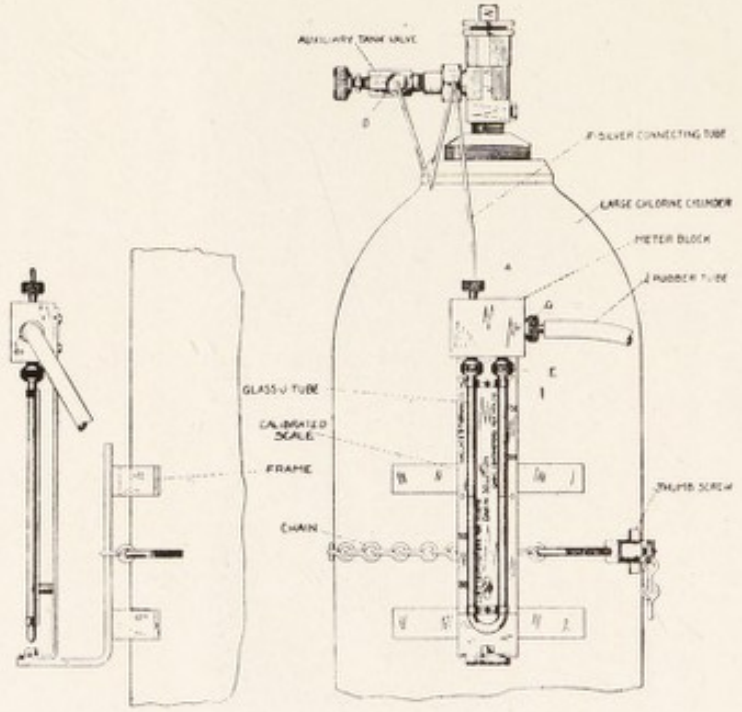
Pure anhydrous chlorine can be obtained in compressed cylinders of various sizes. The second illustration shows the arrangement suggested for connecting the apparatus to a large cylinder. The valve in the head of the large cylinder is not sufficiently sensitive to control the minute quantities of chlorine passing through the Dakin's solution apparatus. It is therefore necessary to attach to the main tank valve as shown, an auxiliary tank valve capable of fine adjustment as indicated in the cut. The connection from the auxiliary tank valve to the meter block is made as shown.

The progressive sterilization of infected war wounds is ascertained through the bacteriological control of the wound, an essential feature of the Carrel treatment. Smear specimens are prepared from time to time, according to the judgment of the surgeon in charge, and the number of germs in several microscopic fields is estimated, especially toward the end of the treatment, when the question of closure by sutures enters into consideration. Practically complete absence of germs is noted in the average case at the end of from 4 or 5 to 12 days' treatment of soft-part wounds free from gangrenous tissue, or from 13 to 25 days in extensive wounds complicated by fractures. When treatment can be begun within 24 hours after the infliction of the wound, sterilization is as a rule rapidly accomplished. Two weeks or more may be required to sterilize a compound fracture, uncomplicated by gangrene, when the instillation is begun within 24 hours. In such cases, after the sterilization has been effected, large bone splinters may be fixed in position with Beck's paste, or large gaps bridged with adipose grafts, after which the wound may be closed and managed as a simple fracture.

Neglected or improperly treated inflamed wounds of more than 24 hours standing may be bathed with the Dakin solution, and fomentations of hot water and alcohol applied, but local interference is



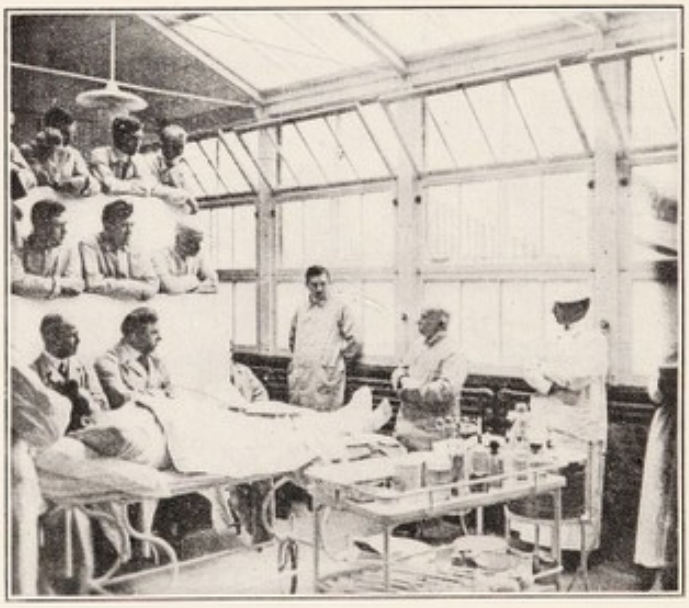
Dakin's solution apparatus.



Dakin's solution apparatus with large chlorine cylinder.



War Demonstration Hospital, New York.



The War Demonstration Hospital. Carrel-Dakin method of treatment being demonstrated at a special course given for Army and Navy surgeons by Dr. Carrel. Prof. W. W. Keen speaking to class, contrasting treatment of wounds in the Civil War and the present war.

contraindicated during the inflammatory period, which lasts several days or even weeks. Suppuration once established, existing abscesses may be evacuated and instillation tubes introduced, postponing the search for foreign bodies or the exposure of sinuous tracks until more favorable conditions have been provided by the antiseptic solution. The Italian proverb, "Chi va piano va sano," is a good one to follow in these cases.

Should convalescence be unduly protracted, with persistence of microbes notwithstanding careful observance of all rules of treatment, the wound must be explored in order to discover the cause of the trouble, which may be in the form of minute foreign bodies, particles of necrotic bone or infected marrow, fistulous tracts, or the like. Neglected wound recesses, not reached by any tube, are frequently responsible for delayed healing. One of the conducting tubes may slip or drop; or one or more tubes may become bent or kinked. Again, the instillation apparatus may have been incorrectly installed, or the relative calibers of the several tubes may not correspond to the rules for the treatment.

At the War Demonstration Hospital of the Rockefeller Institute in New York, where everything needed for the complete exposition of the subject has been provided, large numbers of surgeons have been enabled to study this valuable method of wound sterilization practically as well as in the war hospitals abroad. A hospital with 100 beds, with a first-class equipment for this particular purpose, has been erected, and nothing is omitted in the demonstration of every feature of the treatment and in the exhibition of the theory and practice of this novel adaptation of Lister's teachings to the wounds of modern warfare. The teaching includes the preparation of the solution and of the patient; the adjustment and operation of the instillating apparatus; the application of the dressings; the taking and testing of smears; briefly, the entire technique of the method. The clinics of Major Carrel and lectures of Dr. Loewy have contributed largely to the popularizing of the system among the students, who thus have become acquainted with it theoretically at the fountainhead of information, and practically through some of the trained members of Carrel's Compiègne staff.

The regular course given by Major Carrel, with Dr. Dehelly and Dr. Loewy, has attracted many United States Army medical officers and a few Navy men. Dozens of hospital corpsmen have been enabled to take interim courses in the hospital between trips. Small groups are instructed at a time for a period of 10 days to two weeks. This hospital thus provides an excellent and accurate demonstration of the treatment as it should be carried out according to the ideas of its originator. However, one can not here form an accurate estimate of the results in the treatment of war wounds, for the horrors

of infected wounds at home are as nothing compared with those abroad.

The underlying principles of wound sterilization are applied uniformly in recent as well as in long standing wounds, the technique varying only according to the mechanical difficulties attributable to the location of the injury. The solution must be kept in contact with all parts of the damaged area, and this is difficult to accomplish in wounds so situated as to be quickly drained. In such cases the effects of gravity must be counteracted by plugging the dependent aperture with gauze, so as to make a basin of the cavity. Under no circumstances must gauze be allowed to come between the tube and the discharges, as this would prevent the penetration of the sterilizing fluid.

Wounds of the brain require thorough sterilization after the careful removal of the projectile or any other foreign bodies that may be present. It is essential that the solution be brought into contact with all parts, but extreme caution is needed to guard against damage being done to the delicate cerebral tissue. A special apparatus has been constructed for the purpose, which to quote Carrel, consists of "an external tube permeable to liquids, and an internal tube of small caliber by which the antiseptic substance is injected. The external tube consists of a very light framework, on which is stretched a thin fabric which has been rendered hydrophilous. This framework Du Nouy constructs of bamboo hollowed and perforated by a thermo-cautery, while Daufresne makes it of thin wire. The diameter of these tubes varies from 1 to 1½ centimeters, and the length from 4 to 6. In the interior of the tube is fixed a small rubber tube about 2 millimeters in diameter, which is attached to the framework. This little appliance is fixed in the cerebral wound so that the movements of the head can not displace it. The meninges are protected by a piece of gauze impregnated with vaseline. The appliance is connected with a special apparatus which instills the liquid drop by drop."

Many claim that Dakin solution is too irritating for brain cases; others employ it and agree with the staff at Compiègne that it can be used advantageously in cerebral surgery.

Secondary hemorrhage, which is occasionally encountered, may be due to the destruction of the silk or chromic catgut ligatures by the hypochlorite solution. Plain catgut or linen is safer. It may sometimes be attributable to a faulty Dakin solution, which with free alkali will be capable of ulcerating blood vessels as quickly as Labarraque's solution. Again, it may result from the breaking down of a hemostatic clot under the influence of infection. It can be prevented by care in the initial control of hemorrhage. Its occurrence must be met by prompt ligation above and below the danger point.

Several methods of closure are available when the microscope decides that the proper time has arrived. Strapping with adhesive plaster across the wound is perfectly satisfactory when the skin is movable and cicatrization has not begun. There is no pain and no need for anesthesia. A strip of sterilized paper or celluloid should be laid along the wound to prevent reinfection by the plaster, which is not sterile. When the wound is gaping and can not be closed completely, elastic tension may be applied to it and gradual coaptation of the edges be brought about. Strips of plaster three inches wide and long enough to extend 2 inches beyond the wound at both extremities are laid parallel with it and are fitted with shoe-lace hooks which are connected across the wound by means of elastic lacing. The traction exerted by the elastic laces gradually draws the edges near together, and even if complete closure can not be effected because of the loss of tissue there is a great reduction in the interspace left to cicatrize.

If suture should be selected as the means of closure, general anesthesia may best be employed. The skin should be released from the deeper parts if adherent, and its edges freshened by being cut away for the width of about 2 millimeters. Deep suturing may be needed for divided aponeuroses, for example. The bacteriological examination having shown the requisite freedom from bacteria there is no need of drainage. As soon as the wound is in this condition, divided muscles, tendons and nerves should be brought together.

Wounds associated with fracture may be closed, as a rule, the same as wounds of the soft parts. Even in badly crushed limbs, if asepsis can be secured in a few days closure may be effected without any anxiety regarding the bony element of the problem. It will take care of itself. In certain old fractures it may be necessary to fill an osseous gap with Beck's paste or an adipose graft.

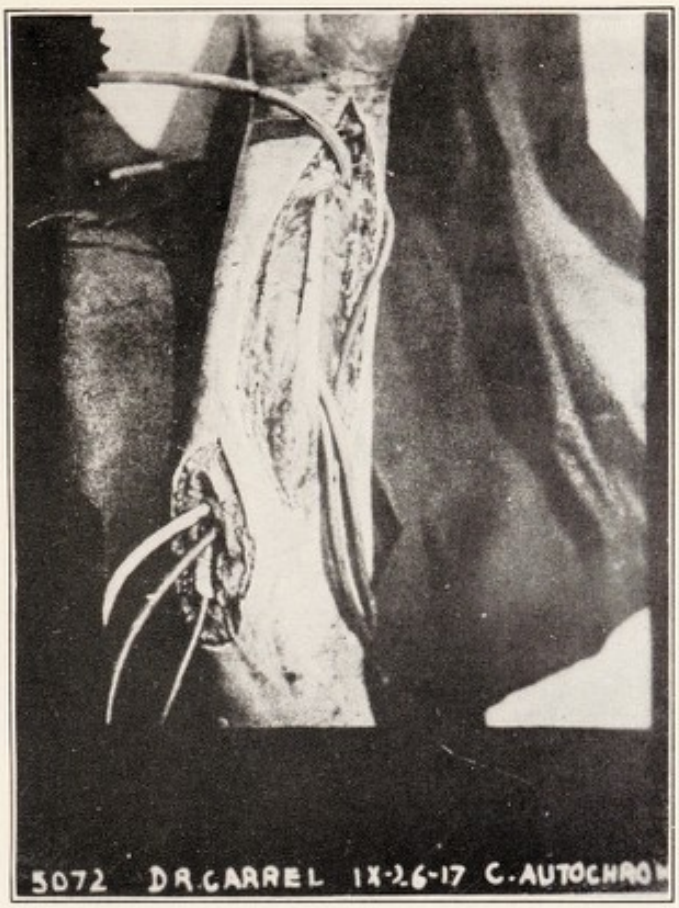
Amputation is nearly always the consequence of infection. An infected wound can not be closed primarily, and hence there is a marked tendency of the soft parts to contract. This may be overcome in great measure through traction, by means of adhesive plaster and a weight. The necessary apparatus does not interfere in the sterilization of the wound. On amputation stumps, a loop of tubing perforated in its middle portion and connected with a Y distributor may be laid next the tissues, and the fluid carried all over the area at the stated intervals. After a few days, according to the bacteriological improvement, the stump may be sutured and treated like any other fresh aseptic operative field.

Joint injuries are treated on the same principle. Simple laceration of synovial membranes quickly resolves under the instillation method. Even where bone injury has occurred, better results and fewer resections follow the gradual sterilization. In streptococcic in-

fection of the joints, amputation has to be gravely considered. If the surface of the bone should have been abraded by the missile it must be scraped to get rid of any infectious material.

The results claimed by Carrel for this departure in the management of war wounds are in broad general terms the salvation of life and limb under circumstances heretofore considered prohibitive. Specifically he cites the "diminution in the frequency and intensity of general complications; diminution in the number of amputations; diminution in the length and cost of treatment." Under the first heading is cited the fact that of 303 cases received from advanced dressing posts in the hospital at Compiègne from December, 1915, to October, 1916, 13 died "after a stay in the hospital of more than 24 hours." Of these, eight had extensive visceral damage, and three had "multiple wounds of thorax, lower and upper limbs." Two cases only died of septicemia. One was due to gas gangrene, the other to staphylococcus infection following extensive damage to the femur. Under the second head, the suppression of infection prevented the complication of lymphangitis, abscess and purulent tracts, thus diminishing the number of amputations. In one year, only three abscesses were observed. Where the extent and character of the lesions did not allow of speedy sterilization they did allow of a great deal of local improvement. This favored the conservative management of many wounds ordinarily calling for amputation. From December, 1915, to October, 1916, only 23 amputations were performed, and where resection of joints was the usual course, the simpler expedient of arthrotomy and sterilization sufficed to save the limb. The amputations were due mostly to such extensive destruction of tissue that nothing else was possible. In only three cases was the cause sepsis. Two have been referred to. The third was a "fracture of the upper part of the forearm with extensive vascular destruction and considerable diminution of the circulation of the limb." This patient recovered. At the hospital at Villars, M. Perret amputated only once in 100 cases. In another series of 100 infected cases MM. Guillot and Woimant did not amputate at all.

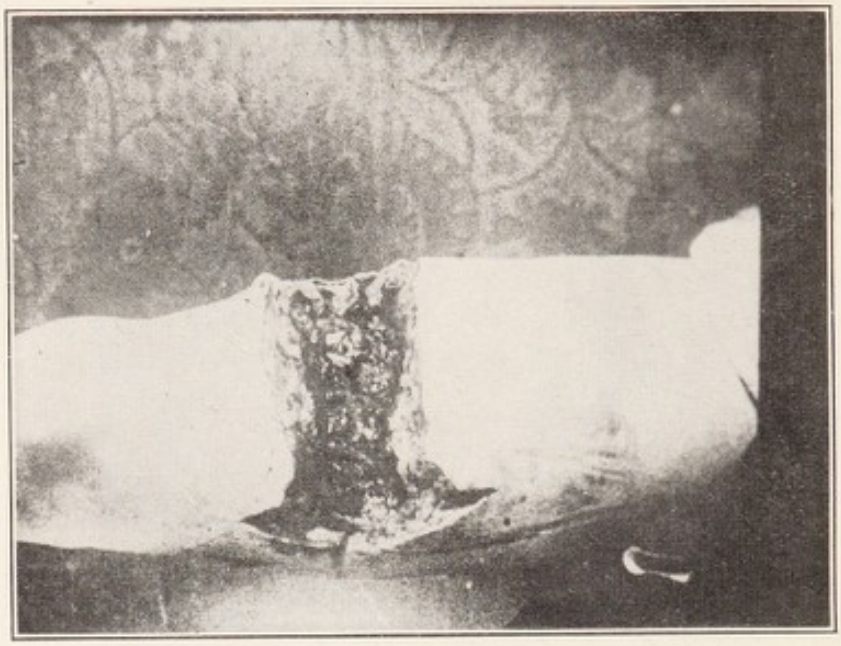
Under the third heading "diminution in the length and cost of treatment," Carrel claims that wounds of the soft parts, no matter at which stage treatment is begun, are closed in 90 per cent of the cases between the 5th and 20th day. The other 10 per cent heal more slowly but much faster than under other forms of treatment. Six months would otherwise be needed to close many of these which are closed in less than one month. The duration of wound treatment is reduced two-thirds. In compound fractures "of short bones, flat bones, and such long bones as the fibula, radius, and ulna, the same progress was made as with wounds of the soft parts." Under "ordinary methods such fractures sometimes suppurate for months." With



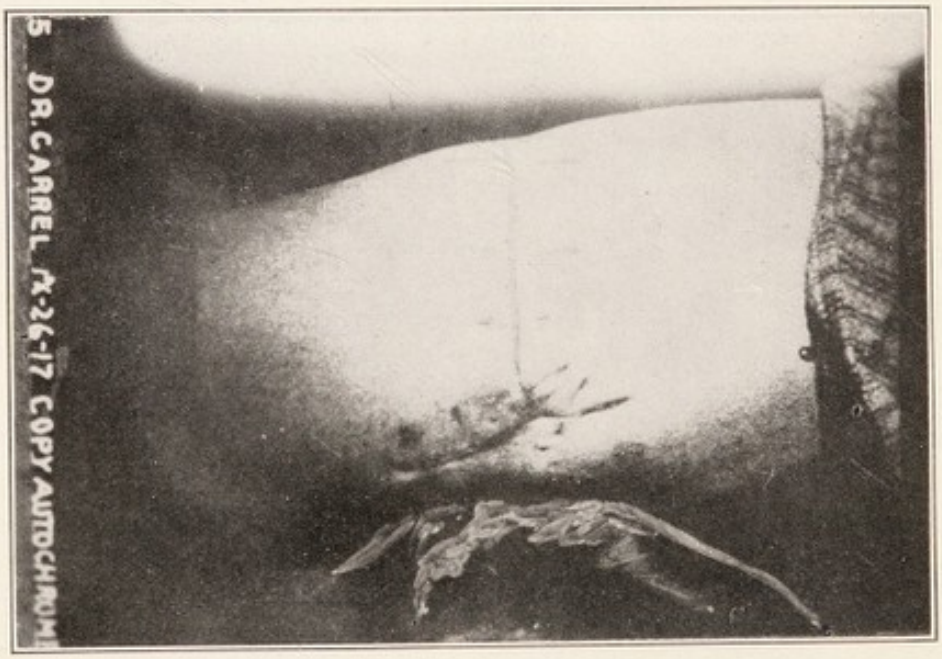
Case No. 1.—Wound of forearm.



Case No. 1.—Wound closed.



Case No. 2.—One of Dr. Carrel's cases. Large shell wound traversing the anterior aspect of the thigh and almost completely dividing the quadriceps femoris. Three and a half hours after the receipt of the injury the wound was laid open and foreign bodies and torn muscular tissue removed. An extensive wound resulted more than 10 centimeters long and extending from one side of the thigh to the other.



Case No. 2.—At end of seven days the patient walked normally.

regard to compound fractures of the "tibia, humerus, and femur, considerable diminution in the duration of treatment is also produced."

The cost of treatment is lessened by the shorter period of care. The materials used are cheap. The net cost of a quart of Dakin's solution is less than 1 cent. Dressings are but slightly soiled and may be resterilized for further use.

The method favors the speedy suturing of nerves and tendons which in a condition of prolonged suppuration would be impossible. Hence the saving of function is very great.

On an average, 97 per cent of old bone sinuses coming to him for treatment are now closed by Chutro, who has used the Carrel-Dakin treatment in all infected cases since 1916 with excellent results. The time required before closure usually amounts to 30 or 40 days.

Pozzi, surgeon in the Hôpital Militaire du Pantheon, was an early advocate strongly in favor of this mode of treatment.

Edred M. Corner, M. C., F. R. C. S., chief surgeon in the Fifth London General Hospital, St. Thomas's Hospital and the King's Hospital, writing in the Clinical Journal of London, April, 1918, advocates this method and quotes Sir George Makins's paper in the British Journal of June 16, 1917, to the effect that "At the present time the most successful results which are being attained in all forms of wound treatment are undoubtedly those in which the Carrel-Dakin method is employed."

In the British Medical Journal of June 2, 1917, Sir Anthony Bowlby and Mr. Cuthbert Wallace say that "the method of Dr. Carrel has been increasingly used and wounds treated in this way have done exceptionally well."

Sir Almroth Wright, who objects to Dakin's fluid on several grounds, considers the Carrel method as the most important contribution made to surgical antiseptic technique since the beginning of the war, which moreover provides a new and improved technique for physiological treatment of infected wounds (Lancet, June 23, 1917).

Sir Thomas Crisp English, on his return from Salonica and Italy, in an interview with me in London and in a subsequent written communication, summed up his experience as follows: "I feel that the Carrel-Dakin treatment is great. I used it extensively in Salonica with excellent results. All of these things call for an open mind and no dogmatic utterance."

In their notes on recent surgery in Salonica (Brit. Med. Jour., March 16, 1918), Colonels English and Kelly, on the basis of their experience as consulting surgeons of the British Salonica force, state that the general treatment of wounds has followed the same evolution as in other theaters of war. At first the ordinary eusol dressing

was most in use. A reaction in favor of the hypertonic saline solution and salt packs then set in. Finally, Carrel's method of treatment has become the one preferred. They emphasize the advantages of continuous wound treatment by one method, and the desirability of adopting a standard plan of treatment, provided an ideal method can be found. "Carrel's method of treatment," they go on to say, "appeared to us to approach most closely to the ideal, and during the past eight months it has been used as the standard method in many of the hospitals. Other forms of wound treatment have been in use, but we have not yet seen with them the same consistency of results, the quick sterilization of the wound and its secondary suture, which certainly occurs with Carrel's method."

The rapid and radical removal of all necrotic tissue is now generally conceded to be imperative in checking infection. In the application of the Carrel-Dakin treatment the proper preparation of the wound in this particular is assisted and supplemented by the constant contact of the damaged tissues with a neutral hyperchlorite solution having a powerful proteolytic action. While further research must show the exact nature of the resulting chemical changes, the activation of proteolytic processes may even now be considered the best-fitting key to the success achieved by the Carrel-Dakin method of treating infected war wounds.

Regarding the mode of employment of hypochlorite solutions, several types of simplified instillation apparatus have been devised which obviate the necessity for a trained hospital staff, carrying into the wound at stated intervals an amount of antiseptic fluid which can be arbitrarily regulated.

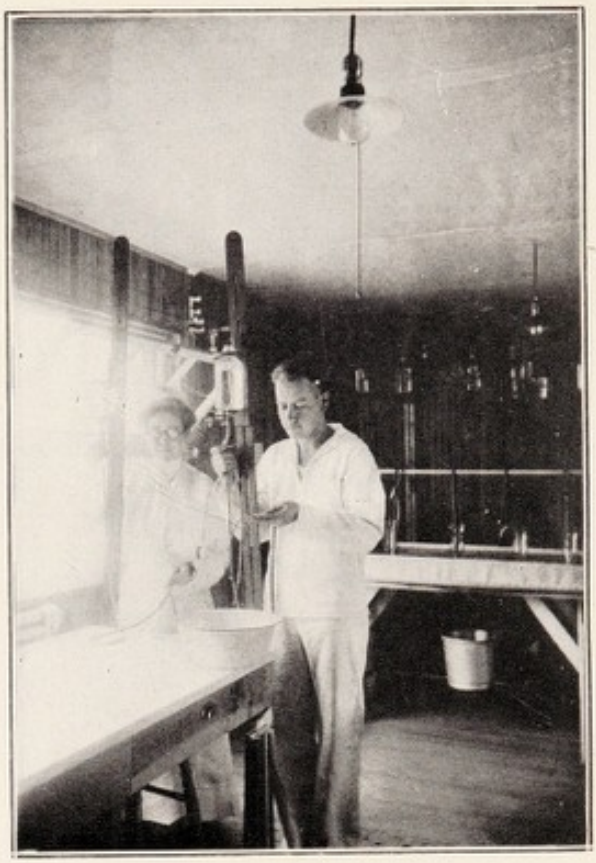
The use of soda hypochlorite solutions has been objected to on the following grounds: (*a*) their irritating effect upon the skin; (*b*) their brief efficiency; (*c*) the necessity for uninterrupted contact of the antiseptic fluid with all wound recesses. The dichloramin-T in oil method, described later herein, was devised by Dakin for the removal of these and other minor objections. The double chloramin used is known commercially as chlorazene; it is dissolved in chlorinated eucalyptol, or chlorinated liquid paraffin may be added. The oils are chlorinated to limit their decomposing action on the dichloramin-T. The bactericidal action persists longer than the activity of hypochlorite solutions. The dressing is simplified by the elmination of the Carrel tube, the dichloramin-T being sprayed over superficial wounds or poured into deep wounds as into a cup. However, the oily fluid does not seem to reach the deep corners of war wounds as the watery solutions do. Besides, necrotic tissue is *not* dissolved by dichloramin-T, which is all-important in many cases. The consensus of opinion is tending strongly toward the retention of the hypochlorite in the Carrel-Dakin treatment and the employing



French surgeon giving a practical illustration of the Carrel-Dakin treatment.



•Hospital corpsman learning to adjust splints at the War Demonstration Hospital, New York.





War Demonstration Hospital, New York. Hospital corpsmen learning the Carrel-Dakin treatment.

of dichloramin-T as a spray in certain infections of the throat, and, if used at all in wounds, only in those which are superficial.

Chloramin paste contains 8 per cent of sodium stearate and 4 to 15 parts per 1,000 of chloramin-T. "It is designed to maintain in an aseptic condition wounds which have already been disinfected, or to sterilize slightly infected wounds. It should only be applied to wounds which yield small quantities of secretion, have little or no necrotic tissue, and little or no infection. Neutral sodium oleate is poured into the wound and the surrounding skin from a flask with a small opening. The granulations, the epithelial edges, and the skin are gently swabbed with a piece of absorbent cotton attached to a forceps. (Great gentleness is required so that there will be no bleeding from the surface.—W. S. B.) By this means an excellent cleansing process is effected. The patient should feel no pain; any suffering indicates either that the sodium oleate is incorrectly prepared or that the cleansing is imperfectly carried out. The sodium oleate is removed with a plug of cotton soaked in water, and the surface of the skin is dried by carefully applying a compress of absorbent gauze. A sufficient quantity of chloramin paste is withdrawn from the receptacle by means of a sterilized wooden spatule and applied to the surface of the wound to the thickness of at least 1 centimeter. It should cover not only the granulations, but also the epithelial edges and part of the surrounding skin. If the wound should be deep and anfractuous, the tube containing the chloramin paste is introduced into the opening, and sufficient chloramin paste is expressed to fill the cavity. But no pressure should be applied during the process. A compress of dry gauze, much larger than the wound itself, is next placed over the chloramin paste. The compress is applied to the surface of the skin and attached to it by means of two or three strips of adhesive plaster. It is important that the gauze should be placed exactly over the wound, for if the bandage is shifted the gauze will introduce bacteria from the surrounding skin on the surface of the granulations and reinfection will ensue. Above the gauze is placed a piece of absorbent cotton enveloped in gauze. The dressing must not be compressed by bandages and should be renewed every 24 hours. The wound is washed out with sodium oleate every day or two, depending on the condition of the skin. The application of chloramin should be painless; any sensation of pain signifies technical error on the part of the surgeon. The bacteriological condition of the wound is examined every day in film preparations of secretions taken from various parts of the wound." (Carrel and Hartmann, Jour. Exper. Med., July 1, 1918, p. 95.)

While claiming brilliant results and supported by eminent surgeons, the Carrel-Dakin treatment is opposed by surgeons just as eminent. Thorough wound cleansing, with immediate suture is held

in high esteem and is undoubtedly the ideal method for treating many cases received at a very early stage. The use of other antiseptices besides the hypochlorites and the chloramines, either in conjunction with the Carrel method of instillation or without it, is also credited with most successful results. Certain excellent authorities with large experience condemn the use of all antiseptics on the ground that they damage still further the injured tissues and contribute nothing to the healing process or the prevention of infection.

The failure of so many able and honest men to agree upon a uniform method of treatment suggests the suspicion that each has hold of a thread of the truth but does not perceive the whole, which is that while much depends upon the sort of wound and the period when it comes under treatment, more depends upon the judgment and skill of the surgeon in first selecting the proper method for each particular case and then applying it.

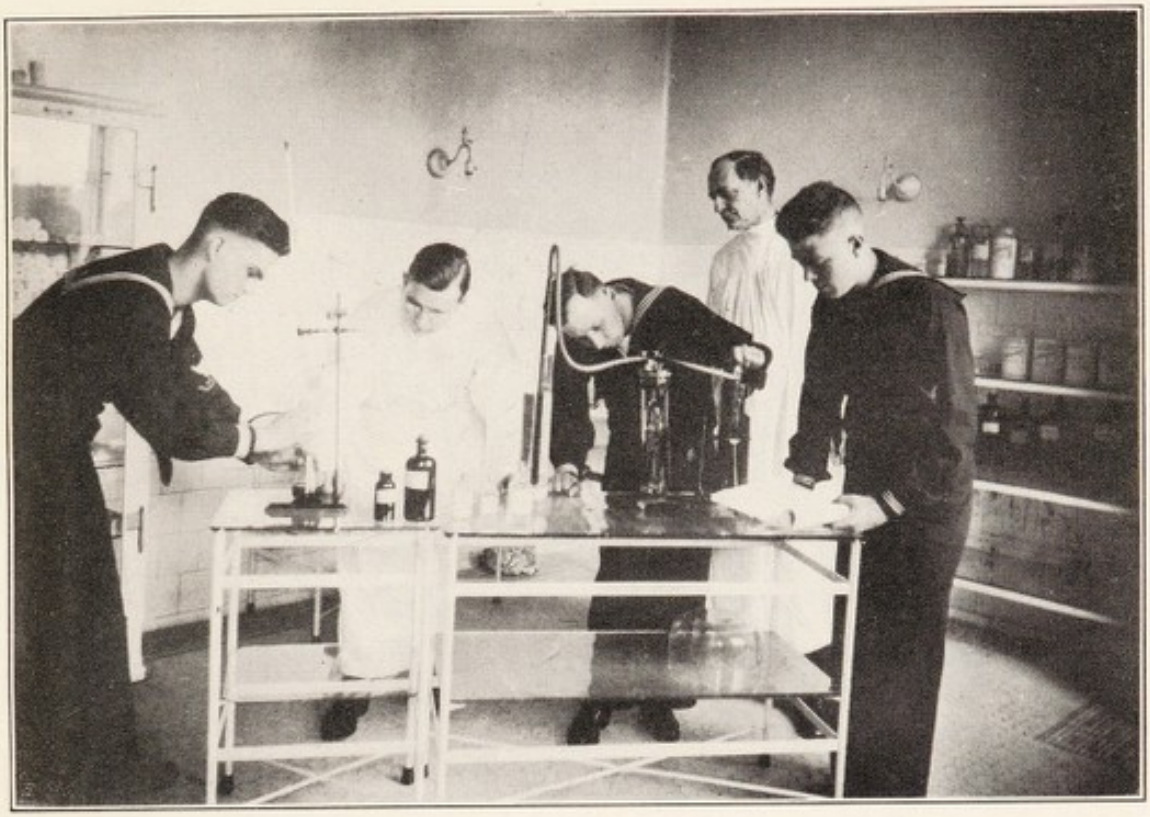
Personal observation in the war zone of the various modern methods of treatment, and the excellent results accomplished by many of them, leads me to accept the judgment of a growing number of surgeons that while most of these methods have definite fields of usefulness, none of them is a panacea. The revival of the sixteenth century practice of immediate wound closure, with thorough débridement, is of undoubted value, and there is reason to hope that it will not again be relegated to the limbo of forgotten things, requiring rediscovery in wars to come. Meanwhile, the Carrel technique has come to stay, as through its employment certain great truths have been revealed. Asepsis, whenever possible, reinforced by antisepsis as required, is the keynote of success. The type of antiseptic and the extent of its employment, may be definitely determined by the future, but at present they are largely matters of individual opinion and preference.

III. OTHER METHODS.

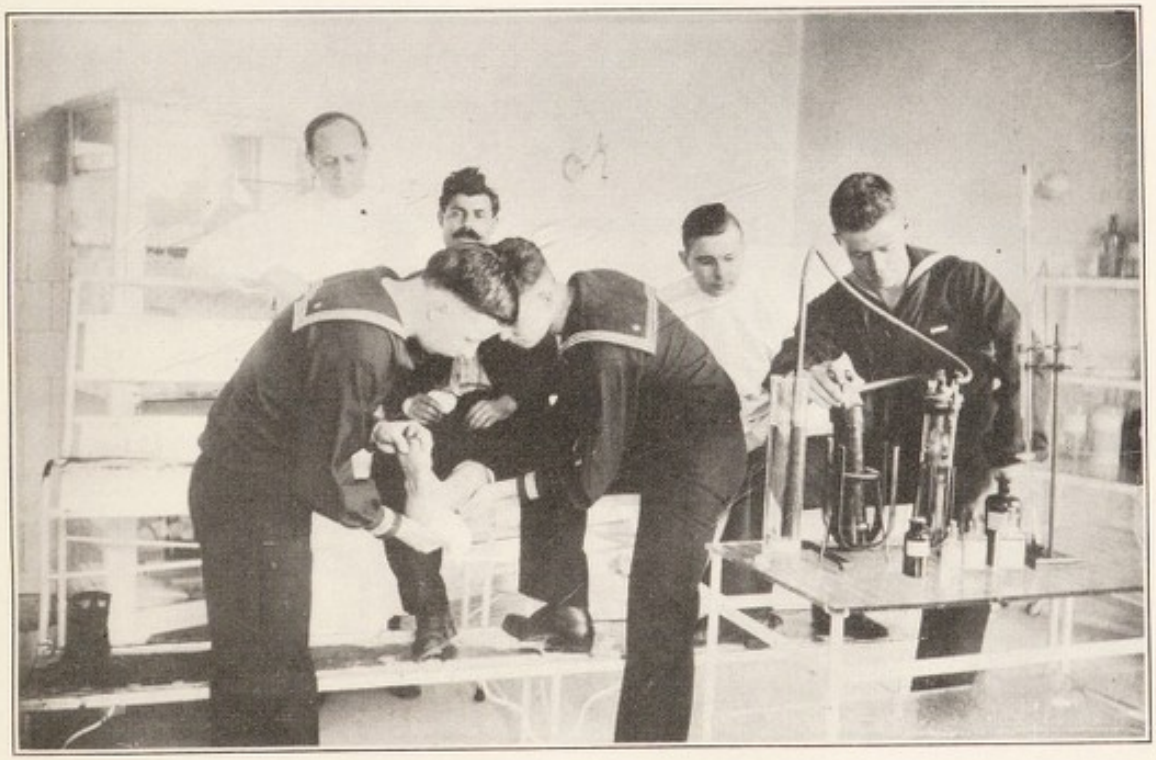
At the many centers visited, numerous antiseptic agents were being employed and varying opinions were held as to the value of such agents. I have attempted to set forth the more important of these and the claims made for them by their originators or those using them, as follows:

HYPOCHLOROUS ACID PREPARATIONS—EUSOL AND EUPAD.

The antiseptic action of hypochlorous acid, and its application to wound treatment, was pointed out in 1915 by Lorrain Smith, Dremman, Rettie, and Campbell, of the department of pathology in the University of Edinburgh. The hypochlorous solution is known as eusol, which is standardized at 0.5 per cent of hypochlorous acid,



St. Bartholomew's clinic. Hospital corpsmen making Dakin's solution.



St. Bartholomew's clinic. Hospital corpsmen strapping a sprained ankle and preparing Dakin's solution.

and was originally prepared on a large scale from dry bleaching powder and boric acid. In smaller quantities, eusol is advantageously prepared, at a moment's notice, by diluting and mixing two stable stock solutions, as follows:

Preparation of eusol.—Take 135 c. c. of liquor calcis chlorinatae (a 10 per cent solution of bleaching powder in water); dilute with water to 1 liter; add 10 grams of boric acid, and shake until dissolved. The solution remains clear, and without further treatment is ready for use. If preferred, a saturated solution of boric acid may be stocked at room temperature; this contains 4 per cent boric acid, therefore 250 c. c. give the amount required for 1 liter of eusol. In making eusol in this way, the 135 c. c. of liquor calcis chlorinatae should be diluted to 750 c. c. and the 250 c. c. of boric acid solution added. This prevents the formation of the precipitate which occurs if boric acid be added to undiluted liquor calcis chlorinatae.

Preparation of eusol for intravenous injection in septicemia.—For this purpose, it is necessary to add sodium chloride in the proportion of 8.5 grams to the liter. In this case, therefore, the 135 c. c. of liquor calcis chlorinatae would be diluted to 500 c. c. with distilled water, the 250 c. c. boric acid solution added, and also a solution containing 8.5 grams of sodium chloride dissolved in 250 c. c. of distilled water.

These methods of preparing eusol were published in the British Medical Journal, September 22, 1917, by J. Lorrain Smith, Tirchie, and Rettie, who say that since liquor calcis chlorinatae keeps well, the method described above has suggested itself as a simple and convenient way of preparing eusol in any quantity desired. Each liter of the liquor yields at least 7 liters of eusol.

(The quantities given in the prescription are calculated on a chloride of lime assaying 25 per cent available chlorine, which is the average obtained from commercial samples at the present time.)

Eusol may also be prepared as follows: To 1 liter of water add 12.5 grams of bleaching powder, shake vigorously, then add 12.5 grams boric acid powder and shake again, allow to stand for some hours, preferably overnight, then filter off, and the clear solution is ready for use.

The solution contains:

	Per cent.
Hypochlorous acid	0.54
Calcium chlorate	1.28
Calcium chloride	.17
Total	1.99

Another method of preparing eusol.—Shake up 25 grams of eupad (equal parts of commercial bleaching powder and boric acid, intimately mixed and ground in a mortar) with 1 liter of water. Let

stand for a few hours, then filter through cloth or filter paper. Keep the mixture in a closely stoppered bottle, and do not expose to light.

Eupad is the name given to hypochlorous acid in powder form, and consists of equal weights of finely ground bleaching powder (chloride of lime) and of boric acid.

Hypochlorous solution, electrically produced from hypertonic saline, was recommended as a strongly bactericidal disinfectant for septic wounds, by Beattie, Lewin, and Gee (Brit. Med. Jour., I, 1917, p. 256). Their apparatus can be installed in any hospital or institution, and a supply of the solution produced at a very small cost. The lymph flow in the wound is encouraged by the hypertonic solution which is used for the production of the hypochlorite. Surface bacteria on septic foci seem to be destroyed almost immediately, and the stimulating action on the lymph flow tends to wash to the surface the more deeply situated organisms.

It is claimed that this lymph increase is very evident in the wounds treated with this solution.

Mode of preparation of eusol, according to Fraser and Bates (Jour. Roy. Army Med. Corps, London, Vol. XXVII, 1916, p. 791): "In a Winchester quart bottle 27 grams of dry bleaching powder were placed, and to this 1 liter of water was added; the mixture was shaken, and 27 grams of boric acid were added; the bottle was now filled with water, the solution was thoroughly shaken, allowed to stand for a few hours, and then filtered through cotton wool. The clear solution is eusol; it is slightly alkaline to litmus and it contains approximately 0.5 per cent hypochlorous acid. The solution was stocked in air-tight stone jars."

The same writers report most gratifying results from intravenous injections of eusol, varying in amounts from 40 cubic centimeters to 70 cubic centimeters in cases of autotoxemia subsequent to infection of a wound with gas-producing organisms.

Packing with salt sacks (Gray's method), to which eupad powder has been added, is advocated in the treatment of septic gunshot wounds on the basis of good results in a large series of cases by Major Hull, of the Royal Army Medical Corps. A convenient method of combining the eupad with salt is to pack the wound with ordinary salt sacks sterilized in the autoclave and introduce into the middle of the sacks without touching the wound an unsterilized sack filled with eupad. (Sacks filled with eupad and salt in the proportion of one to three are destroyed in the autoclave owing to the corrosive action of the hypochlorous acid upon the fabric.) The solid salt sack consists of a two-walled sack of suitable size, made of bandage, between the layers of which four layers of gauze are placed. The interior of the sack is filled with salt and the tail of the bandage forms a drain. The sacks are made in different sizes, sterilized in

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an autoclave and stored ready for use. One or more of these sacks is used to pack wounds, the spaces between the sacks being filled with gauze. A tube of perforated zinc or rubber may be passed into the depth of the wound in case of large septic wounds. Six days may be said to be an average time for the sacks to remain in the wound.

The successful results of this treatment largely depend, as all treatment of septic wounds must, upon an early attack on the sepsis and upon the thoroughness with which it is possible to remove septic and necrosed tissue.

SALT PACK METHOD OF WOUND TREATMENT.

The salt pack treatment of wounds was introduced by Colonel H. M. W. Gray (Brit. Med. Jour., I, 1916, p. 1), for the purpose of promoting a lymphagogue action and obviating the need for elaborate drainage or continuous irrigation. As to results of the treatment with salt pack, Donaldson and Joyce write in The Lancet of September 22, 1917: "The adoption of this method has considerably curtailed the patient's period of convalescence, and has, moreover, succeeded where other methods have failed, including the much-advocated Carrel-Dakin procedure."

The method is distinguished by its simplicity, the avoidance of daily dressing of the wound, the prompt development of healthy surface granulations, and rapid improvement of the general condition.

Application of tablet and gauze packs.—After the wound has been cleaned by operation, all the recesses of the wound (these recesses should be sought out by the finger) are filled, fairly firmly, with gauze wrung out of 5 to 10 per cent salt solution, in the folds of which are placed numerous tablets of salt. Blood clots which may form during the packing should be wiped away. The gauze should be packed concertina-wise, a tablet being placed between every third or fourth fold. A fairly large, fenestrated rubber tube is placed so as to reach to the deepest part of the main cavity, which is then filled with gauze and tablets. The dressing is made flush with the skin and the tube projects slightly from its midst. The surrounding skin is painted with solution of iodine or other antiseptic application. Two or three layers of gauze are then used to cover the wound and surrounding skin. A suitable amount of absorbent cotton wool is applied and a bandage wound on smoothly and firmly. Should pus collect in any isolated part of the wound, it is not necessary always to remove the whole of the pack, and thus to cause the patient unnecessary pain, and to jeopardize the healing of the rest of the wound. Irrigation and drainage of the affected part may be instituted. The rest of the "pack" will probably become loose in a few days. If it is suspected that any part of the wound will give trouble in this way, a drain down to that part should always be inserted.

In the answers to questions regarding saline treatment sent to 22 hospitals in July, 1915, tablet and gauze packs were judged to be best for deep and fairly recent wounds.

DICHLORAMIN-T.

This chlorine compound was introduced by Dakin, and on account of its greater chlorine content is claimed to exert a much stronger germicidal action than the sodium hypochlorite solution used as Dakin's fluid in the Carrel method of wound treatment. Its basis is a by-product in the manufacture of saccharine, and it is known commercially as chlorazene.

The conclusions arrived at by Professor Sweet, working with the United States Army Base Hospital No. 10, in France, show that Dakin's dichloramin-T, in solution in eucalytol and paraffin oil, is of great advantage in wound treatment, because—

(1) It saves the pain of wound dressing.

(2) It effects an appreciable saving of dressing material.

(3) The amount of solution needed is small in bulk.

(4) The number of wounds which a surgeon can dress in a given time is far greater than by any other method.

(5) The elimination of the Carrel tube simplifies the dressing and the problem of transportation of the wounded.

(6) The elimination of the Carrel tube saves the time taken by the nurse for the periodic flushing.

Lieutenant Commander R. G. Le Conte, Med. Corps, U. S. N. R. F., of Navy Base Hospital No. 5, is a strong advocate of this agent in war wound treatment. Some, however, have found its usefulness confined to superficial wounds. Others who were at first enthusiastic have now discarded its use.

Some very favorable reports have recently been made on the value of dichloramin-T solution, 1 or 2 per cent in chlorocosane, as a spray in infections of the upper air passages.

"Chlorocosane" is an oil obtained by the chlorination of paraffin wax, and has been found by Dr. Dakin and Dr. Edward K. Dunham, of New York, to be the most satisfactory solvent. They describe as follows the way in which the antiseptic action of dichloramin-T is exerted:

> It is well recognized that antiseptics incorporated with or dissolved in oily substances usually possess little, if any, antiseptic activity, because intimate contact with the infected matter is hindered by the oil. When, however, such oil solutions of dichloramin-T as will be described are brought in contact with aqueous media, the partition coefficient between the oil and the water is such that a certain amount of the dichloramin-T passes into the water and there exerts its germicidal action. The amount of dichloramin-T thus passing from the oil is enhanced by the presence in the aqueous medium of substances capable of taking up chlorine, so that the oil solution serves as a store for the antiseptics, which is drawn upon to maintain the germicidal activity of the aqueous medium with which it is in contact. Thus the amount of antiseptic leaving the oil solution is, to a certain extent, dependent upon the rate at which it is used up in the aqueous medium.

MAGNESIUM SULPHATE.

The practice of Morison and Tulloch (Jour. Roy. Army Med. Corps, London, Vol. XXVII, 1916, p. 375) in treating recent wounds, both of bone and soft parts, has been to swab the wound freely with pure carbolic acid, packing it afterwards for 24 hours with gauze steeped in carbolic lotion (1 in 20). This, together with free and dependent drainage, has been frequently successful in obviating or minimizing sepsis.

This is followed at the end of 24 hours by the application of the magnesium sulphate dressing, which is painless and easily carried out. Even in the most septic cases the dressings need be changed only twice a day.

The effect on the wound is very striking. In two or three days pus has almost disappeared, sloughs begin to separate, and the whole surface presents a bright color. The granulations never become flabby or edematous, but instead a firm vascular healing wound is seen. Scratching the surface of the wound with a probe hardly disturbs the vascular granulations. The growth of epithelium from the edges of the wound proceeds vigorously, and the treatment may be continued with advantage until the entire wound is healed. The resulting scar is firm and elastic and seldom tends to contract or become painful.

Magnesium sulphate solutions are not recommended as a first dressing for fresh wounds, but as a curative dressing in the succeeding phase of wound repair.

BIPP (RUTHERFORD MORISON'S METHOD).

The name was chosen by Rutherford Morison for the sake of brevity and because it indicates the constituents of the bismuth-iodoform-paraffin paste. Bipp is bismuth subnitrate or carbonate 1 part, iodoform 2 parts, paraffin in quantity sufficient to make a soft paste.

The Morison treatment, in conformity with the most advanced surgical views, consists primarily in the mechanical removal of all necrotic material and tissue detritus from the surface and interior of the wound. Blood clots, wound secretion, bacterial and other contaminations are removed through energetic friction of all wound recesses, and after the wound has been dried with alcohol, the antiseptic paste known as bipp is spread over the wound surface and rubbed in. The wound is then sutured, closed, dressed, and left to itself for about twelve days, after which time it is expected to have healed or nearly so.

Sir Berkeley Moynihan, in a recent paper on surgical experiences in the present war, says that Rutherford Morison's method is widely practiced in the base hospitals in England, and by many surgeons

considered the most satisfactory of all. This method of wound treatment in the opinion of Sir Alfred Pearce Gould (Brit. Med. Jour., II, 1917, p. 677) constitutes the highest attainment yet achieved.

The following results have been obtained by means of this up-to-date method of wound treatment:

(1) Healing of large infected wounds, without special drainage, and without change of dressings up to a period of six weeks.

(2) Safe closing of such wounds by sutures, at any stage of their repair.

In the opinion of Colonel H. A. Ballance, Medical Bulletin (Red Cross), March, 1918, there is as yet no reliable scientific evidence to show that "this much recommended bipp" enables a surgeon to sew up a wound successfully which without it he would have been unable to close.

Bipp first came into prominence early in 1916, and in the winter of 1916–17 was a close competitor of the Carrel method in the British army. Morison's recent book urges most convincingly the merits of his method.

FLAVINE.

Flavine is a chlorine compound, with strong bactericidal properties, and was originally known as trypaflavine, on account of its therapeutic effect on trypanosome infections. On its first introduction into the treatment of war wounds, it was enthusiastically received, and at first highly commended, more particularly by Browning and his coworkers in the Bland-Sutton Institute of Pathology of the Middlesex Hospital, London (Brit. Med. Jour., I, 1917, p. 73). Later experiments, by Hewlett (Lancet, London, II, 1917, p. 493) showed the germicidal value of flavine to be much lower than was originally claimed for it. Moreover, this antiseptic was found by Fleming, in the research laboratory of a base hospital in France, to have a very destructive effect on leucocytes, this effect during 24 hours being greatly in excess of its bactericidal action.

Major W. Pearson, surgical specialist, in comparing the relative value of flavine with other substances used under similar conditions (using no hypochlorites or other agents for which special merit has been claimed) noted no substantial differences between flavine and the other substances, such as normal saline, boric lotion, weak biniodide solution, and cyanide gauze, in regard to the control of sepsis and constitutional signs of toxemia, but in regard to the processes of repair, flavine proved definitely inferior to the others. "That is to say that I found flavine not only not an excellent wound dressing but relatively a bad one," he writes in a letter to the editor (Brit. Med. Jour., I, 1918, p. 271). On the other hand, Colonel E. M. Pilcher and Lieutenant Colonel A. J. Hull (Brit. Med. Jour., I, 1918,

p. 172) point out that in the many hundreds of cases (rather more than 5,000 at present) treated with flavine in the hospitals under the command of one of them, they have found that for ease of preparation and application, rapidity when dealing with large numbers of cases, early cleaning of the wounds, and abatement of constitutional reaction to absorption, flavine (and also its congener brilliant green) is an admirable application under all circumstances, but especially where surgeons are few, time is short, and wounds are many. No skin irritation was noted in the 5,000 or more wounds under their observation.

Both acriflavine and proflavine were found by Major Robert B. Carslaw and Lieutenant W. Templeton (Lancet, London, I, 1918, p. 634) to be of undoubted value in controlling and preventing the spread of sepsis, as shown by the rapid improvement in local and general conditions. "This object having been gained, there is no advantage in continuing their use, as a condition is reached in which the reparative changes are slow, although not by any means absent. Following on the substitution, after a few days, of a more stimulating antiseptic, e. g., eusol, a clean wound is obtained sooner than by any other form of treatment known to us."

Comparison of action of acriflavine and proflavine.—Although the action of these two salts is very similar, there can be no doubt that proflavine is slower. The improvement in the general condition of patients is not so rapid. The formation of the fibrin membrane is not usually complete until the fifth, sixth, or seventh day in contrast with its presence on the third, fourth, or fifth day when acriflavine is used. Further, separation of membrane and attainment of a clean wound are also slightly delayed.

The conclusions of Captain W. Parry Morgan, on the action of acriflavine and proflavine (Lancet, London, I, 1918, p. 256), are as follows:

1. Acriflavine is, as regards both its antiseptic and toxic properties, more potent than proflavine.
2. Acriflavine has a very marked bactericidal inhibiting action on streptococci and a less marked one on staphylococci, but on some other organisms its effect is practically insignificant.
3. Its action is therefore strikingly selective.
4. It has a marked but slow toxic action on the tissue.
5. This toxic action of acriflavine is not so great that when used in dilute solution (say 1:4,000) it should not make an effective application in a dressing for a wound infected with streptococcus or staphylococcus.
6. It should be applied after the wound has been thoroughly cleansed by washing, first with a rapidly acting antiseptic lotion, such as Dakin's soultion, and then by a normal saline.

In a paper (which is the substance of an official report in Oct., 1917) published in The Lancet, I, 1918, page 370, Major W. Pearson reports unfavorable clinical observations on the effects of flavine in wound treatment, and states that since completing his observations he has entirely abandoned the use of flavine in his work. "In cases where infection and sepsis are active and uncontrolled, the use of flavine following suitable operative measures has no beneficial effect on the subsequent progress of the case in so far as the control of sepsis is concerned. Any slight differences observed were unfavorable. In cases where sepsis has already been controlled and repair has begun flavine acts injuriously, chiefly by producing an unhealthy granulating surface." While these conclusions do not prove that flavine may not possess powerful germicidal properties in certain experimental conditions, he believes they show that its clinical use is not attended with good result.

Flavine is preferred by Sir Anthony Bowlby, as a dressing with sterilized gauze, after excision has been done, before the performance of suture for the reason that it has no toxic or irritating qualities and the gauze soaked in it (and kept moist by jaconet and non-absorbent wool) does not stick to the tissues, and leaves a good surface for suture (Brit. Med. Jour., I, 1918, p. 335).

Flavine, brilliant green, malachite green, and other colored pastes consisting of a greasy base and an aniline dye, enjoyed their greatest vogue for war-wound treatment during the year 1917.

Brilliant green, or ethyl green, is homologous with malachite green, which is benzaldehyde green and makes a bluish-green solution, more intense than brilliant green solutions, decolorized by hypochlorites.

Proflavine is a preliminary product in the manufacture of acriflavine (diamino-methyl acridinium chloride) and its preparation is therefore more simple and less expensive. The employment of flavine antiseptics as well as all others must be preceded by the excision of all hopelessly damaged tissue, combined with careful mechanical purification of the wound.

Composition of brilliant green paste.—This paste, which was introduced by Captain Wilson Hey in the treatment of infected war wounds, is composed of boric acid, paraffin, chalk, and brilliant green.

The application of this paste is reserved for those war wounds which can be freely opened and excised, with removal of all necrotic matter and foreign bodies. Small, completely excised wounds could be primarily sutured after the application of brilliant green, in the experience of Captains Rendle Short, Arkle, and King. In war burns, under the care of Major Hull, irrigations with brilliant green lotion, followed by paraffin paste, yielded better results than any other treatment.

CRYSTAL VIOLET AND BRILLIANT GREEN.

The use of a mixture of crystal violet and brilliant green in strong solution, for the sterilization of the skin and other surfaces, was recently suggested by Dr. C. H. Browning, director of the Bland-Sutton Institute of Pathology, Middlesex Hospital, where the method has been a part of the routine for the last two and a half years. The method rests on the theoretical consideration that these substances are both extremely potent antiseptics, and at the same time devoid of irritating effect on the skin when applied in high concentrations. The solution in use contains 1 per cent of a mixture of equal parts of crystal violet (the substance employed should be hexa- or penta-methyl violet or a mixture of these) and brilliant green (specified as brilliant green sulphate, zinc free) dissolved in equal parts of rectified spirit and water.

This violet-green mixture was found to be highly efficient, and strikingly superior to iodine, as a means of effecting both thorough and rapid sterilization of the skin. Streptococci and staphylococci are among the organisms most susceptible to these dyes. (Brit. Med. Jour. I, 1918, p. 562.)

In the experience of Captain R. Massie, covering 46 cases of severe gunshot wounds in which the soldiers' subsequent progress after wound treatment with brilliant green could be ascertained, brilliant green proved a useful antiseptic, especially in a solution of 1:500 in 0.5 per cent chloretone. It produces exuberant, but very vascular, bright red granulations. Noticeable features in cases treated with it are the absence of edema and inflammation around the wound and the rapidity with which sloughs and sequestra separate. It is painless in application, and does not appear to interfere with the growth of epithelium. Although it can by no means atone for a complete or faulty primary excision it may be used with advantage where anatomical conditions render complete primary excision impossible. (Lancet, London, I, 1918, p. 635.)

HYPERTONIC SOLUTIONS (LYMPHAGOGIC AGENTS).

Substances which produce a free flow of lymph from the tissues with which they come in contact, thereby indirectly flushing the wound and diluting the toxins, have been recommended in the treatment of infected war wounds by Sir Almroth Wright and his followers. Although the lymphagogic effect increases in proportion to the strength of the salt solution, it is not desirable, on account of the resulting pain and irritation, to go beyond 10 per cent of salt, even in the case of sloughing wounds. In order to prevent the lymph coagulating on the siphon bandages, and on the walls of the wound itself, citrate of soda is employed in combination with hypertonic salt

solutions. Blood mixed with pus is prevented from clotting by 5 per cent of salt mixed with 0.5 per cent of citrate of soda. For the sole purpose of irrigation and removal of pus, the citrate is unnecessary.

In order to encourage a free outpouring of lymph from the whole internal and external surface of the wound, Sir Almroth Wright proposes an arrangement of bandages by means of which the irrigating fluid can be led into the wound where it is required, be distributed so as to wash down all walls, and then be carried away without any leakage into the bed. Loops of sterile bandages, previously soaked in a solution of 5 per cent sodium chloride and 0.5 per cent sodium citrate are introduced into the wound, after this has first been syringed out with the solution. The free ends of the bandage are carried out from the wound, to be inserted between piles of lint well soaked in the solution and folded over so as to form a thick pad. Finally, one or two tabloids of salt should be placed in between the back layers of the pad, and over the top of all a layer of impervious protective tissue.

Formula of Wright's solution.

Sodium citrate	centigrams	0.50
Sodium chloride	do	.30
Distilled water	grams	100

The employment of this "antiseptic anodyne" yielded excellent results in the experience of Dickinson, who has used it for two years in all sorts of cases, the wounds remaining clean and healing more rapidly than under the use of any other liquid.

Sir Almroth Wright says with regard to this lymphagogic solution, or rather with regard to a simple 5 per cent salt solution, which he finds works in most cases equally well, that it has in this war proved itself permanently useful. When brought into action upon a dry and infiltrated wound, or a wound that is foul and covered with slough, it resolves the induration, brings back moisture to the surfaces, and cleans up the wound in a way that no other agent does. Applied in gaseous gangrene in the form of a wet dressing to incisions which have been carried down into infected tissues, it causes lymph to pour out of the wound, and arrests the spread of the infection. And, again, applied in gaseous gangrene to an amputated stump in cases where it has been necessary to leave infected tissues behind, it reverses the lymph stream and draws out the infected lymph, saving life in almost desperate conditions.

The activity of salt solutions depends on this "phylacagogic" character, meaning their capacity for bringing the protective elements of the body, blood fluid and leukocytes, into activity in the wound.

SUNLIGHT TREATMENT OF INFECTED WOUNDS.

Heliotherapy, or sunlight treatment of war wounds, deserves to be more extensively employed as a physiological curative method, the routine adoption of which is urged by Dr. M. Cazin (Monograph, Paris, 1917) as a measure capable in many cases of greatly abridging the duration of the treatment of war wounds and essentially reducing the number of war invalids. Sunlight treatment, first recommended by Rollier in tuberculosis and traumatism, is most successful when the patients are exposed nude for many hours to the rays of the sun. Although total insolation is always to be preferred, local insolation with a graded action of the sun on the course of the wounds materially assist the processes of repair. The exposure to the sun must be direct, and in the open air, in order to improve nutrition and promote oxidation, and total, including the entire body, the resistance increasing in proportion to the extent of the insolated surface. Insolation of the clothed body is cautioned against as liable to induce visceral congestion.

The insolation method should be carried out progressively, always beginning with the less sensitive lower extremities, even when the wound concerns the thorax or an upper limb.

Aside from the analgesic action of the sun bath, its local effect promptly induces a change in the condition of the wound. In the second stage of the treatment, about the eighth to tenth day, the suppuration diminishes, after having notably increased following the first sessions, and healthy granulation tissue develops; the wound becomes dry and clean, its borders retract, and a zone of epidermization makes its appearance. Constant phenomena in the sunlight treatment of wounds are regional pigmentation, a change in the character of the pus, and an abundant serous exude over the entire surface of the wound, which soon dries up more or less completely.

In the experience of Cazin, atonic and indolent wounds, on exposure to the sun, became regularly covered with a layer of healthy granulations, and in other wounds without an apparent tendency towards epidermization, an epidermal margin promptly appeared at the borders and advanced without arrest toward the center of the wound.

Sunlight treatment was found to hasten recovery, not only in wounds of the extremities, but also in wounds of the thorax and abdomen. Excellent results were obtained in infected fractures, and in several cases where the bony lesions were such as to endanger the preservation of the limb, heliotherapy led to complete consolidation and perfect recovery. Some cases of infected fracture of both leg bones healed in a few weeks under sunlight treatment, after the condition had remained stationary for months, in spite of repeated interven-

tions and all other treatments. The results of heliotherapy were equally favorable in joint infections, and in the cicatrization of amputation stumps with bony fistulas.

In Delbet's service, all wounds are exposed daily for as long as possible to air and light, covered only with a fourfold layer of gauze without cotton or bandage. Very remarkable results were obtained with this simple treatment. Gravely infected wounds which yielded a highly positive pyoculture became transformed, so that in two days the pyoculture became entirely negative. In one instance, the wound secretions became in 48 hours not only bactericidal but bacteriolytic for the vibrio. This simple plan of wound treatment is warmly recommended by Delbet (Presse médicale, XXIII, 1915, p. 237).

Artificial light, in the form of electric lamps, is always available, and in the experience of Chaput (Presse méd. XXII, 1914, p. 606) was found to be as valuable as the sun bath for local use in burns and ulcerations. An ordinary electric lighting outfit provides a simple, cheap, practical and highly efficient method of treating infected or gangrenous wounds, and it is suggested that this mode of treatment may find its uses in certain complications of war wounds.

PHENOLISATION AND EMBALMMENT OF SEPTIC WAR WOUNDS.

(Mencière's method.)

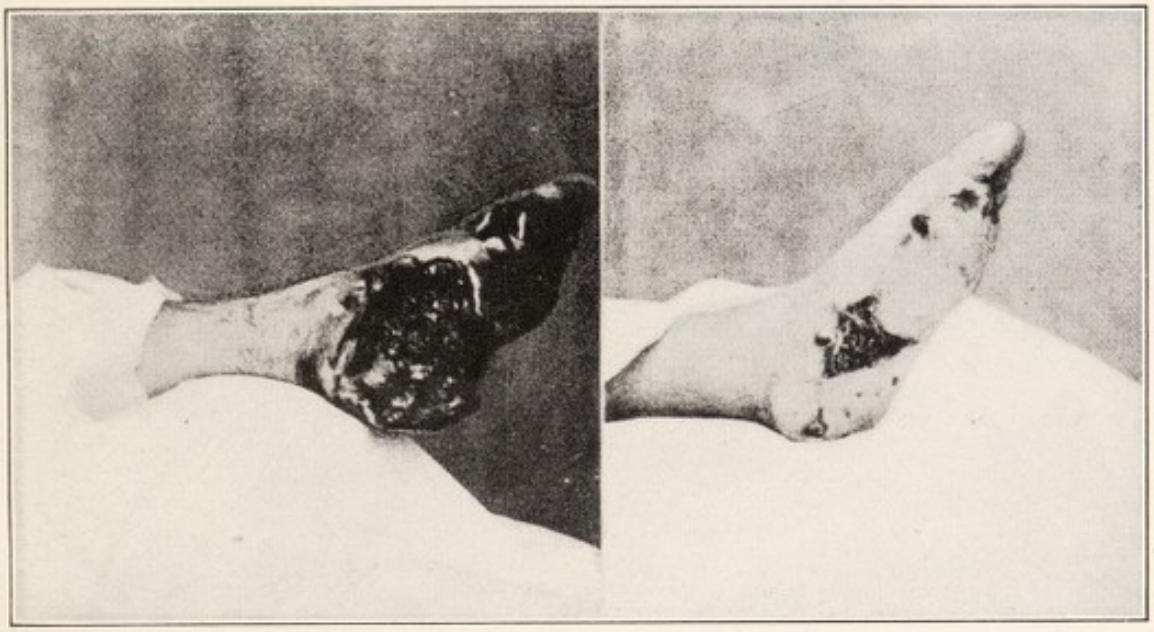
The modern spirit of conservative surgery is embodied in the embalming method proposed by Dr. L. Mencière, the Médecin-Chef of the Hôpital de la Compassion in Rheims, in 1916. A part of the Grand Palais is used as a hospital, and here I found this method of septic wound treatment extensively employed, although in no other place that I visited did I find it used. Dr. Mencière has published a book, which is most interesting, with pictures and statistics of cases. I append hereto pictures of two of his cases.

By phenolisation is meant the subjection of infected war wounds to the energetic action of strong carbolic acid (90 per cent) followed by washing out with alcohol. Reinfection of the cavity is most reliably prevented by the so-called embalmment of the wound, which consists in permanent dressing with gauze wicks soaked in the following powerful antiseptic solutions:

Solution A.

	Grammes.
Iodoform	10
Guaiacol	10
Eucalyptol	10
Balsam of Peru	30
Ether	100

A weaker solution, B, consists of ether, 1 liter; iodoform, guaiacol, eucalyptol, of each 10 grams, balsam of Peru, 30 grams; and alcohol



(a) (b)

April 29, 1916, shell splinter wound, left foot: (a) May 20, 1916, photograph of left foot; (b) June 22, 1916, photograph of left foot. July 25, 1916, walked normally, without a cane; had all movements of hip, knee, and foot.



(1) (2) (3)

Wounded March 2, 1916. Admitted March 5, 1916. Muscles torn off by explosion of "Minenwerfer." (1) Photograph taken March 10, 1916; (2) photograph taken March 19, 1916; (3) photograph taken April 2, 1916.

(90 per cent) 100 c. c. The results obtained with these antiseptic solutions were superior in Mencière's experience to practically everything else.

Phenolisation and embalming of war wounds is advocated by the originator of the method on the basis of favorable experience in wound treatment including the gravest articular traumatisms, and especially in the treatment of gas gangrene. The performance of primary suture, immediate or delayed, is often made possible by the employment of this procedure. About 24 primary sutures of bone and joint wounds, with a successful outcome, after systematic extemporaneous wound embalming, were reported by Gaudier at a meeting of the surgeons attached to the Sixth French Army (Soc. de Chir., February 1916). Preservation of badly wounded extremities, and application of delayed sutures, were made possible in a relatively large number of soldiers apparently doomed to amputation.

ELECTRICITY.

Galvanic, faradic, and static currents are used extensively in the treatment of scars and devitalized tissue resulting from wounds and other war injuries. Lately, the high frequency current and ultra violet ray have been recommended by Rivière of Paris and a number of others. Dr. Rivière showed me some of his work, and urges as follows:

Judicious employment of the high frequency current, also known as Darsonvalization, is a valuable adjunct in war surgery, constituting a potent physiotherapeutic measure for the regeneration of tissues, nerves, and blood vessels. Due to its practically pure content of violet rays, without admixture of heat radiations, this high-frequency treatment exerts a most favorable effect upon cicatrization, besides producing a deep local anesthesia. To this is added the oxidizing and antimicrobic action of the generated ozone, through which the wounds become enabled to resist bacterial invaders. At the same time the ozone, by stimulating the capillary circulation, ensures a beneficent absorption of tried and tested remedies, such as various mineral oils and balsams, iodides, salicylates, etc. The condensed and electrified oxygen stimulates phagocytosis, furthers the formation of red blood corpuscles, and improves the nutritional condition in the surroundings of the lesion.

For the treatment of certain very slowly healing infected war wounds, Rivière, on the basis of favorable experience with a number of cases, suggests the combination of the high-tension current with the most reliable antiseptic balsams; these are atomized by the high-frequency current and superoxygenated through the condensation of the ozone and the static breeze.

OXYGEN AND OZONE IN WAR WOUNDS.

Wound infections and gas gangrene have, in certain cases, been markedly benefited by oxygen-therapy, and aside from older reports, the experience of the present war, although not unanimous, points in the same direction. In the hands of Vennin, Girode, and Haller (Phipps, Thèse de Paris, 1916) oxygen, in the form of injections into the healthy parts, prevented the onset of gas gangrene in badly infected wounds caused by explosive projectiles. In other cases of manifest gas gangrene, but in which the infection was restricted to the wound and its immediate surroundings, its spread was effectively aborted, and when swelling and bronzed discoloration had already invaded the limb, the process was successfully arrested provided no gangrenous patches had developed. Finally, even when the limb was invaded by the putrefactive process, the destruction was successfully limited in certain cases, and in this way a number of lives were saved. Fourteen cases are reported in support of this line of argumentation, and one of these is quoted as especially illustrative of the severity of the infection and the excellent results.

Soldier, shot at short range; comminuted fracture of the humerus, at the level of the upper third, with explosive lesions. The limb promptly became infected, and the gas infiltration soon reached the shoulder, with invasion of the deltoid, pectoral, and part of the supraclavicular regions. Oxygen injections were applied at the root of the limb, the adjacent portion of the thorax and the corresponding side of the neck. Difficulties were encountered in the form of respiratory disturbance due to the tissue-inflation, and the patient's condition appeared desperate. The oxygen injection was repeated the next day, the condition remaining stationary. At the end of another day there was decided improvement, the extension of the gangrene at the root of the limb was definitely checked and a line of demarcation appeared at the level of the fracture in the deltoid region, in the gangrenous area. Improvement continued during the next days, the cleansed wound assumed a good appearance and healthy granulations developed. The patient was evacuated as a convalescent.

It is not claimed that the oxygen method should be employed in war wounds without the assistance of free incisions, or amputation if unavoidable. In Belgium, oxygen has been used to inflate the tissues above and below the wound area to limit infection. It has been extensively employed in gas gangrene by Depage (Bull. et mém. Soc. de chir. de Paris, March 23, 1915, p. 697), who found these injections highly serviceable in the presence of septicemia with subcutaneous gas infiltration. The oxygen spreads under pressure in the entire subcutaneous cellular tissue and checks microbic growth wherever it penetrates. Remarkable changes follow its employment

in the more superficial cases, but when the infection is deep and has invaded the deep cellular tissue of the thigh, buttock, back, or shoulder, the action of the oxygen is necessarily reduced, and the result of its application rendered more doubtful.

Hydrogen peroxide is hard to get but is much favored and considered valuable in sloughing septic wounds.

Ozone treatment of war wounds is a very recent innovation, recommended on the basis of the satisfactory results obtained by Major George Stoker, of the Royal Army Medical Corps (1917). The necessary portable apparatus for generating ozone employed by him is known as the Andriolis ozonizer, which is called into operation by a four-volt battery animating a quarter-inch sparking Ruhmkorff coil. The oxygen passes from a cylinder through the ozonizer, and in doing so comes in contact with a metal armature, the effect of this being to transform the oxygen into ozone.

The treatment consists in the application of ozone to the affected parts. At first ozone causes an increase in the discharge of pus; later on the pus is replaced by clear serum, which at a still later stage becomes reddish or pinkish. Ozone has the peculiar power of disclosing dead bone, foreign bodies, septic deposits and so forth.

Mode of application.—The ozone is applied on the wound surface or to the cavities and sinuses for a maximum period of 15 minutes, or until the surface becomes glazed. It is a strong stimulant, and causes an increased flow of blood to the affected part. It is claimed to be so strongly germicidal that all hostile microorganic growths are destroyed.

Acetozone, or benzoyl-acetyl-peroxide, is a powerful disinfectant of the same group having a remarkably pleasant pungent odor of ozone. It can be applied to deep wounds by Carrel tubes or used cold as a bath containing 5 grains to the pint; in a waterproof bag; or by wet dressings of 10 grain strength solution, renewed two or three times daily. The solution must be made by adding 5 to 7 grains to 1 pint of sterile water at 112 F., left to stand for two hours, and *should not be filtered*. Or a 10-grain to 1-pint solution can be used with dressings or Carrel-Dakin tubes, etc. In very septic cases swarming with anærobes, etc., a 20-grain to 60-grain solution may be used. It should be *made fresh every seven days*, and the bottle shaken before using. In the experience of Gore Gillon and others, numerous septic wounds healed in three weeks under this treatment, after having resisted other measures for four or five months. The action of this germicide is very rapid, and it is claimed that unhealed amputation stumps will heal quickly if placed for 30 minutes daily in a bath of a 7-grain solution with one-third hot water added, the bath to be followed by dressings of sterile gauze soaked in a 10-grain solution. (Brit. Med. Jour., II, 1917, p. 209.)

From the historical viewpoint, it is interesting to note that over 50 years ago, ozonoscopes were installed at Metz, Versailles, and Paris, for the purpose of determining the chief peculiarities of air in inhabited places, and the very suggestive findings are reported in an essay by Gaillard, which was awarded the Fiske Fund premium of the Rhode Island Medical Society, in June, 1861. "The instruments placed in the halls or wards of hospitals give no trace of ozone, whilst placed on the exterior of the buildings they manifested hues corresponding to degrees 7, 8, and even 10 of the ozonometric scale. These hospitals were in the most cleanly and perfect condition, well-ventilated, and manifested no perceptible odor on entering them. Ozonoscopes were placed in the halls for the wounded on the ground floor and in rooms where the windows were opened twice a day, and in which were placed not more than 18 or 20 patients. In the wards for the venereal and fever patients, where the same influences existed, ozonoscopes were placed also, the hygienic relations being equally good, and the thermometer in all instances not exceeding 60 F. Rooms were also selected for these experiments, where the windows were kept always open (by day). The ozonoscope, judiciously arranged in all of these places, remained in situ for 15 days, and exhibited no change whatever, there being not even a trace of ozone present."

The part reserved for oxygen and its congeners in the fight against infection was foreshadowed prior to the war, and 10 years ago, my own investigations dealing with the use of oxygen by infusion into the peritoneal cavity proved so encouraging as to cause me to contribute an article on its use in medicine and surgery to an American periodical, and this has been quoted as one of the sources of information of a very recent French thesis on the subject (Phipps, De l'emploi en therapeutique chirurgicale de l'oxygène à l'état gazeux, 1916). My own experience at the time led me to anticipate the results which the experience of to-day seems to establish. The defensive forces of the organism being peculiarly weakened for a variety of reasons against the infections of war wounds, it seems especially desirable to secure a therapeutic agent which will not exert an injurious action upon the tissue cells. Oxygen, as a matter of fact, far from damaging the cells, has been shown to stimulate cellular activity, to activate phagocytosis, and to favor all defensive reactions, such as diapedesis and secretions. Aside from its effect on anaerobes, it has no direct destructive action upon microorganisms, but by stimulating the activity of the natural defensive forces, it furthers the power of resistance and in this way becomes a valuable physiological assistant in the fight against infection, upon the winning of which depends the success of surgery in general, and of war surgery in particular.

TREATMENT OF WAR WOUNDS BY THE GERMANS.

The lessons of war can not be adequately determined until long after the conflict ends. This is due largely to two factors which are, first, the heat of passion which must have time to cool sufficiently to permit the forming of correct judgments, and, second, the lack of authentic data from both sides. In our search for those lessons which may aid us along medical and surgical lines, the first of these factors may be eliminated, but the second remains, largely as an intentional barrier set up by the enemy.

Germany is making and has made a systematic effort to prevent the leakage of dependable information relating to military medicine and surgery. During a half century of preparation for war the Germans had perfected an organization of ambulance and hospital service, nicely coordinated with the military branch and equal to it in efficiency. They apparently believe that this organization is superior to that of the enemy, and that an interchange of experiences which might tend to prevent suffering and to save life and limb would not be to their particular advantage. This is consistent with their philosophy but devoid of the first elements of humanity.

The severance of postal communication with Germany since our entry into the war, her systematic attempt to prevent trustworthy information from reaching us, and her dissemination of misleading statements prevent us from obtaining full knowledge concerning her progress in military medicine and surgery, but in spite of these barriers there are a few facts relating to her methods and results which we have established from our present sources of information. These are perhaps more valuable by way of comparison than as affording any actual addition to our knowledge.

During the summer and fall of 1915, I was privileged under exceptional auspices to make a hospital, Red Cross, and sanitary survey through Holland, Germany, Switzerland, and back to the United States by way of France and England.

In Germany we were to all appearances received cordially and shown what we desired to see, but it was soon evident that we were even then looked upon in many quarters as future enemies. We were shown what they wished us to see and told only what they were willing we should know. All that we learned could, I felt, be no real basis for generalization, but there must be confirmation and very careful weighing of the whole before any deductions could be drawn.

The sources from which the following was obtained were:

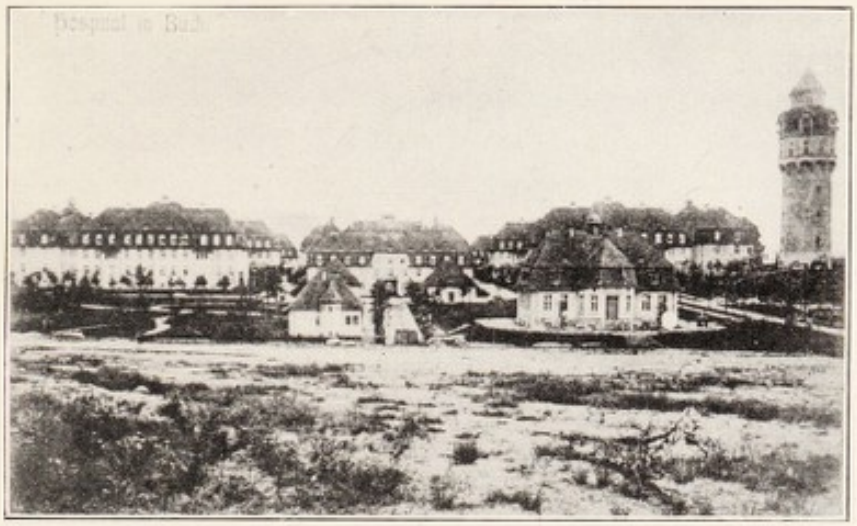
1. Personal observation during the trip.
2. Discussions with those who had been at work in Germany since the beginning of the war, including representatives of the American Red Cross, Y. M. C. A., sanitary agencies, etc.
3. Contact with neutrals or Germans in Holland and Switzerland.
4. Examination of German prisoners in allied camps.
5. Articles in neutral scientific papers.
6. Such books or articles as have been allowed to get through from Germany.
7. Statements by workers in advanced areas at the allied front where the swaying backward and forward of the line often reveals the medical and surgical secrets of one side to the other.

CONDITIONS IN GERMANY LATE IN 1915.

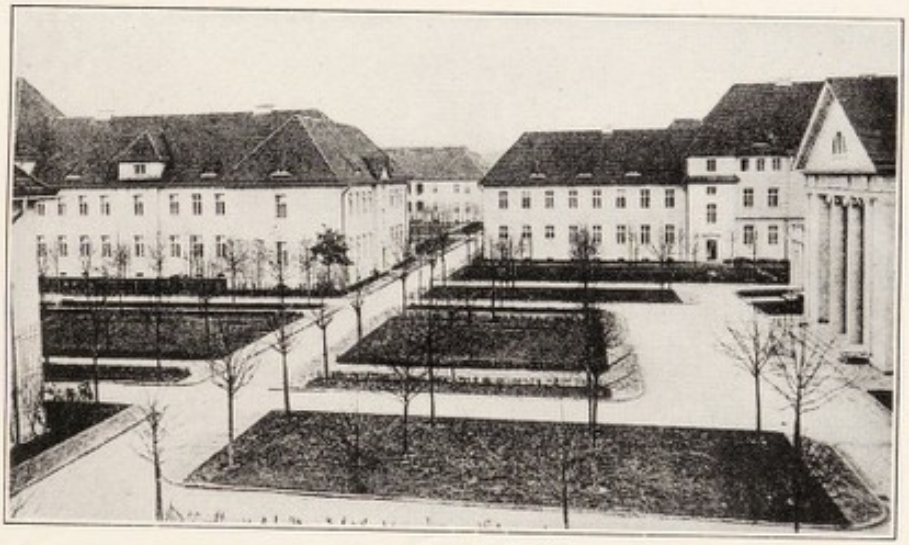
The ambulance and hospital organization at that time was extremely efficient. All had been made ready, and there was indubitable evidence that for years they had clearly foreseen and provided for what was coming. A good example of this forethought was a pavilion hospital at Buch, on the direct line from Berlin to the eastern front. This hospital of 6,000 beds was beautifully situated in the country 40 minutes by express from Berlin. It was already fully equipped for 3,000 patients a few weeks before war was declared and it contained 4,000 patients at the time of my visit. A small railway system connecting the main line with each set of wards made it possible for the wounded entrained at Warsaw to remain undisturbed until their arrival at the entrance of the particular ward to which they were assigned. The most modern methods were employed here, and there was even a special department for gassed cases. This is particularly interesting when the dates are noted, as showing that they were prepared in advance to treat this class of cases.

The equipment throughout was superb and included electrical and mechano-therapy departments, baths of all kinds, a gymnasium with special apparatus for the mutilated, a recreation park, and a theater, seating 600, for plays and moving pictures. Here they showed scenes of peace and pictures of other lands, including, for example, the Yosemite Valley and Niagara Falls; and here also the latest news, always encouraging and patriotic, was flashed upon the screen.

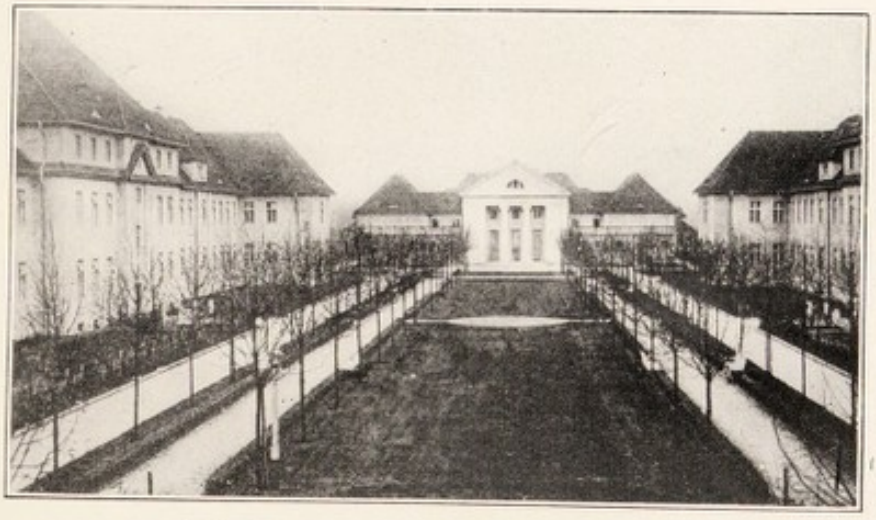
A special feature was the continuous bath ward. Here they treated those patients, who, on account of wounds of the back or, in cases of paralysis, for fear of bedsores, could not remain even on the water bed. Some of the patients had been in the bath for months. This method was also being tried out in cases of septic wounds.



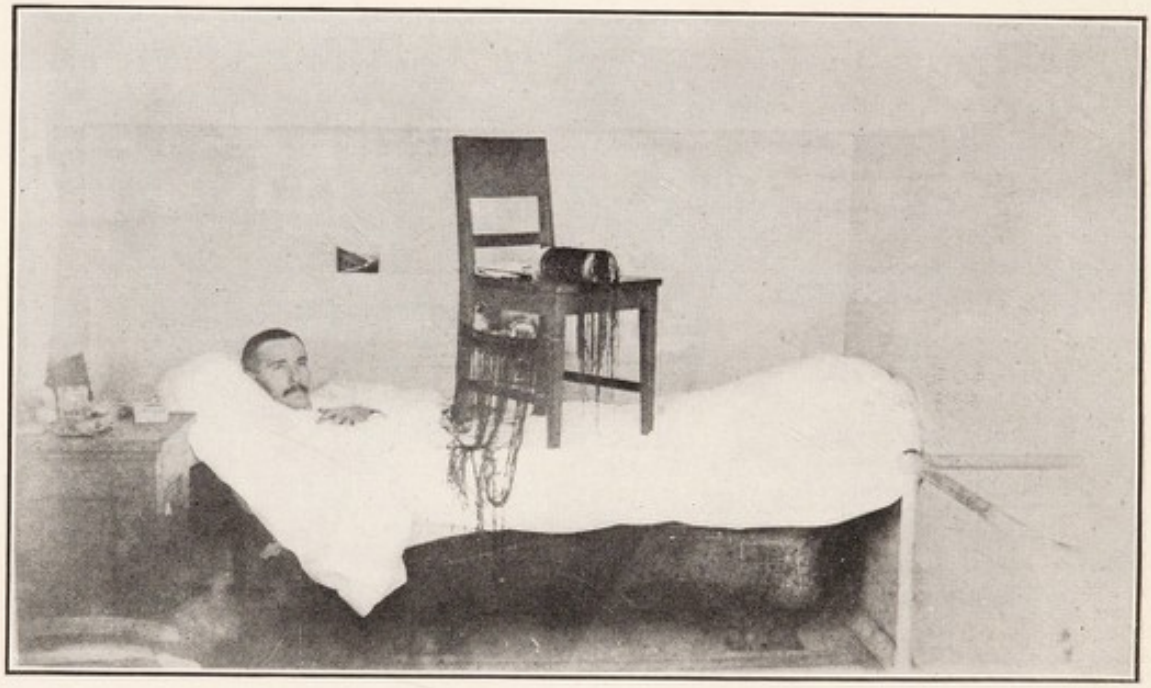
Hospital in Buch.



Kriegs Lazarett. Buch.



Kriegs-Lazarett der Stadt Berlin in Buch.



Patient in continuous bath doing industrial work.

Aside from the strictly medical care of the patients, their mental state was carefully considered, on the principle that "the more hope and courage, the better the healing and the shorter the convalescence." At the earliest date possible patients were urged to do something to occupy their minds and if possible to learn at the same time a trade. The patient shown in the accompanying illustration was suffering from paralysis below the waist and had been six months in the bath, but was learning to do some work with his hands.

We were shown large amounts of food supplies being accumulated, including great quantities of American canned and dried foodstuffs. Evidently the blockade was not very effective up to that time.

In Berlin we saw the central sanitary laboratory, a very large and splendidly equipped building where the various vaccines for the army were prepared. A professor of the university was in charge, and the following statements which he made to us may be of interest in this connection:

We give as a routine three vaccinations, practically all at the same time—for smallpox, for cholera, and for enteric fever. Each man throughout the entire German army now has these three. The cholera vaccination is the most effective. We have had no cholera. The smallpox vaccination comes next and is highly protective. The typhoid vaccination has been wonderfully successful in preventing this disease, but there have been a few cases. The tetanus vaccine is protective in a considerable measure when used in wounded cases, but after the onset of the disease it is of very little, if any, value. In these cases I use magnesium sulphate intraspinally. This is coming into general use and is often proving successful in the active stage. Other vaccines than the four alluded to are not of any real value.

At Cologne there is a military hospital of 2,000 beds, an enlargement of a smaller hospital connected with the university, where, at the time of my visit, there remained only one student. They have here a large physicotherapeutic department with all kinds of electrical apparatus, X-ray equipment, Finsen light, and many mechanical devices for special exercises.

Before the war Germany had adopted a policy of far-reaching effect. The establishment of a gymnasium with baths and a physicotherapeutic institute in connection with a certain large hospital had proved of great benefit to the patients; in fact, considered as an economic measure alone, it had been found worth while. So for years such departments have been established in connection with many of the hospitals throughout Germany, as well as in various hospitals founded by Germans in other countries. When war started these became of double value, inasmuch as they were ready to give special treatment of all kinds to the war wounded.

We have had to introduce these very things, after much delay, and are only now really making a good beginning. In July, 1917, when the plans for enlarging the Brooklyn Naval Hospital were being dis-

cussed, at the request of Captain G. A. Lung, Medical Corps, United States Navy, commanding officer, I drew up and submitted a paper entitled "Some Medico-Military Suggestions," embodying much data on this subject, based upon my observations in Germany.

We found many of the private hospitals had been taken over and were being operated as military hospitals for officers. The only hospitals we saw which we could really criticize were those in prison camps, as at Darmstadt.

The wound treatment then in use consisted in early long incisions, free drainage, and strong antiseptics, with invariable early splinting of fractures and immobilization of wounded parts. Their expert surgeons were stationed well up in the forward areas, so that they could decide what was to be done in each case. This method gave excellent results, since it enabled the wounded men to have the best advice at the time when it was most needed. Severe abdominal wounds and head injuries were rarely moved back and early treatment was instituted at the front in all cases in which it was thought advisable.

Since 1915 it has become increasingly difficult, for the reasons already noted, to secure any reliable information relating to military medicine and surgery in Germany. It has been possible, however, to verify certain facts bearing on this subject, which are herewith presented.

In Germany, no one method of controlling wound infection seems to have been adopted to the exclusion of competitive procedures, as on the side of the allies, where the Carrel-Dakin method of wound treatment has been so largely adopted. Although irrigation with dilute antiseptic solutions is employed by German surgeons, opinions vary widely as to the value of antiseptic agents. Irrigation with hydrogen peroxide has been extensively used in their military hospitals and is claimed to be especially efficacious in the treatment of infected fractures.

Brun, writing in one of the leading German periodicals (Deutsch. Ztschr. f. Chir., vol. 133, 1915) advocated the use of the following solution, with which he claimed to secure very satisfactory results:

Oleum olivar. steril	100
Ether	100
Iodoform	4
Camphor	10

Iodine 2 may be substituted for iodoform if desired. In using this solution the surrounding skin should be painted with iodine, the wound cavity drawn well apart with hooks, and the solution then poured in so as to penetrate all the recesses. The wound is then loosely covered with gauze, which is fixed in place by means of mastic, and the limb is immobilized.

Vernisanum purum, a combination of iodine, phenol, and camphor, has also been recommended as an especially valuable antiseptic in war surgery.

In 1916 a hemostatic antiseptic consisting of a solution of iodoform in acetone, was introduced into Germany. This is applied to the wound by means of gauze strips dipped in the mixture, and the burning sensation which follows its use in wounds of the skin and soft parts is controlled by the applications of compresses dipped in 1 per cent acetone-soda solution. The iodoform-acetone solution diminishes the wound secretions and stimulates the formation of healthy granulations, but its most valuable property consists in its prompt action as a hemostyptic in parenchymatous hemorrhages, especially from porous bones. (München med. Wschnschr. Feldaerztl. Beilage, No. 43, 1916.)

Various chlorin-containing substances have been in use since early in the war, calcium hyperchloricum having been perhaps the most extensively employed. This has been used in a 1 or 2 per cent solution for bathing and irrigating wounds or, in combination with animal charcoal, magnesium sulphate, and bolus alba, as a dusting powder. In January, 1917, the Correspondenz-Blatt für Schweizer Aerzte, a Swiss periodical published in the German language, in an abstract from French original sources, brought the Carrel method of treating infecting war wounds to the favorable attention of its readers.

Other antiseptics advocated by German surgeons include Karlsbad salt; leukozon, a mixture of equal parts calcium perborate and talc; pellidol, a substitute for scarlet-red; liquid tar, etc.

In opposition to the antiseptic method of wound treatment, and in analogy with the physiological lymphagogic method indorsed by Sir Almroth Wright, some German writers on early wound treatment at the front have proposed the use of nitric salts, which on coming into contact with organic substances are at once reduced to nitrous salts. The object aimed at is to increase the hyperæmia in these invariably infected war wounds, and to produce a free flow of lymph. Muller, writing in the Münch. med. Wschnschr. Feldaerztl. Beilage. No. 27, 1916, expresses himself as well pleased with the results of this "abortive" treatment of gunshot wounds, although it necessitates a frequent change of dressings. After the wounds have been incised and foreign bodies removed, he introduces into the wound cavity cotton wool soaked in silver nitrate solution (1:2,000) and wrapped in gauze. The permanent irritation thus induced in the wounds leads to the rapid detachment of nonviable tissues, usually with a rise of temperature due to absorption of toxins.

For fixation of the extremities in fracture cases, German surgeons make extensive use of Cramer's wire splint and Volkmann's T-splint,

femoral fractures being usually treated with extension apparatus. Plaster bandages are considered as unsuitable where a frequent change of dressings is required.

Repeated plastic operations on the mouth and nose are recommended in the treatment of glancing gunshot injuries to the facial region. Soldiers with injuries of the jaw are transferred as soon as possible to the dentist for orthodontic treatment.

Germany has given considerable attention to the after care of the wounded soldier, with a view to returning him to the ranks if possible, or, if he must be sent back to civil life, making him self supporting and not a burden to the community. In an article published in 1916 (Med. Klin., April 16, 1916, No. 16) Prof. H. Spitzy describes some of the work being done at the Orthopedic Hospital in Vienna. Here between three and four thousand wounded are under treatment at one time. Mechano-therapy, hot air, steam, electricity, massage, etc., are used whenever indicated, and when a joint is certain to stiffen great care is exercised to obtain fixation in such position that it will be of the most use to the patient in the future. Occupation therapy is used to its fullest extent, 30 different occupations being taught. In order to restore the disabled men's working capacity to the utmost, soldiers who have lost an upper extremity are usually equipped not only with an arm prosthesis, but also with a set of different attachments, up to 20 or more, according to the requirements of the various occupations.

An interesting fact, possibly bearing on economic as well as surgical conditions, is that in 1915 and 1916 sawdust was being used as a dressing for many wounds, instead of cotton. This was called "scobitost."

Dr. H. M. Richter, of Chicago, who was for six months in 1916 in charge of a German base hospital has published an article, covering his work at that base, which he summarizes as follows:

Recent injuries are best treated by wide excision of the wound, including all contused and soiled tissues, and immediate closure. This applies with greatest force to the larger joints quite as well as to the wounds of soft tissues. Immediate antiseptic treatment of wounds, with free drainage by means of tubes or gauze pack, invariably results in infection though the infection remains localized in proportion to the adequacy of the drainage.

Carrel's treatment has been successful in relatively few hands. The numerous details to be observed in the preparation of the solution and its application probably offer an insuperable obstacle to its general use.

The open treatment of infected wounds forms the simplest and most convenient method of handling patients in large numbers.

The routine tubbing of patients with infected wounds, irrespective of the parts involved, gives remarkable and instantaneous comfort to the patient, and controls suppuration more rapidly than any one method at our disposal, its field of usefulness being limited only by lack of facilities, under ordinary military conditions.

Nonunion in fractures, simple and compound, clean or infected, rarely occurs where the interposition of tissues is prevented and no foreign bodies are left in the wound.

Compound fractures into the larger joints, present a high rate of mortality, only partly controlled by wide open drainage and resection.

All larger shell fragments must be removed. Stereoscopic roentgenography, aided by the proper placing of markers and the insertion of probes along the track of the missile, forms the best means of locating foreign bodies.

In closing this section it may be of interest to point out two contrasts which must strike forcibly any one who is conversant with the facts The one contrast lies between the marvelous efficiency of Germany at the outbreak of the war and the conditions, best described as chaotic, which existed at that time among the allies. The other contrast, more gratifying to us, is shown when we compare those same conditions with the truly wonderful improvement to be found today on the side of the allies.

DEVELOPMENTS IN WAR SURGERY.

ANESTHESIA.

War surgery is demonstrating more clearly than has ever been appreciated in the past, the close relationship between anesthesia and the extent of mortality and morbidity. Major Marshall, who has been for over three years in a casualty clearing station in an active part of the forward area, summed up for me his experience by saying that the bulk of preventable deaths at a casualty clearing station was due to improper anesthesia, "giving the wrong anesthetic, or giving the right anesthetic wrongly."

As a result of this realization, new methods are being devised and old methods improved upon by those actively engaged in war surgery. Chloroform has been rather generally discarded, although many surgeons still employ it and feel safe in its use. As a preliminary to the general anesthetic, morphin and atropin or omnopon, with or without scopolamine, are often used. Ethyl-chlorid as a preliminary or for short cases has some advocates.

The various types of anesthesia that have increased in favor and the newer methods that are receiving consideration are:

1. Local and regional anesthesia.
2. Gas and oxygen (with or without ether).
3. Oral anesthesia.
4. Spinal anesthesia.
5. Rectal anesthesia.

Local and regional anesthesia.—This method is being extensively used in many centers, either alone or combined with light general anesthesia. At various hospitals, I saw it successfully employed in cases involving major operations, such as laryngectomy, trephining, amputations of the thigh and leg, and transplanting of bone and cartilage successfully. It is obviously valuable in many kinds of war surgery.

Gas and oxygen.—The sequence of gas and oxygen, alone or combined with ether, has steadily gained in favor and bids fair to be the method preferred where local anesthesia is not applicable. The work of Crile, Gwathmey, Marshall, and others who have had a large experience with desperately wounded cases seems to establish this method as lessening mortality and reducing morbidity. Without ether, it is especially valuable for abdomen, chest, and abdomen with chest cases. Open ether is dangerous in chest cases, and local anes-

thesia or gas and oxygen without ether are favored. No gassed (inhalation) case should have either chloroform or ether. Moynihan and some others believe that for full relaxation, especially in cases of laparotomy, a preliminary hypodermic is necessary and the addition of ether.

Until recently, the various types of apparatus for the use of gas, oxygen, and ether, especially those which warmed the vapor, were most complicated and expensive. In spite of these drawbacks, increased numbers were being put into use in the hospitals of the allies. Fortunately, the American Red Cross in France, through the work of the staff of its chief surgeon, has recently devised a simpler and far less expensive apparatus, which seems destined to have a large field of usefulness. Already considerable numbers have been ordered for the American expeditionary force. In the selection of a standard apparatus for the United States Army and Navy, the following requirements must be borne in mind. It should be:

1. Simple; no complicated parts to get out of order.

2. Efficient; in supplying continuous flow of gases at uniform pressure.

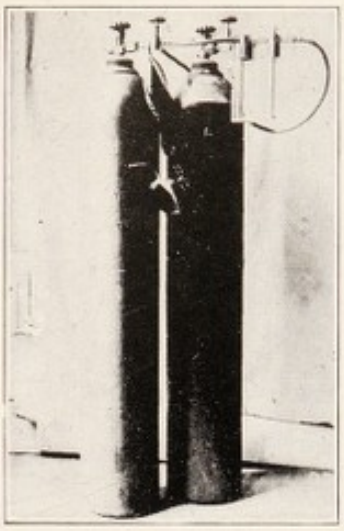
3. Inexpensive; in order to permit of the gases being administered to every case requiring them.

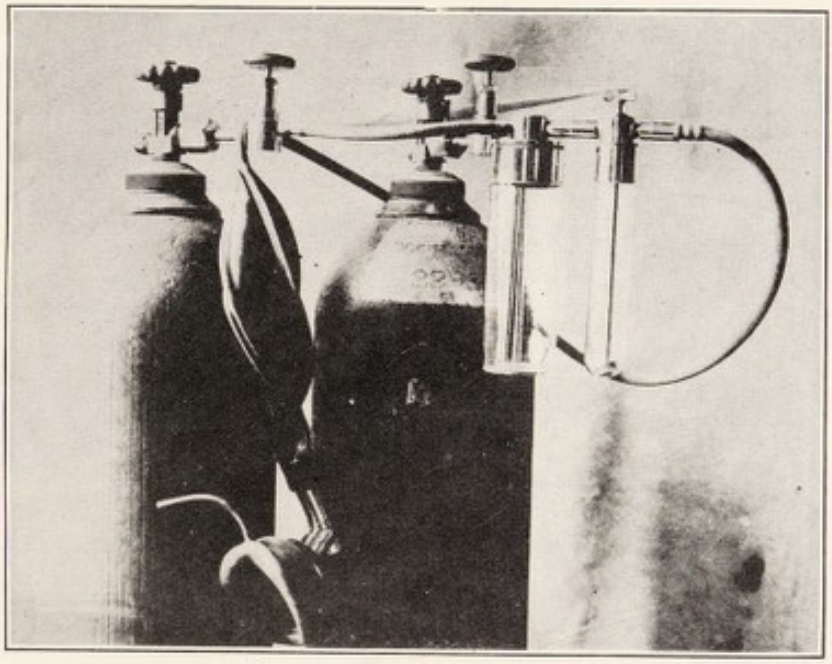
An English Hewitt apparatus, or some modification, falls short of meeting the requirements in that it depends upon rubber bags for the reduction of pressure, and is therefore inaccurate in this respect.

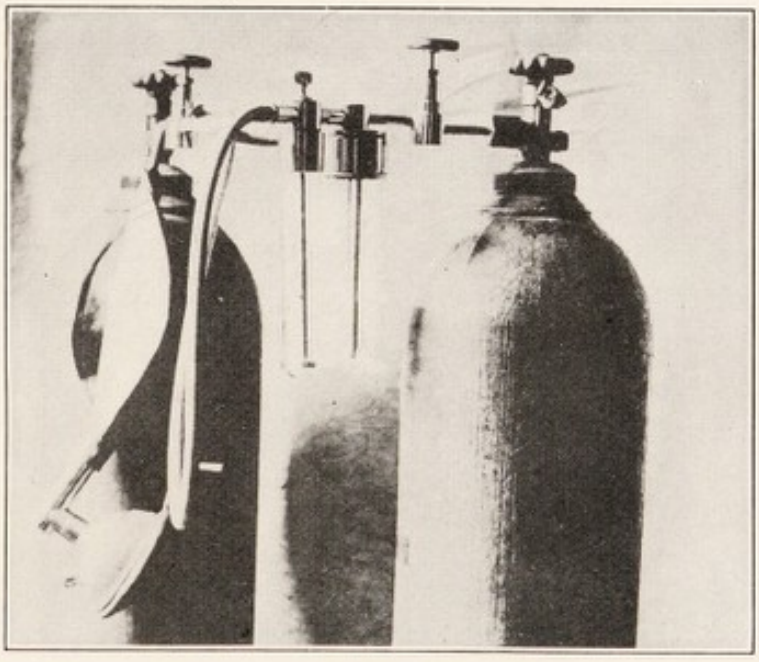
The many types of American apparatus depend usually upon reducing valves weighing from 5 to 15 pounds. Some have as many as four reducing valves to each apparatus, while most of them have a separate bag for the nitrous oxide and the oxygen, respectively. Furthermore, they are all provided with a clock dial or indicator to show the rate of consumption per hour of the respective gases. They all fall short of the first and third requirements.

The American Red Cross apparatus.—The use of needle valves reduces the gases as effectively as the usual large reducing valves, the weight, size, and cost being at the same time decreased to one-fourth that of any other suitable and efficient apparatus. The weight is estimated to be about 8 pounds and the cost about 125 francs.

The sight feed (i e., two tubes immersed in water contained in a glass bottle for the nitrous oxide and the oxygen, respectively, the bubbles made by the gases escaping from the holes in these tubes indicating the approximate percentage) replaces the clock dials and indicators. The first hole in the oxygen tube is approximately 5 per cent by volume of the four holes in the nitrous oxide tube, which is the usual proportion with only slight variations for individual patients.







Appäratus for anesthesia

Furthermore, only one rubber bag is required, the space in the glass bottle above the water being utilized as a mixing chamber for the gases. There is an ether chamber attached to the sight-feed apparatus which permits of the giving of varying percentages of ether according to the relaxation desired.

The patient is the final index irrespective of apparatus (if cyanosed, more oxygen is needed, if too lightly under, nitrous oxide is indicated); therefore an even flow of gases with an approximate and dependable percentage is all that is necessary in an apparatus. The possibility of breakage is greatly reduced by the fact that the needle valves and sight feed are placed immediately upon the tanks. The gases are conducted from the sight feed by two to three feet of rubber tubing to a rubber bag, which is placed near the patient's face in order to reduce the respiratory effort to a minimum. All authorities are agreed that an unnecessary burden would be placed upon some patients if rebreathing were entirely eliminated.

Tanks of nitrous oxide and oxygen adopted by the American Red Cross contain 3,840 kilos each, one nitrous oxygen tank being sufficient to anesthetize 100 patients, and one oxygen tank sufficient for 200 patients. Thirty-two kilos of nitrous oxide and 10 kilos of oxygen are sufficient for one patient in military surgery. The height of the tanks is 56⅝ inches; circumference 29¼ inches. Weight of the nitrous oxide tank (gross), 186 pounds; weight of the oxygen tank (gross), 143 pounds.

Captain Gwathmey, Medical Corps, United States Army, suggests that if a large tank is impractical for use in the Navy, a 2,000-gallon tank, 36 inches high, be used, instead of the 4,000-gallon tank, 60 to 70 inches high. The smaller sized tank will be sufficient for 50 patients.

Oral anesthesia, or general anesthesia by oral administration.—This is among the newer methods employed in hospitals and casualty clearing stations. It was introduced by Captain James T. Gwathmey, Medical Corps, United States Army, in conjunction with Captain Howard T. Karsner, Medical Corps, United States Army. From the favorable results recorded by them and reported to me by others who are employing it on the British front, the future use of this method in surgery seems assured. While in France I discussed the subject at length with Captain Gwathmey and saw some of his work. For the sake of brevity, however, the following is taken from his report on the subject, printed in the British Medical Journal of March 2, 1918, and in the Journal of the American Medical Association of April 6, 1918.

Captain Gwathmey calls attention to the fact that many war wounds are accompanied by fractures of bones, and the importance of keeping the patient quiet during the dressing of wounds is obvious. He

finds that a preparation containing 50 per cent ether in liquid petrolatum or other bland oil, administered by mouth, is a safe general analgesic, has apparently no deleterious effects on the stomach and is not followed by the nausea and vomiting that frequently accompany inhalation anesthesia. It may be given without unpleasant taste when "sandwiched" between mouthfuls of port wine. The patient does not need to be taken from his bed, thus reducing the pain and the danger of displacing bone fragments before and after dressings, and saving the time of surgeons, nurses, and orderlies. Supplemented by local or light inhalation anesthesia, or a hypodermic of morphine, when necessary, the method is being developed to embrace short surgical operations. While it is well not to give the analgesic immediately after a meal, no especial preparation of the stomach is necessary, and the patient is able to take food and water shortly afterward. Captain Gwathmey and three messmen tried the oral analgesic successfully. He now uses the following formula:

Peppermint water	5 minims.
Ether	4 fluid drachms.
Liq. paraffin	4 fluid drachms.

The report describes a number of cases which were dressed in No. 9 (Lakeside U. S. Army) General Hospital, among them the following:

Case 1: A soldier, aged 36, who had received a gunshot wound of the right thigh, and had an infected, compound, comminuted fracture of the femur, had found previous dressings very painful, and the splint could not be changed without general inhalation anesthesia. He was given paraldehyd, 1 fluid drachm; ether, 3 fluid drachms, and liquid petrolatum, 4 fluid drachms. In 15 minutes he fell into a light sleep. The wound was dressed, the splint removed, the through-and-through wound irrigated with ether, a gauze drain inserted down to the femur and a Thomas splint applied with extension. The patient talked during the dressing, felt practically no pain, and suffered no nausea or other unpleasant after effects. The dressing was repeated in a similar manner every other day for four dressings, and in none of them was there pain or any alternation of pulse or respiration.

Case 2: A soldier, aged 28, who had a gunshot wound of the left thigh, with a compound comminuted fracture of the femur, was given the same mixture as in case 1. He feel asleep after 12 minutes. The Thomas splint was removed and replaced, the gauze packing removed, the wound irrigated with ether, and another gauze packing reinserted. The patient groaned when the pack was reinserted, but after regaining complete consciousness he said that he had felt no

pain during the dressing. Three subsequent dressings were done on alternate days with no nausea or other after effects nor alteration of pulse or respiration. The patient complained of the taste of the mixture, but said it was far to be preferred to the extreme pain of the dressings.

Case 3: A soldier, aged 23, with gunshot wound of the left leg, a compound comminuted fracture of the tibia and fibula, a through-and-through infected wound, was given the same mixture. He fell asleep after 15 minutes and slept for 30 minutes during which the dressings were done. The Thomas splint was repadded, the packing was removed and reinserted, and ether irrigation was done. Two dressings were done without bad after effects.

I found that Major Marshall, anesthetist at Guy's Hospital, who for three years has been at No. 17 C. C. S., has somewhat modified the Gwathmey method and is most enthusiastic over the results obtained. The formula used by him is:

Ether	ounces	1½
Chloroform	minims	xx
Liq. paraffin, q. s. ad	ounces	4

This is administered 20 minutes before the operation and the patient is not allowed to smell the mixture, in order to avoid nausea. He lies back with a towel over his face, to induce a sort of rebreathing. The analgesic is effective for 40 to 50 minutes. It may be reinforced by light inhalation.

Major Marshall has used this method in more than 50 cases with excellent results and points out its usefulness in mild cases in saving the time of an anesthetist. He used no hypodermic with this method. He declares it to be the only type of anesthesia that may safely be used after a meal, and that the patient may eat as soon as he recovers consciousness.

I found this oral anesthesia being used in a number of centers which I visited, such as the Duchess of Sutherland Hospital, near St. Omer. Chapple, Schlesinger, and Morgan have used it with success. In fact, wherever I found it had been employed they spoke favorably of its use.

Spinal anesthesia.—For operations on the lower extremities, spinal anesthesia with a 4 per cent novocain solution is favored by a number of surgeons. Chutro, E. V. Morrow, and others with wide experience advocate this method for painful dressings and wound closures below the waistline. At Buffon Hospital, I saw Chutro employ it with excellent results in a number of cases.

Marshall has pointed out that in spinal anesthesia there is a distinct fall in blood pressure. Crile has confirmed this after experi-

ments on animals in his laboratory. He sums up the situation as follows:

> Spinal anesthesia is, therefore, of value in all rush periods, provided that the consequent great fall in blood pressure may be prevented and the psychic factor may be eliminated.

He adds that the psychic factor (i. e., the effect upon the patient of knowing what is taking place) may be largely overcome by a preliminary dose of morphia or by nitrous oxide analgesia or a light ether anesthesia.

Personal observation in over a thousand cases of spinal analgesia leads me to confirm the fall in blood pressure. So far as the psychic factor is concerned frequently no preliminary hypodermic is needed for there is often a sufficient dulling of the mental perceptions to largely eliminate this factor.

Rectal anesthesia.—In certain base hospitals where it is possible to prepare the patient properly beforehand, rectal anesthesia is being employed. It should not be used where there is respiratory difficulty, but where there are to be long operations with plastic work on the head or face it is giving satisfaction. At Sidcup, England, it has been successfully used in over 300 cases.

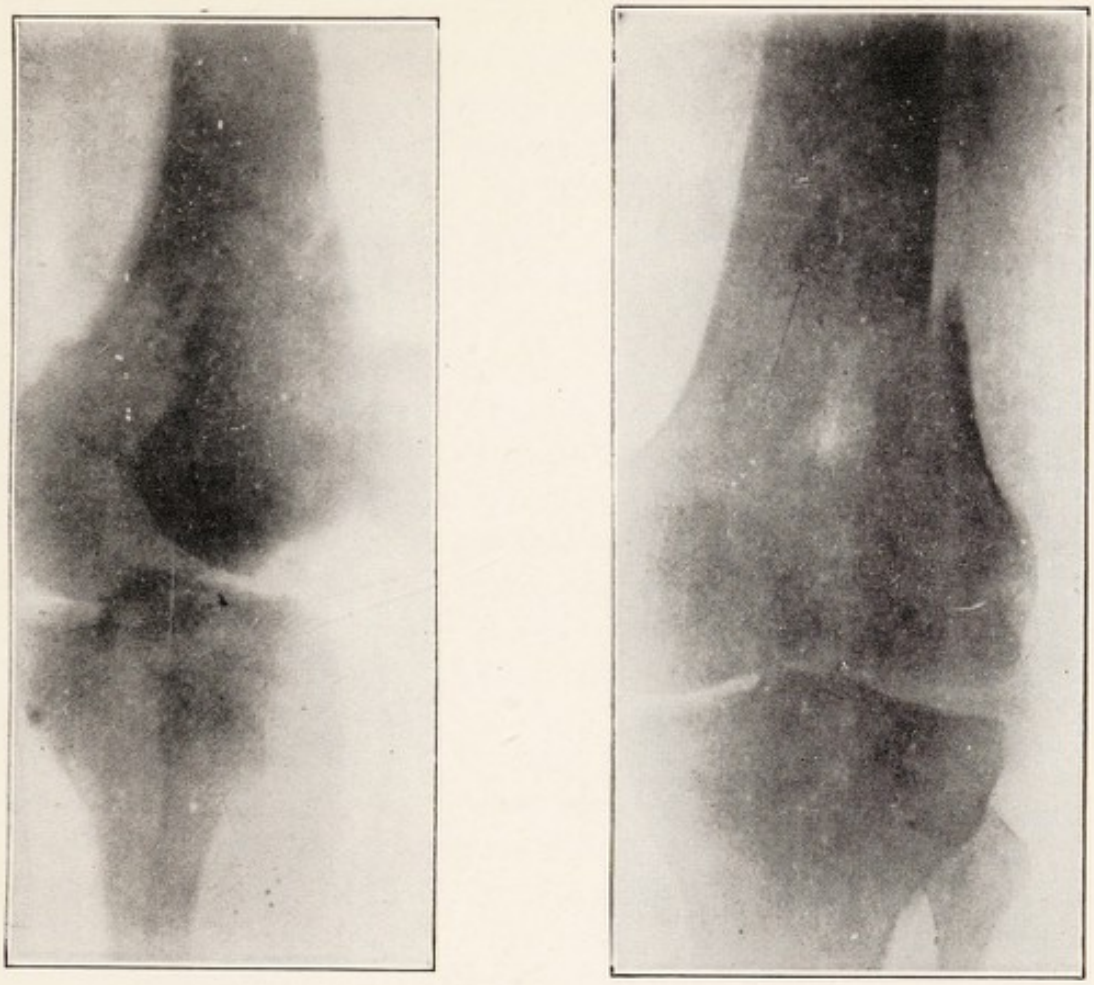
JOINT LESIONS.

C. Willems, in charge of the Belgian Military Hospital at Hoogstade and part of the Military Hospital at Bourbourg, has done some remarkable work in the treatment of joint lesions, and the subject seems to be of sufficient importance to warrant reporting his technique in full. His book is to be brought out at the end of the war, but in view of the frequency of such lesions in war surgery, and of the marked improvement in clinical results frequently following treatment by his method, it seems desirable that this knowledge should be within the reach of all before that time.

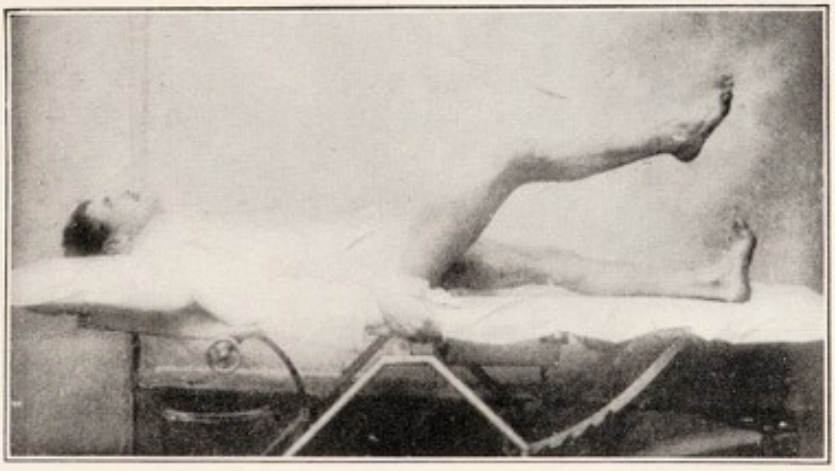
His claims were so extraordinary as to arouse a natural skepticism, but after a number of his truly remarkable cases were shown at a surgical meeting in Paris, I felt that a closer study of his methods would be well worth while. Accordingly, I visited the hospitals at Hoogstade and Bourbourg and found that, far from overstating the facts, he would have been warranted in making even greater claims.

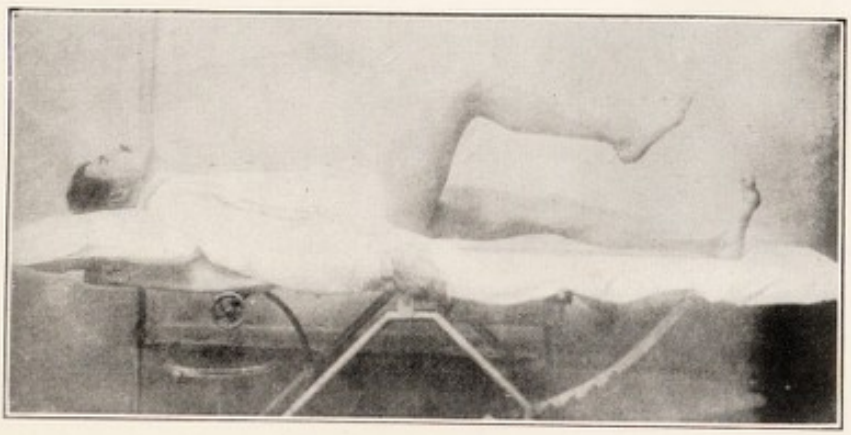
The following gives in some detail the treatment of joint lesions by Dr. Willems in his hospitals at Bourbourg and at Hoogstade.

In dealing with joint lesions of all kinds, immobilization has been the method of treatment invariably followed. It has, however, given such poor functional results that, even before the war began, tentative efforts were made to devise some treatment which would be more successful in preserving the function of the joint. Willems was one



A. De G. Fracture with loss of substance of the external condyle of the femur. Radiographs on entrance.





A. De G. Fracture of thigh. Active movements on fifth day.

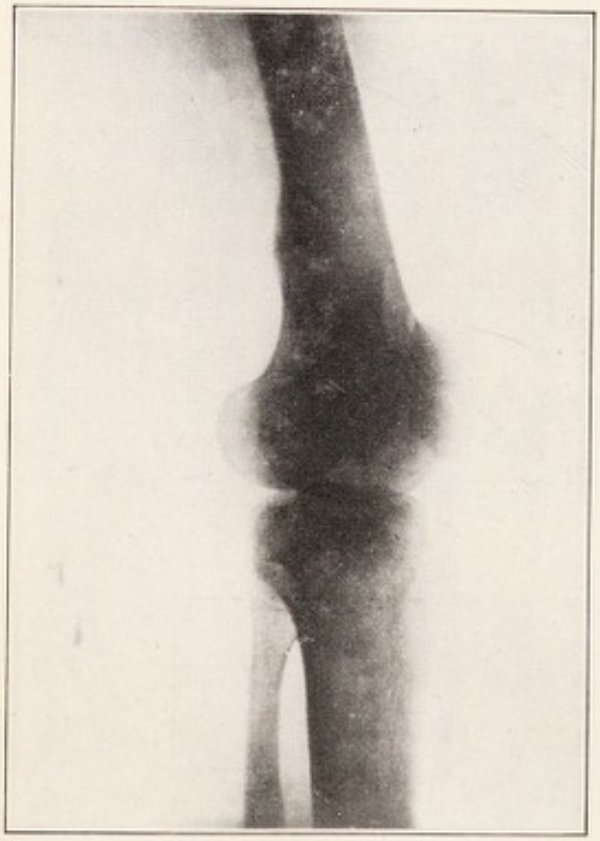


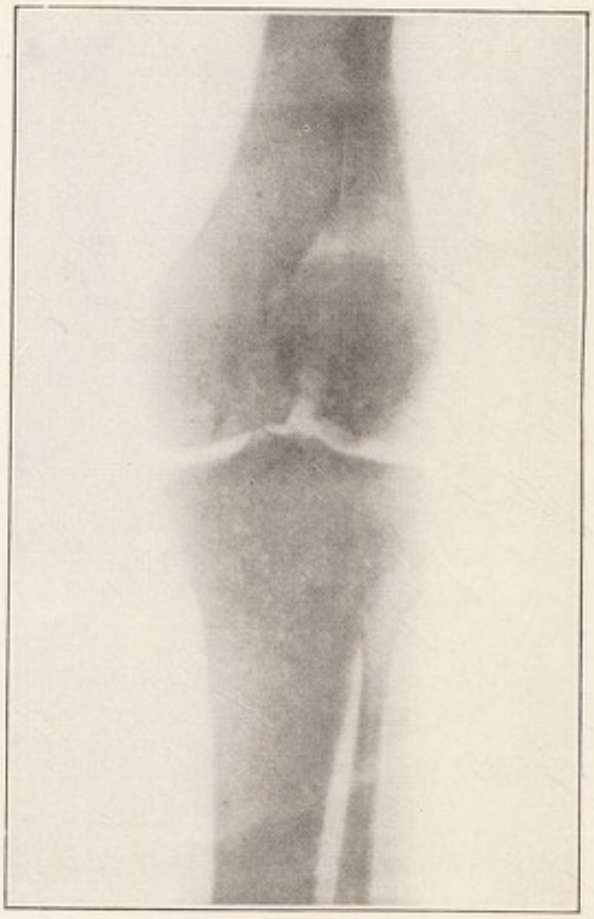
(a)



(b)

A. De G. Condition three months after the injury: (a) Arthrotomized knee supporting the weight of the body; (b) flexion of the arthrotomized knee.





A. De G. Radiograph after cure.

of the first to abandon this principle of immobilization, and his work bids fair to revolutionize all of the old ideas on the subject. Since the war began he has had the opportunity of studying a large number of cases and perfecting his method of treatment, which is based on the principle of *immediate active mobilization of the joint.* He points out that in order to obtain the best results certain general rules must be observed.

The motions must be carried out by the patient himself; they must involve those muscles ordinarily used in moving the joint; they must be begun the moment that the patient comes out of the anesthetic; they must be carried out to the point of their maximum excursions; and they must be as nearly as possible continuous. They should not be supplanted by or combined with passive motion.

These movements cause practically no pain unless they produce displacement of a large fragment of bone, in which case such movements are contraindicated.

This method calls for the constant supervision of a trained attendant, and its success depends to a large extent on the courage and good will of the patient, as well as on his power of coordination.

The details of the treatment vary considerably according to the nature, extent, and location of the injury.

Joint lesions without injury to the bone.—A simple traumatic hemarthrosis or hydrarthrosis is treated by aspiration and immediate active motion, the patient being instructed to walk if the knee is involved or to flex and extend the forearm if the elbow is involved.

Wounds by projectiles call for a resection of the edges of the wound, a uni- or bilateral arthrotomy (always using a vertical incision), removal of the projectile and any other foreign bodies, cleansing of the wound with ether, closure without drainage, and institution of active motion as above described.

Joint wounds with injury to the bone.—The treatment in these cases varies according to the importance of the fracture and the degree of displacement.

When the larger part of the articular surface is intact, and when there is no detached or easily detachable fragment of bone, the treatment is exactly as in the preceding cases, plus the removal of any splinters of bone. The cases in this class which give the poorest results are those in which there is more or less extensive injury to the articular cartilages.

Another class of cases includes those in which an important fragment of bone is detached or easily detachable, thus changing the articular surface and affecting the statics of the joint. If the wound is in one of the arm joints, especially the elbow, the case can be treated as if no fracture existed. The constant motion of the joint

prevents the formation of any intraarticular exostosis and the functional result is good. If the wound is in the knee, certain precautions must be taken. Active flexion and extension must be begun immediately, but the patient can not begin to walk until the bones have knit sufficiently so that there can be no danger of displacement. This requires about three weeks, after which the treatment is as usual.

A third class of joint wounds includes those with considerable injury to the bony tissue. This may be subdivided into the following groups of cases: Those involving an extensive loss of substance of one of both epiphyses; those involving the fragmentation of one or of both epiphyses.

In the first group, part of one side of the epiphysis has been destroyed, the corresponding part of the other epiphysis has lost its point of contact and the statics of the joint have been disorganized. In the elbow this is not of much importance since this joint does not have to support much pressure. The patient will make active flexion and extension as quickly, completely, and easily as with a lesser injury. There will be some lateral deformity and at most some lateral mobility which tends to improve or disappear, but the functional result is good.

When the knee is affected, the usual treatment should be followed while the patient is in bed. When he starts to walk he is at first unable to bear his weight on the affected knee and should be given a jointed Thomas splint. After several days of walking with this apparatus the patient will be able to walk, using only a cane for support. A certain lateral mobility will persist, tending sometimes to improve or disappear, though in certain cases the patient will have to wear a jointed leather support for the knee before he can walk without a cane. The improvement or disappearance of the lateral mobility is brought about partly by a contraction of the muscles on the opposite side to the lesion and probably partly also by the contraction of the ligamentous capsule on the healthy side.

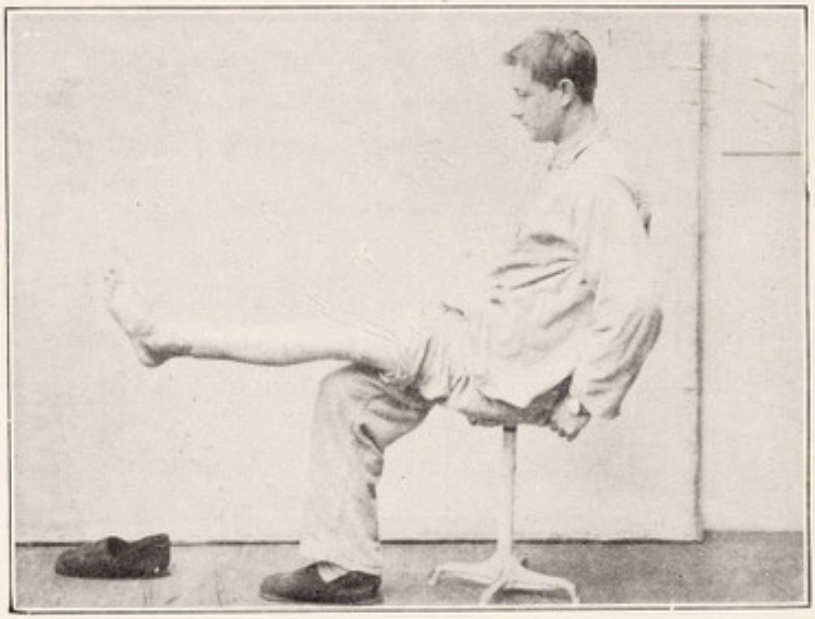
If the destruction of tissue has been too great, resection will have to be done, but Willems states that if not more than one whole condyle or half of the articular surface of the tibia have disappeared conservative treatment should still be tried, resecting the joint later if the result is not satisfactory.

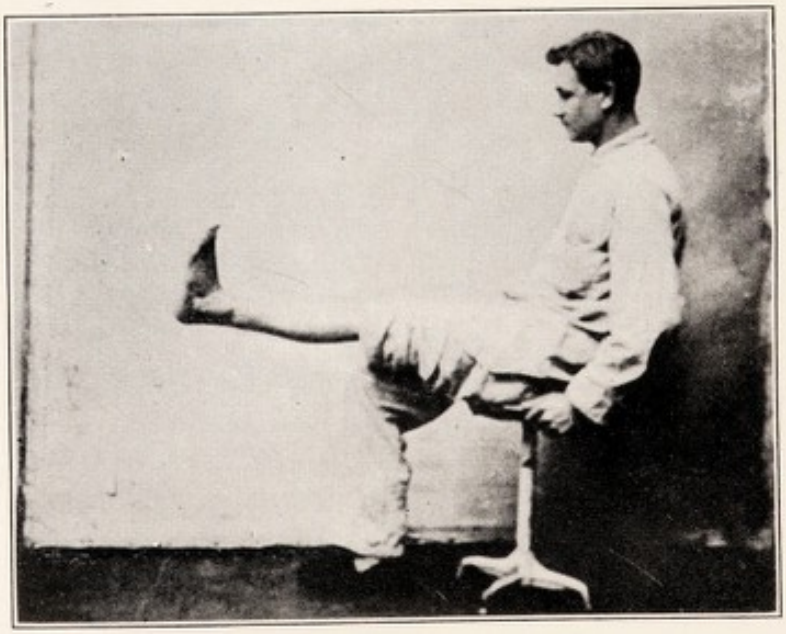
When there is extensive loss of substance of both epiphyses, conservative treatment should be tried if, in the knee, the crucial ligaments are still intact and if more than half of the articular surface is preserved. Resection can be resorted to later if necessary. Patients with wounds of this sort can begin to walk as soon as the wound is cicatrized or well granulated, using at first the apparatus as above described.



J. M. Open fracture of the fibula with infection; purulent arthritis of the tibio-tarsal joint: Arthrotomy.

58–1





J. M. After two months.

When there is extensive fragmentation of one or more epiphyses, the treatment must be somewhat modified, inasmuch as the fracture is accompanied by marked displacement.

In this class of cases, it is convenient to consider separately injury to the knee and to the elbow, and injuries involving one and both of the epiphyses. Wounds of the knee joint involving only one epiphysis call for a careful removal of all fragments which manifestly can not be saved, and the application of an extension apparatus fastened by screws above the malleoli. This apparatus, with screws, chains, and foot tractor, is made by Collins in Paris. Active flexion and extension should be begun immediately. This is at first difficult and limited in its action, but may be facilitated by a momentary relaxation of the extension. The length of treatment necessary and the functional result will depend upon the possible infection of the wound and upon the extent of the injury. If one epiphysis is entirely gone, there will of course be shortening and almost complete loss of function. If, however, the larger part of the articular surface on one side is intact, the extension will bring the fragments into place and keep them there and the functional result will usually be good. Wounds involving the tibia are much more apt to become infected than those involving the femur.

When both epiphyses have been shattered into numerous fragments, conservation can still be tried if a sufficient number of them remain adherent and fall into position, after the extension apparatus has been applied. If the treatment succeeds, the joint will be ankylosed, but not shortened. If callus does not form properly, or if it is manifest in the first place that conservative treatment will not succeed, resection or, if necessary, amputation may be performed. If, on the other hand, the damage is less extensive and if after extension part of the articular surfaces of the two epiphyses on one side can be preserved, the fracture may consolidate, and there may even be some mobility of the joint. Of course if the popliteal vessels are injured, amputation will have to be resorted to immediately.

When the elbow is involved, conservative treatment should be tried so long as any part of the articular surface of the two epiphyses or even of one epiphysis alone can be preserved. After cleansing the wound in the usual manner, the splinters of bone should be removed, the wound closed if possible and active flexion and extension immediately begun. Remarkable results can often be obtained with a minimum amount of articular surface.

It is, however, in the treatment of purulent arthritis that the most surprising results can be obtained by immediate active mobilization.

It is exceedingly difficult to secure the proper drainage in these cases by arthrotomy, and resection has been, ordinarily, the operation of choice. Willems' method has the immense advantage of pre-

serving in almost all cases the function of the joint, as well as of simplifying the treatment. He advises a uni- or bilateral arthrotomy followed by immediate active motion of the joint, even instructing the patient to walk after the temperature has fallen below 100 F. and while the joint still has a large opening. So far from being painful, the motions relieve the pain by emptying out the secretions and relieving the distention of the joint. Pus is expelled with each contraction of the muscles, and if the movements are repeated often enough and vigorously enough, the secretions are disposed of as rapidly as they are formed and complete drainage is assured. This treatment should not be supplemented by irrigation, which is, to say the least, useless.

As soon as the treatment is begun, the general condition of the patient improves very rapidly, and the temperature loses its septic character, falling to at least 100 F., although it may not reach normal for some weeks.

Locally the suppuration follows the course of an ordinary abscess, though somewhat prolonged. The swelling around the joint diminishes, but does not quite disappear until the wound has healed. Periarticular abscesses are practically unknown. The secretion is abundant at first, but gradually decreases and finally disappears completely.

The motions of flexion and extension are easily made at first, but as the secretion begins to dry up there is a slight tendency to stiffening of the joint. To avoid this danger it is wise to close the arthrotomy wounds partially, as soon as the secretion has become considerably less. It will usually be found that the wound has become canalized along a certain path where the pus is discharged, and this is the only sinus which it is necessary to keep open.

Other things being equal, the drainage will be better in those joints in which the movements are more extensive. Thus the elbow and the knee respond best to this treatment, whereas the wrist and the ankle, in which the movements are more limited and the secretion consequently less easily expelled, will respond less quickly.

The function of the joint will almost invariably be preserved to a large extent, if not completely, and it is not unusual to see a perfect result, especially in the elbow. There is, moreover, practically no atrophy of the muscles.

The success of the method seems to be due to the complete drainage which limits the infection to the synovial membrane and prevents it from spreading to the cartilage or bone.

At the hospitals at Bourbourg and at Hoogstade I saw many elbow, ankle, and knee cases, fresh and old. Dr. Willems explained his work, which began long before the war, when he felt that surgeons were doing wrong in not moving joints early enough. This

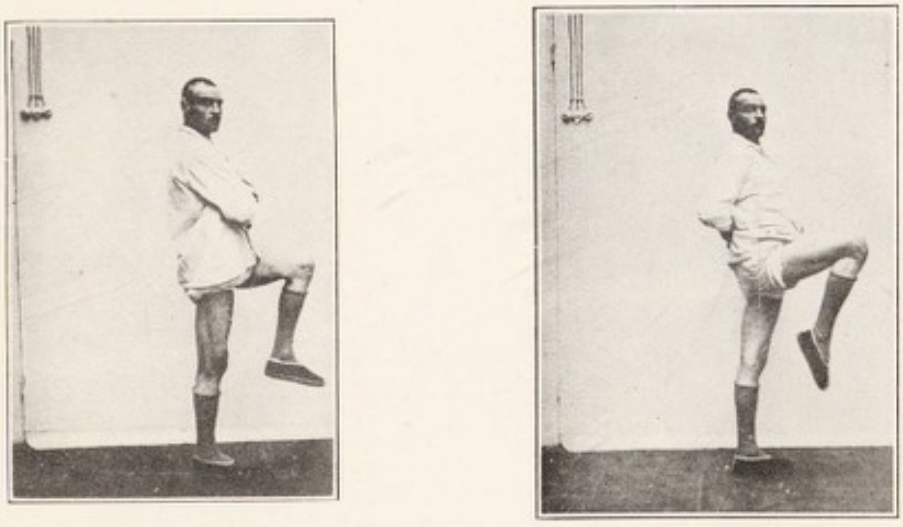


(a)



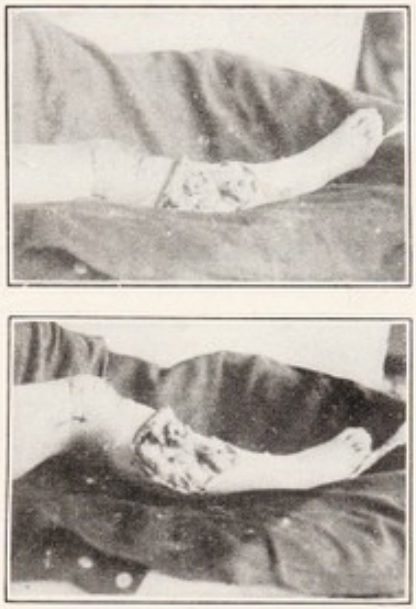
(b)

A. Van H. Arthrotomy for projectile in the right knee: (a) Active movements on the fourth day: (b) active movements on the eighth day.

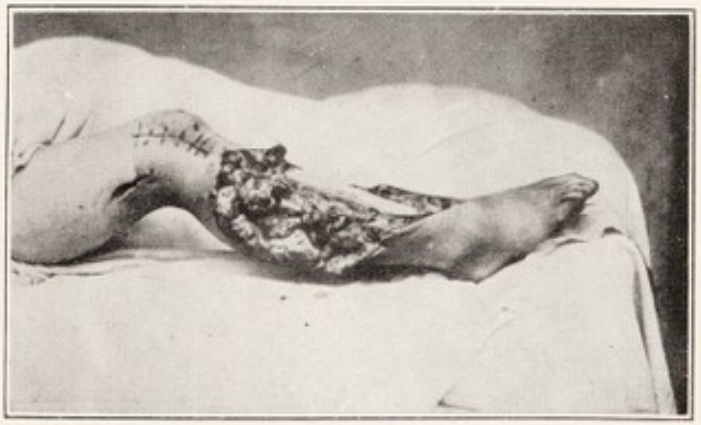


(a) (b)

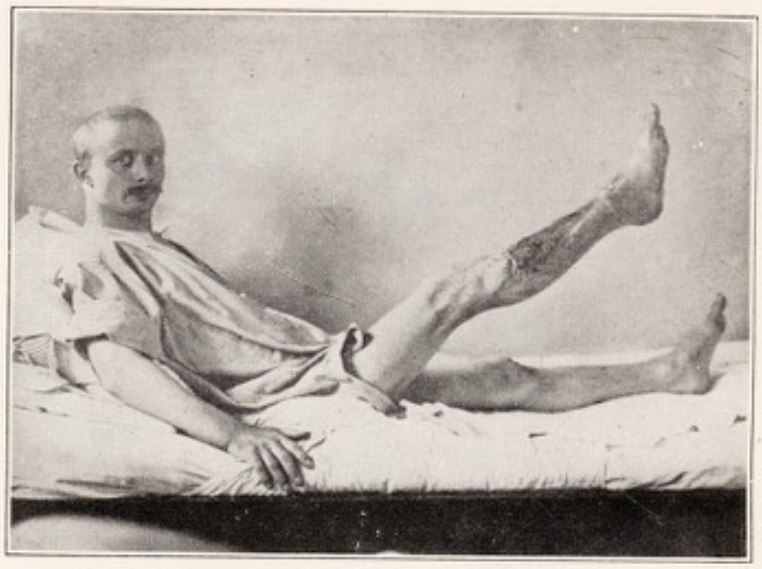
A. Van H. (a) Arthrotomized knee supporting the weight of the body; (b) flexion of the arthrotomized knee three weeks after the injury.

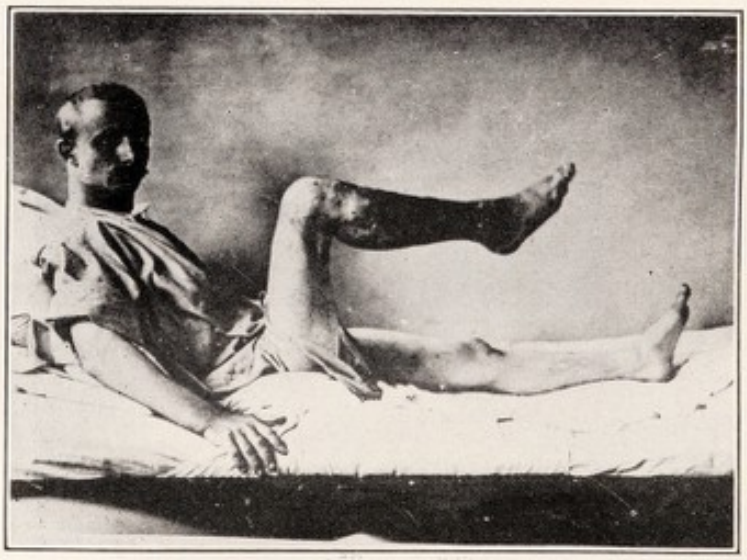


J. Van H. Extension and flexion 14 days after the wound, in spite of gas gangrene.



J. Van H. Extension 18 days after the wound.

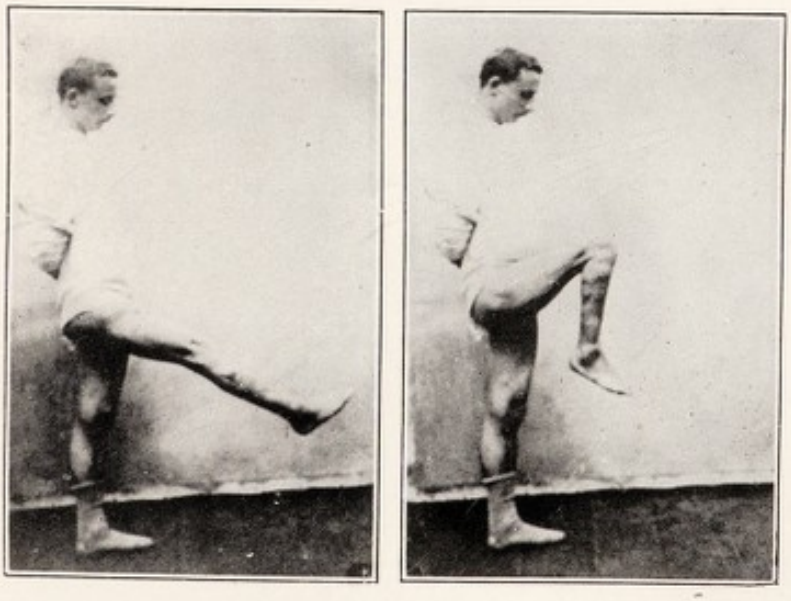




J. Van H. Active movements two months after the wound before skin grafting.

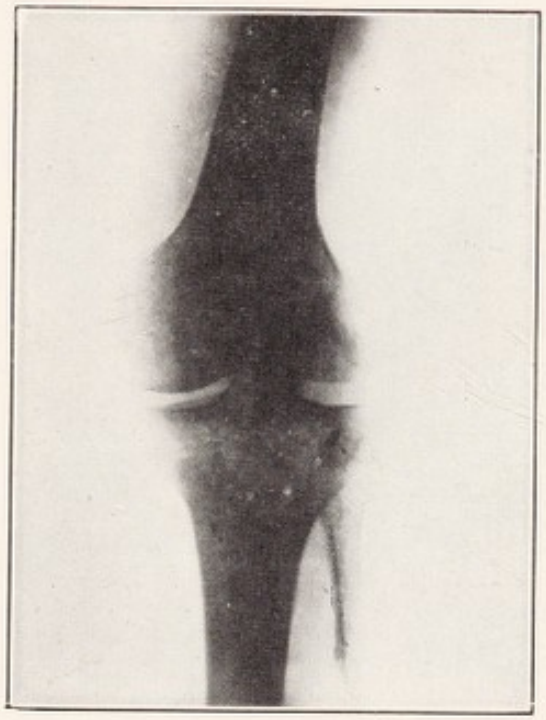


(a)

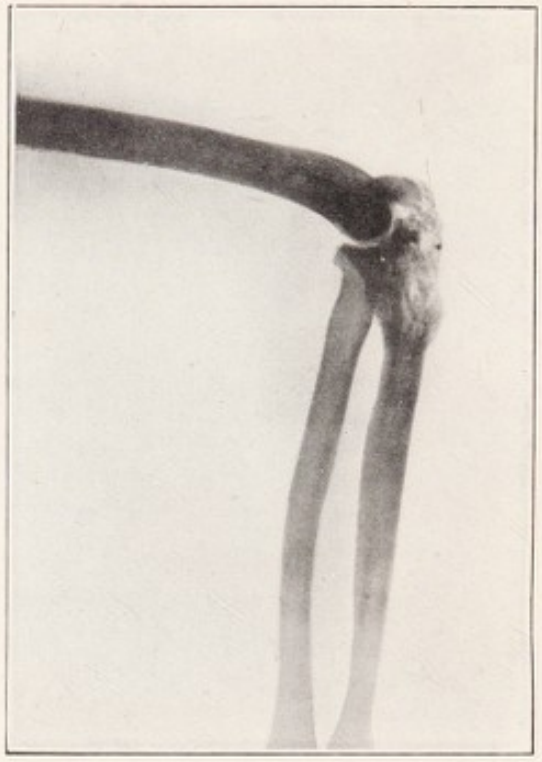


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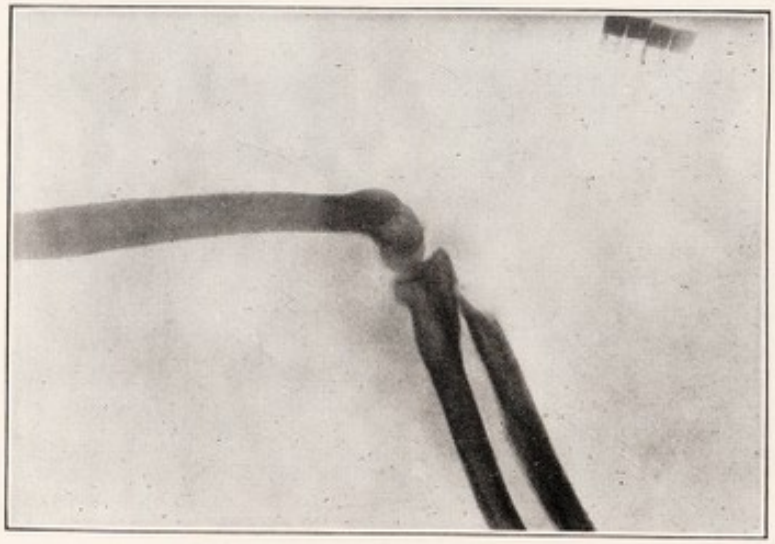
J. Van H. (a) After skin grafting; (b) extension and flexion five months after the wound.



(a)

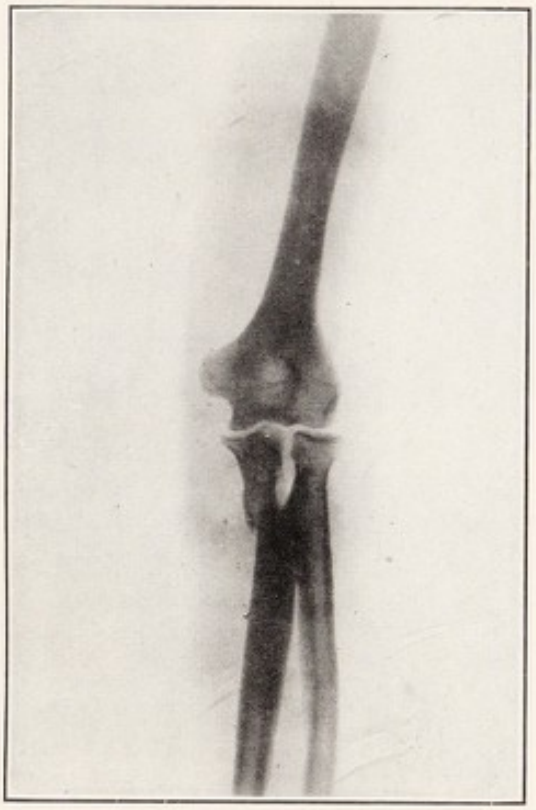


(b)



(c)

(a) J. Van H. Splintered fracture of the external condyle of the femur in the right knee. Radiograph after cure. (b) V. R. Wound of the right elbow; fragmentation of the olecranon process and splintered fracture of the ulnar epiphysis. Radiograph on entrance. (c) V. R. Radiograph af er removal of splinters.



V. R. Radiograph after removal of splinters.





V. R. After three days.





V. R. After seven days.





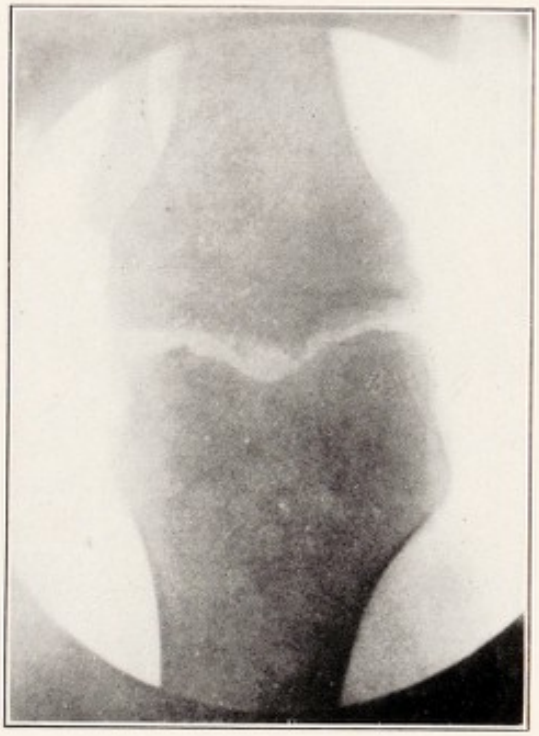
V. R. After ten days.



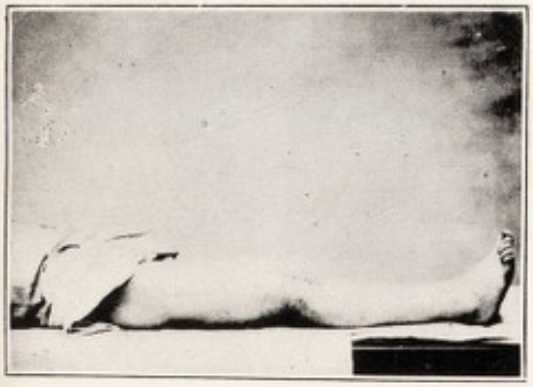


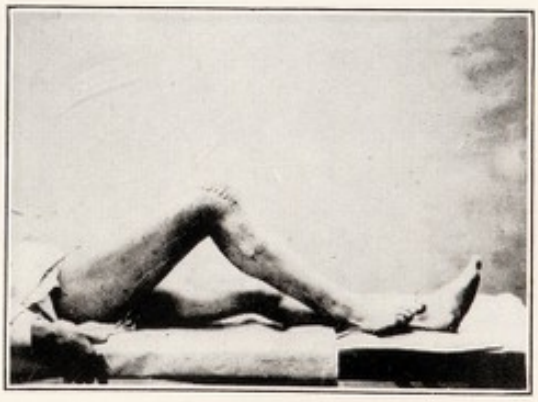
V. R. After four months.





J.M. Two splinters of shell in the right knee.





J. M. Active flexion and extension on the eighth day.



(a) (b)

J. M. Condition three months after the injury: (a) Arthrotomized knee supporting the weight of the body; (b) flexion of the arthrotomized knee.

was in nonseptic cases. Since the war he has enlarged the scope of his work. He willingly answered all questions and furnished me with pictures of some of the cases I saw. These are annexed hereto.

One case which I saw was a purulent synovitis of the knee, streptococcus in type, which had been under treatment for three months. Pus squeezed out from the joint as the leg was fully flexed and extended, but the joint surfaces were of a clean red color, and there was no pain on motion, or when the patella was grasped and pushed or pulled from side to side.

Another streptococcus knee case, seen on the fourth day, was able to flex and extend his knee with a fair amount of freedom.

A compound fracture of the ankle, operated on the previous day, had been opened, cleansed, and sutured up tight, and the patient was already beginning to move it without pain.

A fractured patella had been sutured with silk-worm gut, which was left in, and the patient, six days later, was walking easily.

Another patient had had a compound fracture of the elbow, involving the external condyle and epicondyle. The bone had been removed, the edges of the wound cut away, the wound cleansed with ether and sutured up without drainage. Seven months later there was perfect union with no loss of function.

Willems gives the following statistics with regard to 100 consecutive knee cases. Eighteen of these were accompanied by a purulent synovitis of a virulent type, chiefly streptococcus, but in the 100 cases there were no deaths and no amputations. There was one resection in a case in which the crucial ligaments were gone and the popliteal artery was thrombosed, and there were two stiff joints, one of which it was hardly fair to count, since the patient had failed to follow directions.

Dr. Willems was thoroughly imbued with the belief that many would be saved joint and limb by the treatment which he recommended, and his great desire was to save the soldiers and not to prove his theory to be correct.

Both Major Lockwood, D. S. O., B. E. F., chief surgeon C. C. S. No. 36, who accompanied me, and I had been skeptical when we went to see the cases, but came away greatly impressed by what we had seen. The results certainly were wonderful and bore out Dr. Willems's claims.

There is unquestionably much to be learned from this man. The treatment of joint cases by his method without doubt gives better functional results and a larger percentage of cures, and it seems evident that when this method becomes more generally known it will modify, to some extent at least, if it does not supplant, the practice of most surgeons to-day.

FRACTURES.

In 1911 the International Congress of Surgeons selected the subject of simple fractures as the main topic for discussion at the session held in Brussels. Leaders from all over the world gathered for a three days' conference and freely exchanged their views in an attempt to arrive at a conclusion as to the best treatment for this class of injuries. In a large hall near by were exhibits, such as charts, pictures, drawings, slides, apparatus, models and graphic statistical records of fracture cases.

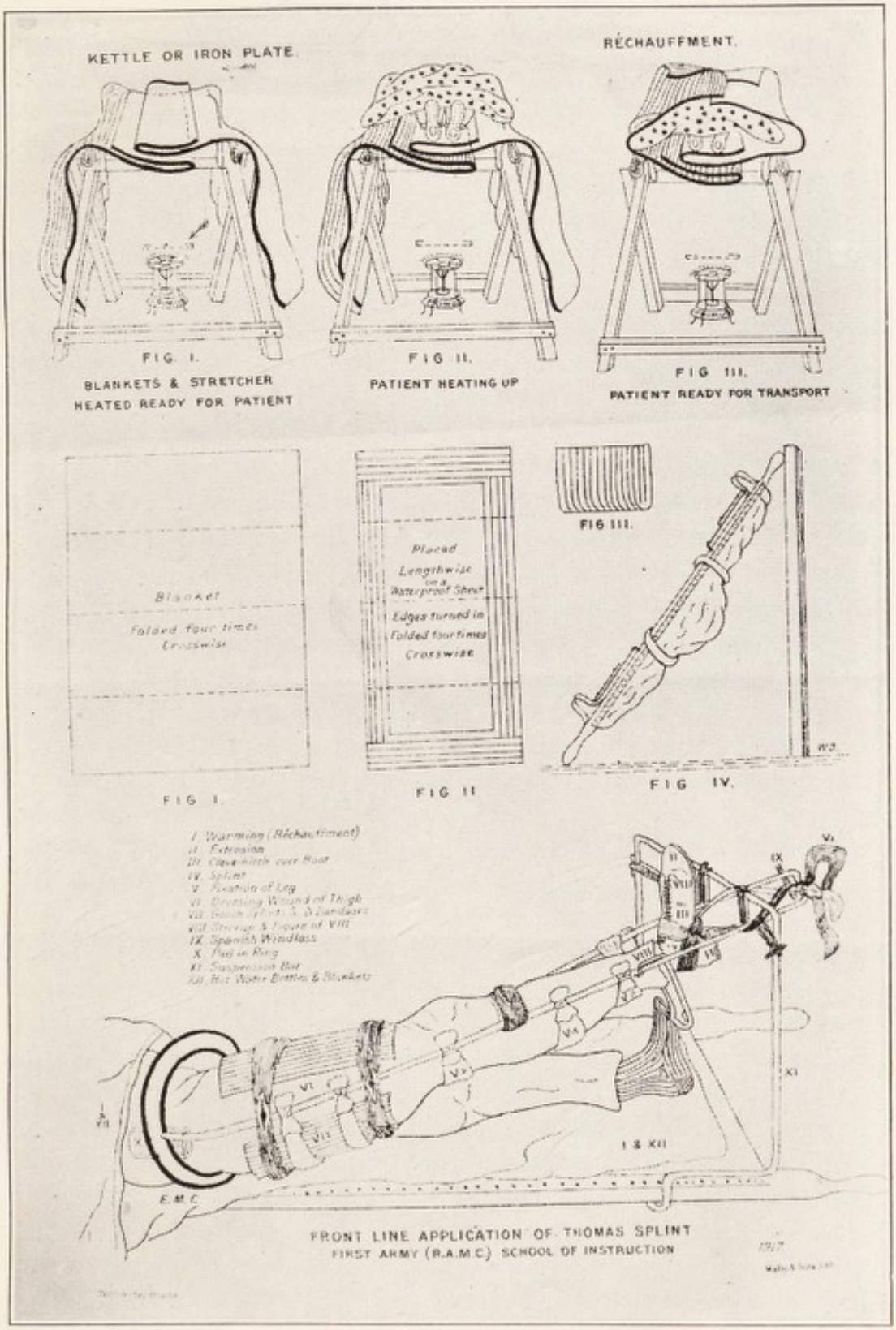
To those of us who were onlookers, it was obvious that there were three groups with conflicting opinions. There were those who emphasized the value of open operative treatment and reinforced their arguments by showing the poor results obtained from the employment of other methods. Again, there were the earnest advocates of the practically exclusive use of apparatus, who sought to demonstrate that operative results did not compare favorably with those obtained when the essentials of mechanical treatment were observed. Then there was the third group which pointed out the unfortunate consequences likely to follow if either of the first two methods were adopted. They maintained that in a large number of cases the best results could be obtained by insuring immobility and correct alignment through the use of sand bags or the like, while at the same time minimizing circulatory interference by reason of pressure. They used massage at once and passive motion early. In all three, the adovcates admitted that there were exceptions but maintained that the rule was as they severally claimed.

Here were the wisest honestly differing. Apparently at the close of the conference there were still the three opinions, although each group had learned much of the viewpoint of the others.

Since 1911, there has been a gradual coming closer together, but at the beginning of the war there was still a wide divergence of opinion as to the best treatment of many fractures, simple as well as compound. After four years of war experience, while there are radically differing methods in vogue, there are nevertheless, certain essentials as to which there is close agreement.

Early in 1915 the death rate in some classes of compound fractures was appalling, but owing to improved methods this has been greatly reduced and a contrast between the mortality and morbidity then and now is most gratifying.

Immediate immobilization, the use of a Thomas splint or some modification of it, careful splinting so as to allow of no grating of bone ends, the removal of foreign bodies introduced with the projectile, the types of cases which may be safely evacuated and those which should be left behind· and the importance of not dis-



Front line application of Thomas splint. First Army (R. A. M. C.) School of Instruction.

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turbing the injured parts any more than is imperative are all subjects upon which there is substantial agreement. Other questions, such as the extent and character of operative interference, whether antiseptics should be used at all, and if employed, which one is best, and the kind of splint which should be used after the case leaves the casualty clearing station are as yet matters of varying opinions.

The field of special hospitals is developing rapidly. The French have established certain hospitals for the care of fractures, each with a specially trained staff in charge. Other institutions have set apart entire wards for this work, resulting in uniformity of treatment and increased efficiency. The British in their orthopedic centers have gone a step farther and are sending to the Eighth General Hospital at Wimereux, and the Red Cross Hospital at Netley, as many as possible of their thigh fractures. Thus there is being created a specialty within an already specialized field.

Colonel J. A. Blake has been particularly interested in the treatment of fractures and formerly at the American ambulance, Neuilly, and now at the American Red Cross Hospital No. 2, is devoting himself largely to their care. Recently a start was made on a hospital to be used exclusively for fractures near Chalons-sur-Marne, but the German drive interfered with Colonel Blake's plans. Doubtless this unit, with those of Colonel Goldthwaite and Major John B. Walker, all of the Medical Corps, United States Army, and others, will do for us what Jones, Sinclair, Souttar, Thevenot, Patel, Leriche, Gosset, Depage, Willems and their confrères have done and are doing for our allies.

Colonel Sir Robert Jones, C. B., director of the orthopedic centers of Great Britain, will shortly issue a volume on his experiences in dealing with this line of cases. Colonel Blake has in press a book on fractures. Prof. R. Leriche of Lyons, lately at Bouleuse in charge of fracture cases, has already brought out this year the second volume of his work on this subject. Prof. Willems and Major Sinclair state that they will not have their books ready until after the war.

All these authorities differ materially in theory and practice, but all are doing excellent work and obtaining good results.

I refer only thus briefly to those whose books are bringing within our reach at the present time their views and opinions. The work of Sinclair and Willems, however, is extremely important, and as now, when we most need to know what they are doing, it can only be learned through a personal visit or through some one who has had an opportunity to see it at first hand, I have attempted to describe some of the outstanding features.

Essentials of Sinclair's method.—I visited the Eighth General Hospital a number of times and went through the fracture wards with Major Sinclair and saw many wonderful results of his treat-

ment, especially in cases of compound fracture of the femur, in which he is particularly interested. He said:

Immobilization and drainage are the main elements of success in the treatment of compound fractures. My method is—Thomas splint, sterile dressings, free drainage. Immobilize as early as possible. I would do this at the advanced dressing stations, putting on a Thomas splint at once. Treat the wound *after immobilization.* Thus the ends of bone are kept from doing harm and opening up new avenues of infection. Wait and see if there is trouble before overdoing the surgery. Never mind the fragments of shells or bullets unless they do harm. It is the infection that injures—the organisms. I often leave in bullets that are doing no harm—leave them unless they require removal.

Preserve pieces of bone that are in any way attached. In the beginning of the war we removed all the pieces and some do this still. *Don't do it.* What is the use of taking away a natural graft and months later transplanting bone from the tibia? We never see shortening unless part of the femur has been removed, in fact, the patients go out with the leg a little longer than normal. Splint early and do not disturb any more than necessary. I even do small operations in the ward, such as inserting calipers or traction screws, in order not to move the patient about. Drain with rubber tubes, putting as little fluid as possible into the wound, if any is used at all. I employ a little peroxide full strength to clean the wound. We do not use Carrel-Dakin. The antiseptic is injurious to the tissues and washes away the blood serum containing the antibodies with which nature fights off disease. I use alcohol and then 3 per cent picric acid upon the skin before incising. In compound fractures of the femur incise at least 4 inches in length where there is good dependent drainage, then use dry dressing. Introducing the finger into the wound and feeling about, tearing the tissue or curreting is bad. Drainage by repeated clean cuts is the best.

Any plaster which contains rubber is likely to irritate and blister the skin. I have prepared a glue which acts well and holds for some weeks without difficulty (see formula).

Unless drainage is necessary most of the cases of fracture of the thigh do not require any anesthetic for reduction, but proper traction for 24 to 48 hours accomplishes it. Sixty per cent will be held down by the use of glue; 40 per cent need other holding points. In order of preference, the points of direct bone traction are:

1. Three fingers below the tubercle on either side of the tibia; two screws should be inserted part way through the bone but be sure they do not go all the way through. Then tape is fastened on metal loop.

2. Calipers to malleoli, so fixed as not to go more than one-quarter inch into the bone on either side of foot.

3. Condyles of the femur, with large calipers.

4. Calipers to os calcis.

There will be no pain or discomfort of any moment, and none at all after 24 to 48 hours.

Do not move the patient from where he is, and if properly treated he will be able to walk in three or four months. For fractures of the upper third of the thigh, while in a position of marked abduction, the patient is supported in a swing bed on a sheet made of a network of strings. In all other cases, and for the upper extremity, I use a Thomas splint as slightly modified by me. Observe temperature and pulse and examine local condition with X-rays. It takes the greatest care of details to succeed with this work, but if the method is followed strictly one does not see those terrible sinuses persisting and having to be re-

peatedly curetted for dead bone. For anesthetic I use chloroform 1 part, ether 2 parts.

There should be special hospitals for the care of fractures, and the surgeon who applies the permanent dressing should see it through to cure. There is not the interest or uniformity of treatment if the case changes hands. America had better leave her thigh fractures over here until they can walk.

For the purpose of collecting any discharge from a dependent wound, a small sterilized pus basin is placed under the outlet of the tube which is inserted for drainage. Major Sinclair emphasizes the importance of noting the character of the discharge, as it affords clinical data of value. The tube itself has perforations within the wound, but is not spirally cut and has nothing over the outlet. He considers this important, as there is no danger of damming the drainage. (This is a practical point and should be considered in other conditions requiring drainage.)

He says: "Bone is formed from bone, not from periosteum alone." In this he differs from Chutro and agrees with Sir William Macewen of Glasgow. The latter has grown an entire shaft of a humerus by chipping off pieces of solid bone (in operating for bowlegs and knock-knees) and placing them between the two ends of the humerus, the whole shaft growing solid from these pieces. This took a number of years.

SINCLAIR'S FORMULA FOR ADHESIVE GLUE.

TEST FOR GLUE.

Place 4 ounces of glue in 4 pounds of cold water and leave in a cool place for 12 hours.

If dissolved, it is bad.

If coherent and gelatinous, weighing 8 ounces, it is good.

If coherent and gelatinous, weighing 16 ounces, it is very good.

If coherent and gelatinous, weighing 20 ounces, it is excellent.

The following is the formula:

Very good glue	50 parts
Water	50 parts
Glycerine	4 or 6 parts
Menthol	1 part

Soak for 12 hours and then melt on a water bath.

Neutralize to litmus with sodium hydrate, as commercial glue at times contains free hydrochloric acid.

Add 4 parts in summer and 5 parts in winter of glycerine and 1 part of menthol.

Frequent heating evaporates the water, which should be added from time to time. When reheated many times, adhesive power is lost.

Technique:

1. The skin is not shaved.

2. Wash the skin with soap and hot water, which contains about 4 drams of washing soda to the pint, to convert the oil of the skin into soap, as glue will not adhere to a greasy surface.

3. Dry the skin.

4. Apply the warm glue evenly, brushing all the hairs of the limb in an upward direction.

5. Keep a tension on the gauze all the time, bring it quickly but carefully into contact with the limb (inner and outer surface), and apply neatly a loose-woven bandage, starting a hand's breadth above the malleoli up to the knee joint.

6. When dry apply traction.

(The adhesive can be made waterproof with a 2 per cent solution of potassium bichromate applied in the dark and then exposed to the light, or by means of formalin.)

7. The extension must always be very carefully applied, whether with Maw's elastic cotton net or with gauze.

8. The extension must be changed at once if the patient complains of a tickling or burning sensation under it, but it generally requires changing about the tenth, twentieth, and fortieth days.

WILLEMS' SCREW EXTENSION APPARATUS.

This apparatus for continuous extension of fractures of the femur and leg bones consists essentially of 2 screws, a bolt with 2 short attached chains, and a stirrup at the 2 ends of which the chains are fastened. For femoral fractures, the screws are introduced into the uppermost portion of the condyles close to the diaphysis, and are inserted to a depth of 2 to 3 centimeters. For fractures of the leg bones, the screws are placed above the malleoli, at a depth of about 2 centimeters. The bolt is approached close to the skin so as to render the traction juxta-cutaneous. Counter-extension is made by suitable adjustment of the bed.

The principal advantages of this apparatus are that: 1. Traction is exerted directly on the lower fragment, a condition not met by any other method of continuous extension. The result is great accuracy and efficiency of the traction. No part of the force being lost, the object is accomplished by a relatively weak traction. 2. The disadvantages of indirect traction through one or more articulations are obviated by this method exclusively. 3. The apparatus leaves free the entire surface of the limb, thereby facilitating the care of the wound. 4. Mobilization of all joints is possible during the entire treatment. 5. The apparatus not only prevents overriding of the fragments, but permits the correction of angular deviations by changing the axial into lateral traction.

The screws are very readily tolerated provided they are firmly fixed in the bone, above the epiphyses, where they remain indefinitely in place, causing no tenderness. The insertion of the screws never breaks the bone, and radiography has never revealed the smallest fissure, even in the case of the fibula.

Screw extension is easily combined with suspension by means of the Thomas splint. For the evacuation of the wounded, to which

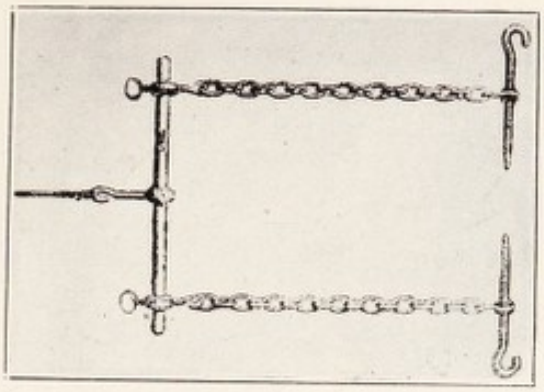


Fig. 1.—Extension apparatus; two screws with two short chains terminating in a stirrup which bears a hook for the traction cord.

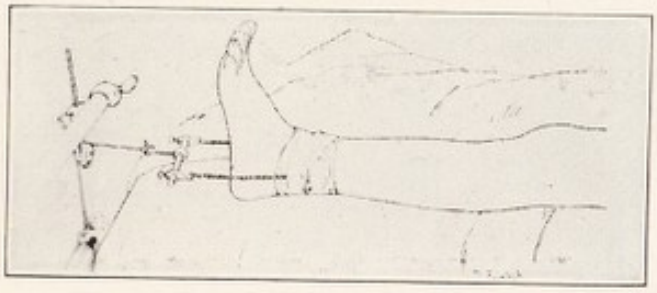


Fig. 2.—Apparatus in place for fracture of the leg

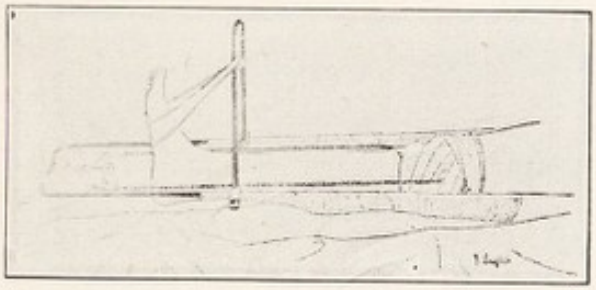


Fig. 3.—Apparatus in place for fracture of the thigh, combined with suspension.

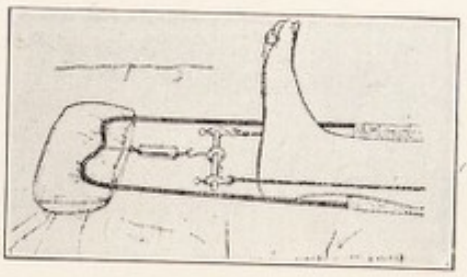
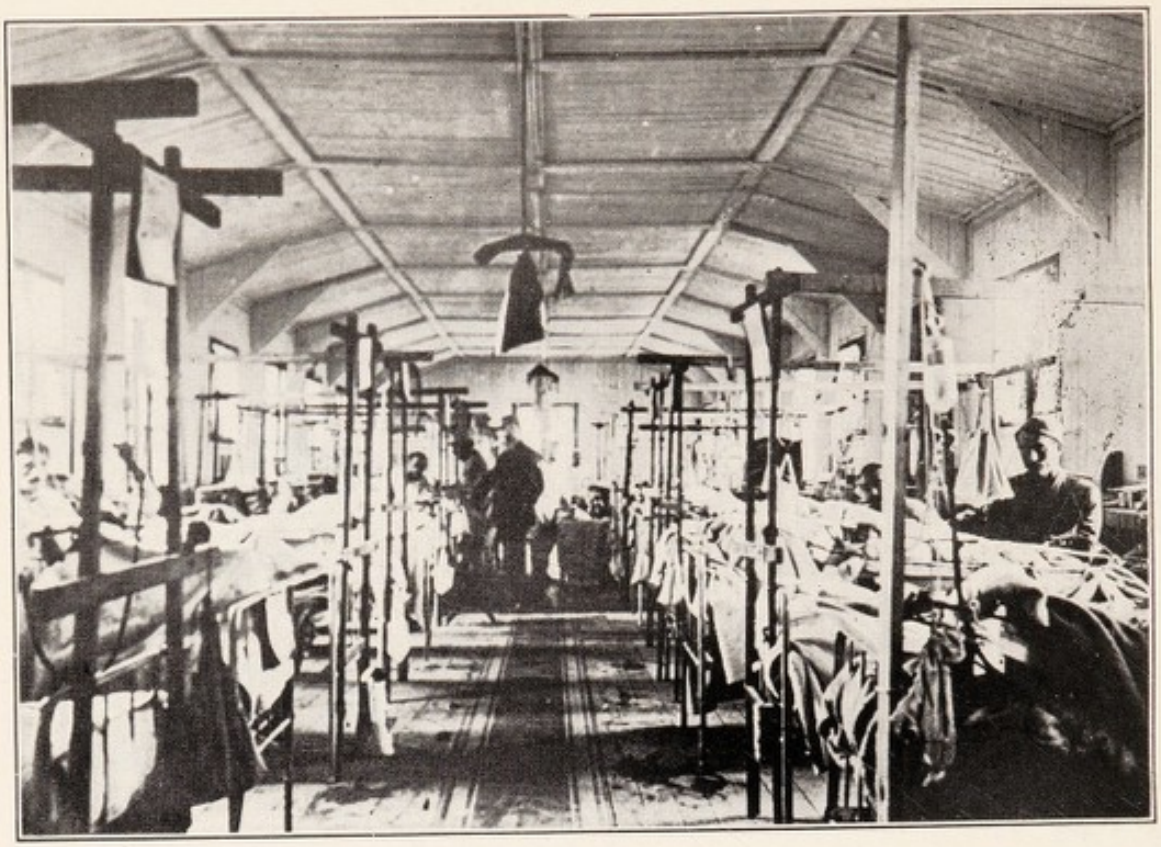
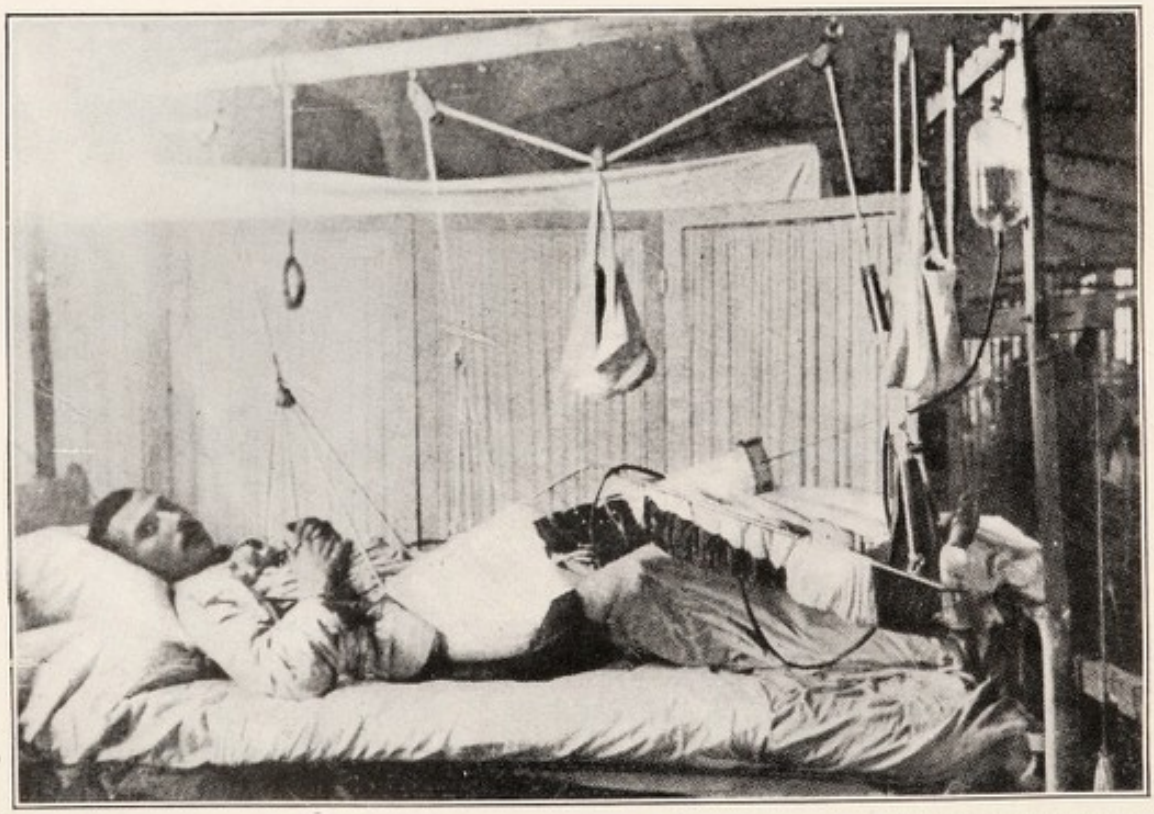


Fig. 4.—Apparatus in place for femoral fracture. Spring extension for evacuation.





Many hospitals are doing excellent work in caring for fracture cases, and the accompanying pictures show a fracture ward at the Val-de-Grâce Hospital, with its many varieties of apparatus needed, and also a fracture splint in position as used at that institution.

the apparatus is very well adapted, it suffices to substitute for the extension with weights an extension on a spring interpolated between the stirrup of the Willems apparatus and the extremity of the Thomas splint. (Presse méd. No. 69, 1917.)

A splint which is receiving much favorable attention and being widely used is one devised by Leclercq and Varigard, and about to be described.

APPARATUS OF LECLERCQ AND VARIGARD.

(For reduction and maintenance of fractures of the humerus.)

This continuous extension apparatus has been adopted by the sanitary service of the French Army, and is in use in the English Army. It is intended to reduce and retain complicated fractures of the arm (humerus), while permitting the application of dressings and other interventions necessary for the healing of the fracture. Made entirely of metal, nickel-plated copper, in order to avoid oxidation, this apparatus has been devised and manufactured in conformity with modern methods. It serves for the right as well as the left arm (symmetrical and interchangeable axillary splint) and is easily and quickly applied (in about 10 minutes) with only two flannel bandages. With the apparatus once adjusted the patient has no further pain or inconvenience; he is not kept immovable in bed, but may go and come, or be evacuated in the sitting position. Suppuration is reduced to a minimum, and reduction is as complete as possible. Dressings are easily applied without displacing the apparatus. Bony consolidation takes place rapidly. In grave cases, amputation may thus be avoided. The apparatus saves time, suffering, limbs, attendance, and money.

The adjustment of the apparatus, which serves for either arm, is best understood by a study of the explantory illustrations. Some preliminary precautions should be observed. The hooks for fastening the arch must be on the side of the thorax; when they are on the arm side the position is incorrect. Open the screw, turn back arch A, replace the screw after having pressed the bolt into the hole of arch P, as shown in the illustration.

Before applying the apparatus the wound must be dressed (not too thickly). Lightly stuff the axillary arch with cotton wadding, held in place by a strip of gauze or oiled silk. Pad the forearm with a good thickness of cotton wadding held in place by a strip of gauze. Make three small cushions, to be placed between the extremities of the arch and the shoulder, as well as over the shoulder itself. These cushions are best made with cotton held in a napkin or a piece of cotton wadding may be wrapped in a strip of gauze closed at the end with a few stitches. Place the apparatus on the healthy side to

ascertain the proper length. Lengthen or shorten, by opening the screw and changing the hold. There are four such holes on the splint, No. 2 from below fitting a medium-sized arm. The apparatus is now applied by slipping the arch under the screw and then adjusting the forearm plate, the patient being instructed to hold his elbow with the healthy hand. Note that the attachment of the apparatus is thoraco-suprascapular. The arm should be placed slightly backward, so that the thoracic hooks are very straight. Hold in place with very long (6 meters) flannel or cotton bandages about 10 centimeters in width.

The fore-arm plate must not lie too tightly in the bend of the elbow. In order to change the dressings, the fore-arm plate can be loosened, slipped forward, and then replaced. The shoulder can be mobilized after having opened the screw, then proceeding to abduction or to adduction. In forcibly holding the lower portion of the humerus so as to immobilize it, the elbow joint may be made to work, by means of a special contrivance. This should be done every day when the wound begins to improve.

The apparatus having been adjusted, the tension of the spring is regulated by turning the tension buttons near the fore-arm plate. The spring gives 2 kilos of extension when its length taken vertically is 4 centimeters. This is the most that should be used. The rule is to tighten the spring gradually and to verify the proper position of the bone fragments by radiography. There is always a tendency to overtighten the spring; great care must be exercised, for the fragments would separate and consolidation would not be obtained. Keep in mind that the extension is continuous. Some edema of the elbow in the first days is not serious, and simply requires lessening the extension.

Other splints of various types are being used, such as the Paterson splint for fractures of the humerus, and the American Red Cross splint, which are illustrated here.

The French Army has developed an admirable system for the care of fractures and joint injuries which insures the patient remaining under the control of the same staff of surgeons from the time he is injured until he is discharged from further treatment. This results in uniformity of treatment, a definite feeling of responsibility on the part of the staff, and a higher measure of success because of these two factors.

This system, as it is now in operation behind four of the French armies in the field, is arranged as follows:

The patients are received in hospital No. 1 from three to six hours after injury. They are X-rayed and operated upon and the proper splint is applied. If possible they are not moved until the union of broken bones has been established. There is some criticism of this

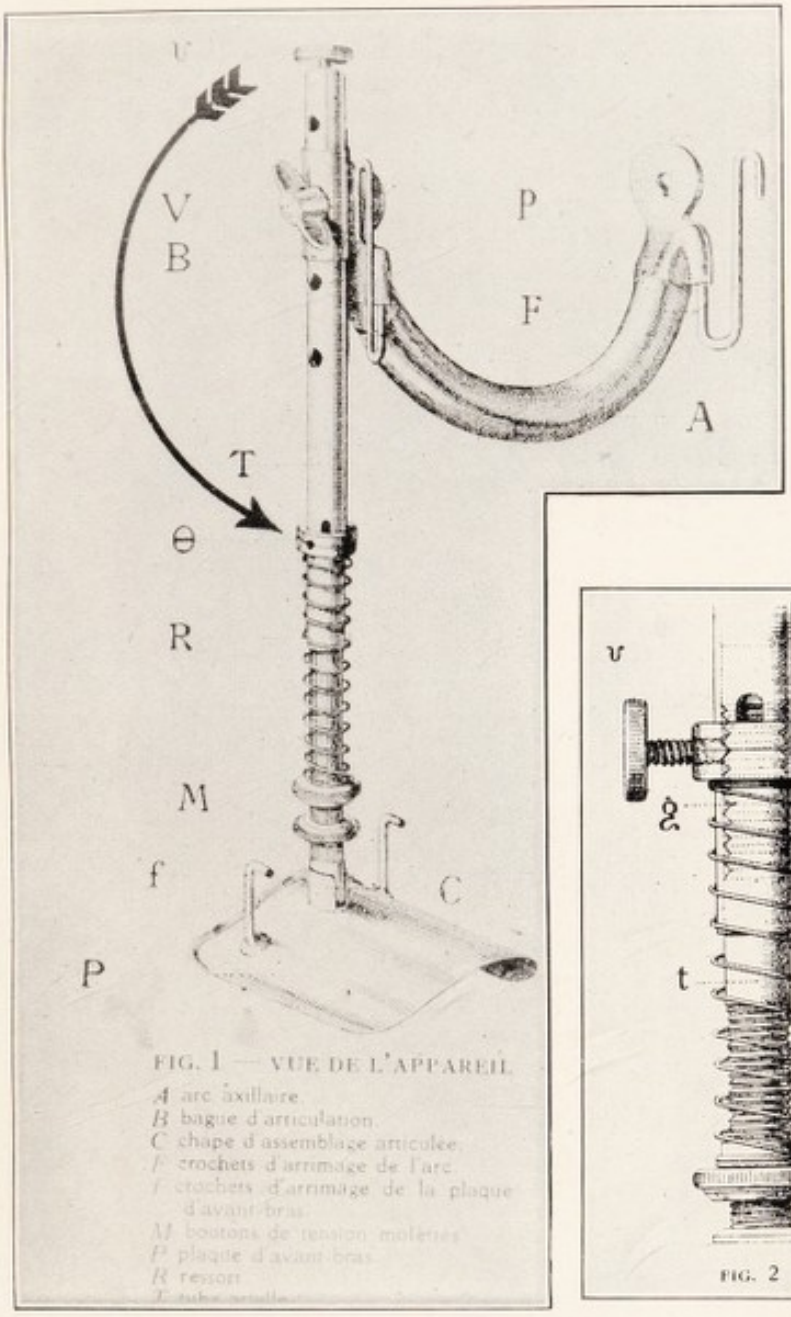


FIG. 1 — VUE DE L'APPAREIL

A arc axillaire.
B bague d'articulation.
C chape d'assemblage articulée.
f crochets d'arrimage de l'arc.
f crochets d'arrimage de la plaque d'avant-bras.
M boutons de tension molletés.
P plaque d'avant-bras.
R ressort.
T tube guide.

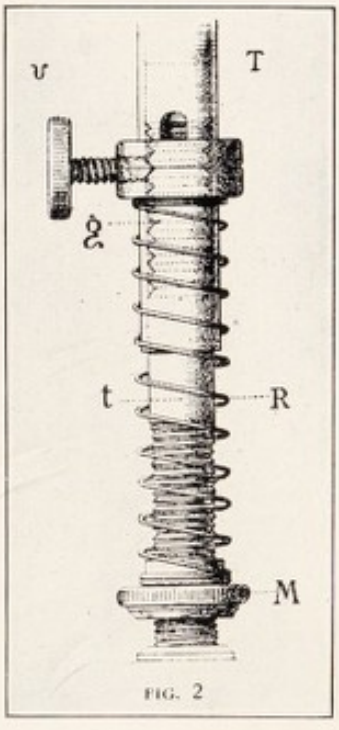


FIG. 2

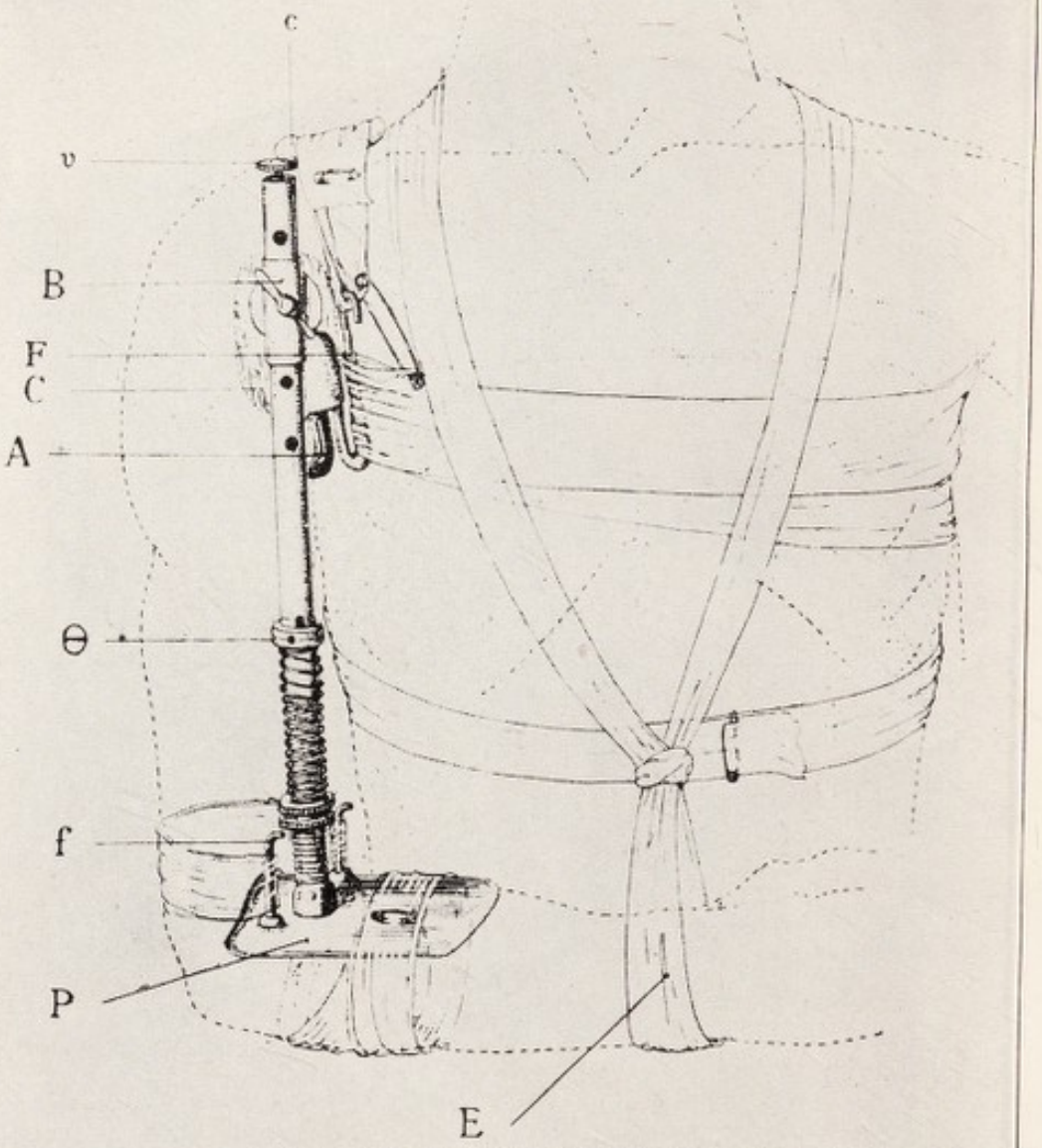
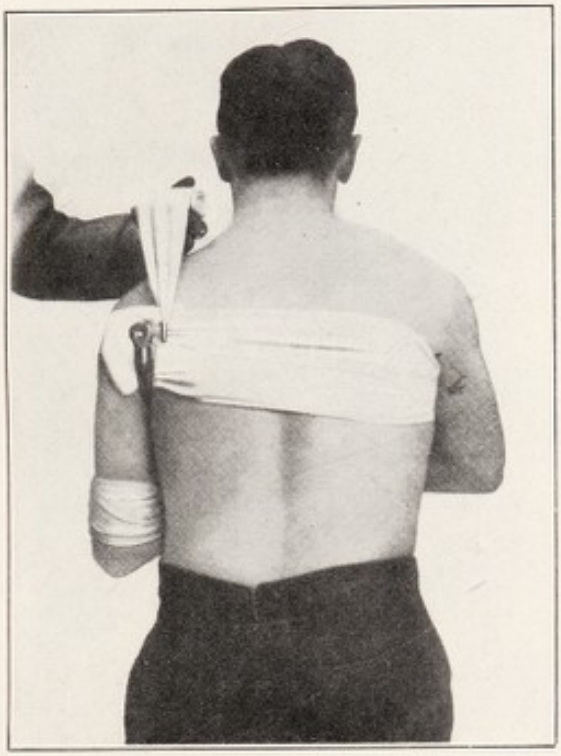


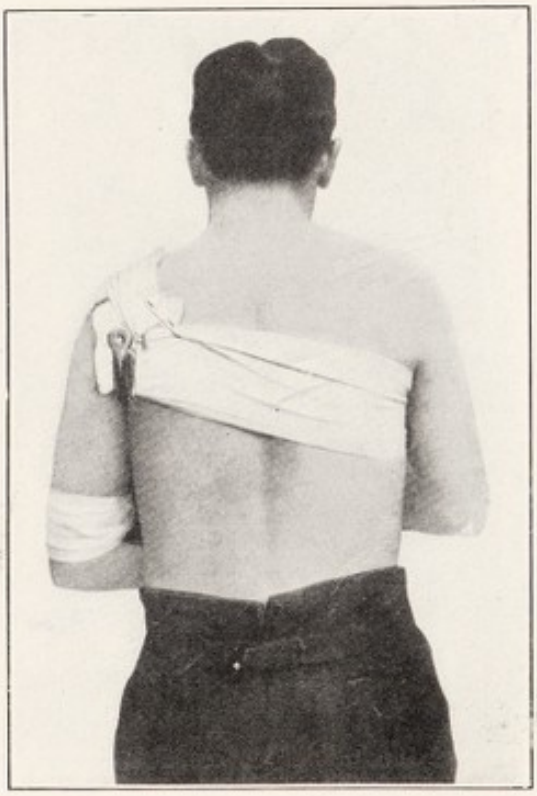
FIG. 3 — L'APPAREIL MIS EN PLACE, VU DE FACE

A arc axilaire.
B bague d'articulation
C c coussins.
E écharpe.
F f crochet d'arrimage.
P plaque d'avant-bras.
v vis de blocage au repos se mettant dans l
θ pour opérer le blocage de l'extension

Apparatus in position. Front view.



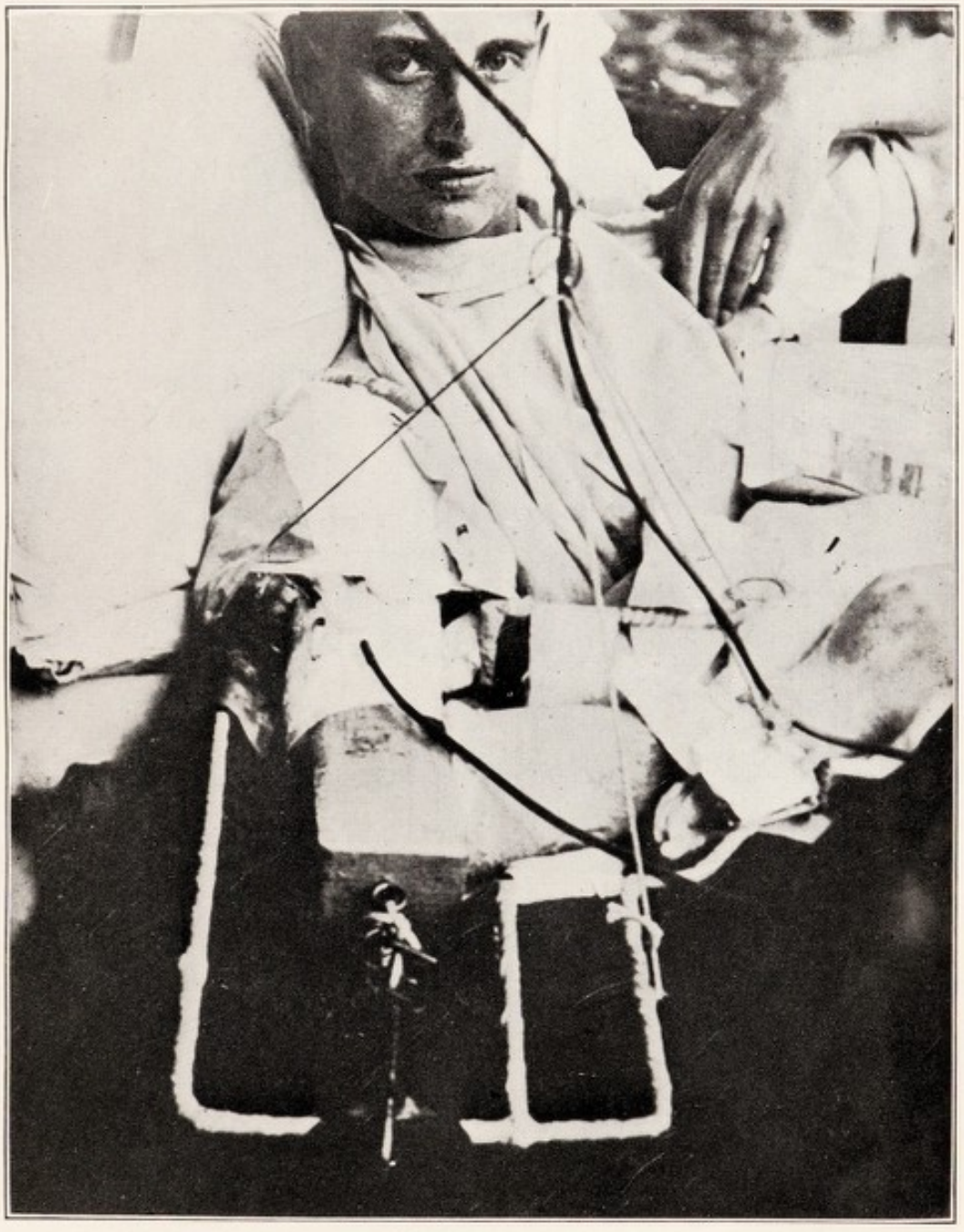




Device for immobilization of fracture of arm applied.



Paterson splint.



Paterson splint.

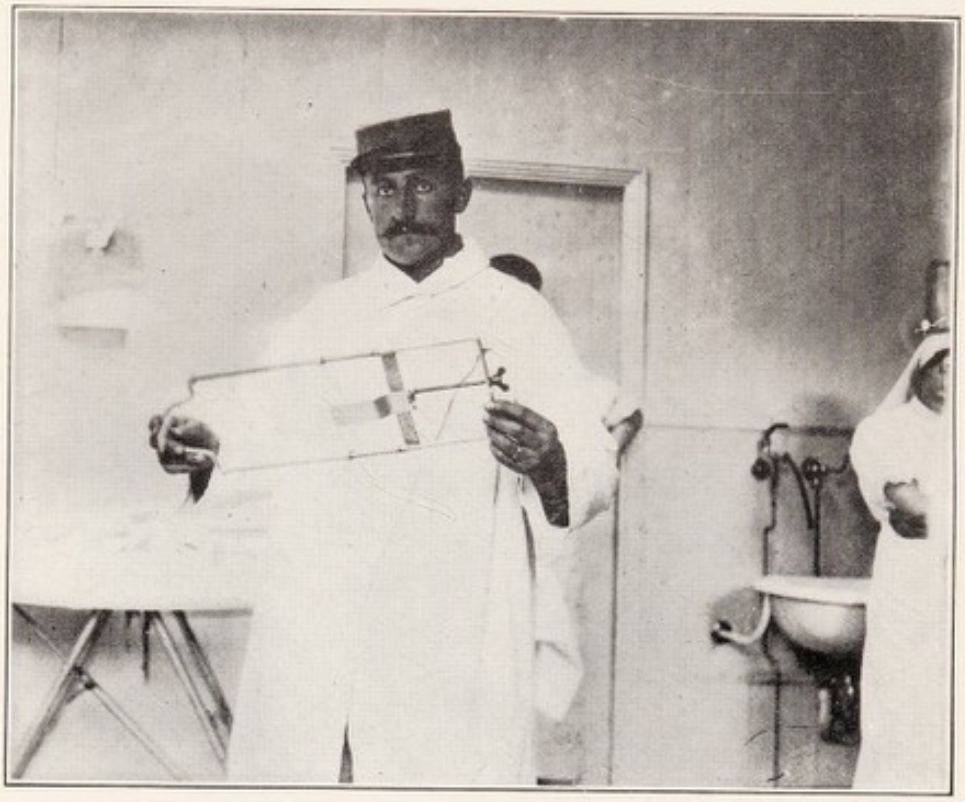




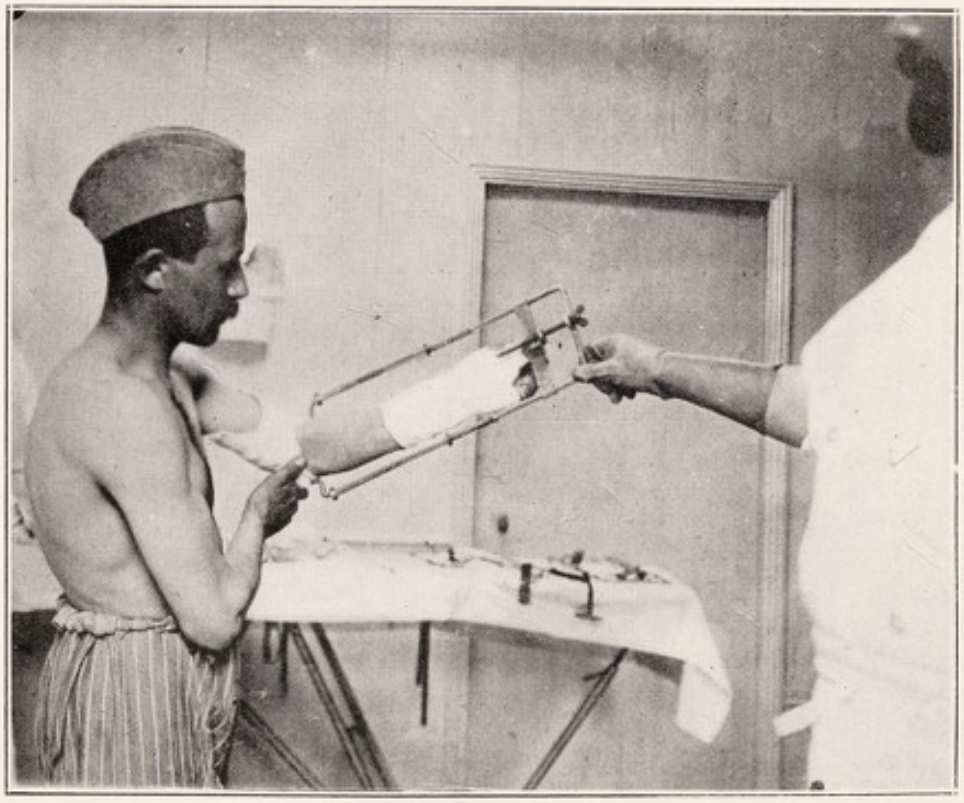
Adjustable abduction arm splint made in the American Red Cross splint shop.



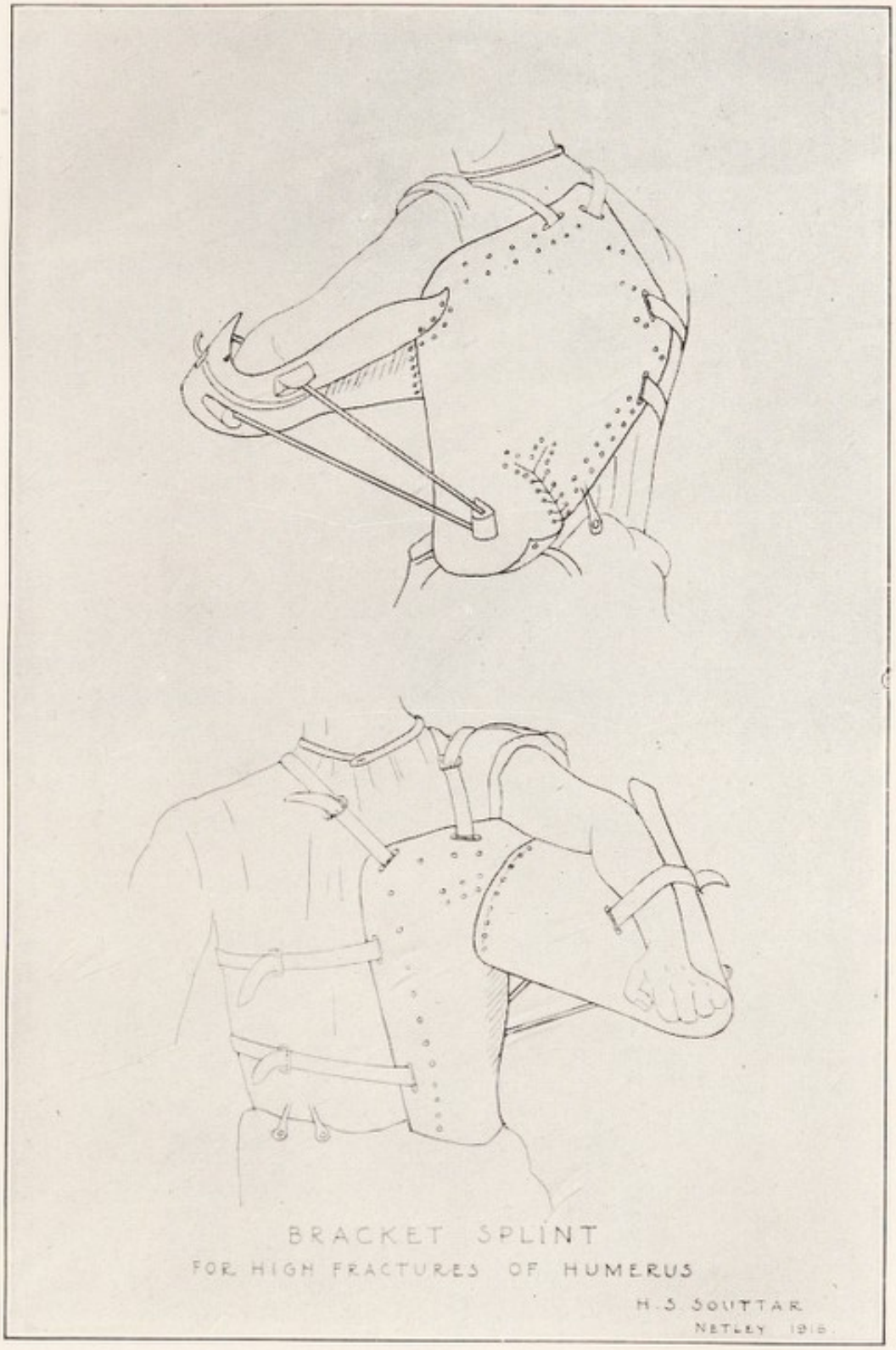
New adjustable abduction splint perfected for the U. S. Army by the American Red Cross splint shop.



1.—Arm extension splint used by the French.



2.—Arm extension splint in place.



Photograph made from pencil sketch by Maj. H. S. Souttar. (See special section, British Red Cross Hospital, Netley.)

arrangement on the score that it is harmful for a patient to be retained for a long period within the battle area with its noise of conflict and constant danger of the necessity for a rapid evacuation. It may be that in the new French Army plan this will be changed and such hospitals placed much farther to the rear. After leaving hospital No. 1, the patients are transferred to hospital No. 2 from 30 to 50 kilometers to the rear. Here any necessary repair work is done, bone infections are treated, and the cases remain until convalescent, when they are sent to hospital No. 3. This class of hospitals is located well to the rear and in such centers of physiotherapy as have been established, where there is provision for massage, mechanotherapy, fitting of artificial limbs and the like.

A board composed of Colonel William L. Keller, Medical Corps, Colonel Joseph A. Blake, Medical Corps, and Captain Nathaniel Allison, Medical Corps, visited four French Army areas where this system was in vogue and made the following report to the chief surgeon of the American Expeditionary Force as to their conclusions:

1. The board has carefully observed the character and efficiency of the splints and appliances used at these various centers for the treatment of fractures and as a result is gratified to state that in its opinion the appliances in splints recommended for use in the American Army under your direction are sufficient and practical to meet all the conditions even better than those in use by the French Army.

2. The board feels that an improvement can be made in this system by having the simple splints which supply the principle of traction applied when the man receives his first surgical dressing.

3. Infection is to be avoided if possible. To this end the French system is admirable. The board feels that fractures and wounds of the soft parts and injuries to joints can be primarily closed in a large percentage of cases if they reach an operating hospital in the first few hours after receiving their wounds.

4. Hospitals for the treatment of fractures and injuries to joints should be special services and should be equipped for X-ray work and operation and for after care. The most capable surgeons should direct the work at these stations.

5. The board feels that so far as is possible the above outlined system should be followed in the American service. It has taken the French three years to evolve this system. It is still not in use by the British. We feel strongly that our own results will be greatly improved by following the principles of this system.

6. The staff arrangement for fracture services should be as follows: The chief surgeon of the group should direct the entire service from hospital No. 1, that is the hospital near the front. The surgeons at Nos. 2 and 3 hospitals should work in complete cooperation with him.

TREPHINED CASES.

A very difficult class of patients to deal with is composed of those who have been trephined. At the schools for reeducation, the farms for the mutilated, and the clearing depots, such as at 28 Quai Debilly, Paris, the frank statement is made that these men are usually mis-

fits. They do not get along well with other patients, and while they often look entirely well they never seem to feel right. They are obsessed with the idea that something is going to press on their "soft spot," and their actions are frequently peculiar. Headaches and a long train of nervous symptoms are complained of.

Dr. Lines, at the clearing house of the Colonie des Étrangers, in speaking of two such cases who had been returned from other institutions to Paris, "because they could not get along with the others," said:

No reeducation, even on a farm, could do much for trephined cases. It is almost useless to try to help these men.

The same opinion was expressed elsewhere, and I early realized that here was one of the great problems of the war wounded. Medical treatment gave very indifferent results. I was therefore anxious to learn whether anything of real value had been developed in surgery for the relief of these unfortunates. I found that Morestin, Gosset, Chutro, and a few other surgeons had done considerable work along the line of filling up the gaps left in the skull by introducing between the skin and the dura a plate of some kind. By this means protection is secured from pressure and relief from direct adhesion between the dura and the subcutaneous tissue—often the scar.

Upon learning that many of these operations had been performed at the Buffon Hospital, and that Prof. Babinski, not only the leading neurologist in France, but one of the greatest in the world, had followed the results, I went to him for his views. He very courteously and freely discussed the treatment of this class of cases, showing histories and patients. He said:

Trephined cases usually are a most unfortunate lot. I have nothing special to offer them in the line of treatment. I either wait to see how time will affect them or have an operation. Some get a little better after awhile if left alone. Gosset's and Chutro's results are excellent from the surgical standpoint. The cranioplastic operation should be tried, but I am not willing to give a final verdict from the neurological point of view. Years must pass before that can be given. I would advise operation in all cases where the symptoms are persistent and marked, and the scalp is adherent to the deeper structures. Whether cartilage or bone should be used is a matter for the surgeons to decide. Some say that bone is absorbed and others that cartilage is absorbed.

To sum up, the opinion of this great authority is, in trephined cases with persistent symptoms; do a cranioplastic operation, but do not promise too much.

The employment of perforated silver plate coverings for cranial gaps has been found serviceable in the experience of Mitchell (Brit. Jour. Surg., July, 1917). The thin plate (not so thick as an ordinary visiting card) is punched with holes one-eighth of an inch in diameter as close together as possible. The orifices, aside from helping

to fix the plate, permit the escape of blood or other fluids thereby guarding against pressure on the brain through accumulation between the plate and the dura. The fitted plate is held in position by a series of catgut sutures passing through the periosteum and out through the most convenient perforations. The scalp flap is sutured over it, and a drainage tube inserted at the most dependent angle for 24 hours, so as to avoid the formation of a hematoma. In the experience of the originator of the method, primary union was obtained in all of his six cases and the operation was followed by marked relief of symptoms.

Cranioplastics by means of osteocutaneous or osteoperiosteal flaps proved highly satisfactory in the experience of Cazin, and Mayet recommends the repair of a loss of cranial substance by turning down an osteoperiosteal flap cut from the external table of a contiguous region of the skull.

After the performance of a trephining operation, the gap in the skull is probably most advantageously closed by means of cartilage which combines a certain yielding property with sufficient solidity to provide the necessary protection. The relief obtained in cases of painful cicatrices is most gratifying. The cartilage may be applied in a series of autoplastic or homoplastic layers, according to Morestin's method, or in the form of a sometimes voluminous single segment of cartilage, with its perichondrium, in order to prevent the ultimate formation of adhesions with the brain. The last named plan is followed by Gosset, who reports 15 successful cranioplastic operations with excellent results (Bull. et mém. Soc. de Chir., de Paris, vol. 42, 1916).

The repair of the gap left in the skull after trephining, by means of cartilaginous grafts, has the advantage of providing a permanent and physiological protective covering of the head. These grafts are accorded preference by Warren Woodroffe, surgeon to the Ulster Volunteer Hospital, because they are safe, simple, autoplastic and autogenous. Cartilage moreover is highly resistant against infection, making this tissue a practically ideal material for reconstructive surgery. The grafts are shaved from the sixth, seventh, or eighth costal cartilage, and may be held in place by a network of catgut attached to the margin of the pericranium, the hole in the skull being filled by an adjustment of overlapping grafts beneath this catgut trellis. Although no bony change follows, the cartilaginous plate affords a satisfactory and reliable closure of the gap in the bony skull. It must be mentioned, however, that phenomena of cerebral compression have been reported, following the closure of a cranial gap by a large piece of cartilage (Bull. et mém. Soc. de Chir., de Paris, 12 Dec., 1917).

To return to the Buffon Hospital. At Chutro's clinic I saw a number of these cranioplastic operations and some post operative results. The patients I examined certainly were in excellent condition and the records were most satisfactory. Chutro's operation is a modification of Gosset's, with the use of rib cartilage, and done under local anesthesia. He has had 62 cases with uniform success and I was most favorably impressed with the method of operating, the technique of the surgeon, and the results in those patients observed.

Although the details of this work have not been published by Dr. Chutro, in response to my request he allowed me to send an artist to his clinic and he himself wrote out, in Spanish, a description which is to be made a part of this report. A translation of the paper and the original pictures I am advised are on the way from Paris and will be submitted as soon as they arrive. (See page 237.)

AMPUTATIONS.

There is practically unanimous agreement that in the early days of the war there was much unnecessary amputation. The development of better methods of treatment and facilities for the care of the wounded have resulted since then in a great saving of limbs.

In those cases where amputations are still found necessary a most important consideration is the point of amputation. While the saving of bone and tissue and the early healing of the wound are of great moment, the opinion of those who have had the greatest experience in this line of work is that the main object to be borne in mind is the obtaining of such a stump as will develop the greatest functional activity in connection with the use of an artificial limb.

Captain P. D. Wilson, Medical Corps, United States Army, at the American Red Cross orthopedic department showed me cases at his clinic which clearly demonstrated the truth of his statement that—

> Often good prosthetic stumps are, according to old ideas, bad surgical results—skin adherent to bone end, etc. Nevertheless they are very much better from the standpoint of function, and for the artificial-limb maker, than if even a few centimeters were removed in order to give what were surgically considered, up to the time of the war, satisfactory stumps. Let more bone be removed if necessary; even a centimeter may count greatly against function for prosthesis.

The following views of Dr. Stassen, at the head of the great Belgian hospital at Port Villez, are concurred in by many of the leading surgeons abroad. These were furnished to me by Dr. Stassen in a personal communication after my visit:

> The idea of a "preferred spot" for amputation has taken root in France since the day of Ambroise Paré, and the experience of the war tells in its favor.

The cooperation which exists between the front and rear hospitals has resulted in a renovation and an improvement in the technique of amputations. The progress made in prosthetic art and the study of scientific methods appertaining thereto will soon lead surgeons to invoke the collaboration of the gymnasium and prosthetic doctors with regard to the aftertreatment of the patient, and the subsequent obtaining of maximum good results. This is already being done, and the revision of amputation technique is the result. The following principles ought henceforth to serve as a guide to the surgeon:

1. In the amputation of a member, it is necessary to preserve the maximum of stump to be used as a lever, even to the extent of placing the wound of the operation in a position classically known as bad. A long, conical stump even with a wound clinging to the bone is better than a stump too short, but well padded.

2. The amputé must begin to actively mobilize the different segments of his stump in the early hours which follow amputation. The logical and necessary complement of this method is a speedy functional utilization of the stump, and to this end, the patients must in the early days, even before cicatrization is complete, be provided with provisional apparatus.

These latter should be light and simple, easy to manufacture and replace and would consist of (*a*) an encasement exactly modeled to fit the stump. Plaster is the best material for this purpose; (*b*) simple attachments made with a view to

1. Maintaining the normal orientation of the longitudinal and articular axes of the member.

2. Maintaining the normal integrity of articular movement and the function of the muscular groups.

(*c*) A terminating apparatus (a shank in the case of lower member amputations; terminal instruments and implements for use in relation to therapeutic work in the case of those of the upper member).

The three items on the therapeutic program are:

1. Immediate active mobilization.

2. Speedy functional utilization.

3. Functional reeducation through walking or working with prosthetic apparatus.

If carried out the result will be a mutilé more able to take his place as an active member of the economic life of the nation.

Upper member.—Hand: Preserve as much as possible, even rudiments of the fingers, metacarpals, all of which are of use.

Wrist: Disarticulation of the wrist with resection of the styloid apophysis of the radius is preferable to amputation of the two bones of the forearm above the articular interline. The position of the wound should be on the back plane; the point is, the preservation in the stump of the forearm of the normal pronation and supination movements in the lower radio-ulnar articulation.

Forearm: Preserve the maximum amount of bony leverage, even to the detriment of the situation of the wound.

Arm: Apply the above principle in all its force. In high amputations, preserve as much of the humerus as possible, even the rudiments of the humeral head and have recourse to disarticulation of the shoulder only if and when the worst comes to the worst.

Exception.—Elbow region: Where this is unavoidable, it is as well to reject any high amputation of the forearm, because the result will merely be an inert stump devoid of all utility. Disarticulation of the elbow or better still, ampu-

tation above the condyles of the humerus is to be preferred. Which of these two alternatives is the better, is still a matter of controversy. For the utilization of automatic arms it may be an advantage to preserve the condyles of the humerus, i. e., disarticulate the elbow. The condyles of the humerus may even serve as a stop for the armpiece of the automatic apparatus. When, however, a working arm is required, amputation above the condyles of the humerus is preferable, because it does not cause dissonance between the real and artificial elbows. Whatever be the case, however, the question merits still further study. At present, one can not establish a general rule and state that amputation above the condyles is to be preferred to disarticulation of the elbow or vice versa.

Lower member.—Foot: Amputation of all the toes with preservation of the heads of the first and second metatarsals is a good amputation. The preservation of a portion of the big toe and its metatarsus, with amputation of all the others, is preferable to Lisfranc's amputation. The question is still under discussion as to which of those two amputations is better, viz (*a*) amputation of the first four metatarsal bones with preservation of a part of the fifth toe and its metatarsus, or (*b*) the amputation of Lisfranc (tarso-metatarsal). We have not had occasion to see cases where the second or third or fourth metatarsals ought to have been amputated, and we can not therefore give a formal opinion as to this operation. Classically speaking, this kind of operation is more prejudicial to the patient than a veritable Lisfranc's operation.

As an amputation of the forefoot, Lisfranc's operation is excellent.

Chopart's amputation (medio-tarsal disarticulation) is a rather bad one. There nearly always ensues a certain degree of equinus, and a dislocation of the instep. Moreover, the foot acquires a vicious attitude and the patient suffers largely from his mutilation.

Pirogoff's operation is to be recommended as it enables patients to walk very satisfactorily. It is to be preferred to tibio-astragalar amputation with resection of the malleolus.

The instep: When Pirogoff's amputation can not be performed, it is preferable to have recourse to amputation above the malleolus.

The leg: Between the line passing above the malleolus and below the line passing by the insertion of the patte-d'oie, and the insertion of the quadriceps muscle in the tuberosity of the tibia, the principle must be the preservation of the maximum of bony leverage, and that to the detriment of the position of the operating wound, and the padding of the stump.

Thigh: Above the femoral condyles apply the same principles. In high amputations of the thigh, preserve as far as possible the length of the femur, and consider coxo-femoral disarticulation only as a final resource.

Exception.—Knee region: High amputations in the leg, in the region of the knee, ought to be rejected. The same refers to disarticulation of the knee. The result of each of these interventions is a stump as difficult to apparatus as an iron bell-tongue. Amputation on the thigh above the condyles is preferable.

When possible this latter amputation should be replaced by amputation after the method of Sabanejeff, and especially by Gritti's operation which give excellent stumps.

Prof. Tuffier, of Beaujon Hospital, said:

Reamputations were frequent at the beginning of the war; they are less so now. This is due to the traction exercised upon the skin and flaps during the whole period of cicatrization.

Out of 1,731 amputés at the Maison Blanche on the 1st of December, 1915, who were examined by me, 1,474 were fit to be apparatused straight away, but 257 had to undergo a complementary operation in my service, say 17.4 per cent.

Furthermore, questions elicited the fact that 279 of these 1,731 wounded had had to undergo previously two to four successive amputations, say 16.1 per cent. That makes a total of 536 amputés whose first operation was inadequate, say 30.9 per cent. The majority of the amputations, according to the Maison Blanche statistics, give results which, if not perfect, suffice for prosthetic purposes, in only 69.1 per cent of the cases, and consequently after one amputation, the chances of a fresh operation are thirty to a hundred.

Statistics from the the sixteenth region show for the upper member, 90.5 per cent of good stumps, and 9.5 per cent of bad ones; for the lower member, 68 per cent good for the thigh and 32 per cent bad; and for the leg, 53 per cent good and 47 per cent bad.

Out of 279 amputés who have been retouched in some way, regulation or re-operated upon, practically all were cases of the lower members; 252 lower members, say 90.3 per cent (111 thighs, 141 legs), 27 upper members, say, 9.7 per cent.

(COPY.)

[Translation.]

PARIS, *May 25, 1918.*

DEAR DR. BAINBRIDGE: I have received your letter of May 22.

(1) The number of amputations is due in part to the severity of the traumatism and in part to the infection.

The infection was responsible for one-half of the amputations. This figure is very low at the present writing, but I find it impossible to fix a percentage.

(2) The promised drawings to show the conditions which can lessen the number of reamputations appear in the contribution which I have caused to be forwarded to you at the Hotel Crillon.

(3) I have also answered this question, and have sent you detailed statements concerning an army in the period of an offensive.

(4) The results of each offensive are not published.

(5) A reply has also been given on this matter, indicating which wounded should be returned to America. I have likewise indicated to you what classes of wounded are better sent to America than kept in France.

With kindest regards, etc..

TUFFIER.

The following résumé of the lessons of the war with regard to amputation was given to me by Captain H. W. Miller, of the American Red Cross bureau for the manufacture of artificial limbs, and by Captain P. D. Wilson, detailed from the United States Army to the orthopedic department of the American Red Cross, in Paris, and is said to represent the consensus of opinion to-day among those best qualified to judge:

1. No amputation should be sutured primarily. When a man is seen with a good stump and there has been a primary suture there has no doubt been needless removal of part of the limb. Always conserve length of the lever. Primary suture does not do this.

2. Early secondary suture, after smears show less than one per field of bacteria, then suture. Never suture, however, when there are streptococci, no matter how few.

3. Never do a Chopart's amputation. You can never get a good apparatus to fit it. There is always shortening of the tendo Achillis. If the tendo Achillis be cut the part is much weakened so never employ this amputation.

4. A Pirogoff amputation is not good. Syme's is best.

FOR THE LEG.

5. If one can not do a Syme's, do an amputation at the junction of the lower with the middle two-thirds. This is an exception to No. 1, which says: "Conserve the length of the lever." Don't operate in the lower third of the leg if you can help it. The objections to the lower third are as follows:

(*a*) The stump is always cold because of poor circulation.

(*b*) It is always sensitive.

6. The minimum length of the lever in ordinary cases which is utilizable is 2 inches below the knee.

7. Never take out the head of the fibula because you sacrifice the attachment of important flexible muscles.

8. The preferred length of the lever of the leg is 4 inches below the knee. With 4 or 5 inches one can secure practically 100 per cent efficiency with an artificial member; 75 per cent efficiency with 2 to 3 inches.

The steel and leather orthopedic leg with laced corset about the stump has been given up practically by the French. They have adopted the American leg and principle. This was done about June, 1917. At the present time they are using approximately 15 per cent of American legs. We know this because they are being manufactured to that extent for them. The French have not yet gotten around to doing it successfully. The steel and leather leg is gone for good.

The improved American leg is the one gotten up by Hendricks and Martin, of Belgium. They differ somewhat in theory but very little in practice. One can read their articles, which deal more with theoretical than practical differences.

Prothesis has been extended since the war far beyond the field of dentistry where it originally started. We may define prothesis as a system of restoring an amputé to his maximum efficiency.

FOR THE THIGH.

(*a*) Operation.

(*b*) Treatment.

Cushions are bad. Put the thigh out straight, not flexed. Extension after amputation helps save from contraction, deformity, and ankylosis. Tends to prevent adhesion of the scar to the bone.

(*c*) Always turn a patient on his face and extend the thigh for a few minutes each day. One such movement daily will do an immense amount of good and saves contraction.

(*d*) Disarticulation of the knee or other joints, except the shoulder or hip, is bad.

(*e*) In thigh amputations get the maximum length.

(*f*) Disarticulation of the hip ought to be done in two stages, as it means much less mortality. Amputate the thigh and later disarticulate the bone by lateral vertical incision.

FOR THE LOWER LEG.

(*g*) Crutches are very bad. They change the statics of the body. Bad habits are formed. They can walk early with provisional apparatus. End bearing pressure does not exist. Bad-looking stumps often are most useful. This doing away with crutches is best, yet we have many crutches. The Government has not yet taken hold practically of the provisional apparatus. The crutches are easy to get and supply and it looks well to get the patients up quickly.

WHY DO AWAY WITH CRUTCHES?

1. Deformities are produced by crutches in the way the man carries himself.

2. There is always pressure atrophy when apparatus is used. There is atrophy of disuse which is prevented when we employ provisional apparatus. Thus by the early use of provisional apparatus we save one kind of atrophy, which can be prevented, and we have early the atrophy from the pressure of the apparatus and can more quickly adjust the permanent apparatus. Then a stump has, as a rule, an extra accumulation of fat if it hangs, so by early use of apparatus we save this extra increase of fat on the stump, which must later disappear. This takes time.

3. Loss of time. The form of the stump does not take its final shape as quickly if crutches are employed, as when provisional apparatus is used.

4. Bad statics. The statics of an individual are transformed. He gets a new habit of walking which has to be overcome. Provisional apparatus can be used in about 14 days for amputations below the knee and three weeks for the thigh. *Don't use crutches.* Instead use provisional apparatus. The patients get out very nearly as quickly.

PROVISIONAL APPARATUS.

The best is plaster of Paris molded with steel rods at the sides, a bolt in the center for the knee, so as to allow all flexion, and suspenders over the shoulders holding up the apparatus which is molded to the extremity. A leather corset is used above on the thigh. Use the end bearing when it exists, but it is not usually necessary. When both legs are off use provisional peg legs but no crutches. Give them a stick to walk with.

VALUE OF PROVISIONAL APPARATUS.

1. Correct statics.
2. Active agent physicotherapy.
3. Hastens atrophy of stump; lessens time of evolution of stump one-half.
4. Saves cost. Provisional apparatus can be had for $7 or $8, whereas if no provisional apparatus is made there will be an additional fitting adjustment to the permanent apparatus costing $20 to $40. The extra period of fitting is most trying on the patient.
5. Finally, there is the mental side of it all. When the member is removed profound depression comes on. The patient sinks down to the level of a professional cripple. He feels himself a human derelict. Provisional apparatus lessens this greatly and combats this tendency as early as possible. At Rouen they get the patients to hop before they have provisional apparatus, so as to encourage them. Begin as early as possible to let them see they are going to do something and be something in the future.
6. Saves by early use much stiffness and maybe ankylosis of near-by joint. *Prevent the crutch habit.* A Danish surgeon, Dr. Svindt, developed one of the best provisional apparatus, a cardboard peg leg for provisional use with a starched bandage. The funnel end is open.

POINTS OF SUPPORT.

1. Bony prominences the points for support in all apparatus.
2. The soft parts of the stump.
3. The end of the stump when utilizable.

Legs and thigh are so far all that we have studied.

Musculo-spiral paralysis or crutch paralysis.—So many of these cases of crutch paralysis have been seen in France that there has been demanded and produced an ultra-brachial crutch. Still it is bad. Get the amputated leg case up early, but *don't use the crutch.*

FINAL APPARATUS.

This depends largely on what the patient is to do hereafter.

1. *The peg leg.*—It is simple, any one can use it and it is not expensive. When going to do hard work it is the best. It gives the maximum strength with the smallest cost for repairs. It is well constructed, and the French have developed it exceedingly well. With a decent socket and a joint-lock at the knee the man really sits in it with comfort.

2. *The articulated leg.*—It looks much better. The splint manufacturers are entirely against the peg leg.

An artificial member is to serve always either of two purposes: One is function and the other appearance. One must weigh up the two. A peg leg may mean added advantage in some cases; in fact, with a peg leg a man may even capitalize his injury. This is a dangerous philosophy, but it is actually a fact.

WHAT CAN A MAN DO WITHOUT A LEG?

1. After an amputation below the knee, as indicated above, he can do anything as he did it before. There is no problem of reeducation here at all.

2. Above the knee there is need of reeducation. The man may become a shoemaker, a basket maker, a shopkeeper, or he should certainly be taught a trade which would allow him to sit a good part of the day, fruit culture, etc. There are many outlets for him. The French have turned most of them into shoemakers and basket makers. Of course, these cases of mutilés of the lower extremities are usually young men and they can easily learn. Most manufacturers will tell us that they can take a man from any place in which he is working and make him do more work and better work than the trade he has himself selected. A time may come when efficiency engineers will put the man in his most useful place.

Captain Miller states that in making legs they have developed a real business which is growing every day. The Red Cross stands ready to furnish limbs or give any aid along the lines indicated herein. It will put its resources at the disposal of both Americans and French, to be of assistance from the time the patient leaves the operating table until his return to his maximum efficiency.

He also states that up to date in the war there have been 60 per cent reamputations, necessitating greater loss of limb, which is a distinct economic waste.

From the standpoint of fitting splints, the flaps in amputation are bad. The site of the scar is negligible—absolutely of no importance. Flap amputations being bad, circular amputations are first choice.

Statistics of amputation from August 4, 1914, to March 1, 1917.

FRANCE.

Upper limbs	25 per cent.
Lower limbs	75 per cent.
Of the lower limbs	64 per cent thigh.
	34 per cent leg.
Disarticulation of hip	1 per cent minus.
Syme's and Pirogoff amputations	1 per cent plus.

Of considerable interest is the questionnaire sent out to the English and Belgian centers of prothesis and to 12 cities in France, including not only the ones in charge of these centers but also the chief surgeons. The answers represent a large majority of those who replied.

In order that this bureau may render an intelligent report to the United States Army as to the best methods of amputation of the lower limb, will you have the kindness to answer the following questions and return to me in an inclosed envelope.

All of these questions are in regard to amputating stumps of the thigh or leg and do not include disarticulation of the knee or hip or amputations of the ankle such as the Symes or Pirogoff.

1. Do you consider the ability of a stump to bear weight on its end as of any importance?

No.

2. When a stump is able to bear weight on its end, do you utilize this ability when fitting an artificial limb? If so, how?

No.

3. With an artificial limb fitted so that the end of the stump bears much of the weight, have you ever remarked improvement in the ability of the mutilé to walk or work?

No. Because they have had no experience with it.

4. Given that end bearing is usually secured in the types of stumps above described at the expense of length, do you think the surgeon shoud be advised to strive for end bearing when making an amputation?

Secure maximum length of lever.

Major Edred Corner, of the Fifth London General Hospital, gave me a synopsis of his experience as to amputations, which will be found under the description of the work at that hospital. (See Fifth London General Hospital.)

From the experience of all of these authorities, the following generalizations may be made:

1. Every surgeon who amputates should know the best place for amputation consistent with the obtaining of the best functional results for the use of apparatus.

2. The horror of amputation should be mitigated in the minds of those injured and they should be shown that often those who retain a deformed limb have much less function than those with artificial extremities.

3. After the patient has an artificial limb and begins to learn a trade, his work should be such as to fit him to do that which is of most benefit in the community where he expects to live. For example: If a mutilé has his limb, and when able to return to work is taken to his home, say in Montana, there to live and be reeducated, he should be encouraged to do mining or farming. If on the other hand he comes from Massachusetts, he should be taught jewelry work or shoemaking or the like. In other words fit him for the trade where there is the greatest demand. We in America should have such centers of reeducation thoroughly adapted to teach in accordance with the needs of the community or section. Of course, we must always consider what the mutilé can do and whenever possible he should return to the trade or occupation in which he was most proficient before his disablement.

At the Roehampton Hospital, 5 miles from Charing Cross, London, there are 900 beds for convalescent amputated cases, and there are always hundreds awaiting admission. This is only one of a number of similar hospitals, and 14,000 cases have been fitted with artificial limbs here and sent out. The manufacturers of the instruments work on the premises, and while waiting for the apparatus or learning its use, the men may take up new trades. Sailors come here as well as soldiers and we saw one of the British Navy surgeons fitting splints.

It would seem to be an excellent idea for the Navy to be thoroughly in touch with this work. With our marines in the thick of the fighting, we should be prepared to let them profit by all that experience has taught our allies.

At Roehampton (an old sailor, J. M. Andrews, who is also a skilled mechanic, is of the greatest aid in advising the men as to their future. He is full of cheer as well as most practical, and goes about and talks with each man and discusses his future occupation and how he can best be fitted for it.

Lieutenant Colonel MacLeod, who is in charge, said:

> Most of the cases should have provisional apparatus before they come here. Up to the present time they have had none, but I believe it will come soon.

He said that there had lately been an increase in the number of double amputations—61 such cases in the preceding month. The average stay in the hospital is thirty days for a leg, but less for an arm. Double amputation or joint amputation means, of course, a much longer stay. High amputation of the thigh with only 3 inches of bone left was of no value as a rule. Such a case is treated as if it were a hip joint amputation.

He considers the hip joint amputation apparatus one of the really great things of the war. The patient "sits" in the apparatus quite comfortably and can walk for miles with ease.

He says: "Ninety per cent of the amputated cases should before long be self-supporting."

In the matter of provision by the Navy for artificial limbs, the following letter from Captain Miller should be given careful consideration:

AMERICAN RED CROSS,
DEPARTMENT MILITARY AFFAIRS,
ARTIFICIAL LIMB SERVICE,
Paris, June 27, 1918.

From: Capt. H. W. Miller, 12 Rue Boissy d'Anglas, Paris.
To: Surg. William S. Bainbridge, U. S. N., R. F., Hotel Crillon.
Subject: Mutilés.

1. The bureau of manufacture of artificial limbs of the American Red Cross has been in operation for over a year. It has made what we hope has been a careful survey of the manufacture of artificial limbs in France, Belgium, Italy, and Great Britain. At the same time we have conducted a workshop, where the past nine months we have been actually manufacturing artificial limbs. As the result we have adopted a type of leg which, although far from ideal, is nevertheless, in our opinion, the best that can be made to-day.

2. The greater part of it can be manufactured in quantity. It is of the wooden American type, following on the whole the principles of Dr. Martin, of the Belgian Army, as to statics. It has been adopted by the surgeon general's office of the French Army and is being supplied to the orthopedic division, A. E. F. Following design of Capt. P. D. Wilson, M. R. C., we are manufacturing for the A. E. F. a type of provisional apparatus which we have found satisfactory.

3. The organization and equipment of our workshop has taken considerable time and has been attended with a good deal of difficulty. We beg, therefore, to call this to the attention of the Navy Department and to make the following suggestions:

(*a*) That this bureau should be prepared to manufacture samples of any prothetic apparatus which the department desired to have manufactured.

(*b*) On application from the Navy Department to the American Red Cross (to Maj. J. H. Perkins, commissioner for Europe, 4 Place de la Concorde, Paris) arrangements could be made to manufacture such apparatus in quantity.

4. The Navy Department could send a personnel to this bureau to be instructed in the production of prothetic apparatus, such personnel to consist of a foreman (not necessarily a man with previous experience in the artificial-limb business) and an orthopedic surgeon. These men could enter our shop and work there as long as desired. It would give us pleasure at the same time to put them in touch with the various French centers. In our opinion it is essential that the manufacture of artificial limbs be studied in Europe, it being impossible to obtain a correct knowledge of the problem through the American manufacturers, plus a study of the French and English literature on the subject. Much of the latter, although interesting, is extremely misleading and must be checked up with the actual results being obtained here.

(Signed) H. W. MILLER.
Capt. H. W. MILLER, *Chief.*

PLASTIC SURGERY.

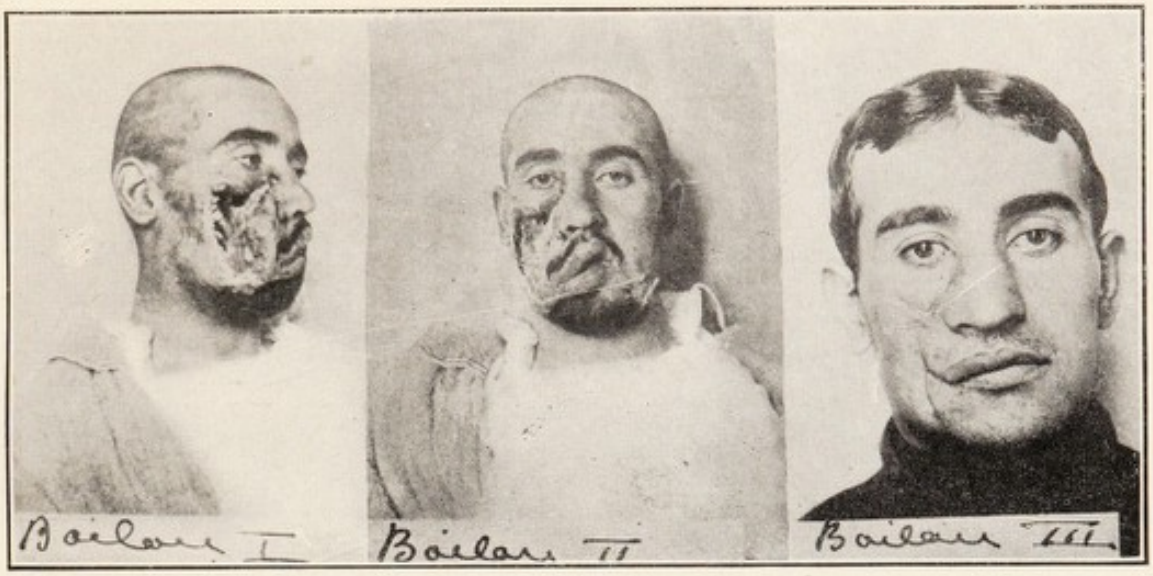
In our enthusiasm over the results being obtained in plastic surgery during the present war, we are apt to regard the work as a recent development and to overlook the fact that there is no other branch of surgery in which such advance has been made during the 25 years preceding the war. Indeed, while antisepsis and asepsis have done much toward making possible the successful treatment of cases requiring bone and tissue transplanting, plastic surgery is by no means a discovery of our own day. The ancient Hindus, to whom so many wonderful achievements are popularly attributed, are credited with having performed plastic operations 2,000 years ago. Doubtless this was brought about by reason of the fact that quite a popular form of punishment was the cutting off of the nose. Strange as it may seem, the tile makers, who are reputed to have been a more or less despised class, delegated to themselves the task of nose mending. Presumably the thought came to these particular artisans as a result of their familiarity with cements and repairs calling for the adhesion of one substance to another.

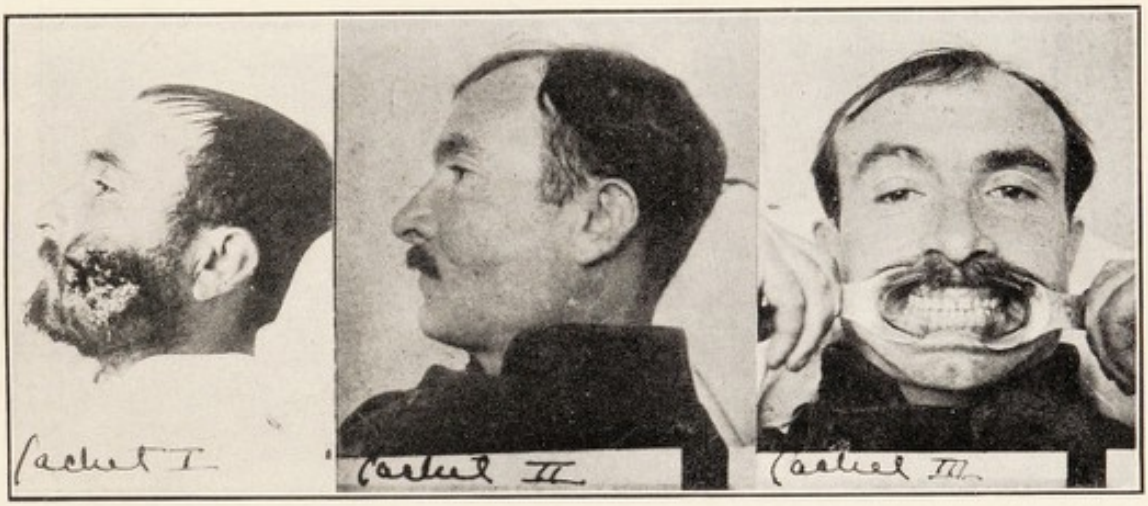
In more modern times, the ingenuity of the most skillful surgeons has been taxed to enable them to remedy congenital defects, such as cleft palate and harelip, or the results of accidents, such as extensive burns, and also deformities from lupus or malignant disease. Pieces taken from the ribs and from other parts of the framework of the body have been successfully utilized. Lane, Brophy, and a host of others were doing wonderful work along these lines before the horrors of war multiplied many times the number of patients requiring such treatment.

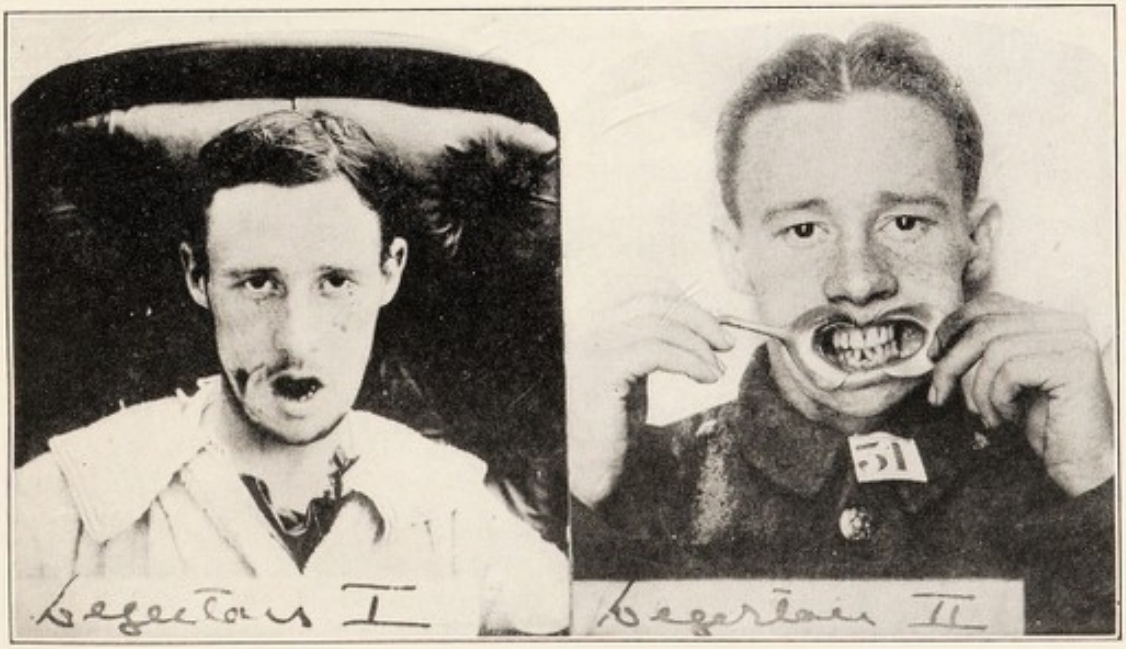
Restorative surgery, in the broad sense of the term, includes plastic work in many lines, such as bone grafting, the restoring of nerve continuity, tendon transplanting, and the implanting of adipose tissue to fill bone or lung cavities; but perhaps the most gratifying results have been obtained in cases involving the restoring of the jaw and the remedying of gross defects of face and mouth.

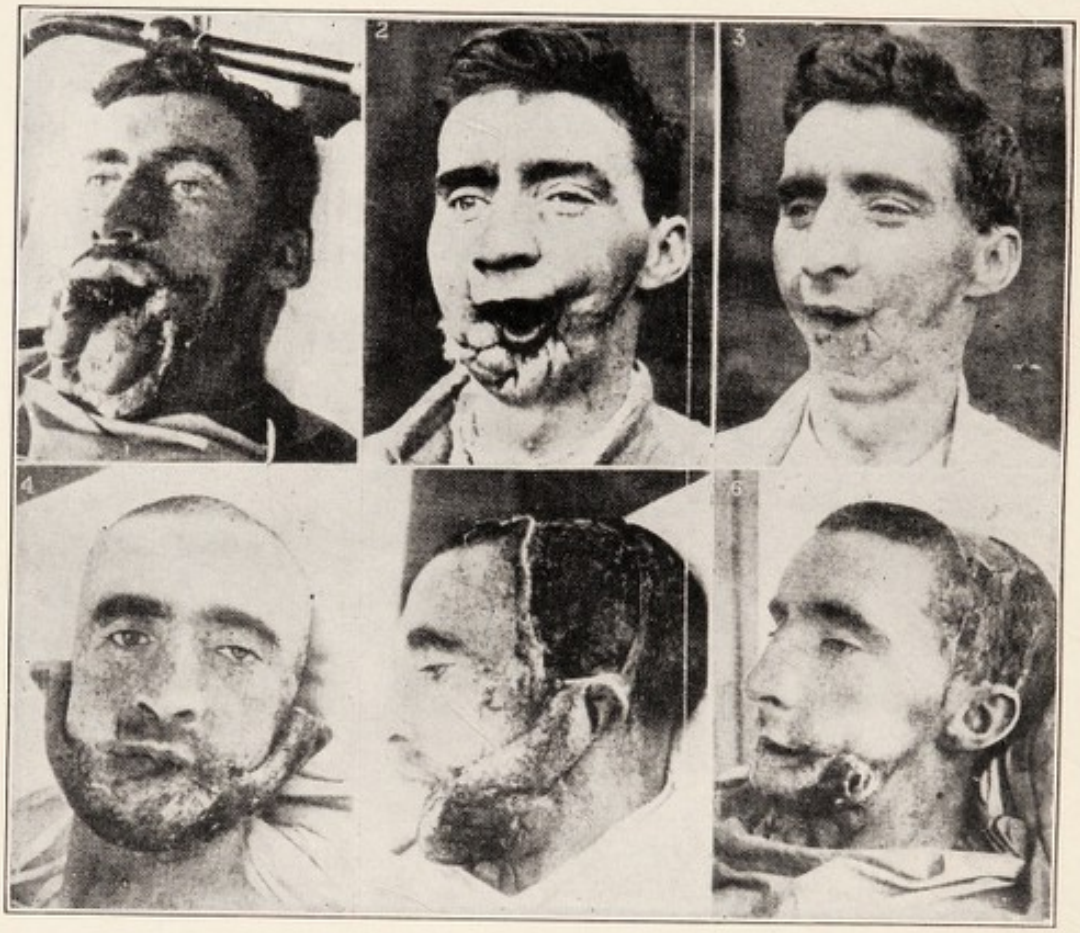
Modern warfare has resulted in much deformity, especially horrible when the head and face are involved, and it is to plastic surgery that all are hopefully looking for relief for those who have suffered such injury. The injury may be slight and only of cosmetic interest, or so great as to endanger life. Between these extremes there is a multitude of unfortunates who must have repair work performed in order that they may be made more presentable before they can go back either to the fighting force or to civil life and be economically self-sustaining.

It is evident that one of the great responsibilities with which we shall be faced at the end of the war will be the aftercare which must


Boilard I
Boilard II
Boilard III


Corbeil I
Corbeil II
Corbeil III


Desjardins I
51
Desjardins II



At Queen's Hospital, Sidcup, by Maj. H. D. Gillies: 1, On arrival; 2, wnen healed; 3, after first operation; 4, first stage of second operation; 5, side view of same; 6, second stage of second operation; pedicles returned to scalp.

be given to those whose injuries require plastic work. While the preliminary care of such cases should be started immediately in order to avoid contracture of muscles, stiff joints, and atrophy of tissues, the plastic surgery needed will, in many cases, extend over a period of years. Just as we must make plans now for the postwar care to be given those who have suffered amputation, we must also make ready by plastic surgery to assist those unfortunates who otherwise would be more or less shut off from society.

With this object in view we should establish special departments in certain hospitals or, if the number of cases requires, a special hospital where the best dental and mechanical work will be joined with the most advanced plastic and oral surgery. (It would be well if this center could be so located that those taking such courses as are given by the United States Naval Medical School could have the benefit of the clinical teaching.)

This assumes that the patients are to be brought back to the United States promptly, but, as stated before, in every case there should be some temporary splint work done immediately and before the men are sent across the ocean.

One of the distinct advances growing out of the present war has been the recognition of the need for cooperative work in this field between the general surgeon and the dental surgeon. In the organization of military hospitals the dentist is established as indispensable, and the value of his work along the line of dental repair can not be overestimated. But the field of the dental surgeon is being greatly enlarged by reason of the vast number of jaw and face wounds resulting from present-day warfare, involving loss of bone, teeth, and soft parts, and cooperation between the general surgeon and the dental surgeon is bringing about such satisfactory results that every means must be taken to encourage and extend this teamwork.

The need for such cooperation was pointed out by Surgeon A. M. Fauntleroy, United States Navy, in his report on the medico-military aspects of the European war (1915), and has steadily grown more apparent, until it is now regarded as an essential feature in plastic surgery of the mouth and face. A number of surgeons are devoting their attention to work in this line and achieving noteworthy results.

The American Ambulance at Neuilly, now Red Cross Hospital No. 1, was one of the pioneers in establishing an enlarged dental department and advocating a close relationship between the dental and the general surgeon. Some of the striking results that have been obtained there have been published, the report of Dr. Fauntleroy, above referred to, containing at page 100 et seq. an excellent description of the general technique and methods employed. Major Du Buchet, Major Powers, of late, and especially Dr. Hayes and

Dr. Davenport, working with Colonel Blake and others, have made distinct advance in this line. In 1915 and again in 1918 I was enabled to see the work at this institution, and while progress is being made in other branches, such as Colonel Hutchinson's nerve grafting, in no line are more gratifying results being obtained than in this field of plastic oral surgery carried on jointly by the general and dental surgeons.

So valuable has been the work at this center that a report on it is being prepared, accompanied by an exhibit showing in detail the apparatus used and pictures of the results. This is to be filed as a permanent record with the Army Medical School at Washington, and at my urgent request a duplicate has been promised for the Naval Medical School at Washington.

While many other centers are doing excellent work in this field, the ones selected for me to visit as being the ones from which we could learn most were the hospitals at Sidcup, England; Le Mans, France; the Val-de-Grâce Hospital at Paris, and General Hospital No. 83 at Boulogne, as well as the hospital at Neuilly.

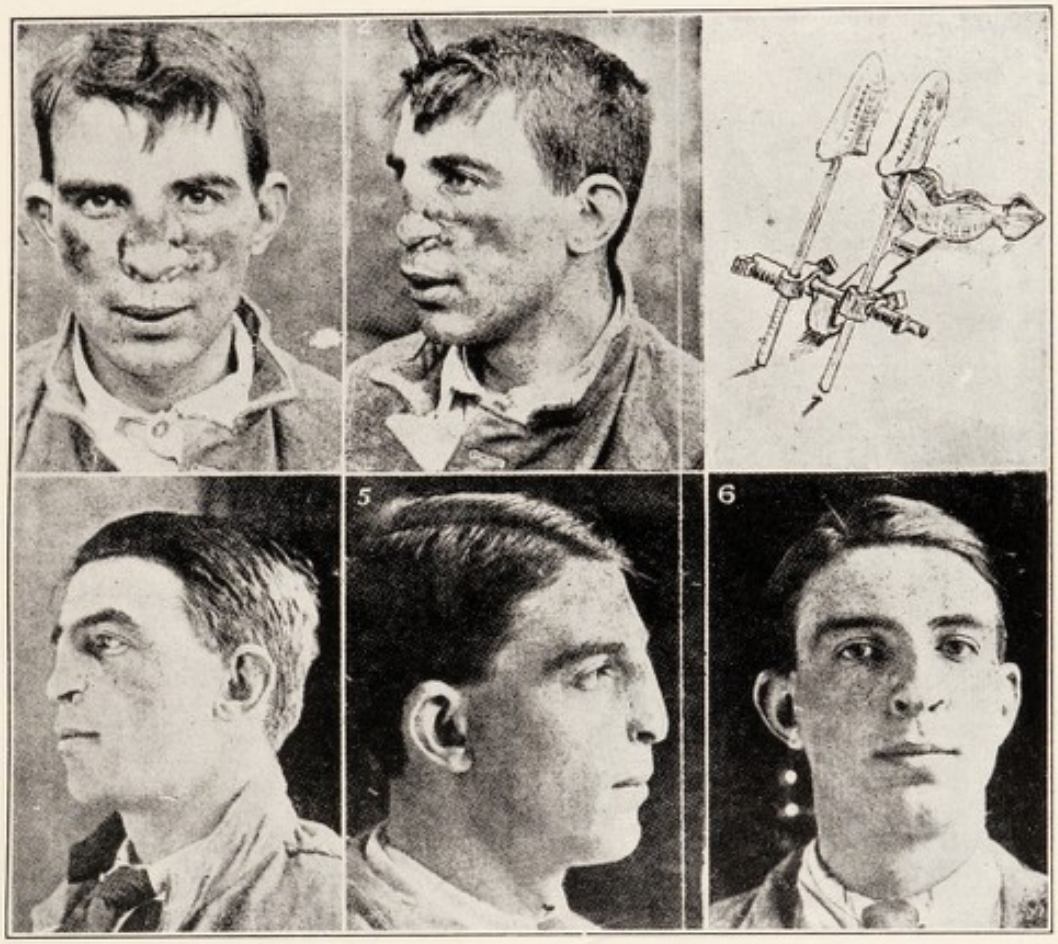
(1) Queens Hospital at Sidcup, Kent, is devoted exclusively to plastic and oral surgery and has accommodations for 500 patients. It is located in one of the most beautiful spots in England, but a short distance from London. Sir W. Arbuthnot Lane, Bart., is deeply interested in the work of this hospital, and recently at the meeting of the American Medical Association at Chicago he spoke of it as the center of plastic surgery in Great Britain. Major H. D. Gillies, R. A. M. C., the chief surgeon, is a recognized authority on plastic surgery, and most of the jaw cases in the British Army are sent here or to King George's Hospital, London. (See accompanying pictures.) This hospital is divided into five units, as follows:

Two units British.
One unit Canadian.
One unit Australian.
One unit New Zealand.

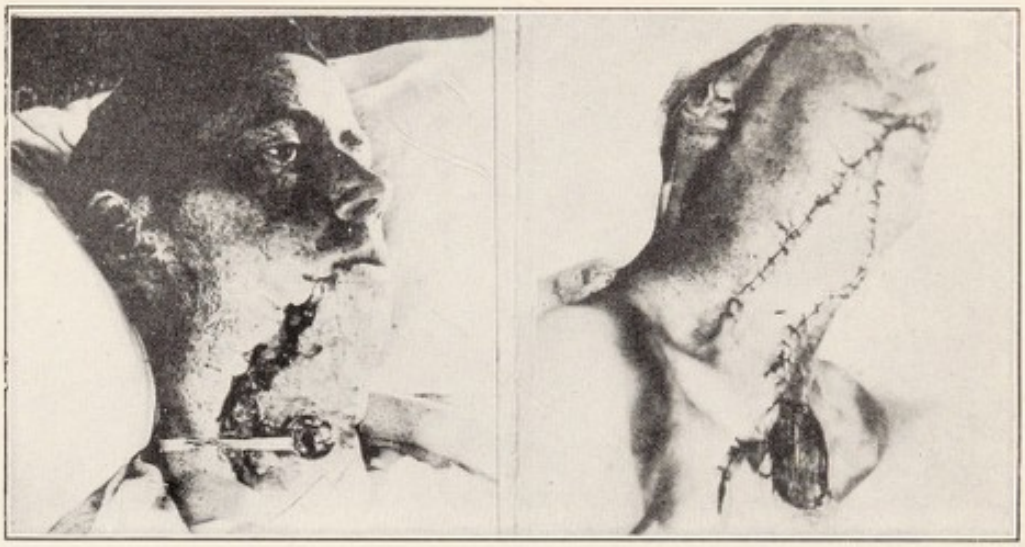
I am told they will be very glad to add an American unit if requested.

Casts are taken and the mechanical side is well studied. At present there are three teams from the United States Army here observing and assisting, each team consisting of one dentist and one surgeon.

This institution has an excellent dental department, and there is a great wealth of material for study. The Navy could well take advantage of the opportunity offered and send some of its dentists and surgeons here and to other centers specializing in this work, in order that the marines and sailors requiring such treatment may have the



(1 and 2). Condition on admission; (3) adjustable intranasal support carried from a metal cap splint cemented to the upper teeth; (4) improvement obtained by operation and insertion of nasal splint; (5 and 6) result of insertion of cartilage graft from rib. Taken three months after operation. (At Queen's Hospital, Sidcup, by Maj. H. D. Gillies.)





Private J. P. Horizontal right portion of mandible missing from third molar to canine. Cartilage of larynx exposed. Tracheotomy tube inserted from the side at the casualty clearing station. Shows large flap taken from chest, leaving buccal fistula, which was finally closed. Prosthetic appliance was made for the pseud-arthrosis. (At Eighty-third British General Hospital, by Maj. Valadier.)

benefit of the experience acquired by our allies in four years of active war work.

(2) At Le Mans, France, Delagénière is doing excellent reconstructive work for the French wounded, and I was fortunate enough to obtain the following description of his methods, which I quote in full:

THE RECONSTRUCTION WORK OF DELAGÉNIÈRE.

As an offset to the appalling mutilations wrought by the destructive implements of modern warfare, the new and vast experience in surgery has brought forth some wonderful achievements in the repair of such injuries. The remarkable reconstructive work of Delagénière on bones and joints ranks among the foremost of these contemporary contributions to surgical resourcefulness in apparently hopeless or insuperable tasks. Credit for the conception of this method of bone repair belongs to Ollier, but for the elaboration of the surgical technique, the formulation of the operative indications, and its introduction as a practical procedure, we are indebted to Delagénière. In view of the fact that this important work is hardly known as yet on this side of the Atlantic, it appears desirable to present a brief review of the procedure and its results.

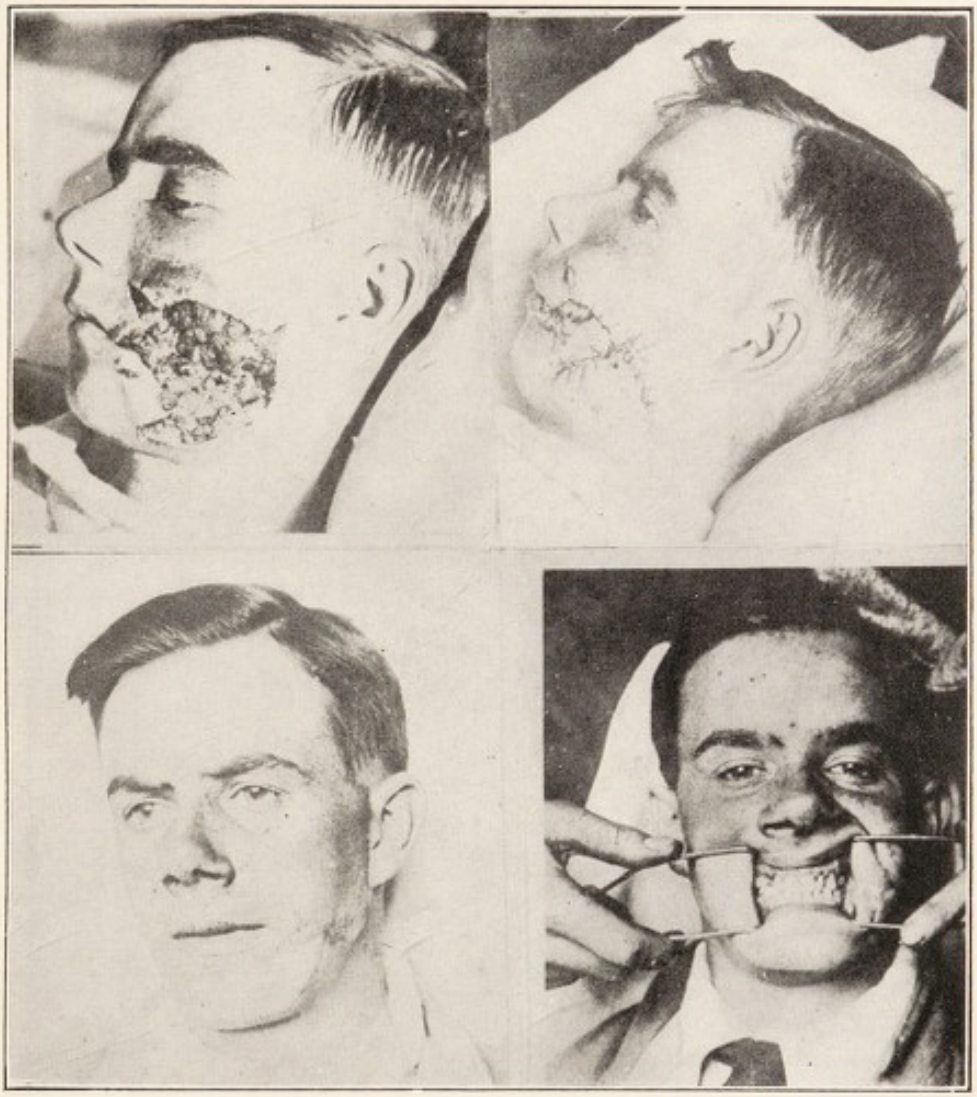
Delagénière's first report, covering 41 personal observations, published in the Bulletins et Mémoires de la Société de Chirurgie de Paris, Tome 42, I, 1916, page 1048, dealt with the utilization of osteoperiosteal grafts from the tibia for the reconstruction of bones or the repair of lost bone substance, more particularly for the repair of bony defects of the skull after trephining, as well as in the treatment of pseudarthroses of the shaft bones. The fresh osteoperiosteal grafts from the tibia are immediately transferred to the operation wound, without intermediaries of any kind, taking care to handle them only with sterile compresses or instruments. The tibia is treated simply by rapid skin suture over the denuded bone surface from which the periosteum has been stripped, and a small drain is left under the skin for 48 hours in order to guard against the formation of a hematoma; the wound heals in 8 to 10 days, without complications. The graft must be transferred without delay to its new position in the interest of perfect asepsis. The employment of antiseptic agents is contraindicated as interfering with the vitality of the graft. As far as possible, the two surfaces of the graft must be in contact with living tissues. While this condition is easily met with in the closing of bony defects of the skull, more serious difficulties are encountered in the case of the extremities. The entire graft must be well covered with skin in order to guard against necrosis and sequestration of the uncovered bony portions of the grafts.

About a year later Delagénière discussed the repair of bony defects and the reconstruction of bones by means of osteoperiosteal grafts from the tibia on the basis of 118 personal observations. (Bull. méd. chirurg. du Mans et de l'ouest, Tome I, No. 6, 1917.) The results in the series of 118 cases were as follows: Fifty-four cranioplastics, with a very favorable outcome in 44 cases; 7 good results and 1 failure through elimination of the graft; a second operation proved highly successful. Of 27 grafts for pseudarthrosis of the inferior maxilla, with loss of bone substance, 10 had an excellent permanent result; in 7 cases, not completely healed at the time of the report, the outlook is favorable; satisfactory results in 2 cases, partial results in 3, and no success in 5 cases. Delagénière's 21 grafts for pseudarthrosis with loss of bone substance in the shaft bones yielded 15 good results, 3 partial results, and 1 recurrent pseudarthrosis, requiring a second operation; 1 result was zero, due to complete elimination of the graft. Finally one patient, a chronic inebriate, died of chronic septicemia three months after the operation. Three bone cavities were closed by means of grafts, with a favorable outcome.

Sixteen grafts for reconstruction of the bony framework of the face were entirely successful in 14 instances and partially successful in the remaining two cases. Conditions in the facial region are especially favorable for the healing of the grafts, which can be placed in living tissues where it is easy to avoid dead spaces and to secure good hemostasis. Failure is accordingly rare, and almost invariably due to the opening of a natural cavity of the face. The bony framework of the nose can be entirely repaired by means of these osteoperiosteal grafts.

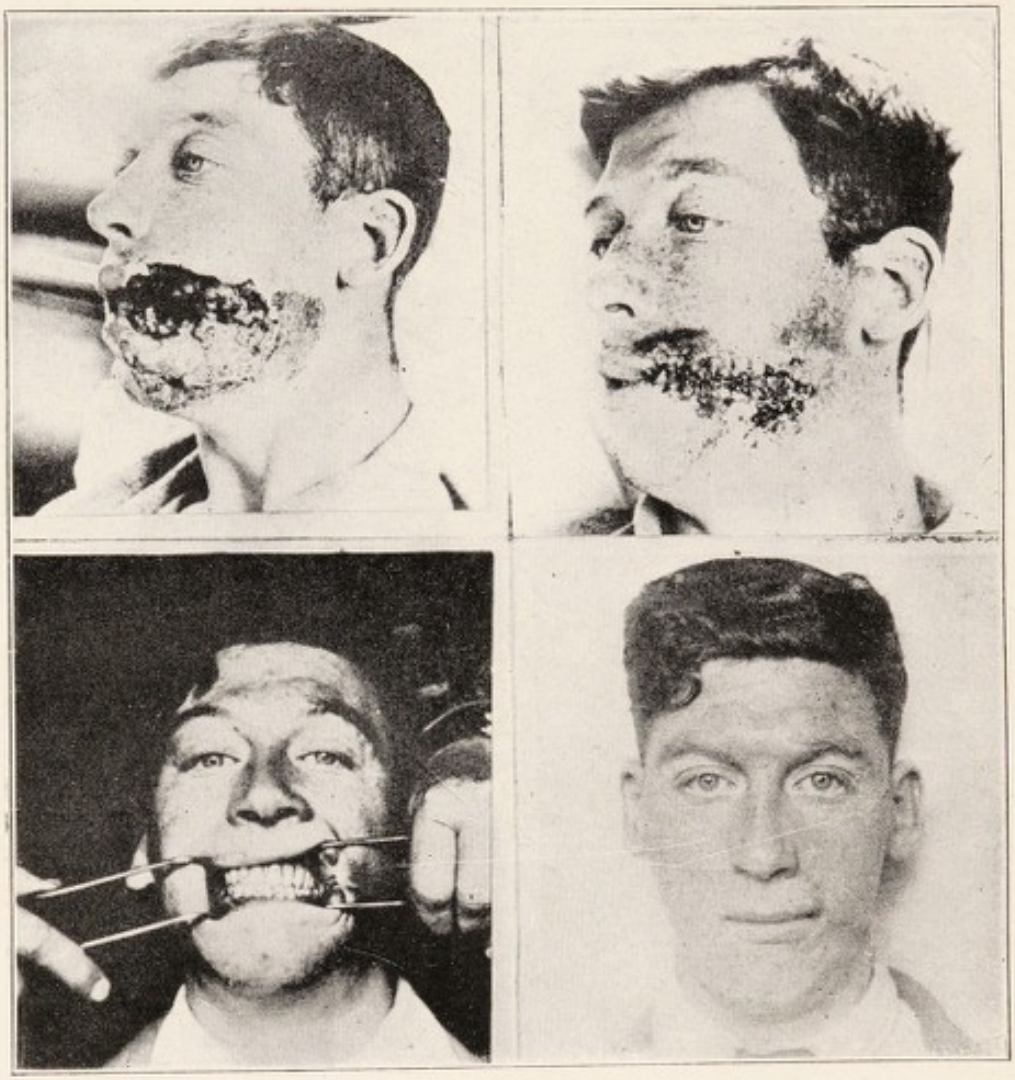
It is emphasized by the pioneer worker in this promising field that the indications for the applications of osteoperiosteal grafts are extremely numerous and varied, and will constantly increase when once the procedure is adopted as a routine method. In his last report, published in the Journal de Médecine, volume 89, 1918, page 81, at which time Delagénière was enabled to base his conclusions on altogether 159 observations, he points out that any missing portion of the bony framework of the body can be repaired and reconstrusted by means of osteoperiosteal grafts. It is perhaps superfluous to comment upon the marvelous vista opened up in the formerly so discouraging treatment of maimed and mutilated warriors. The results obtained through this procedure are lasting, so that the function of any bone can be restored with the assistance of these grafts.

Summarizing, it may be stated that the results of plastic work on the skull are excellent and always obtainable, provided the correct

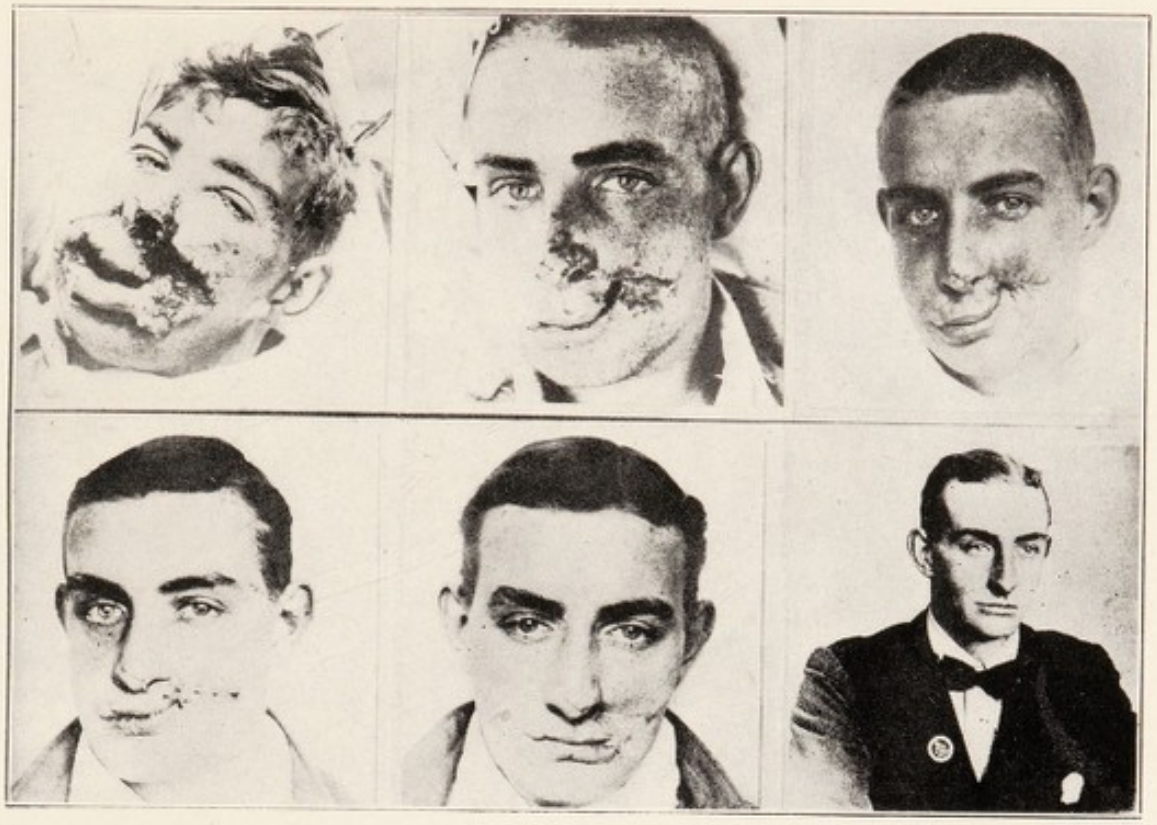


Private P. Fracture of inferior maxilla. One inch of left ramus pulverized; immediate suturing and insertion of flange splint to hold jawin position. Bone reformed completely, notwithstanding that root of molar tooth was subsequently discovered when final X-ray was taken. (At Eighty-third British General Hospital, by Maj. Valadier.)

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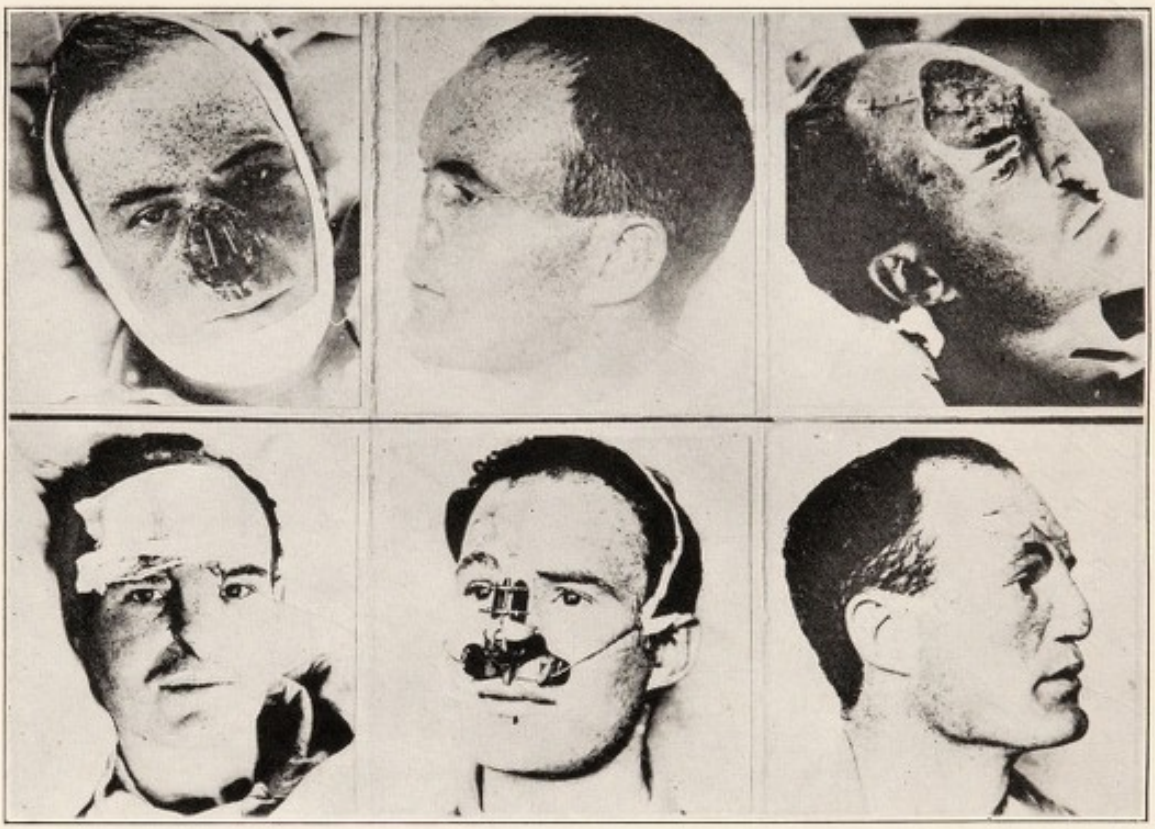
Private J. P. Fracture of superior and inferior maxilla; extensive loss of tissue; immediate suturing. Removal of scar tissue and formation of angle. Teeth inserted. (At Eighty-third British General Hospital, by Maj. Valadier.)



Private W. S. Premaxillary bone missing, both antra foul, shattered and septic Fracture of left ramus. (At Eighty-third British General Hospital, by Maj. Valadier.)



Private J. S. Fracture of inferior maxilla; symphysis missing; two molars and bicuspid standing. Angle band and bar inserted to retain arch as far as possible; flap from neck taken to fill gap and artificial hare lip made. Hare lip operated and teeth inserted. (At Eighty-third British General Hospital, by Maj. Valadier.)



Private W. Fracture of inferior maxilla; nose shot away. Ninth and tenth cartilaginous portion of rib inserted in forehead in 9 weeks; flap, all of cheeks, turned down; in 9 days pedicle severed and skin graft over space where flap was lowered. Prosthetic appliance made to help shaping of nose. (Final result of this case has never been published.) (At Eignty-third British General Hospital, by Maj. Valadier.)

technique is adopted and properly carried out. A favorable outcome may be anticipated in practically all cases.

In pseudarthrosis of the lower jaw, where the grafting method has been definitely introduced and established, the causes of failure are more numerous on account of the site of the graft, which is more accessible to infection. However, the actual results already equal 72 per cent of complete success, and this percentage will steadily grow. In bony defects of the limbs conditions are similar to those obtaining in the case of the maxillæ, and the results are analogous, but even better, with 85 per cent of successful cases.

Practically constant results, equaling a percentage of 100, are accomplished by osteoperiosteal grafting in the repair of bony cavities and in the reconstruction of the face. With special reference to the latter, the transformation by the operator's skill of those unfortunates whose countenance has lost all semblance to humanity through the frightful ravages of bomb and shell is little short of miraculous, and for a variety of considerations, ethical as well as medical, must be regarded as one of the greatest triumphs achieved by the beneficent art of surgery.

(3) The Val-de-Grâce Hospital, at Paris, is one of the largest in France. Here and at the Hôpital St. Louis Dr. Hippolyte Morestin is accomplishing excellent plastic surgical results. He has at the Val-de-Grâce a museum containing a most interesting and instructive collection of wax casts and slides showing not only the work in the present war but what was done during the war of 1870 and 1871. The contrast between what was then the high-water mark of achievement and what is now being accomplished is encouraging in the highest degree.

(At the University of Lyons also a large number of casts and pictures are on exhibition and show the remarkable results obtained by the French surgeons at this center. The collections of casts, pictures, and drawings at these centers of plastic work are well worth study by those about to take up this line of surgery. They will be invaluable records for the future.)

(4) At No. 83 British General Hospital, Boulogne, I met Major A. Charles Valadier, R. A. M. C., who is in charge of the oral surgery. He is an American graduate physician, and before the war was a practicing dentist in Paris. He is now an officer in the British Army and has 50 beds in the hospital where he does special jaw work, some of which I witnessed. The accompanying illustrations show the results of his skill. He attributes part of his success to the fact that he at once puts in an apparatus for the jaws so that the parts will not contract badly. He said: "Save all the bone possible. Whenever any piece is attached at all, save it. I would rather chance its sloughing out than remove it. Early in the war

I needlessly sacrificed bone, but do better now." He uses only sterile water for dressings and mouth washes, irrigating every hour under hand-pump pressure. His collection of wax models, pictures, and stereoscopic photographs in color is really remarkable.

In certain cases of injury to the face and jaw, it may be found that the defects are too great for immediate repair or that the condition of the patient precludes operative treatment. Sometimes it takes months or years to do the necessary work because it must be done in stages. For this class of cases, other means of relief must be found, and this need is being met by mechanical substitutes for portions of the face.

The American Red Cross in France is doing excellent work in this line (see accompanying pictures); also the Third London General Hospital.

Striking are the accompanying examples of plates made for masking facial defects at the Third London General Hospital by Captain Derwent Wood, R. A. M. C., the well-known sculptor.

Case I: Driver F. Skull wound April 25, 1915. Admitted May 28, 1915. No operative treatment.

Picture 1. Deformity after healing.

Picture 2. With plate in position.

Case II: Trooper E. Gunshot wounds face and arm, May 13, 1915. Admitted September 2, 1915. Plastic operations by Capt. Richard Cruise, R. A. M. C., September 29, 1915; again October 8, 1915, and finally October 27, 1915. Condition of patient greatly improved by these extensive repair operations. Mouth closed off from nares, antrum sinus closed, and large opening into left nasal cavity repaired.

Pictures 3 and 4 show unsightly deformity even after excellent surgical restoration.

Pictures 5 and 6 show facial mask which enabled patient to return to his former occupation as a taxicab driver.

Captain Wood described his methods and showed me many casts and masks. The work is of great value and I therefore give largely in his own words a description of the process.

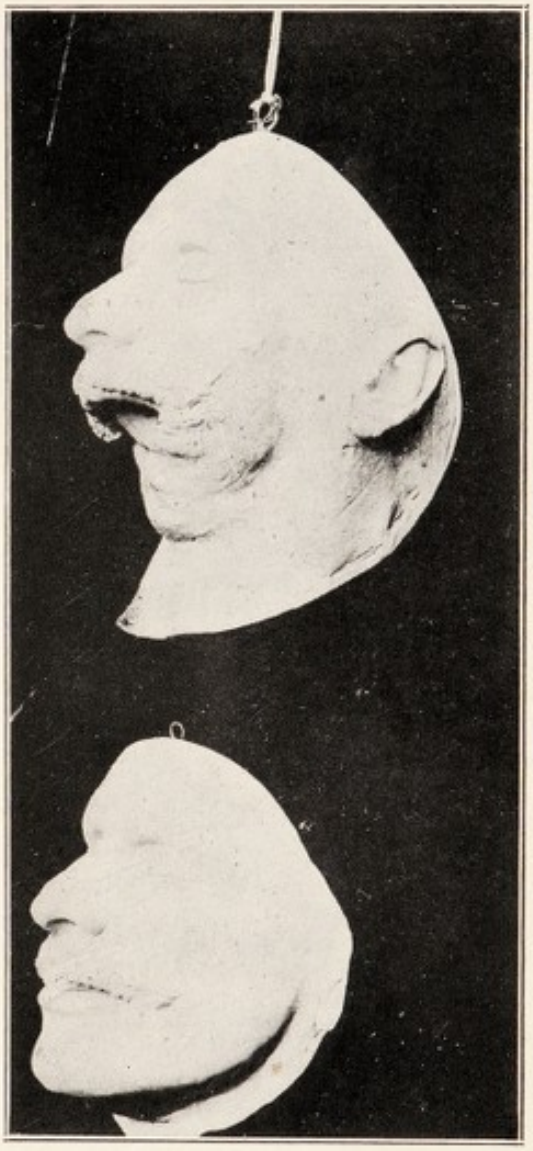
PROCESS.

(1) *Casting patient's face.*—It is essential that a good fit on the edges of the plate should be secured; to this end a plaster mold of the face is obtained.

In the case of driver F., and in consideration of the nature of his wound, I filled the cavity with his usual dressing, cotton-wool, covering this and his left eye and eyebrow with goldbeater's skin, bandaging all portions of his head that were not wanted in the mold; his nostrils were blocked with cotton-wool, the patient during the casting breathing through his mouth and being seated with head thrown back and pillowed on a box. After the exposed portion of face has been oiled, the plaster is mixed with tepid water and applied. In five minutes the mold is removed, bandages stripped, and the patient cleaned up.

(2) *Modeling.*—The mold having been obtained, it is dried, French chalked, and a clay or plasticine squeeze is obtained from the mold, giving a positive

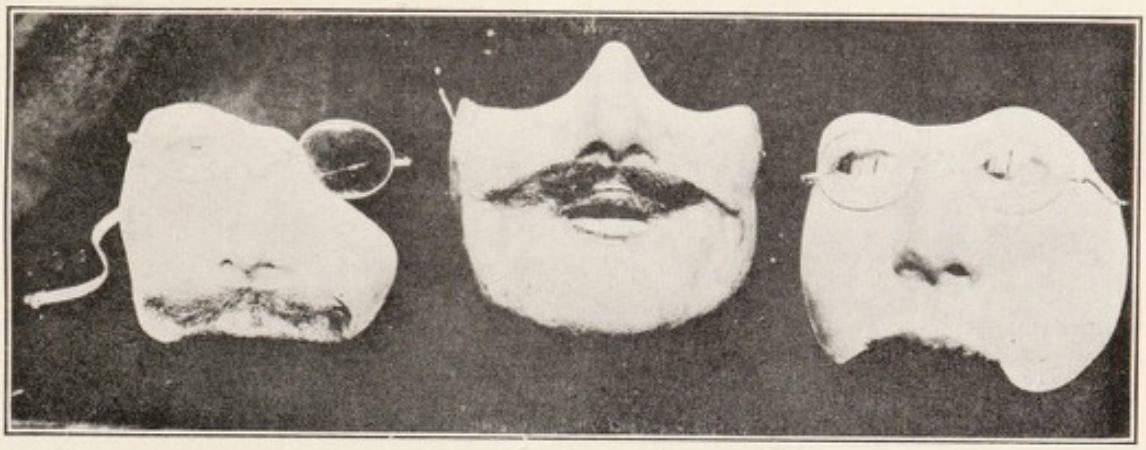




Views of masks made by Mrs. Ladd, of the American Red Cross, Paris. The masks at the top are taken direct from nature; the lower ones are the remodeled faces.



Masks for deformities of the face made by Mrs. Ladd, of the American Red Cross, Paris.



Masks made by Mrs Ladd, of the American Red Cross, Paris.



Driver F.

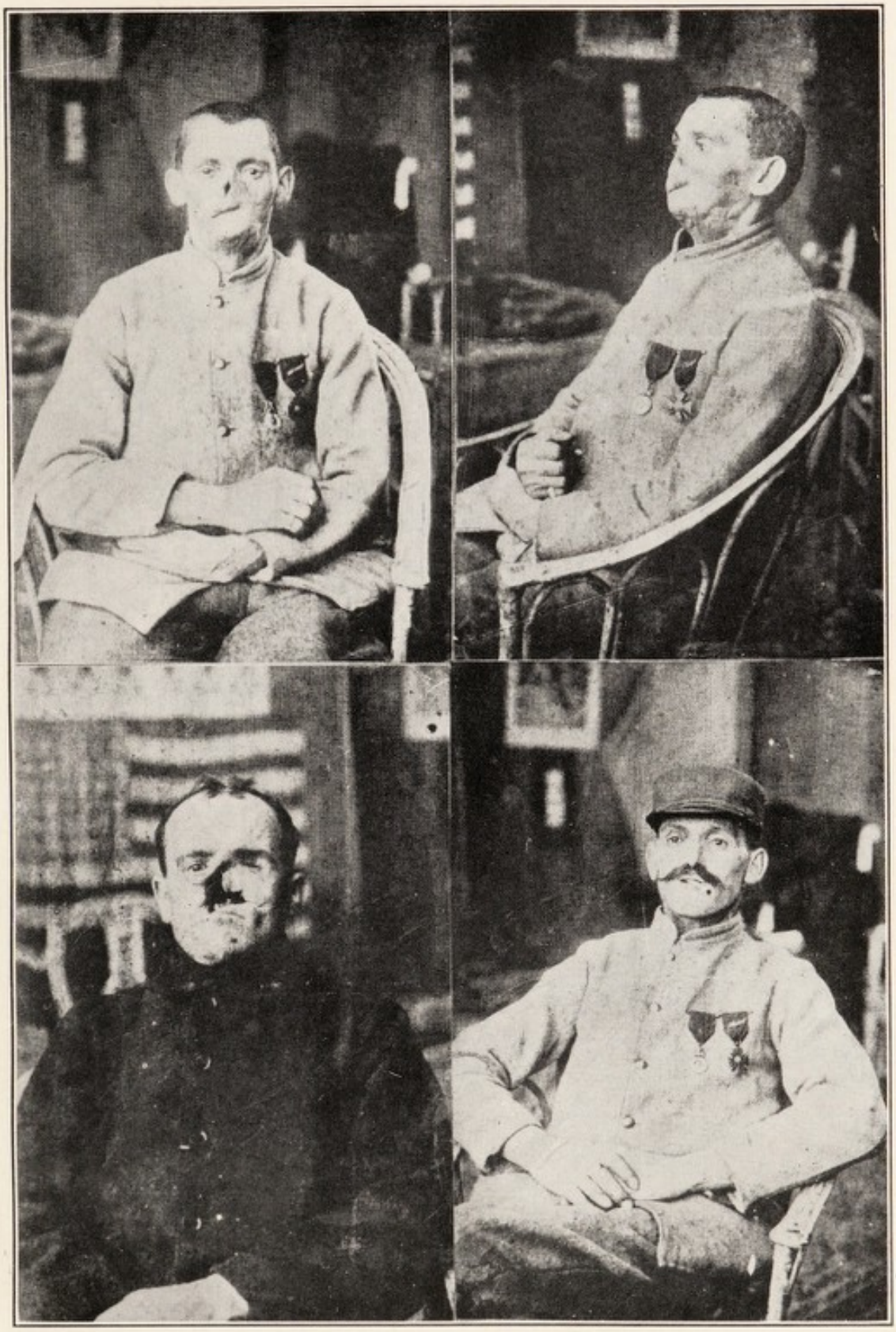








Trooper E.



Showing the use of masks to conceal disfigurement.



Disfigurement from wounds concealed by face masks.

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model of the patient's dressed wound and the surrounding healthy tissues. This is fixed to a board on a modeling stand, and a sitting from the patient with undressed wound is obtained. Modeling now commences, and such art as the sculptor may possess is brought to the test. A reconstruction of the wound in every detail is established, taking care that the depths and widths of the wound are accurately measured and modeled. The sculptor having completed his model, he proceeds to cast it and procures the plaster positive of the wound and its surrounding structures. Another sitting is obtained, and the portions which are to be hidden eventually by the metal plate are modeled in clay or wax, the edges being blended to the uninjured portions of the face, thus effectively masking any trace of wounds. This is once more molded in plaster, and the edge of proposed plate being marked on the negative, a cast is obtained, edges are trimmed to marking, and the model is ready to have the artificial eye fitted to the lids; this is done from the back of the model. The plaster eyeball is dug out, the requisite thickness of lids carefully worked down, the glass eye placed in position, and the edges of the lids made good with thin plaster.

(3) *The plate.*—The model is now taken to the electrotyper, where an exact reproduction by galvanoplastic deposit is made in virgin copper $\frac{1}{32}$ inch in thickness. This is finally well coated with silver. Thin bands are soldered in on the back to clamp the eye in place. The plate is again fitted to the patient, strong spectacles are adjusted at the requisite angle to give a well-distributed pull on the plate. In the case of a large plate being used, an elastic band around the back of the head is necessary.

The final sittings are devoted to the pigmentation of the plate. I have found a thin coating of cream-colored bath enamel a good preparation for flesh color matching, as it leaves the oil-color mat when dry, which is essential to the illusion of a good blending of plate with face; should the patient have shiny skin, this is easily obtained by varnish rubbed down to match the skin.

I have tried false hair on eyelids and eyebrows, but they will not stand the weather, and have adopted tinfoil split with scissors and soldered into lids for the eye, and for the eyebrows pigment applied to the modeled forms.

TRENCH FEVER.

A vital medical problem for a long time confronting those responsible for the health of the armies abroad has been what the British have termed "P. U. O." (pyrexia of unknown origin). Comparatively recently the louse has been definitely incriminated as the carrier of the disease, and through this discovery a long step forward has been taken toward the elimination of much serious illness and disability resulting from this cause.

In June, 1918, I was present at the conference on this subject, held at the headquarters of Major General Guise Moores, D. G. M. S., and was privileged to hear the discussion between Lieutenant General Burtchaell, C. B., chief of the medical service of the British forces in France, and Colonel G. A. Moore, C. M. G., D. S. O., D. D. M. S., who had been given this important problem to study practically in the field and make a report. In describing his work he spoke first

of the cases of trench feet which developed early in the war and which called for vigorous measures:

First we learned what caused the trouble and then took steps to check it, and now we prevent it altogether. An official order prescribes definite detailed care of the feet, such as clean, dry socks and rubbing the feet thoroughly with oil at stated periods. This treatment has put an end to trench feet.

We can now stop trench fever by keeping the skin clean and disinfecting the clothing properly with the Foder-Thresh machine. By doing this once every 12 to 15 days the lice can be killed off. Nits are more difficult to kill. They come on the hair in the pubic and axillary regions, about half to a quarter of an inch from the skin. The question of louse extermination is the main one to-day, medically considered, in relation to the trenches. Frequent bathing and the rubbing of a small amount of blue ointment into the hairy regions of the body, together with clean clothes, will eliminate the scourge. To make such sanitary conditions possible for 4,000,000 of men is a stupendous problem.

Now that the importance of the louse as a factor in the transmission of disease is being recognized, it becomes evident that the eradication of these vermin is one of the most urgent problems to-day of the medical officers in the Army and Navy.

At the beginning of the war many cases of disease not conforming to any known type were classified under the heading of "P. U. O." Further experience showed that three-fourths of these cases gave a fairly definite symptom complex and could be safely included under the term "trench fever." There are two types of this disease; one, the "short" type, lasting from 5 to 10 days, with a slight remission; the other, the "long" type, sometimes lasting several months, being recurrent in character. This disease is an important source of disability, as it is responsible for a large percentage of hospital admissions in all the armies. Major Swift, for example, states that 20 per cent of the admissions to his hospital are definite cases of trench fever, and in some of the armies of northern France the percentage has risen as high as 33⅓ per cent. While the ultimate prognosis of the disease is good, it is very likely to be followed by general debility and disordered action of the heart (D. A. H.), thus incapacitating a large number of men for active service. It will readily be seen, therefore, that the prevention of this disease is a matter of the first importance. The trench-fever investigation committee, of which Major General Sir David Bruce, K. C. B., M.D., F. R. S., A. M. S., is chairman, has definitely established the fact that this disease is louse borne. When the louse feeds upon a patient with trench fever its intestinal canal becomes infected, and if then the excreta are deposited upon the skin of a new victim the organism gains access to the blood of the patient through scratching, and the disease is transmitted in this way. The problem of eradicating trench fever, as well as typhus and relapsing fever, thus becomes very largely the problem of eradicating the louse.

That the task is not an easy one will be realized from the fact that the trenches on all the fronts are louse ridden from one end to the other. The transport service has to face the same problem, inasmuch as at present on some transports the percentage of lice is high on disembarkation of our troops in France. Colonel Seiler and Lieutenant Colonel Strong, of the Central Research Laboratory at Dijon, are working on this problem and have collected considerable data. Lieutenant Colonel Darrach, United States Army, with whom I talked at Etretat, was much impressed with the importance of the subject and felt very strongly that as in one instance 90 per cent of the men on a certain transport were found to be infested with lice, the Navy as well as the Army should take up the matter. He said that a number of men in his unit had become infected with trench fever after handling the clothes of the patients, but that since that time they have been more careful about protecting these men.

When the problem of louse eradication is considered, it is to be remembered that the soldier himself is the chief source of infestation. As Dr. Peacock says, the louse "is a parasite which is dependent utterly upon man's blood for sustenance and man's body and clothing for prolonged, prosperous longevity and reproduction." They are spread chiefly by contact, crawling from soldier to soldier, and leave the human body only when the surroundings are warm and moist, as in bed. The louse can live 10 days at longest when unfed, and according to Warburton the nits can remain dormant when away from the body for not more than 40 days. The nits may survive freezing, but when they are kept dry and away from the body they usually begin to shrivel up in a few days. The eggs are laid chiefly in the seams of the clothing, being found in greatest numbers in the underclothing and in the fork of the trousers. They are laid also on the body hairs, and the infested parts, or even the whole body, may have to be shaved in order to prevent a rapid reinfestation.

Frequent bathing and at least a weekly change of underclothing are usually sufficient to prevent infection, when there is no overcrowding. Under such adverse conditions as exist in time of war among men in active service, the problem becomes a very difficult one.

When circumstances are such that the men can not be provided with adequate bathing and laundry facilities and disinfectors are few in number or altogether lacking, palliative measures must be resorted to. Many of the lice and nits can be killed and removed by the men themselves, especially in warm weather, when the clothes can be taken off, hand-picked and thoroughly brushed or beaten. Underclothes can be immersed in boiling water and the outer garments can be baked in the sun or in an improvised oven, or the seams can be ironed or passed along a jet of steam from a kettle of boiling water.

Insecticides are useful in killing the lice themselves, but usually do not affect the nits.

The multitude of remedies suggested for this purpose proves that the ideal insecticide has not yet been wound. Creolin, 1 per cent solution for steeping or spraying clothes or from 8 to 10 per cent solution vaporized, is apparently the most satisfactory preparation, as it is noninflammable, nontoxic, cheap, and not injurious to fabrics. Cresol-soap solution is also very useful and may be used for bathing, as well as for soaking clothes, including boots and leather articles. Naphthaline 96 parts, creosote 2 parts, and iodoform 2 parts, known as N. C. I. powder, has been extensively used in the British Army for dusting on the clothes and body, and was recommended by Peacock as the most satisfactory insecticide which he had tested.

The measures above described will do much to mitigate the evil, and when thoroughly carried out, being controlled by frequent inspection of the men, will give excellent results.

When a unit comes out of the trenches, the process of freeing the men from vermin can be carried out more thoroughly and on a larger scale. Hot dry air or steam, applied by various methods, has proved most efficacious in accomplishing this purpose.

G. H. F. Nuttall, M. D., Ph. D., Sc. D., F.R.S., has done considerable research work on the viability of lice and nits under varying conditions of temperature, moisture, etc. His experiments prove that both lice and nits are killed by a moderate degree of dry heat, by 55 C. in five minutes, or by 65° to 75° in one minute. He advises that in practice the infested clothing should be exposed to a temperature of 60° to 65° for 15 minutes, in order that every part of the garments may be penetrated by the hot air. Both lice and nits are killed in five seconds when immersed in water at 70 C., but in practice the infested clothes should be left in the water for one or two minutes at this temperature, or for 10 minutes at 55 C. They are killed instantly by moist heat at 80 C., and the period of exposure in a steam disinfestor, when the clothes are not too tightly packed, should be about 15 minutes.

When it is impossible to obtain apparatus especially designed for the purpose of disinfestation, it is almost always possible to improvise more or less simple apparatus which is fairly efficient. An ordinary baking oven or a brick superstructure, placed over a kitchen range, will furnish dry hot air of the desired temperature, or a packing case or barrel resting on a sheet-iron plate with a thin layer of earth may be used over an out-of-doors fire. A very simple and efficient hot-air hut has been devised by Captain Harold Orr, C. A. M. C., and modified by Grant and Peacock. Plans for the various models of this hut may be found in Nuttall's excellent pamphlet on Combating Lousiness among Soldiers and Civilians.

In disinfesting barracks, railway carriages, etc., steam is the most efficient means that can be used. Clothing, blankets, and other equipment, if hung or packed very loosely, can be sterilized at the same time. Steam disinfection huts or disinfecting vans or trains, the latter having the advantage of mobility, are extremely useful in disinfesting outer garments and blankets.

Whenever possible, it is, of course, more satisfactory to use the more elaborate apparatus especially designed for the purpose of disinfestation. Numerous types of hot-air and steam disinfestors have been devised and of these perhaps the most extensively employed have been those made by the Thresh Disinfector Co., 4 Central Buildings, Westminster, London, S. W. They manufacture a fixed type, to be used in hospitals and disinfesting stations, a horse-drawn type, and one mounted on a Foder steam lorry, commonly known as the Foder-Thresh machine.

It is highly important in the use of any disinfector, from the simplest to the most elaborate, that it should be properly managed, as carelessness in any one detail may render the whole procedure valueless. If the clothes are too tightly packed, or if the temperature does not reach the necessary height, some nits or lice will survive and the garments will be quickly reinfested. If the clean garments are not kept strictly separated from the verminous, or if the personnel attending to the disinfection are themselves infested, the same result will follow. Thoroughness and attention to detail are absolutely essential. Experience with each particular disinfector will enable the operator to standardize the load which it can treat at one time. The problem of ascertaining the temperature in a disinfector has proved to be a rather difficult one. Nuttal considers the method of Captain C. G. L. Wolf, R.A.M.C., to be the most practical when it is desired to record different temperatures. In this method advantage is taken of the fact that various substances have different melting points. Any colorless substance having a melting point of the desired temperature is mixed with a minute quantity of any aniline dye and placed in a small glass tube sealed at both ends. If the dye is finely divided, the mixture will be practically colorless, but when the substance melts it will instantly take on the color of the dye.

Where a complete disinfestation plant can be established, with baths and laundry facilities, freeing the men from vermin is comparatively simple. The men are usually treated in groups of 20 to 100. The station is divided into two sides, clean and unclean, these two sides being separated on the outside also by a high wall. The men strip when they come in and hand all of their belongings to an attendant, to be taken to the disinfestor. The men then bathe, are shaved or receive a hair cut when necessary, and after due precau-

tions are transferred to the clean side where they receive their disinfested garments. As far as possible, care should be taken to keep the clean men from mixing with the unclean, and new men coming into a unit should be inspected before being allowed to come into contact with the other men.

It seems to me that the importance of this question can hardly be overestimated, and that the proper working out of the problem will result in an incalculable increase in efficiency in both the Army and Navy.

The following statistics, furnished to me by General Moores, show the need for vigorous measures to prevent the spread of this disease among the fighting forces. They are the figures relating to sick admissions in casualty-clearing stations for the second British Army in France for the period of 12 months ending April 6, 1918, and show over 25,000 cases of illness traceable to this source.

P. U. O., (mostly trench fever)	15,392
Trench fever	5,244
Myalgia (mostly trench fever)	4,755
Rheumatism (mostly trench fever)	633
Debility (mostly result of trench fever, late)	2,535
Cardiac (mostly result of trench fever, late)	2,587

KEY TO DIAGRAM SHOWING THE PROCESS OF EVACUATION OF CASUALTIES AND THE DIFFERENT COMMANDS OPERATIVE IN EACH SECTION.

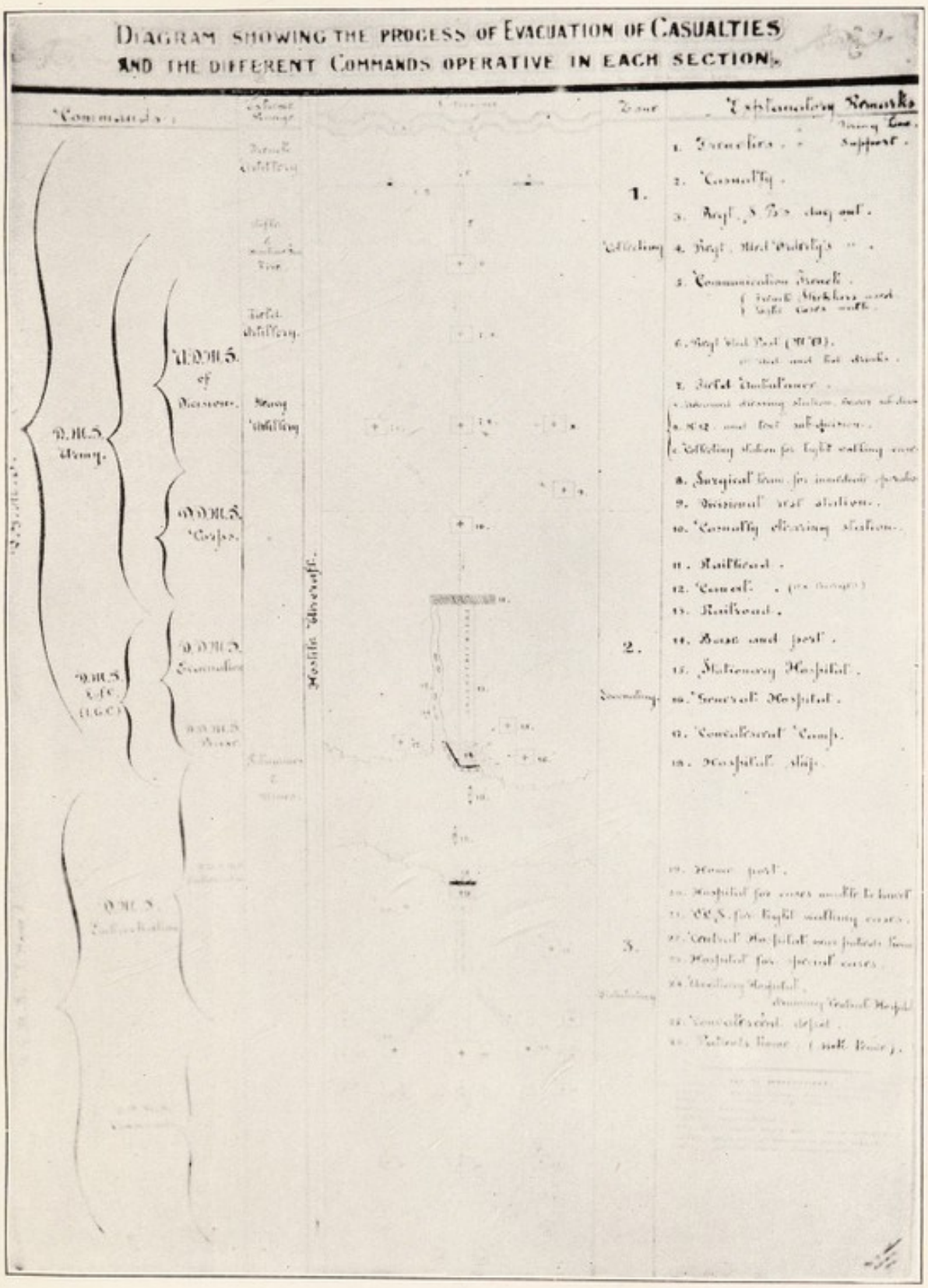
I. Collecting:

1. Trenches.
   - (*a*) Firing line.
   - (*b*) Support line.
2. Casualty.
3. Regt. S. B.'s dugout.
4. Regt. Med. orderly's dugout.
5. Communication trench.
   - Trench stretchers used.
   - Light cases walk.
6. Regt. aid post (M. O.).
   - First aid and hot drinks.
7. Field ambulance.
   - (*a*) Advanced dressing station, bearer subdivision.
   - (*b*) H. Q. and tent subdivision.
   - (*c*) Collecting station for light walking cases.
8. Surgical team, for immediate operation.
9. Divisional rest station.
10. Casualty clearing station.

II. Evacuating:

11. Railroad.
12. Canal (12A barges).
13. Railroad.
14. Base and port.
15. Stationary hospital.
16. General hospital.
17. Convalescent camp.
18. Hospital ship.

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III. Distributing:

19. Home port.
20. Hospital for cases unable to travel.
21. C. C. S. for light walking cases.
22. Central hospital, near patient's home.
23. Hospital for special cases.
24. Auxiliary hospital, draining central hospital.
25. Convalescent depot.
26. Patient's home (sick leave).

KEY TO ABBREVIATIONS.

D. G. M. S.—Director general medical services.
D. M. S.—Director medical services.
A. D. M. S.—Assistant director medical services.
D. D. M. S.—Deputy director medical services.
D. M. S. (L. of C.)—Director medical services, line of communication.
D. A. D. M. S.—Deputy assistant director of medical services.
I. G. C.—Inspector general communications.

CARE OF THE WOUNDED FROM FIRING LINE TO CONVALESCENT CAMP.

SURGERY OF THE FORWARD AREA AND TRANSPORTATION OF THE WOUNDED.

A complete description of a trip which, through the courtesy of Director General Goodwin and his aides, I was enabled to take in order to observe every step in the history of the wounded man from the moment of receiving first aid until he was either restored to military duty or discharged as unfit for further service, would be full of human interest, but would serve no useful purpose in this report. However, some observations made at certain points in that trip may be found to be of practical value, and these are recorded as briefly as possible. The trip itself began at the trenches in the British zone and progressed, step by step, from the stretcher on which the wounded man was borne from the battle field, through regimental aid post, advanced dressing station, field ambulance, walking wounded post, main dressing station, casualty clearing station, ambulance train, stationary hospital, ambulance transport to England, ambulance train to the base or special hospitals, and finally to the convalescent camps. A graphic chart of the present plan of the British military medical service for handling casualties was especially made for me and a small photographic copy is included in this report for convenience, and a close study of it will show how systematically the plan has been worked out.

The wounded are collected at certain points or aid posts, where there are medical orderlies. They are then carried by stretcher bearers or, if able, are allowed to walk back to the advanced dressing station (A. D. S.). On the way the regimental aid post is passed, where a medical officer with R. A. M. C. men is ready to give first aid. Part way back, for the walking wounded, there is a camouflaged station by the road where they may rest under shelter and receive food and have their wounds dressed, if needed.

The advanced dressing station is usually found in some old church, house, outbuilding, or improvised hut, and there the first field dressing is applied. At times of extreme urgency a major operation may be done to save life, but the rule is to evacuate as rapidly as possible to the casualty clearing station (C. C. S.), 6 to 10 miles from the front. The A. D. S. is usually about midway between the advanced

trenches and the C. C. S. The field ambulance includes both the advanced and the main dressing station, the latter being between the A. D. S. and the C. C. S. Here light cases and walking wounded are cared for and often directly evacuated by the Army Service Corps to the base hospital.

The C. C. S is the hospital nearest the front in the given sector and the real center of surgical activity. Each British army has about 15 C. C. S.'s. Experience has taught that they should be located near the railway by means of which they usually evacuate to the base, but not too near for fear of bombing.

While I was privileged to see the work of many C. C. S.'s, No. 36, at Watten, which is considered one of the best and has had a vast experience, was particularly selected for me to study most closely. Lieutenant Colonel J. S. Hardey, C. M. G., A. D. M. S., was in command, and Major A. L. Lockwood, D. S. O., R. A. M. C., was the surgical specialist. The entire staff made me most thoroughly welcome and did everything possible to contribute to the success of my visit. Major Lockwood accompanied me to the Belgian and northern French fronts and to many centers in the British advanced area. He is regarded as an authority on the surgery of the forward area and has been requested to write up this subject, and his book, it is hoped, will appear next year.

A description of this station and a summary of the results of the experience of Colonel Hardey and Major Lockwood as given by them to me may be found of value.

C. C. S. No. 36: This is a mobile unit of 800 beds, with capacity for large crisis expansion, well equipped, and having an excellent X-ray outfit. The staff consists of 7 medical officers, 9 nursing sisters, 180 orderlies, and 3 chaplains. During the "Kimmel push" 5,000 cases were received in five days. When a drive is on surgical teams are drafted from quiet sectors and sent from the base to help. A team usually consists of one surgeon, one trained orderly (who acts as assistant), one sister, and one anesthetist. These teams work in day and night shifts. In September, 1916, 17,000 stretcher cases passed through this C. C. S. and there were over 700 deaths. Often 75 die within 24 hours. "We need all three chaplains when busy."

Three per cent of the walking wounded are usually bad cases who have missed the stretchers. A medical officer should see all cases on arrival, whether walking or carried, and cut down the dressing to determine the disposition of the cases and whether there should be (1) immediate operation; (2) delayed operation; (3) no operation required.

Major Lockwood said:

> The C. C. S. should operate as a rule upon everything which will require any surgery for six weeks or two months. No case should be moved until it can be done without harm.



First aid to the wounded. French Army.



Slightly wounded French soldiers.



Arrival of a wounded soldier at an aid post.



General view of an evacuation hospital.

Place cotton in the ears of the men upon arrival. This saves anxiety. Keep the ears dulled for some days. Whenever there is a raid or bombing, if cotton has been removed, replace it at once.

(I was reminded of this practice later when visiting Queen Alexandra's Hospital for officers. The chief surgeon there said: "These wounded officers who can stand shelling in the trenches and never fear going 'over the top' get panicky at once in these night raids. The poor chaps in bed with fracture apparatus holding them there suffer mentally as never before.")

Shock is a complex problem and one that is still shrouded in uncertainty. Major Lockwood's advice is:

Control hemorrhage and do necessary splinting early. Never use stimulants. Quiet and external heat are the best restoratives. At times saline under the skin may be useful but this must be given carefully. There have been cases of which I know where there has been sloughing of the breasts due to hypodermoclysis into the breast and needles have been broken off and left. Bicarbonate of soda solution with glucose by rectum is excellent to support the patient's vitality.

Wounds, he suggests, should be treated as follows:

1. Primary suture wherever possible. Use picric acid, 3 per cent, in pure methyl alcohol for the skin instead of iodine. Excise some skin around the wound. Remove all injured tissue. Follow this by ether or Dakin solution, then suture with deep, interrupted silkworm gut.

2. Where the wound can not be closed after the débridement, pack loosely with gauze in glycerine, with 5 per cent sodium chloride and one-half sodium citrate. This may be left *in situ* from four to seven days. There will be a large amount of flow produced, but when the gauze is removed healthy tissue remains.

3. When it is impossible to get rid of the tissues injured, or for some other reason it is not advisable to treat as above, use Carrel-Dakin from four to six days and then close by delayed primary suture, provided bacterial tests allow.

I tried bipp on 60 cases, but the results were so discouraging that I discontinued its use altogether. Flavine also has not proved satisfactory.

Filling up the wound with salt tabloids and leaving on the dressing from a week to ten days is an excellent method. Nature irrigates through the great amount of serum produced, and when the gauze is taken off there is a healthy surface. But there is great danger of death of tissue from too much pressure, and this method needs so much care and experience that I have given it up.

In head cases, operate as early as possible, preferably in a forward unit. Entire head should be shaved, careful neurological examination made, and stereoscopic plates. Use local anesthesia, novocaine one-half per cent. Never use general anesthesia. Make a small perforation one-fourth inch back from fractured area and nibble out a button of bone with the jagged fractured surfaces in center. Remove sufficient bone to expose one-fourth inch of healthy dura. Excise jagged edges of dura. Use a catheter to locate missile and magnet for extracting same. Sometimes, with the head lowered so as to make the track dependent, an undistorted bullet may be driven back through its own course by several forcible blows on the opposite side of the head. In 96 per cent of cases it is possible to completely close the skin. Never leave a solid drain in the brain. Wounds of the sinuses may be closed with the very thinnest (postage stamp) of peri-cranial tissue. Never attempt suture. Plugging

of the sinuses with gauze or muscle is absolutely wrong. Patient should not be moved for at least 14 days.

Bone or cartilage transplantation to close aperture in skull should not be attempted earlier than three to six months after incision has entirely healed. Repeated lumbar punctures will relieve headache and prevent tendency to hernia cerebri.

Chest cases are as urgent as abdominal cases and should be evacuated direct to the casualty clearing station as soon as they can stand the journey.

The better the evacuation from the battle field and from the advanced medical units the severer is the type of case that reaches the casualty clearing station. Thus deaths occur in the casualty clearing station which would otherwise take place farther forward.

The percentage of severe chest wounds reaching the casualty clearing station is very much greater when the casualties are principally due to shelling and bombing, especially of the back areas, when the casualty clearing stations are the nearest medical units.

Cases of traumatopnea should be closed (preferably by suture) at the advanced dressing station or even, if possible, at the regimental aid post.

All chest cases should be given morphine early.

Active resuscitation must be carried out at the casualty clearing station immediately upon admission. The majority of severe chest wounds require blood transfusion.

The value of X-ray examination in chest surgery can not be overestimated.

The complete intrathoracic operation is a serious one and should not be lightly undertaken.

Local anesthesia, combined with gas and oxygen (if required), should be employed in chest surgery.

Speed and absolute asepsis are essential to success.

The operation must begin with *excisio in toto* of the wound and end with hermetical sealing of the thorax.

No fluid must be allowed to collect in the pleural cavity after operation.

Resection and drainage should be a late resort and are rarely necessary, never unless severe constitutional symptoms of infection are present.

Nonoperated cases should be treated precisely as post-operative cases.

Men who have been exposed to asphyxiating gases bear chest wounds badly.

At certain seasons broncho-pneumonia is a complication greatly to be feared. (Vide autopsy report.)

In March, 1917, Major Lockwood, with several of his confrères published the reports of their observations on the treatment of *gunshot wounds of the abdomen* in 500 cases. In June, 1918, after having had under observation about 1,000 cases, he indorsed the conclusions then reached, and said:

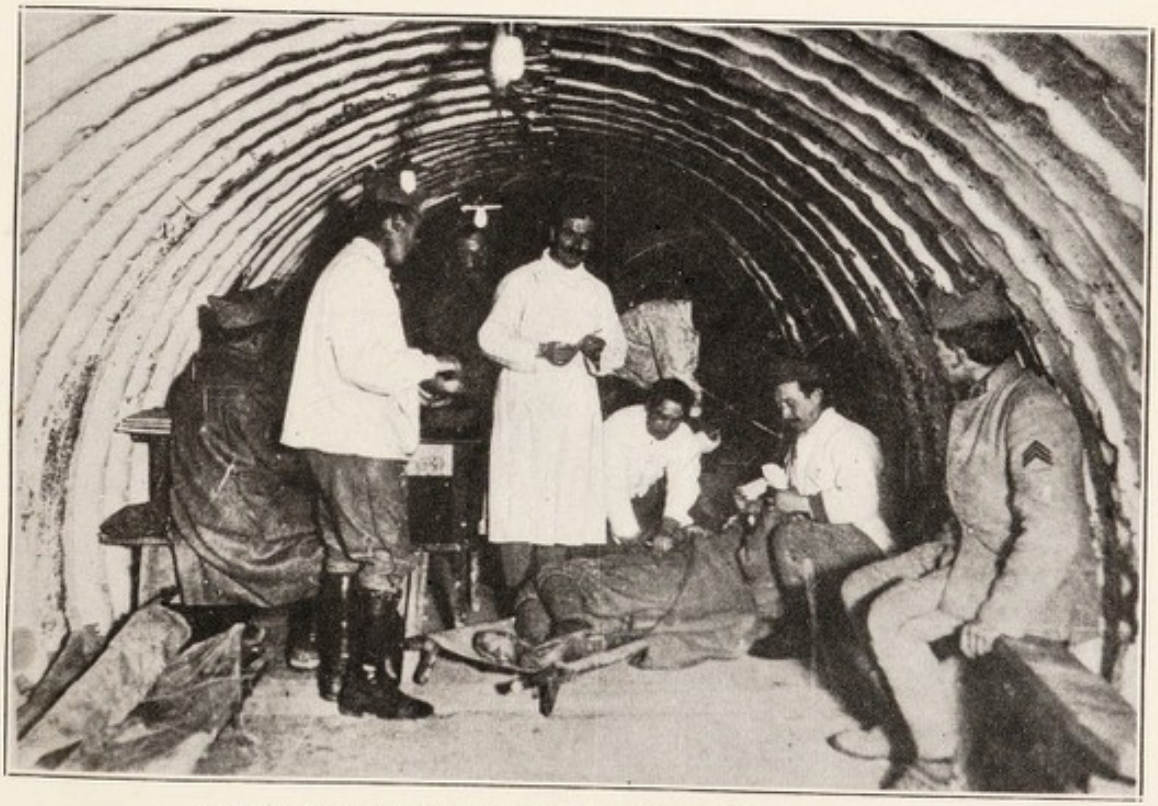
Wounds of the large vessels to the liver, kidney, and spleen are fatal before they can come to operation. Wounds involving the pancreas are seldom seen on the operating table, by reason, perhaps, of the contiguity of the organ to large vessels. Only one case was seen here. In that a foreign body was lodged in the tail of the pancreas.

Antero-posterior wounds, especially in the epigastrium, are least dangerous, and wounds from side to side, especially low down, are dangerous.

Wounds of solid viscera are not as dangerous as those of hollow viscera.



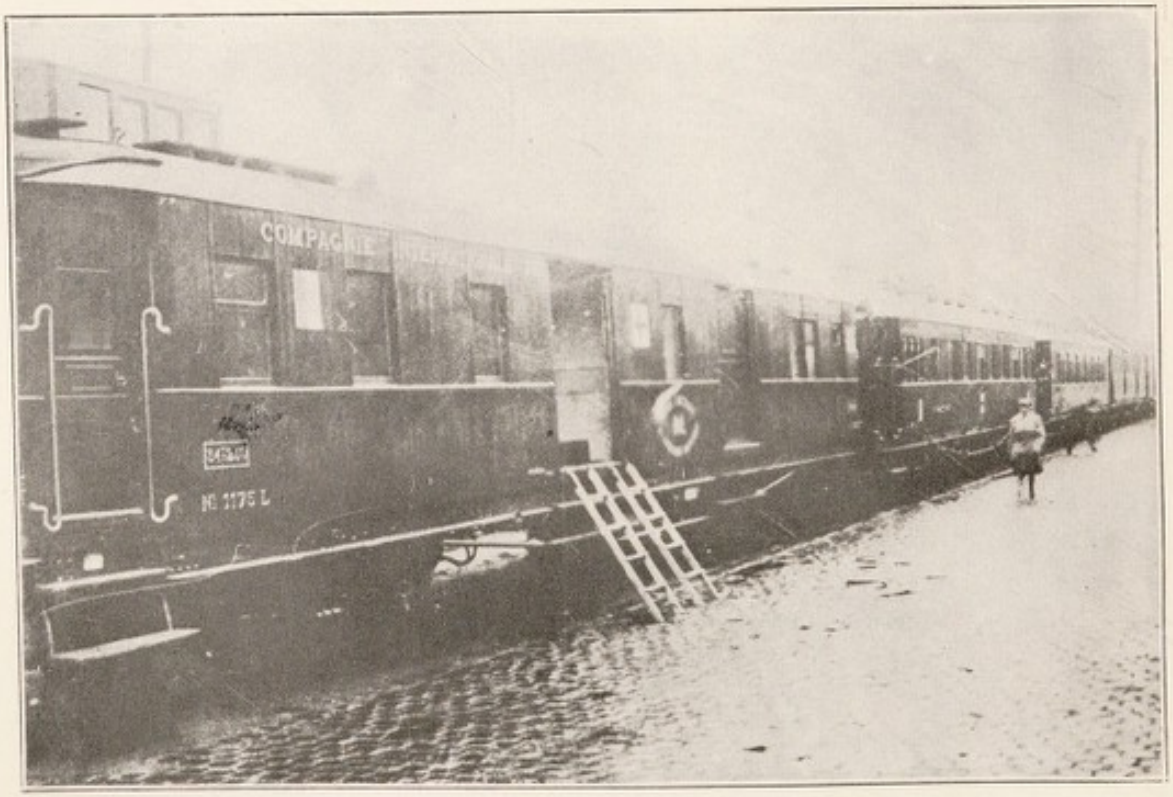
A church transformed into a hospital. France.



An advanced underground dressing station. Sorting the wounded.



Pavilion Henry. A hospital improvised from a private home in France.



Railroad terminus of La Chapelle. The sanitary train presented by the United States to the French Government.

Cases that come to operation with a herniated loop of bowel exposed do badly, especially if much bowel is lying exposed; the same is true when the stomach is partially herniated.

Wounds of the stomach, colon, and especially the small intestine, require exploration, but in posterior wounds involving the colon the greatest care should be taken not to convert a retroperitoneal condition into an intraperitoneal one.

Wounds of the liver and kidney should be carefully determined as such only, and then treated expectantly, doing no more than exploring and cleaning up the track, and not that if probably a through and through wound produced by an undistorted rifle bullet or shrapnel ball.

Avoid resection.

End-to-end anastomosis is preferable to lateral when resection is essential.

Wounds of the diaphragm are not necessarily fatal, nor even to be greatly feared. Careful repair gives excellent results.

Multiple drainage tubes are rarely necessary, and always to be avoided if possible.

Abdominal lavage is a dangerous practice.

Never leave free, unprotected gauze in the abdomen.

Paul's tube should be relegated to the museum, except in very rare cases.

Speed in operating is essential, not only for the benefit of the patient, but because of the demands of scores of less vitally wounded men requiring attention during an active offensive.

Resection for fecal fistula is better done late, when the patient is in England.

During a heavy rush of work the question inevitably arises, "Is it possible to give every case of penetrating wound of the abdomen the chance of operative interference without prejudicing the chances of others who are wounded less vitally?" The answer is obvious that, granted an adequate and sufficient personnel—surgeons, nursing sisters, trained orderlies, etc.—it should be feasible to deal with every case as its urgency demands, and that no class of case should be relegated to expectant treatment when surgical interference is indicated and capable of giving a wounded man even a remote chance of life.

The following instructions issued in March, 1918, at C. C. S. No. 36 are of considerable interest and show the diligence with which the care and comfort of the patients are looked after:

Efficient work during a heavy rush, when personal supervision of every case is impossible, will be much facilitated if the sister will impress on orderlies the vital importance of a definite routine in dealing with surgical cases.

On "taking-in" days:

1. In the preoperation ward.

The lamps attached to the blanket warmer and bed heater will be lit and then turned off or on as required by the number of cases and pressure of work; in any case they must always be kept ready for immediate use. Beds will be kept equipped with fracture boards.

2. In the postoperative wards.

Spare beds will be kept equipped with fracture boards and 4 to 6 beds *always* kept warmed.

Preparation of patient for operation: If feasible, castor oil, 1 ounce, will be given the night previous; an enema before going to the theater and the bladder emptied. Omnopon and scopolamine, 1 ampoule (unless counter-ordered) one hour before operation. Parts adjacent to the wounds must be

shaved. Patients will invariably be sent to the theater dressed in clean bedclothing, and during cold weather every patient must have a pneumonia jacket with him. *All cases on admission to the preoperation ward will have a small pellet of wool inserted into each ear, which will be left until the patient is quite convalescent. During any heavy shelling of the neighborhood all surgical cases in bed will have cotton-wool plugs placed in their ears.*

Postoperative treatment: Orderlies must not allow undue exposure of patients recovering from anesthesia. Fatal postoperative broncho-pneumonia may result from such exposure. In case of collapse the foot of the bed should be raised, except in abdominal cases, and saline, 8 ounces, administered per rectum, to be repeated every three hours if necessary. Subcutaneous saline will be given only when wounds are in the vicinity of the rectum or when rectal injection is difficult. All abdominal and serious chest cases will receive saline, 8 ounces, per rectum—three hourly—for two injections, then continuous sodii bicarb. and glucose aa, 5 per cent for 48 hours. All cases to receive 10 or 20 grains (depending on the severity of the case) of soda bicarb. by the mouth four hourly, and, except abdominal cases, to receive 8 ounces of 2 per cent glucose by the mouth every two hours until the patient is convalescent.

No stimulants of the camphor in oil, coffee, and brandy type, etc., will be given.

Except in abdominal cases, sips of brandy and champagne may be given to more or less convalescent patients or to allay vomiting. Morphia and pituitrin are never to be given unless by orders of an officer, and pituitrin, when given, will be administered intramuscularly.

A cylinder of oxygen, with fittings, will be kept in each ward. Two tourniquets will hang in a prominent place in the postoperative wards. Urotropine, 20 grains, and pot. brom., 15 grains, will be given 4 hourly to all head cases.

Dressings.

Sterilized towels, gauze, wool, and dressings must always be used and sterilized gloves must be worn.

Dakin's solution or saline, according to the case, will be used to clean up skin and wounds unless otherwise ordered.

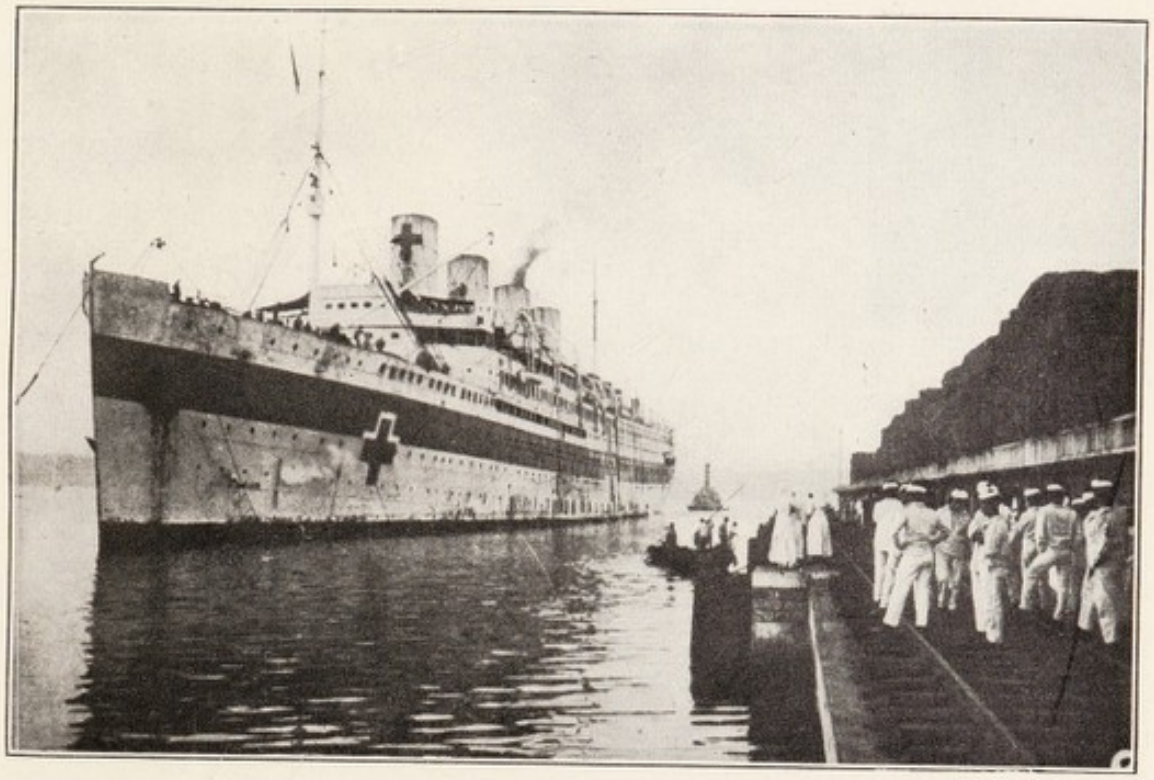
Picric acid, 3 per cent, to be always available.

Carrel's tubes to be syringed two to three hourly as directed by the surgeon in charge of the case. The end of the tube protruding through the bandages must always be covered with sterile gauze. Tubes should be taken out, thoroughly cleaned and boiled, every 48 hours.

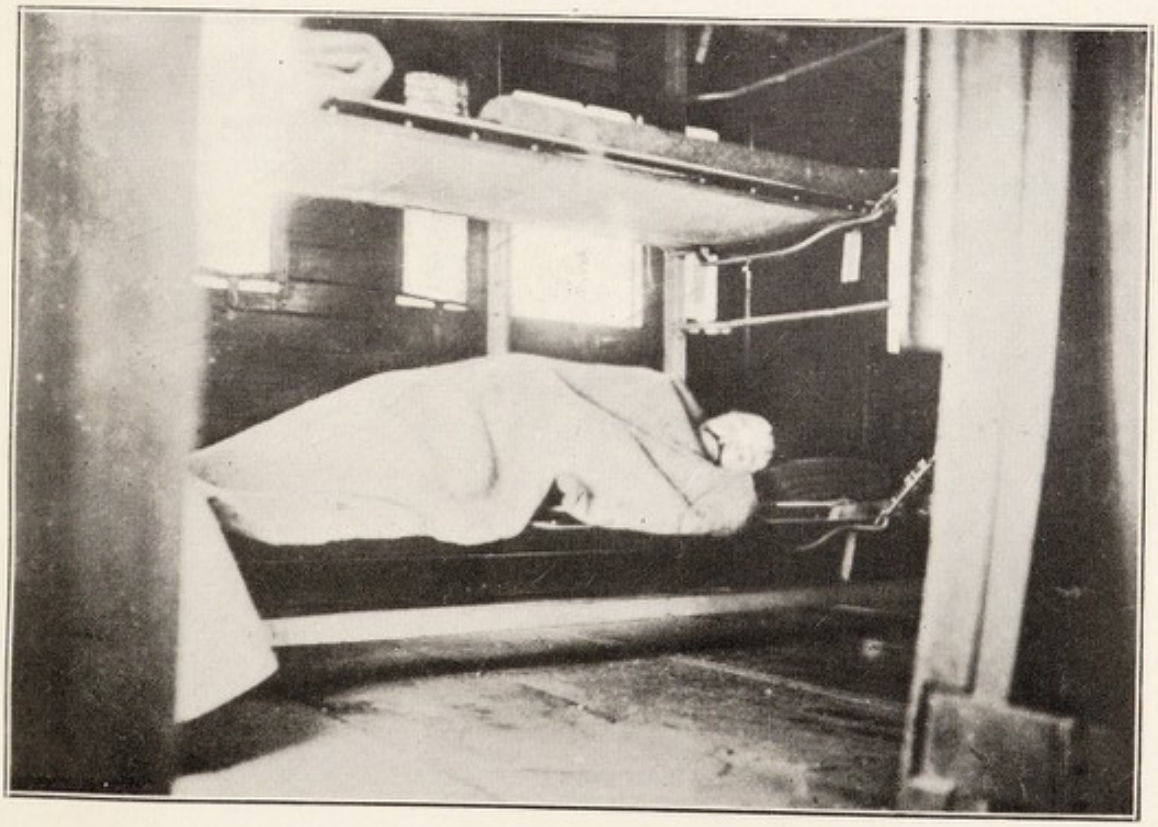
Glycerine and saline flavine or bip dressings should not have the last piece of gauze adjacent to the tissues removed earlier than four days after operation unless specially ordered. Each ward should have at least one complete intravenous set sterilized and ready for immediate use. Soda bicarb. and saline for intravenous use will always be obtainable from the theater.

Attention is particularly drawn to the great value of "forced" and frequent feedings of all foods, especially gelatine, etc., in all cases which are seriously ill with grave septic infections.

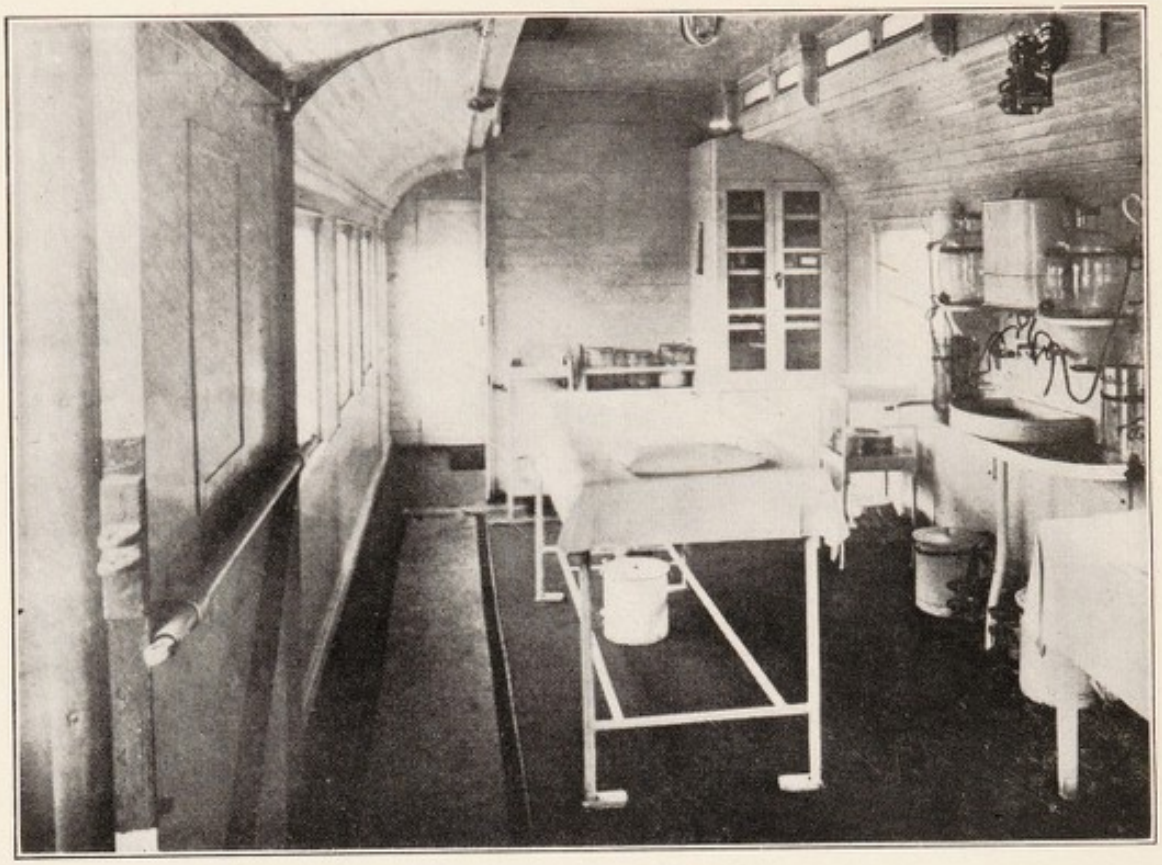
Divisional rest camp, located near C. C. S., and relieving the strain upon it. This is an important institution. Many men while not injured or really ill, yet are nervously worn out and unfit for active service. Such cases are sent to one of these camps for rest and change. All lice are removed and they spend 10 days in sleeping, frequent bathing, eating good food, and amid surroundings which



The hospital ship " La France " arriving from Saloniki.



Stretchers suspended in car of a sanitary train in France.



Operating room, sanitary train. France.



Embarkation of wounded. Somme.

direct their thoughts to other things and help them to forget the tense strain of the battle. The plan is worked out at the rest camp near C. C. S. No. 36 very successfully. It is situated in a beautiful part of the country and all signs of the horrors of war as far as possible are eliminated. There are no wounded and no mutilated here. Any who do not get back their nerve in 10 days are sent overseas to England. There were 500 in the camp the day of my visit and the general impression created was of men enjoying a vacation.

British ambulance trains.—For some days I was a guest of Colonel G. A. Moore, C. M. G., D. S. O., D. D. M. S., at Ebblinghem, behind the British lines. Colonel Moore organized the ambulance train service for the British early in the war, and there are now 42 splendidly equipped trains in use, and our own Government has ordered a large number of the same model with only slight modifications. His official report, "The Story of the British Ambulance Train Service in France from August, 1914, to April, 1915," giving the details of the carrying, in that period, of 67,000 of Britain's best from the battle line to the sea, with equipment improvised as the exigencies of the occasion permitted, is a story of a magnificent struggle against almost overwhelming odds.

Each ambulance train now consists of 16 cars, 10 of which are ward coaches while the others are for stores, kitchens and dining room, staff, personnel, officers, etc. The normal load of patients in such a train is 118 lying and 462 sitting cases. In a crisis, the load is 118 lying and 690 sitting. Usually a captain or a major is in command, with a lieutenant as an assistant. There are two medical officers, one sister in charge, two trained nursing sisters, four orderlies, one quartermaster sergeant, two sergeants, and three corporals. It has been found that operating rooms are not needed on these trains. This demonstrates how carefully the patients are selected and cared for before entraining.

In addition to inspecting a number of the British ambulance trains, I went over the American ambulance train No. 66. It is practically the counterpart of the British train and at that time had made five trips with British wounded aboard. It was admirable in every way.

Ambulance transports.—At Boulogne I went aboard the *Jan Breydel* and *St. Denis*, which, with two other ships, convey the British wounded from Boulogne to Dover. Both were well equipped and they had provision for 636, and 751, respectively. As the passage takes only two hours, there is practically no need for an operating room. Over each cot there are suspended rings so that the patients may raise themselves. In fine weather many stretchers, with patients on them, are left on deck. All have life belts on and each one is assigned to a place on raft or life boat. It is a pathetic sight. Inas-

much as the Germans have avowed that they will not respect the Red Cross in these waters, none is displayed, and the ships are used as transports one way and hospital ships the other way. They are convoyed by destroyers. On the Atlantic and the North Sea also the Red Cross is not a protection.

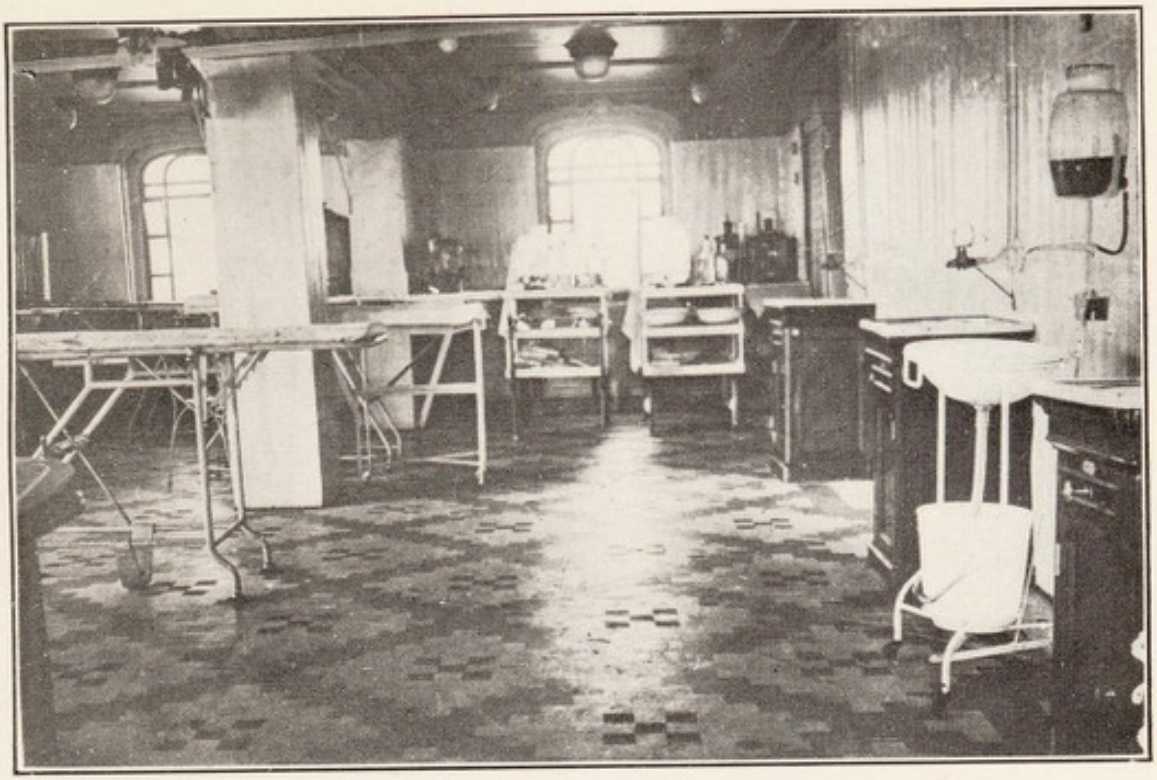
The transfer of the patients to the boat and later from boat to train at Dover, was accomplished with system and dispatch under intelligent oversight. All knew what to do and the men were carefully moved and kindly treated. Every effort was made to keep up their spirits. On the boat there was a victrola playing; some had games, each had three cigarettes to smoke upon arrival at Dover, but not on the trip, for the life belts are inflammable. All were seen by the doctors to make sure they were comfortable. A small stretcher cart is used which not only adds to the comfort of the patient but saves the stretcher bearers materially. We should have these for our wounded (see illustration). One suggestion to the bearers might be valuable—that they should not keep step as it swings the patient too much.

A British ambulance transport, which I saw, had successfully used electrolysis for three years for purifying the water.

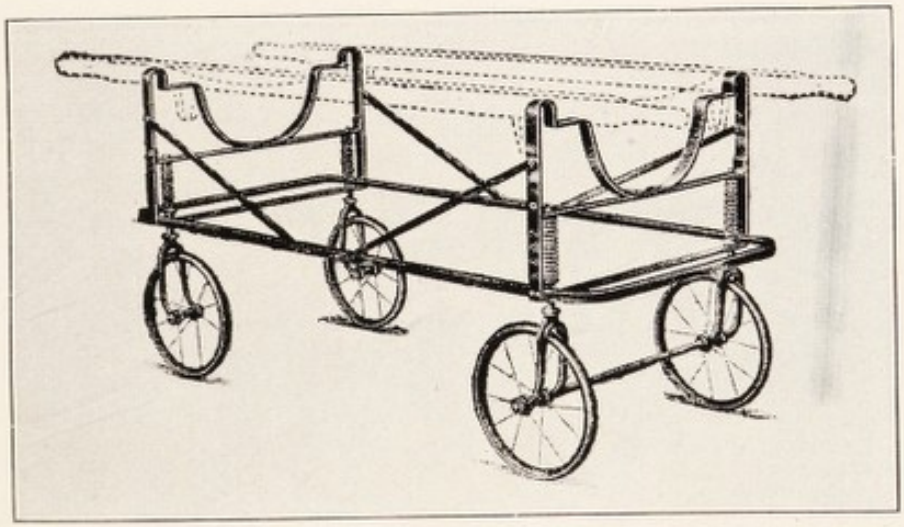
At Dover there are 20 trains, 7 for sitting cases and 13 train ambulances. At the station there is an excellent system, exact telephone communication and wire confirmation as to the kind and number of cases arriving. The men are quickly and carefully sorted and an effort is made to send them to hospitals near their homes. Cases requiring specialized treatment are sent to the centers equipped to give such care. Tuberculous, infectious, and mental cases are sent to hospitals with special facilities, but if there is a choice, the wishes of the patient are consulted. There are certain restrictions for colonial and overseas troops as their Governments prefer to have them in particular localities so that they may keep track of them.

The atmosphere was most human and kindly. Patients were gently handled and no orders were seemingly given. Women of refinement, volunteer workers, were at hand with a dainty tray for each, with coffee, chocolate, sandwiches, sometimes a few strawberries, a bit of sugar, a cigarette, a tiny bouquet of flowers, and a small white or khaki handkerchief. The latter all enjoy, the first often for many a long day. To every one—the men on stretchers, walking, in motors—there is a cheerful word of welcome.

The following résumé of the organization and work of the ambulance column, London district, under the British Red Cross Society, gives an idea of the magnitude of the undertaking and the value to the Government of this work in the hands of volunteer aids:



Operating room on a hospital ship.

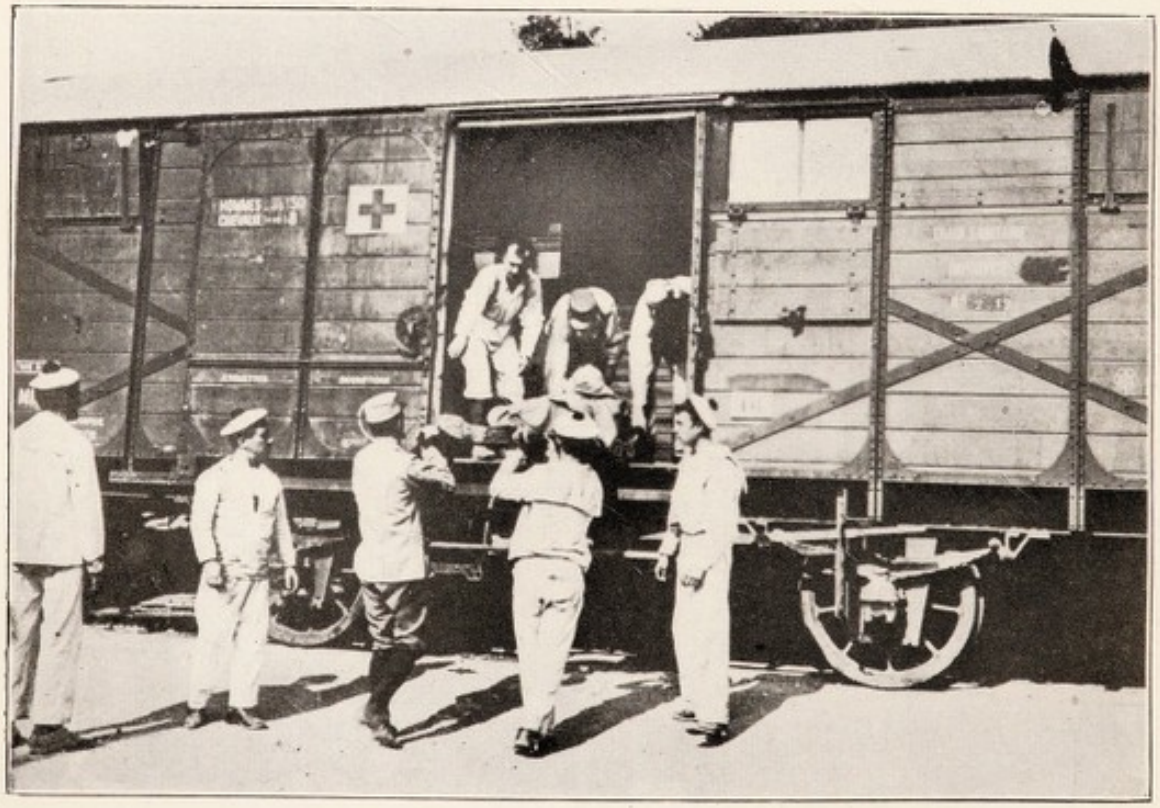


The Leslie-Wolstenholme stretcher trolley. As used by H. M. Government and the British Red Cross Society in France. The use of these trolleys greatly relieves the suffering of the wounded when they have to be removed. Extremely strongly built of 1¼ by ¼ steel, with steel angle frame, mounted on 12-inch by ¾-inch cushion tired, automatic wheels. These are fitted to the framework on resilient, highly tempered spiral springs. The whole highly enameled. It will take a stretcher 23 inches wide. Inside distance between uprights, 4 feet. Distance from ground to stretcher, 2 feet 5 inches. Over all measurements, width 2 feet 3 inches, length 4 feet 11 inches, height 2 feet 7 inches. Alleged advantages: Fewer men and less work required; vibration practically eliminated; stretcher always on a level; can be wheeled in any direction with the greatest ease. Of convenient height (about that of a bed) and of width only a few inches greater than that of a stretcher.

104—1



A canal boat in France. Room fitted up for the sick.



Wounded being put aboard a sanitary train in France.

BRITISH RED CROSS SOCIETY, CITY OF LONDON BRANCH, AMBULANCE COLUMN, LONDON DISTRICT, 9 GOWER STREET, W. C. 1.

Lieut. Gen. Sir Francis Lloyd, K. C. B., etc., G. O. C. London district.

Director.—Maj Gen. S MacDonald, C. M. G., D. D. M. S.

Deputy Directors.—Commandant W. F. Symons, bearers; Commandant R. B. W. Crothers, vehicular.

Commandants.—Miss M. Byron, womens' detachment and headquarters staff; A. D. Hastie, honorary treasurer and headquarters staff; Philip Runciman, garages, etc., and Baltic ambulances; Sir. Wm. Savory, Bart., honorary secretary; F. V. Simmonds, F. H. Tallack, S. J. Toms, bearers.

The first train was met on August 30, 1914.

The total wounded (all ranks) carried is 596,038.

The total volunteer workers on the column is 600.

The value of the vehicles lent or given is estimated at	£135,000
The estimated saving for vehicle maintenance and services May 31, 1918, at	£1,210,000
	£1,345,000

The ambulance column, London district, works as a self-contained unit of the City of London Branch of the British Red Cross Society.

ADMINISTRATIVE HEADQUARTERS, 9 GOWER STREET.

Commandant.—Miss M. Byron (day).

Commandant.—A. D. Hastie (night), in charge of the headquarters staff and responsible for organization and administration.

Petrol room.—Quartermaster Straker, in charge, owner and driver of the first ambulance on the column.

A complete record of every vehicle on the column is kept in this room.

Every gallon of petrol used is accounted for by the drivers on journey cards, which are returned to this room. These are checked and compiled here from records kept, and are sent once a month to the Army service and transport, where they are again examined.

Records room.—Quartermaster, Mrs. Glover (day); assistant quartermaster, Miss Hulse (night), in charge.

Every telephone message, telegram, or letter received in connection with the transfer of the wounded, exchange prisoners, air raids, etc., is recorded in this room at any time of the day or night.

Orders are received on a direct line from the D. D. M. S. office, or by the D. D. M. S. instructions from hospitals, railway stations, and the ports of embarkation; also air-raid warnings and action.

Orders are then transmitted from records to the bearers and to those officers responsible and in charge of each branch of the work.

Details of the distibution of the wounded to various hospitals are received from the D. D. M. S. before the arrival of each train and instructions issued.

Cards are filled in for every hospital on receipt of the distribution and at the station these cards are handed to the sister in charge of each ambulance, or to the drivers of the cars.

The names of the wounded carried are entered on these cards, and they are signed at the hospital by the M. O. and returned to headquarters as a receipt and a means of checking the safe arrival of the wounded and their kits at the right hospital.

Records are kept of every case handled since the column was inaugurated in August, 1914.

Books are kept showing every journey done by each individual driver or sister on the column, as well as the time of day or night they finish. This is done to enable headquarters to prevent, as far as they possibly can, drivers and sisters being out all night every consecutive night. As 90 per cent of the workers on the column are either rejected grade 3 men or over the military age before the recent act, this point in connection with their work gives rise for anxiety, especially with volunteer workers, and "go-to-bed" orders have to be issued frequently for the sake of efficiency and safety.

Telephone room.—The switchboard has a private line to the D. D. M. S. office, 6 main lines, and 18 extension lines.

The switchboard is in charge of trained telephone operators. Three of these operators are telephone girls who, after being remunerated for a week or two, found that workers were volunteers and at once refused to accept remuneration. They give their services after business hours, working alternately, and one as a relief.

No messages are taken at this board, and about 1,000 calls are frequently registered in a day.

The headquarters staff, including the telephone operators, remain at their posts voluntarily throughout air raids. It may be mentioned that in addition to the military transport, the column has given its services for air raids since the first Zeppelin raid on London through the L. C. C. Ambulance Corps and the police.

Eight ambulance stations in London are supplied with ambulances, and the column has moved the major portion of the casualties as the result of bombs.

During air raids the column keeps in touch with the L. C. C. and supplies additional ambulances as requested by telephone.

Whenever any serious damage is reported, a responsible officer goes at once from headquarters to the scene.

Extension 1.—Ambulances: Whoever is on duty at this extension, immediately the time of the arrival of the train, and arrival station is chalked up, proceeds to call the required number of ambulances for a given time, half an hour before the arrival of the train. When the distribution is received he calls any more necessary. This is to allow the bearers time at the station to remove the stretchers, with the used blankets and pillows from the last train. These stretchers have to be redressed with clean blankets and pillows at the station before the train arrives.

Drivers must go when called, at any time of the day or night. The movements of every driver between trains are recorded on the ambulance board. He must be in such touch with the column that he can be found at any moment.

The ambulance board is so kept from hour to hour that any officer can take it over at any moment and carry it on without fear of mistake.

Extension 2.—Sisters: At this extension the comfort of the wounded is arranged for.

The blanket and pillow department is kept fully advised of every order about trains.

The free buffets at the stations are advised of the numbers arriving by each train.

Sisters and orderlies to accompany the wounded in each ambulance are called.

Extension 3.—Cars: The same remarks apply as those against extension 1 except that the car drivers are called to be at the station 15 minutes before the train is due. The transfer work done by the cars from hospitals to trains or other hospitals makes this extension very busy and responsible.

Extension 4.—This extension is used when under pressure (with trains clashing) to receive incoming calls from drivers and sisters reporting from hospitals.

Every driver and sister must, under standing orders, report immediately they have arrived and safely delivered the wounded at a hospital.

Bedrooms.—Three bedrooms on the top floor are provided. One of these is always occupied by one of the vehicular commandants and another by a quartermaster of the vehicular detachments.

GOWER MEWS.

Commandant, P. Runciman, In Charge.

Machine shop.—The vehicles on the column include a large number of Rolls-Royce ambulances, and it can be safely said it is the finest fleet of ambulances in the world.

The Baltic Exchange, Coal Exchange, Lloyds, Tea Trade, Rubber Exchange, Master Lightermen, Silver Thimble, and many individuals have subscribed large sums of money for ambulances. These ambulances are unique in construction and are designed on the experience of the drivers. Water bed, arm or leg extension cases of any kind can at once be put into any ambulance without a moment's delay.

Appliances and tools to repair every kind of breakdown are provided and the usual men's timesheets are kept.

The column keeps all its vehicles under repair either at the expense of the driver or if the vehicles are given to the column at the column's expense.

An expert engineer is in charge of the mechanics.

Stores house.—As a register is kept of every vehicle, spare parts, tires, oils, etc., to meet the requirements of these vehicles are always in stock.

It is also so arranged that the stores can be mobilized for emergencies.

Complete books are kept, so that accounts for repairs, stores, etc., can be rendered monthly to the many drivers who maintain their vehicles.

Garages and flats.—Garages for blanket buses, stand-by ambulances, cars, and sleeping accommodation for stand-by mechanics for breakdowns and blanket bus drivers are provided.

Blanket room.—Section Leader Peall in charge. Full detail of every train is received from extension 2 and recorded on the blackboard.

The blanket bus is then packed with clean pillows and blankets, equipment for special cases, hot-water bottles, surgical emergency outfit, gifts for the wounded, including handkerchiefs, cigarettes, etc.

Pillow slips are changed after every train, and blankets are sent away for disinfection, etc.

Ladies give their services daily, sewing, folding, etc., and generally taking every precaution that can be taken to insure cleanliness.

The blanket busses return from the trains with soiled blankets and pillows which have to be unloaded and sorted.

Officers' and sisters' kit.—Vehicles and drivers are provided by the ambulance column for the carriage and distribution of kit to the various hospitals. The sorting when necessary is done through a central depot rented by the column.

BEARERS' HEADQUARTERS, 7 GOWER STREET.

Commandants.—F. V. Simmons, T. H. Tallack, and S. J. Toms in charge.

Telephone extension.—All calls are received from records by the section leader in charge and transmitted by him to the various squads.

On receipt of the distribution of a train from records, the due complement of bearers is dispatched to the station and arrangements are made for squads to proceed to the various hospitals to receive the patients as they arrive from the station. Calls are received from records throughout the day for squads required at hospitals for transfer work.

Work.—The work of the bearers entails not only long hours on duty but great physical strain. They are voluntary workers mainly recruited from sedentary occupations in the city. All are either over age, rejected, or of low military category.

At the stations stretchers are unloaded from the ambulances, blankets and pillows removed, and the stretchers are redressed with clean blankets and pillows, and carried down to the platform. The patients are transferred by the bearers from their beds in the train to the stretchers with the utmost care and are then carried down the platform and loaded into the waiting ambulances. Many of the station platforms are several hundred yards in length.

Club.—No. 7 is also used as a club waiting house, and the sitting rooms have accommodation for 180 men.

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5 GOWER STREET.

Sleeping quarters.—No. 5 is furnished solely as sleeping quarters for the bearers. Special sanitary arrangements, including shower baths, etc., have been provided. Bearers are thus available night and day for any emergency such as air raids, etc.

Training.—Each recruit before acceptance on the column undergoes a course of several weeks' training, and is then required to pass an examination.

Lectures.—Lectures are given by the City of London British Red Cross doctors with the object of keeping the men up to date.

I visited the Southwark Military Hospital in company with Mrs. Katharine Glover, quartermaster of the ambulance column. She or her assistants meet all trains, and with Mr. Robert Crothers, deputy director, are in charge of the work at the stations. All ambulances were either gifts to the unit or loaned and are often maintained by the givers.

The following copy of arrangements for receiving convoys at that hospital is an excellent model which any institution might well copy.

ARRANGEMENTS FOR RECEIVING CONVOYS.

The following procedure will be adopted as a means of showing the number and disposition of the vacant beds in the hospital:

A card will be provided for each bed, to be known as the ward-index card. On this will appear the description of the block and the number of the ward.

The ward sister will see that these ward-index cards are kept with the papers during the period for which the bed is occupied, and upon the discharge of the patient will be responsible for sending the card to the sergeant major, who will file it in the case provided in the general office.

Thus there will always be an index card for each occupied bed in the ward and an index card for each unoccupied bed in the general office.

Surgical and medical wards will each have their distinctive colors, and the floors to which the ward-index cards relate will be further distinguished by snipping, i. e., the ground floors will have a complete 2½ by 4½ card; the first floors will have the right-hand upper corner of the card removed diagonally; the second floor will have both upper corners of the card removed diagonally.

In filing in the office the index cards relating to each floor in each block will be filed together.

Upon the arrival of a convoy, as the cases are admitted to the hospital, the orderly medical officer will ascertain which are medical and which surgical cases.

The medical cases will be directed to the left-hand side of the entrance corridor; the surgical cases to the right-hand side.

The orderly medical officer will then as rapidly as possible inspect each case, recording the name of the patient and the ward to which he is allotted on the slip, at the same time handing to the orderly who receives the patient the index card of the vacant bed to which he allots the patient.

The patient will then be removed as promptly as possible, the orderly handing to the ward sister the ward index card, and the sister will then allot a bed and file the card in accordance with the above instructions.

Immediately after the convoy has been admitted the orderly will return to the ward and fill in the details relating to the case on the slip provided, and will then hand the slip to the sister who will fill in the particulars required to be entered by her.

This slip will be completed by the orderly medical officer on his visit to the ward immediately upon the completion of the admission of the convoy.

All necessary entries on the slip having been completed, the ward sister will then return it to the general office.

The absence of a suitable admission room makes it extremely important that the admission of patients should be conducted with the greatest possible expedition.

Every patient should be seen by the orderly medical officer as soon as possible after the patient has been admitted to the ward.

Any necessary dressings or surgical or medical attendance is to be given at this visit, and the necessary record made on the slip.

J. W. CRANE, *Major, R. A. M. C. I.,*
Registrar for O. C.

SOUTHWARK MILITARY HOSPITAL.

On arrival at the hospital to which he has been assigned, the patient is given a postal card to be sent to his next of kin announcing the fact that he is there and giving information as to how a relative may obtain either a free or half-rate railroad ticket to the nearest station if unable to pay the full fare. Vouchers for such tickets are issued by the medical officer in charge of the hospital upon application, except that in case a soldier is in a grave condition, the authorities telegraph the next of kin to come without delay, and upon production of this telegram at the nearest police station a free return pass is issued immediately by the police. This system has been found to work exceedingly well.

I have gone into considerable detail in describing the British system of caring for and transporting the wounded because they have

so satisfactorily solved some of the problems with which we are now struggling.

The French have recently modified their sanitary organization for the care of the sick and wounded and will shortly adopt a new plan. A copy of this, with pictures, is promised for the Bureau of Medicine and Surgery when it is in operation. Elsewhere I have referred to the system now in vogue, and have spoken particularly of the special-fracture hospitals which are being established. A copy of the sanitary plan of the Fourth French Army, furnished me by Colonel Gosset, and a sketch of a proposed new evacuation hospital are contained in this report and present some interesting features. (See illustrations, pp. 211–216.)

In so far as the Belgian organization is concerned, their problems are to a certain extent simplified by the fact that the battle line is so close to many of their base hospitals that they serve also in the capacity of advanced dressing stations and casualty clearing stations. While this has certain advantages in that patients need not be carried long distances, on the other hand the proximity to the sight and sound of conflict and the danger from bombing render such location most undesirable.

The American authorities have made an excellent start in organizing the service of supplies, under whose supervision these problems are being worked out for our Army, and, with the lessons before them learned during the past four years by our allies, should reach a high standard of efficiency in caring for and transporting the sick and wounded.

SPECIAL NOTES ON SOME OF THE HOSPITALS VISITED.

After careful consideration by those most thoroughly acquainted with the details of the work being carried on in the various hospitals in Britain, France, and Belgium a number were selected as being the ones which it would be most advantageous for me to see in the time at my disposal. It would take volumes to do justice to the work being done at the various centers visited and to chronicle all the points of interest, and therefore I have chosen for special mention only a few where there is either some particular type of work or special feature which seems to me to have a direct lesson for us.

LIST OF HOSPITALS VISITED.

A. E. F. Base Hospital No. 4, loaned to the British as B. E. F. Hospital No. 9, Rouen (ordinarily called the Lakeside unit).

Chalons-sur-Marne Hospital, the Barracks.

H. O. E. De La Veuve.

Carrel Hospital No. 21, Compiègne.

Advanced Carrel Hospital.
Beaujon Hospital, Paris.
Buffon Hospital, Paris.
Hôpital Broca, Paris.
La Panne Hospital (Ambulance de l'Océan).
Zuydcoote, Belgium.
No. 8 Stationary Hospital, Wimereux, B. E. F.
Hôpital De La Marine, Brest.
American Red Cross Hospital No. 1.
American Red Cross Hospital No. 2, Paris.
American Red Cross Hospital No. 3, Paris.
Thirteenth General Hospital (B. E. F.), Boulogne.
Fifty-third General Hospital, B. E. F.
Eighteenth General Hospital and Twenty-second General Hospital, Dannes Camiers.
British Red Cross Hospital, Netley, England.
Second Northern General Hospital, Beckett Park division.
Alder-Hey Military Orthopedic Hospital, Liverpool.
Military Orthopedic Hospital, Shepherd's Bush.
Royal Victoria Hospital, near Southampton.
Queen Alexandra's Hospital for Officers.
Fifth London General Hospital (formerly St. Thomas Hospital).
Hyde Terrace Hospital, Leeds.
Third London General Hospital.

A. E. F. BASE HOSPITAL NO. 4 LOANED TO THE BRITISH AS B. E. F. HOSPITAL NO. 9 AT ROUEN, ORDINARILY CALLED THE LAKESIDE UNIT.

Lieutenant Colonel G. W. Crile, of Cleveland, senior consultant in surgical research, A. E. F., is clinical director. The hospital is located 4 miles southeast of Rouen, where Napoleon had his training camp when he was preparing for an invasion of Britain. It is in the midst of fighting units, gas schools, artillery parks, replacement and training camps. There is provision for 1,600 beds, two-thirds located in huts, one-third (for crisis expansion) in tents. Here the insignia of the Red Cross is not employed at all for protection. Sandbags and trenches are about the tents and hut wards for defense.

Colonel Crile formed the Lakeside unit and went over to cooperate with the British about a year before we entered the war. He has spent much of his time in keeping in close touch with the work in the field of the British and French. During my visit he summed up for me the present status of advanced surgical opinion upon a number of important subjects. He went over the field carefully, and I am deeply indebted to him for the following, which I reproduce from my notes of our conversation:

Lessons learned from the world war to date.—The best economy in war hospitals is to have large units from 1,000 to 3,000 beds. Have considerable movable canvas always ready for crisis expansion. Any building used through

one battle must be counted as having paid for itself; still it is well to have something you can salvage.

It is always essential for efficiency to have the professional end and the administrative absolutely distinct but cooperating. No clinical authority to the one and no administrative authority to the other.

In periods of battle, as a general rule, the chief of the surgical staff should perform no operations with his own hands. He should make decisions and direct. He thus operates with many hands, and many hands have the advantage of his expert and mature judgment.

In every rush time Colonel Crile sees each case and dictates to a stenographer notes concerning the care of each patient.

After seeing every case I spend in the operating room as much time as I have left. I decide not only what is to be done, but who is to do the operation. I know my men and select the best man for the special work. Some do certain work better than other work.

Wounds should be carefully read. We try to treat each phase of a wound. Treat the wound and treat the man, but follow no dogma.

Since the drive of March 21, 1918, the character of war wounds has somewhat changed and there is less primary suture being done.

WOUND PHASES.

I. *Period of contamination.*—1. Forward area in the casualty clearing station (contamination period about 10 hours). Revise the wound and close if you can keep the man at least for one week under your own observation.

2. Revise and pass the man on for a delayed closure at the base. It really does not matter much which of many things is used on the wound—flavin, bipp, Carrel-Dakin, etc.—no decision as to which is best. Wright's hypertonic salt solution is useful. Bipp should not be employed in excess, for the filled-up wounds may cause poisoning. There should always be physiological rest, whether there be any fracture or not. Early and proper splinting is essential.

3. If in a crisis and it is impossible to carefully revise, incise freely, and pack with some antiseptic of your choice, not "plug shutting," but allowing free drainage. Many cases have previously suffered from having wounds plugged tight.

II. *Period of infection.*—1. Acute phase: Physiological rest essential. Hot pack with alcohol is excellent, but there are many other things from which to choose. Impossible to say which is best.

2. When infection passes into the neighboring parts, and whether there be tension or not, incise early. Often we have waited too long. After the incision, hot packs.

3. After acute stage, if superficial wound, use alcohol or electric lights, or make delayed closure.

4. In all inaccessible deep wounds and all compound fractures use Carrel-Dakin; this can not well be used for traveling cases.

On ambulance trains and ambulance transports going to England, I saw the Carrel-Dakin treatment being employed. On a card fastened to the man and on a case-report list "Carrel" is marked. Injected by nurse every few hours. It is more trouble but is carried out very well.

Effects of infection are:

I. Abscesses.

II. Septicemia.

III. Secondary hemorrhage.

1. Abscesses: Often a hidden abscess causes chronic sepsis.

2. Septicemia: This is largely preventable. Roughly dressed compound fractures are likely to result in septicemia. Avoid all grating ends of bones.

Improper anesthesia means the anesthetizing of a man's phagocytes, thereby weakening his resistance to disease. I always use gas and oxygen for dressing painful wounds.

In prolonged infection with anemia and emaciation, use whole blood transfusion. Paraffin tube method is the one we have been employing.

3. Secondary hemorrhage: In this war there has been a great amount of secondary hemorrhage, due, we believe, to infection within the wall of the artery itself. *This is an entirely new theory.* The trouble, then, is higher up. Follow up the artery to a sound place by feeling the wall. As to secondary hemorrhage from veins, we think it possible that here we have an infection within the lumen of the vein, like an endocarditis. This subject is being carefully studied.

SHOCK.

This we believe is due to effects upon the central nervous system. There is no specific treatment. We use:

1. Transfusion of blood.

2. Morphine in repeated doses, always given with saline hypodermocylsis.

When there is cyanosis in shock, morphine should never be used.

In closing Colonel Crile said:

Every man should be working on a problem as well as doing his daily work, if for no other reason, for the effect upon his own mind, to keep it fresh and virile. His routine work is bettered.

It was most interesting and inspiring to see how this is developed. Colonel Crile goes over the work with the men and often gives them the problem. A research laboratory, fully equipped, is at hand, and several specially trained workers are there to lend aid.

In company with Colonel Crile I visited members of the staff in their wards and found them enthusiastic. Many of them gave me detailed accounts of their special work. I mention two, the results of whose work seem most striking:

I. Captain Barney, Medical Corps, United States Army.

II. Captain Shawan, Medical Corps, United States Army.

1. Captain Barney. Blood transfusion for chronic sepsis. Procedure:

Blood count taken and blood cultures made. Customary means of combating infection used. In a few days or a week another count and another culture. If no gain and no organisms in the blood, then transfuse from matched donor. Kempton-Brown tube, 700 cc.

Marked improvement in practically every case. After the infusion the temperature goes down gradually and there is a gain in weight, with improvement in the blood. This is an added means of combat-

ing the diseased state. Of course the local surgical condition is treated carefully.

There have been 12 cases treated in this way and all have recovered sufficiently to go back to England, and, so far as known, are well.

2. Captain Shawan. Careful study of skin grafting.

Skin grafting seems to take along blood law lines. Four groups: One will take all. Four will give all. Two will take 2 and 4. Three will take 3 and 4.

He has made a large number of experiments involving pieces of skin from many on different parts of the same raw surface.

This is a very important find, and our work here establishes the fact absolutely.—*Crile.*

If the donor law is to apply to the transplanting of skin, then when transplanting any tissue we should conform to the same law. It may be that this will make possible the successful transplanting of glands, like the ovary and thyroid.

CHALONS-SUR-MARNE HOSPITAL, THE BARRACKS.

(Colonel Gosset, Chief Surgeon.)

This is a large military hospital on the outskirts of the city, and at the time of my visits about 18 kilometers behind the front. Patients are frequently received within three to five hours after being wounded. The main buildings are of stone, and many hut wards have been added.

Dr. Gosset in peace times is a professor of surgery in Paris. He is now senior consultant to the Fourth French Army, and one of the foremost leaders in war surgery. He showed me the sanitary formation of the fourth army and a number of hospitals, including this one where he has been actively at work since early in the war.

He was interested in the objects of my survey, and most courteously gave me the following synopsis of the lessons which he and his staff had learned:

War surgery may be said to be divided into two periods, before Carrel and after Carrel. At first there was great opposition to this method, but it is different now. Since Carrel has pointed the way we can not properly treat war wounds without a laboratory at hand. Before that there was much uncertainty and many antiseptics. Each surgeon had a different one. Now there is practical agreement that the best results are obtained by first using soap and water, with shaving, alcohol, and ether to the skin, and iodine as well; then excising all traumatized tissue (cutting as for a cancer) and applying an absorbent sterile dressing. Control any hemorrhage by catgut ligatures. After the end of the third day, before granulation has started, close with silk and maybe a few strands of silkworm gut. This latter is excellent. Much care must be taken in all of this work, and plenty of instruments and gloves provided so that nothing will be used a second time without resterilization.

If there is bone fracture, bad infection older than 20 hours since injury, bone exposed, large vessels and nerves exposed and therefore impossible to cut

out fully, use Carrel-Dakin regularly every two hours until the bacterial count is well down. If there is to be success with Carrel-Dakin, solution must be made fresh daily and used regularly and careful laboratory control employed. Use sterile vaseline on skin about wound.

Often streptococci come from the skin and you can see them spread from the edges to the surface of the wound. Dichloramin-T will kill organisms on the surface, but is not good deep in the wound.

Sterile dressing with no packing, or Dakin and ether, alcohol, and iodine for the skin; that sums up the situation to-day.

In war surgery, never use chloroform. Ether or gas and ether are best. Never drain anywhere unless absolutely necessary. Drainage is usually plugging the wound.

For the brain, I use normal or isotonic salt solution freely. Dakin here is too irritating. Do not open the dura if possible. When open, ask patient to cough, and all the portion which should be removed will protrude. For extracting pieces of metal, use instrument with powerful magnet. Close dura without drainage.

Never use general anesthesia in brain cases; use local—novocain.

In the abdomen, when a bullet penetrates and perforates, clean up by wiping peritoneum with pure ether on gauze.

Treat compound fractures with Carrel-Dakin if necessary. After a time, use traction by American apparatus first to last, or apparatus with Depage addition.

In joint injuries, such as knee, close at once—no other treatment—and begin moving joint the first day. This will give perfect success in 8 out of 10 cases. If the other two are not successful or are infected, open and drain through and through with Carrel-Dakin, taking out tubes every day and having patient move joint himself. Begin this within the first day or two and keep it up. There will be no especial pain and excellent results will follow. If one waits four or five days before beginning active movement, there is great pain.

Colonel Gosset has had over 150 knee-joint cases. He showed me a series where foreign bodies had been removed and the joint closed primarily with perfect healing and function, and others where, due to injury to the joint cartilage, there had been a primary resection with good results, good intention, and no infection.

As showing the great amount of work to be done, he said:

A team of experts, one surgeon and two assistants, can give the necessary treatment to over 50 severely wounded cases in 24 hours. That means working from 16 to 18 hours. I have done this for some days myself with my two able assistants.

He sounded a note of warning to surgeons, pointing out that war surgery of the ordinary type tends to injure the technique and spoil the touch resulting in loss of ability to do fine work.

H. O. E. DE LA VEUVE.

(Dr. Legrand, Chief Surgeon.)

This is a large evacuation hospital of 3,000 beds for the Fourth French Army situated back of the Champagne front north of Chalons-sur-Marne.

Along this particular front there are many cases suffering from terrible burns due to mustard gas, and at this hospital special large tents and alkaline bath facilities are provided for their care. The cases must have these baths as early as possible.

No attempt has been made in this report to go into the subject of the treatment of those suffering from gas inhalation or gas burns, as it is understood that a special report on this is to be made by another observer.

The nearness of this unit to the front makes primary suture feasible in many cases.

Dr. Legrand, who is also chief surgeon of autochir No. 9, advocates the use of formol and methylene blue in fresh wounds and excising of the colored tissue. This is followed immediately by suture. He kindly described the method in detail:

Solution of methylene blue in formol possesses the property of coloring the contused tissues to various depths, and it also permeates all the diverticuli of the wound. It serves, therefore, as a guide to the complete excisions necessary for successful primary sutures.

Applied to healthy tissue on an excised surface, the color merely penetrates superficially. Nevertheless, it must be applied cautiously. Solution:

Formol, pure solution, 40 per cent Water	aa	50 cu. cm.
Methylene blue		5 grams.

This can be preserved indefinitely in corked flasks.

TECHNIQUE.

I. *Large surface wounds.*—Inundate the wound, especially the edges, which often present subcutaneous detachments, then wash with a neutral liquid after several seconds (boiled water or Dakin's solution) in order to remove superfluous fixture. Then excise the colored part with bistoury or scissors. Suture.

II. *In-cul-de-sac wounds containing foreign bodies.*—Gently catheterize the tract with a rather rigid rubber catheter, avoiding any error in direction. The situation of any foreign body can be revealed by radiograph.

With a 10 centimeter 3 syringe, gently inject the mixture. After the blue inject a little boiled water or Dakin's solution in the same manner. Then largely excise the colored parts.

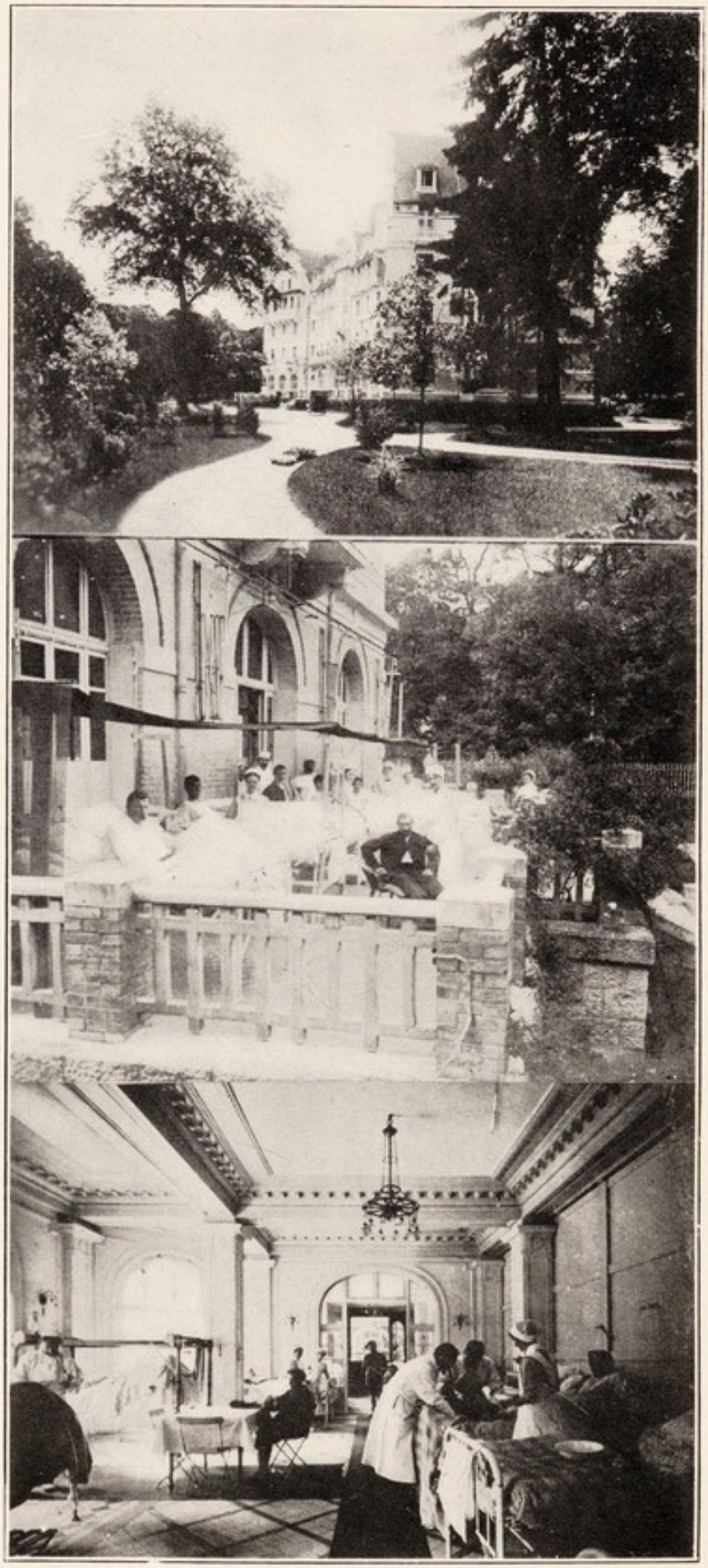
III. *Fractures.*—After ablation of the contused tissue and loose splinters do not be afraid to leave the splinters adherent to the periosteum or the bony extremities tinged by the mixture. Formol is distinctly osteogenetic in action.

When in contact with a healthy vessel for a sufficiently long time formol may have a hardening effect, but a very thin layer of tissue serves as a protection to the vessel.

In itself, a vessel isolated in a wound is dangerous, and its coloration, consequently, is of no importance since it must always be examined and tied.

Nerves prove resistant to impregnation and are not affected by the action of the solution. The operator must wear rubber gloves.

In cases not suitable for suture, the Carrel-Dakin treatment is employed.



Outside of the Carrel Hospital, and grounds, Compiègne. Carrel Hospital, Compiègne. Porch patients. Making rounds at the Carrel Hospital, Compiègne.

This hospital is well planned, admirably equipped, and has a large, up-to-date laboratory. Close by is an animal house well filled for clinical and experimental purposes. Although not many miles from the front some research work is being done here.

CARREL HOSPITAL NO. 21 AT COMPIÈGNE.

Beautifully located in a converted hotel on the northeastern edge of the city this was a general surgical hospital and had a fully equipped laboratory with a number of special workers. Swiss trained nurses were employed, being the best obtainable.

Here Carrel perfected his technique, Dakin worked out his solution, and du Nouy developed his curve of wound cicatrization and established his law of healing. The typical Carrel treatment was here seen at its best, and the results were most gratifying. With this method a new era in septic war-wound treatment has dawned. I was fortunate enough to see the actual development of this work, visiting the hospital on several occasions, the first time in the fall of 1915, and the last time December, 1917. I saw many interesting cases of the employment of this method; also cases involving the filling up of bone cavities either by flaps of flesh slid over or grafts of fat transplanted. Many pictures in color of actual cases treated were most convincing as to the great value of this method.

On March 23, 1918, the Hun deliberately bombed and destroyed the hospital. It was a bright night and the Gotha flew very low, seeming to carefully plant the bombs and aerial torpedoes—five in all—about the main building. From the time of the alarm until all was over about six minutes elapsed. In that time all of the patients were taken to the cellar except a double compound fracture of the thigh. He was covered with mattresses and his nurse stood against the wall at his bedside quietly on duty while the front and side walls of the building were blown in. Two doctors were slightly injured, but no one else.

I go into the details because they furnish a wonderful example of the efficiency of the staff, especially as many of the patients had only a few days before been evacuated from the advanced Carrel hospital, about 4 miles beyond Soissons.

Dr. Carrel says Dr. Depage has made a special study of the money loss resulting from improper treatment of compound fractures of the femur in the present war, and places it at over 300,000,000 francs. At present there are also under treatment in France over 70,000 with bone sinuses. With proper treatment, most of these cases could have been prevented.

(See description of Carrel treatment under separate heading.)

ADVANCED CARREL HOSPITAL.

This is a 100-bed tent hospital, located, at the time of my visit, between Soissons and the German lines. It was later forced to withdraw, owing to the German drive. It had a complete equipment—electric lights, laboratory, operating, and X-ray rooms, all capable of being quickly packed up and removed in camions. In front of our tent was a large red cross, clearly indicating the character of the unit. We were near enough to the battle lines for the noise of guns to be heard clearly every few minutes, and occasionally the hospital had been bombed.

During my visit Prof. Tuffier came from Paris in his motor car and took us to see the sanitary formation of the French Sixth Army, including the underground hospital. This was very close to the front lines and used for shell shock and other cases which could not safely be taken back. It was 30 feet below the level of the ground, through solid rock, and the entrance was elaborately camouflaged. Several dozen patients could be accommodated, and there was the necessary equipment for ordinary emergency surgery.

The location of a hospital close to the front, where serious cases can be given care without being moved a great distance, is considered by the French of great importance. This underground type is particularly valued, since it is safe from bombardment and yet near at hand.

BEAUJON HOSPITAL, PARIS.

(Prof. Theodore Tuffier, Surgeon.)

Repeated visits to this hospital were found to be most profitable. Dr. Tuffier is the chief consulting surgeon of the Sixth French Army and mainly responsible for its excellent sanitary formation, which is now being adopted in great measure throughout the French Army. Both at this hospital and at other hospitals with which he is connected his services in the field of war surgery have been of the greatest value.

An interesting fact is that Dr. Tuffier, without uniform or military rank, goes about freely as a civilian, but with all the power of and receiving the deference due an officer of high rank. The only other instance that I saw of this was Dr. Chutro, with his important work at the Hôpital Militaire, Buffon. He also is in mufti and has no rank, yet he is chief surgeon to one of the important military hospitals of Paris. Both of these men are recognized leaders in war surgery. Dr. Tuffier said frankly: "I can do better work; I am freer without a uniform and can more safely give advice and tell what I

see than I could with a uniform." My own conviction was that no military title could add to the greatness of Prof. Tuffier. He is frequently sent on important sanitary missions for the Ministry of War.

Dr. Tuffier emphasizes the following points:

1. Primary or delayed primary wound suture should be employed in suitable cases received early enough.

2. Carrel-Dakin treatment of empyema is excellent. He has made a special retractor to separate the ribs so as to get at the entire abscess cavity in all its ramifications. X-rays are used to determine the extent of the cavity and also to ascertain that the Carrel tubes have reached every part. I saw a number of these cases at two of Dr. Tuffier's hospitals. The results were very satisfactory. The method employed is as follows, dressings being made each day: A smear from the inside of the pleural cavity is taken to be examined by microscope. The cavity is flushed out with Dakin solution, individual tubes are tested, and fresh tubes are inserted when necessary. Often four Carrel tubes, stiffened with fine silver wire, are inserted, endeavoring to reach all parts of the cavity. Then compresses wet with Dakin solution are placed in the external wound to prevent a too rapid interchange of air. The skin is protected with vaseline compresses or zinc oxide ointment and a cotton pad and chest binder are applied. The external dressings are changed by the nurse whenever necessary. After the tubes and compresses are in place an X-ray examination is made to determine whether the tubes reach all parts of the cavity. When the cavity is surgically clean the wound is closed. By this method convalescence is materially shortened.

3. For general septic wound treatment employ the Carrel-Dakin method.

4. Adipose grafts may be used satisfactorily to fill up lung and bone cavities.

5. In the case of a knee joint where there is need of ankylosis, as in a beginning tuberculosis, small strips of bone from the patient's tibia have been used, pegged through the femur above and into the tibia below, coming through the joint like an X.

Prof. Tuffier showed many pictures and slides of amputation stumps in the present war. He has often had to reamputate in cases where other surgeons have done the first work, because pieces of bone were left behind or the bone was too long or there were overhanging bits of periosteum where new bone formation existed. He has had over 350 such cases, most of which were preventable. He says:

> Do not leave the periosteum too long; cut it off even with the bone.
>
> With improved methods of treatment of wounds, larger experience, and better judgment, the number of amputations has greatly decreased since the earlier days of the war, when there was much needless sacrificing of limbs.

It was rather interesting to note in Dr. Tuffier's hospital the following sign in the wards: "Tout blessé qui suppure a le droit d'en demander la raison à son chirurgien."[1] On inquiry it was stated that the signs had been placed there some months before by direction of the chief surgeon.

BUFFON HOSPITAL, PARIS.

(Dr. Pedro Chutro, Surgeon.)

At this hospital there are 350 surgical cases under the care of Dr. Chutro, who was professor of surgery at Buenos Aires, Argentina, and who came to Paris early in the war as an assistant to Dr. Gosset. For over two years he has had full charge of this clinic, doing remarkable work, and his name is now included in the first half dozen surgical leaders in Paris. He is a firm believer in the Carrel-Dakin method and treats all cases, when he does not get them early enough for primary suture, by this plan. However, he does not use the bacterial examination control except when about ready to close the wound. All dressings are done by the surgeon, and, with a perfected system, he goes rapidly from bed to bed, covering the work in scores of cases in a remarkably short space of time.

The technique of operating is excellent. No one except the operator is allowed to touch the instruments, dressings, or even the towels about the operative field.

Because of his success, Chutro has had sent to him many cases of old bone sinuses, some of which have had from one to twenty previous operations. He says: "There are in France at present over 75,000 unhealed bone sinus cases under treatment. Many have had repeated operations and years of suffering. This is one of the tragedies of the war! Most of these could have been prevented."

He added: "The secret in handling old bone-sinus cases is to get rid of the cavity. Chisel away the bone until either periosteum, fascia, or other soft parts come in contact fully with raw bone surface. Often by incising the periosteum laterally in the long axis of the bone it can be drawn over to cover. Bone is replaced from periosteum, not from the cancellous or other part. Usually the Carrel-Dakin treatment in 14 days will render the wound sterile, but the treatment must be continued until the bone surface is covered with healthy granulations before suturing. In the femur this is usually about six weeks, in the tibia and humerus 30 to 35 days. I can get 97 per cent permanent closures."

A free incision method is employed. All the diseased tissue is thoroughly removed, and all overhanging osseous structure, retaining

[1] Every wounded man who has suppuration is entitled to ask his surgeon to explain it.

that part of the bone which seems the strongest; for the tibia it is the antero-external; for the femur the posterior; for the humerus there is no choice.

The incision should always be curved, as one is able later to better fashion flaps. "Never leave a cavity; cut away the edges, then fill up the cavity by a flap of muscle or other soft tissue."

(See special section on trephining.)

HÔPITAL BROCA, PARIS.

(Prof. Pozzi, Chief Surgeon.)

In this institution particular emphasis is laid upon the therapeutic value of a bright atmosphere and pleasant surroundings. For years Dr. Pozzi has had upon the walls of the wards paintings full of hope and cheer, real works of art. The wards themselves are light and airy. When I was with him a short time ago, only a few weeks before his assassination, he said:

> These wards with the beautiful pictures have done a great deal of good in peace times, but now they are of double value for the poor mutilated and wounded soldiers. I am glad we had them ready.

Dr. Pozzi was one of the first and most enthusiastic advocates among the medical profession in France of the Carrel-Dakin method. He said:

> The advantages of this method are that it shortens the time of treatment, diminishes very materially the number and the seriousness of complications, and insures a minimum amount of scar tissue, decreasing thereby the possible stiffness, deformity, or loss of function.

LA PANNE HÔPITAL (AMBULANCE DE L'OCÉAN).

(Dr. A. Depage, Belgian Army, Chief Surgeon.)

Ever since the war began this institution has been a prominent and active center. It is so situated on the Belgian coast, close to the border of France and not far distant from the line of battle in Flanders, that it acts in a triple capacity as field ambulance, clearing station, and base hospital. The splendid surgical work of Dr. Depage and his staff is everywhere recognized, and anything originating with them is deserving of careful consideration and study. In fact, in Prof. Depage and Prof. Tuffier we have two surgeons whose experience and ability have been among the most potent factors in shaping and developing modern war surgery.

In June, 1918, when I was at this hospital, it had been largely evacuated owing to bombing and fear of another drive. Only 250

beds were left, the remaining patients having been sent to a center in Brittany and to another near Calais. American aid, in money and in personnel, have been gratefully received and have helped to make possible the good results which have been obtained.

In septic cases the Carrel-Dakin treatment is employed.

Dr. F. Martin is doing excellent splint work here. His "La Prothèse du Membre Inférieur," published this year, sets forth clearly the methods of aiding by apparatus those who have suffered amputation of the lower extremities. The importance of provisional apparatus, the mechanics of artificial leg making, and the results of their work are given in a most interesting way. Lieutenant Commander R. G. Le Conte, Med. Corps, U. S. N. R. F., has recently translated this brochure and forwarded a synopsis of the work to the Bureau of Medicine and Surgery, and I will therefore not discuss the subject in detail. The main points have been carefully studied and made use of in large measure in the construction of the new American Red Cross artificial leg, which is receiving so much commendation and being ordered in large numbers for the French and American Armies.

ZUYDCOOTE, BELGIUM.

(Major Pierre Duval, Chief Surgeon; Consulting Surgeon of the Seventh French Army.)

This unit is an automobile ambulance called Autochir No. 21, at the time of my visit working with the French Army of the north. There are 24 such in the French Army. It operates very close to the front and goes with the soldiers into the field, utilizing wherever possible buildings which it may for the time have at its disposal, such as the former tuberculosis sanitorium at Zuydcoote-by-the-Sea, where it is now located. The hospital has 500 beds, with a possible crisis expansion to 2,000.

Points emphasized by Dr. Duval:

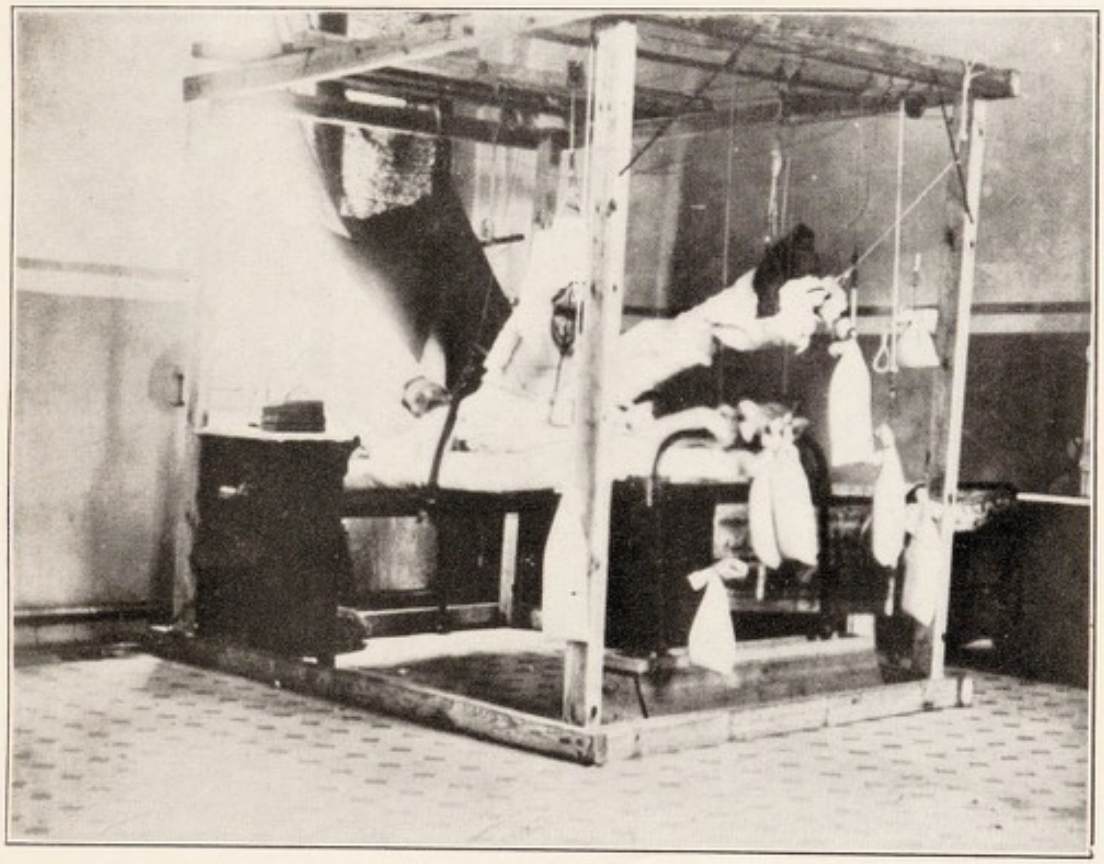
1. Primary closure with silkworm gut, using ether after débridement.

2. Use of Carrel technique in some cases but substituting ether instead of Dakin.

3. Fracture treatment of Sinclair. He adds a special feature, pulling the patient up into a flying position when dressing the back. (See illustration.)

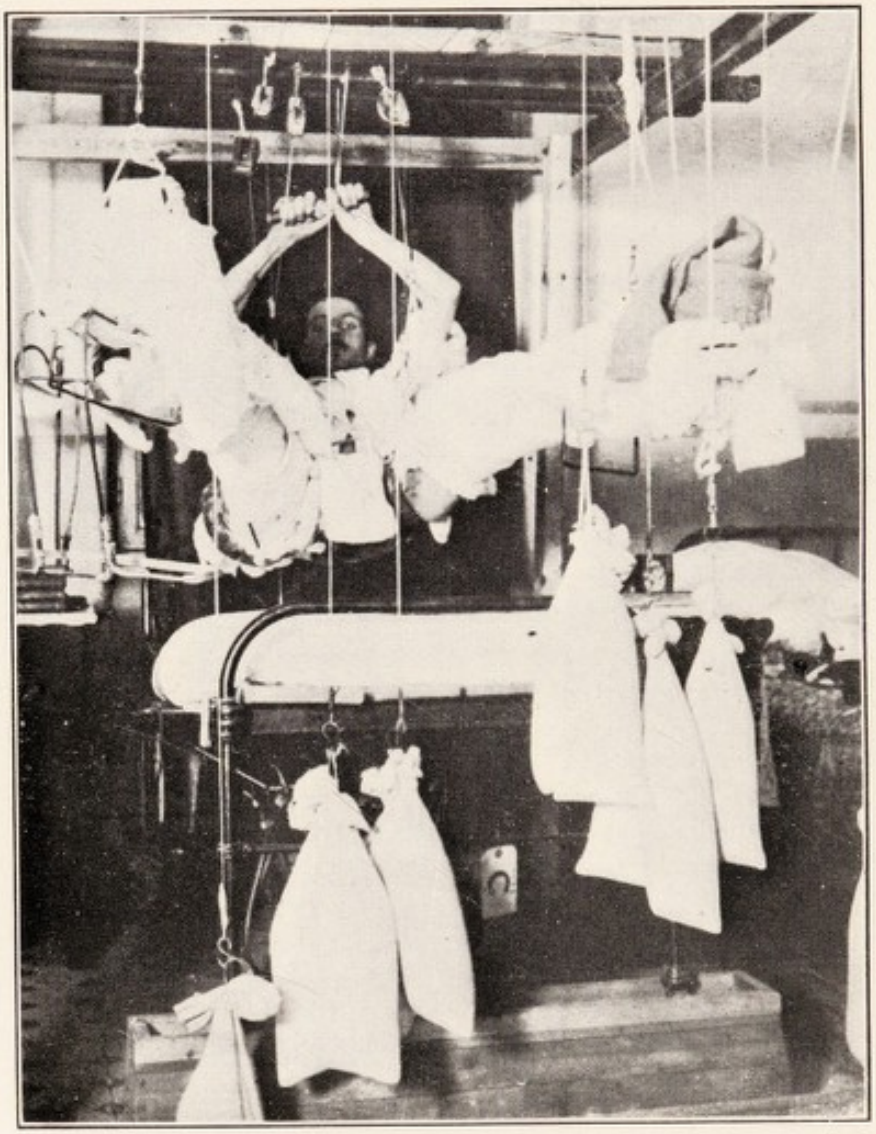
4. In very septic cases, open freely and use sunlight. Cover the wound with tin netting so that no flies can get at the surface. He begins with one-half hour exposure, then 1 hour, 1½ hours, and on the fourth day 2 hours. After that the part should be sterile, he claims, and showed me a series. Uses sterile gauze between light exposures.

5. Takes X-rays on celluphone. This largely avoids carting bulky glass and does away with much breakage. Dr. Béclère, radiographer of the unit, introduced this method, which is described as follows:



Fracture treatment of Sinclair. (Feature added by Duval. Patient in flying position when the back is to be dressed.)

122–1



Fracture treatment of Sinclair.

122–2

Pellicles prepared according to the Caillods method, can be mounted between two sheets of transparent celluphone paper, so as to keep the specimens on file. The celluphone permits the taking of positives, as well as all markings or inscriptions with a dermographic pencil.

Caillods technique:

1. Submerge the dry cliché (plate) in the following solution during a quarter of an hour:

	Grams.
Water	1,000
Formol at 40 per cent	160
Potassium carbonate	50
Glycerine	10

2. Remove the plate and gently wipe it with a pledget of cotton soaked in the same solution.

3. Let it dry, without washing, at a practically even and cool temperature (10° to 20 C.).

4. After thorough drying, clip off the gelatine at 1 to 2 millimeters from the border of the plate, using a ruler and a good penknife, cutting close to the glass.

5. Cautionsly lift a corner, and the pellicle will come off spontaneously or after gentle traction.

A great amount of thoracic surgery is done here—pieces of shell removed from the lungs by Dr. Duval. He showed me a number of X-ray pictures taken before and after operation.

NO. 8 STATIONARY HOSPITAL AT WIMEREUX, B. E. F.

(Major Maurice Sinclair, C. M. G., R. A. M. C., Chief Surgeon.)

The capacity here is 1,240 beds, one-half medical and one-half surgical; but often there are more surgical than medical cases. Special emphasis is laid on the treatment of fractures, mostly of the femur; 10 per cent of those treated being simple, 90 per cent compound. All such cases from the entire district are sent to this hospital to be under Major Sinclair's care. In 1915 I saw him in Boulogne in the same line of work, and upon my recent visits to Wimereux was much impressed by the great advances he has made. The method which he has developed is being adopted in many centers as the best. Certainly, as one goes about the wards the results seen are most convincing. Nowhere that I have been is his work excelled, and it is not often equaled.

Repeated requests have been made for a book from Major Sinclair on fractures of the femur, but he replies that he will have no time for this until the war is over. The importance of the subject is such, however, that I have felt it wise to give considerable space to his views. (See "Fractures.")

HÔPITAL DE LA MARINE, BREST.

(E. Damany, Médecin Chef.)

Here I found the following features emphasized:

X-rays are absolutely essential to good war surgery. In every well-equipped hospital, even in advanced ambulance units, X-rays must be available. It will be found advantageous to have the X-ray room adjoining the operating room, so that the patient may be easily taken from one to the other.

In this and a number of similar hospitals, a dark room is fitted up for an operating room, so that the removal of the bullet or piece of shell may be accomplished under the fluoroscope, the surgeon first locating the foreign body and then, through a small incision, directing his instrument down to it.

If the bullet or shell fragment is in the lung, the ribs are parted and the forceps are pushed through the lung, the foreign body is extracted, and the wound closed.

I saw excellent work being done here in this line.

AMERICAN RED CROSS HOSPITAL NO. 1.

(Lieutenant Colonel J. P. Hutchinson, Medical Corps, U. S. Army, Commanding Officer.)

This was formerly known as the American Ambulance, Neuilly. The word ambulance has several meanings in France. A conveyance for the sick, a mobile hospital unit, and an improvised building used as a hospital, may all be so designated. The latter class is the one within which this institution falls, for it is located in a large school building on the outskirts of Paris converted temporarily into a hospital and to be later returned to the authorities fit for its original work.

Early in the war a committee of Americans organized the American Ambulance at Neuilly, and for years before the United States became involved it had been at work. The splendid cooperation of that committee and the unselfish devotion of its staff of volunteer workers will always be held in grateful remembrance by the French.

There have been many changes in the personnel of the hospital staff, but at the time of my visit Lieutenant Colonel Hutchinson was in command, assisted by Major Charles Powers and Captain S. F. Jones. In the dental department, which is so widely known and commended, Dr. Hayes is in charge, assisted lately by Dr. Dunning. It is being further enlarged and the teaching facilities augmented. Under "Plastic Surgery" I have more particularly described work done here.

Both French and American wounded are cared for, and special emphasis is placed upon nerve suture as well as plastic surgery.

At first the experience here with Carrel-Dakin treatment was disappointing, but, like many others, they found later that to obtain satisfactory results full attention to every detail was necessary. Colonel Hutchinson said:

We believe fully in the Carrel-Dakin treatment. Dichloramine-T spray may be of use in superficial soft parts, but for deep wounds I prefer Carrel-Dakin. Carrel will go down in history for two lessons relating to war wounds: 1. They can be made sterile. 2. They can and should be closed when sterile. Another solution may supplant Dakin, but the Carrel technique is a great step in advance.

The work which has been done at this hospital entitles it to rank among the best in France.

AMERICAN RED CROSS HOSPITAL NO. 2, PARIS.

(Lieutenant Colonel J. A. Blake, Medical Corps, U. S. Army, Commanding Officer.)

This was formerly the large private hospital of the late Dr. Doyen, splendidly equipped and well manned, where in peace times many Americans have been treated. The patients now are both French and Americans, but mainly the latter, both officers and enlisted men.

Dr. Blake's work at Neuilly with plastic and oral surgery is mentioned more in detail elsewhere. At this hospital he has emphasized the treatment of fractures and is soon to publish a book on the subject, giving the results of his experience during the past four years. In April he expected to establish a special fracture hospital near Chalons-sur-Marne, but the night bombing delayed the project and the recent offensive has further postponed it. The need for hospitals near the front, where severe compound fractures, chest injuries, abdominal wounds, and cases of marked shock can be treated without being transported a long distance, is urged as certain to result in a great saving of life.

In gas gangrene, so much better denominated by Surgeon Fauntleroy, United States Navy, "progressive emphysematous necrosis," Colonel Blake has been using, with excellent results, the following acidulated solution:

Quinine hydrochloride, 0.1 per cent in distilled water, physiological salt solution, or simple boiled water.

Acidulate with 1 c. c. hydrochloric acid (strength 50 per cent).

The efficiency of the above solution is increased by acidulating with hydrochloric acid.

For moist dressings 1 per cent quinine hydrochloride solution in distilled water, with addition of 1 per cent alcohol, to prevent formation of precipitate on contact of alkaline solution with gangrenous wounds.

For continuous irrigation, 1 per cent quinine hydrochloride solution in physiological salt solution. In freely suppurating wounds, the same quinine hydrochloride solution is used in simple boiled water.

Quinine hydrochloride solution, 1 per cent in physiological salt solution, has been used for hypodermic injection into infected tissues around wounds with definitely established gas-gangrene infection.

Results in the Neuilly hospital are so good that a weaker concentration (half the above strength) may prove equally efficient against the microbe of gas gangrene.

This solution is used every two hours with the Carrel tube and technique and is almost specific in Colonel Blake's judgment.

He believes that the Carrel-Dakin treatment of wounds is no better than dichloramin-T, and says that the best treatment is the excision of bruised tissue, control of hemorrhage, and immediate closure of the wound, with perhaps a little iodine applied. Or, if one gets rid of the bruised tissue and sterile gauze is placed on the wound for three days and then closed, excellent results are, as a rule, secured. In recent wounds in soft parts one can get 90 to 95 per cent closures. In compound fractures there is not so good a percentage.

We have learned that the joints which were supposed to be extremely susceptible to infection are not easily infected. When infected, if one simply opens them, washes them out, and then drains to the joint, but not into the joint, the patient may get up and walk around while there is still pus coming from his knee, for example, with no harm but with good results.

AMERICAN RED CROSS HOSPITAL NO. 3, PARIS.

(Lieutenant Colonel Samuel Lloyd, Medical Corps, U. S. Army, In Command.)

This hospital is so beautifully arranged and equipped that it is a model of comfort and convenience. Mrs. Whitelaw Reid has taken one of the art students' centers near the edge of the Latin Quarter and fitted it up as a hospital for American officers. There are already 75 beds, and plans have been made to enlarge the capacity. Nothing reasonable is lacking that money can buy which would add to the comfort or aid in convalescence. The open court with its trees and flowers, and the location on a quiet side street off the boulevard afford surroundings that are most attractive and restful.

THIRTEENTH GENERAL HOSPITAL (B. E. F.), BOULOGNE.

(Lieutenant Colonel Harvey Cushing, Medical Corps, U. S. Army, Chief Surgeon.)

This, as well as Lieutenant Colonel Hugh Cabot's unit, are popularly known in America as the Harvard Units. While the hospital is

British, the staff is composed of Americans (80 nurses, 24 medical staff, 190 enlisted men), and they have been engaged in this work since before our entry into the war. The old casino at Boulogne, beautifully located on the water front, was made over for hospital use, and a number of hut wards have been constructed in the garden, making provision for 650 beds. Colonel Cushing said: "I would rather have some of these up-to-date hut hospitals for my work than the best hospitals at home." Since the early days of the war Sir Almroth Wright has been here engaged in laboratory research work.

While there are all kinds of cases cared for, special emphasis is placed on head surgery. Colonel Cushing is strongly of the opinion that there should be a mobile unit for head and neurological cases, and there is considerable talk at the present time of forming one. He also urges the importance of special hospitals for a number of departments of war surgery with experts in charge.

The joint work here is having excellent results. No irrigation is allowed.

Dichloramin-T has proved only evanescent and not as good as Carrel-Dakin. The early advocates were too enthusiastic.—*Cushing.*

One of the chiefs of the surgical staff said:

One disadvantage in our work is that we can not follow our cases. The patients get a certain improvement and then are evacuated to England. We have return postals, but a word after two months is not enough. There would be better results if the same treatment could be continued. Many an amputation would be unnecessary, we believe. We have had bad cases astonish us by improving and, while still serious, seem on the high road to recovery. Then they have been transferred and the next surgeon, not knowing about the gain, takes off the leg, and a limb is unnecessarily lost.

Colonel Cushing confirmed this view, saying:

"There should be not circumferential areas under consultants, but lines from front to back," that is, all the way from the battle front to the base hospital the patient should be under the control of the same directing head.

Recently this plan has been tried in one of the French Armies and has worked exceedingly well.

FIFTY-THIRD GENERAL HOSPITAL, B. E. F.

This is the usual 1,040-bed unit, some huts and many tents, and is beautifully situated on a hill west of Pernes. In the absence of the commanding officer, the registrar, Major A. Elliott, showed me the institution. It is an excellent one in every detail, and is unusually well arranged and equipped from a sanitary standpoint.

Here a number of German prisoners are detailed for work. They come down in squads from the prison camp about a mile away.

One is deeply impressed at this camp as everywhere else, with the excellent care that Britain gives to her prisoners. Every essential comfort is provided. For example a complete corrugated iron shed is furnished in a suitable place where the prisoners may eat their meals without discomfort from sun or rain.

One of the best equipped hospitals in Britain, located on a beautiful site, at Belmont, Sutton, Surrey, is used for German prisoners.

The contrast between the care given to wounded or unwounded prisoners by the British and French and that which I saw given to prisoners by the Germans late in 1915 is a striking example of the difference between the standards of humanity held by the allies and by the central powers.

EIGHTEENTH GENERAL HOSPITAL, DANNES CAMIERS.

(Lieutenant Colonel Beasley, Medical Corps, U. S. Army, Chief Surgeon.)

This is largely a "hut" hospital with about 2,000 beds, located 18 miles from Boulogne. At the time of my visit the unit had been in France just one year, and in that time 40,000 cases had been treated.

TWENTY-SECOND GENERAL HOSPITAL, DANNES CAMIERS.

(Lieutenant Colonel Hugh Cabot, B. E. F., Commanding Officer.)

A hospital of about the same type and size as the 18th general, which it adjoins. (In almost all cases "hut" hospitals contain 1,040 beds and have tents for crisis expansion.)

Because of bombing at Etaples, some days before, both of these hospitals were practically evacuated at the time of my visit. The same was true of Etaples, which presented a marked contrast with its aspect of great activity upon my former visit, when it was full to overflowing. The destruction of hospitals and town buildings was very evident.

So far as view and sanitation are concerned Etaples hospitals are well located, but from a military standpoint they are most unfortunately situated. Surrounded by replacement camps accommodating two score thousand troops, a drill ground, machine-gun depot, and antigas school, the wonder is that bombing did not occur earlier and more often.

In this connection a word in general as to the location of war hospitals may not be out of place. In selecting sites for such hospitals as must be located fairly close to the area of military activity, more stress should be placed upon the desirability of separating them as far as possible from centers which are legitimate targets for the enemy. There has been a great stir because of the bombing of the

hospital at Etaples, but to those who know the environment at that center no surprise was caused. In such places the Red Cross can not be and is not relied upon very greatly for protection, because where a hospital is located in the center of a military area one can not expect safety. In addition to this most important consideration of safety is the fact that from a medical standpoint such surroundings are bad, inasmuch as the dust and noise attendant upon the movements of troops, and the general military atmosphere, are injurious to the patients. By circumstances, frequently unavoidable, very many of the hospitals on the western front are subject to criticism for being thus located.

On the other hand, where hospitals are far removed from the forward area, perhaps in another country altogether, while the selection of the general locality must be governed by several considerations such as climate, accessibility, etc., the particular site of each such hospital should be not only one where the sanitary conditions are favorable, but, equally important, where beautiful view and surroundings will have a chance to lend their undoubted therapeutic aid to the recovery of health.

Among the hospitals visited many were thus beautifully located. In particular the surroundings of the British general hospital No. 1 (in charge of the Presbyterian Hospital unit), at Etretat, seemed almost ideal. Here the casino and some private houses along the sea front have been converted for hospital purposes, and it is an excellent example of good judgment in selecting a site.

Another delightfully located hospital is the one now approaching completion at Sarisbury Court, near Southampton. Here upon one of the most beautiful sites in England, the American Red Cross is building nearly 10 acres of "huts" for the wounded American soldiers. It overlooks the bay, and is surrounded by acres of woodland and is far enough from the main roads to be free from noise and dirt.

A word of commendation should be said for the good work done by both our Army and Navy medical forces when they have found it necessary to take over and adapt various antiquated buildings, such as convents, monasteries, schools, barracks, etc. These buildings were often utterly unfit for hospital use, lacking all sanitary facilities and the like, but, in spite of serious obstacles in the way of obtaining necessary supplies and labor our men have made the best of the very difficult situation, and have converted the buildings into more or less satisfactory bases. A number of examples could be cited, such as the work of the Red Cross at Beauvais and Orleans, the Army at Pontanezen Barracks, and the Navy at Brest. All are entitled to great credit for the satisfactory results thus far obtained.

BRITISH RED CROSS HOSPITAL AT NETLEY, ENGLAND.

(Major H. S. Souttar, R. A. M. C., Chief Surgeon; Assisting Consulting Surgeon for the British southern command.)

Major Souttar has been actively engaged in war surgery since September, 1914. During his nearly two years on the Continent in the thick of the work as surgeon in chief, Belgian field hospital, and in the past two years at Netley, he has learned at first hand the lessons of the war. His book, "A Surgeon in Belgium," dealing with experiences in the early days of the war, has been widely read and is considered one of the most impressive books that the war has produced. A man of wonderful optimism, his personality permeates the hospital at Netley, which I visited in his company. At my request Major Souttar has briefly summarized as follows, some of the surgical treatments particularly emphasized at Netley and some of his experiences:

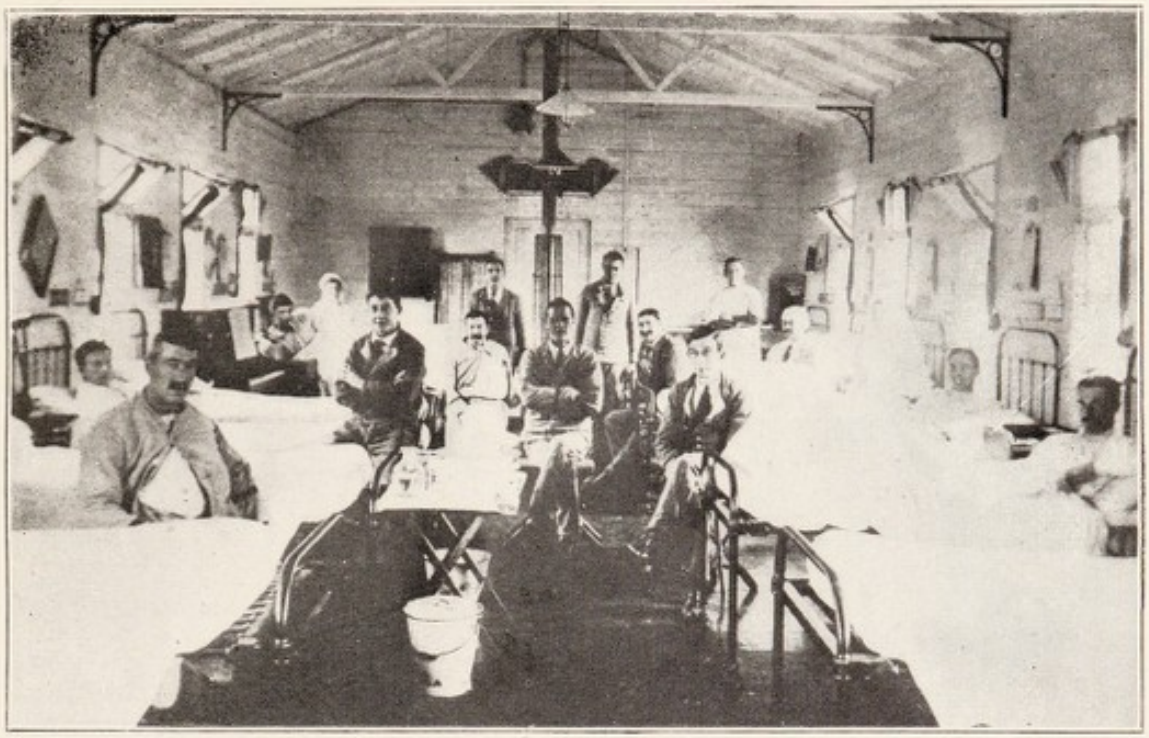
In a military hospital the conditions of work, the nature of the cases, and the results aimed at, all present differences from those of a civil hospital. I propose to sketch in the briefest possible manner those features of the work which have seemed in my personal experience to merit special attention, and to mention the conclusions to which that experience has led me. Though I am solely responsible for the views I express, I may say that they are in close agreement with those of my colleagues.

1. *Wounds.*—These, as they reach us, either are sutured or are large granulating areas. The deep puncture of earlier days does not now pass the C. C. S. Our treatment of wounds therefore resolves itself into that of large granulating areas, more or less clean. At this late stage we have not found Carrel's treatment nearly so satisfactory as it has proved in early wounds. We have found great difficulty in obtaining sterility, and it appears to have been followed by a deep and permanent fibrosis. Where the wound can be sutured it is our practice to smear the surface with a very thin coating of bipp (equal parts of bismuth subcarbonate, iodoform, and liquid paraffin, by weight), after swabbing with spirit. The bipp appears to abolish the febrile reaction which occurs in general after any interference with a septic wound, and we have obtained primary union in a large number of cases. We use the same method in performing reamputations.

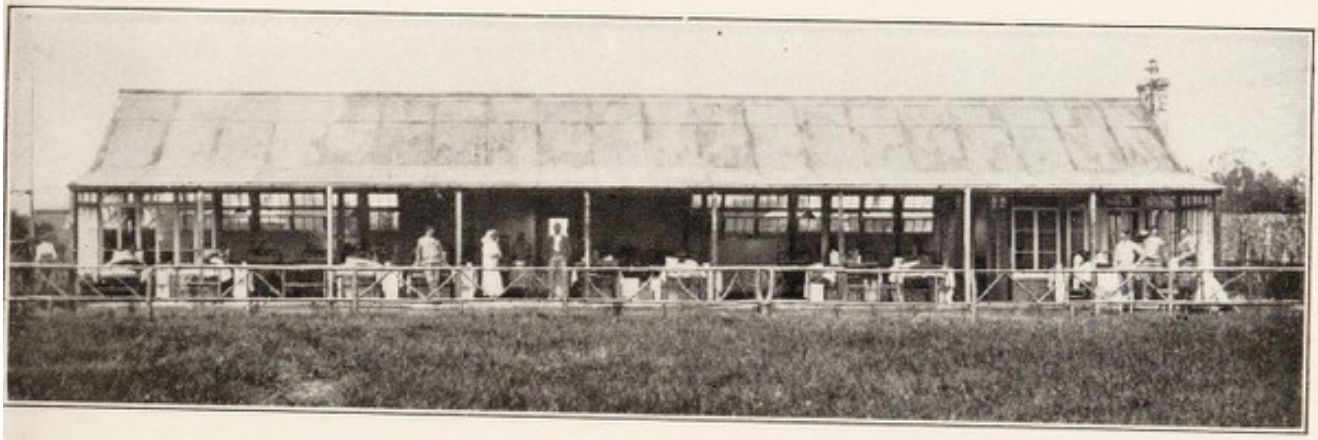
Where suture is impossible we cover the surface with Thiersch grafts, holding these in place with a very fine metal gauze (known as "tinsel dress trimming"). By deep retaining stitches this can be held down firmly over any irregular area. It absolutely prevents displacement of the grafts, which may be dressed with saline daily. The large areas we have covered, and the uniform success of our grafts has been striking.

Only in rare cases have we employed flaps, and then not often with success. Flaps would appear to be quite unsuitable for open wounds and should be reserved for plastic operations after healing.

For the cleansing of large wounds of the buttocks and genitals, such as are frequent in gas burns, we have recently employed continuous baths. Our installation consists of 10 baths, through which there is a constant flow of water at the rate of 50 gallons per hour in each bath. They are kept by this flow at a temperature of 98° to 100 F. Our 10 baths, with the hut and water heating and



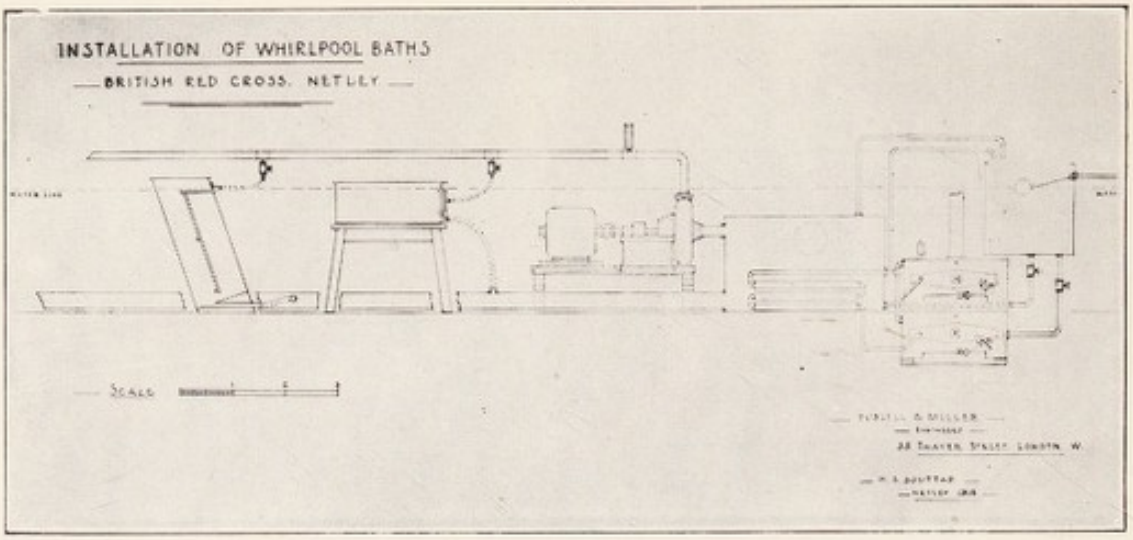
Ward. Netley



Red Cross Hut, Netley.

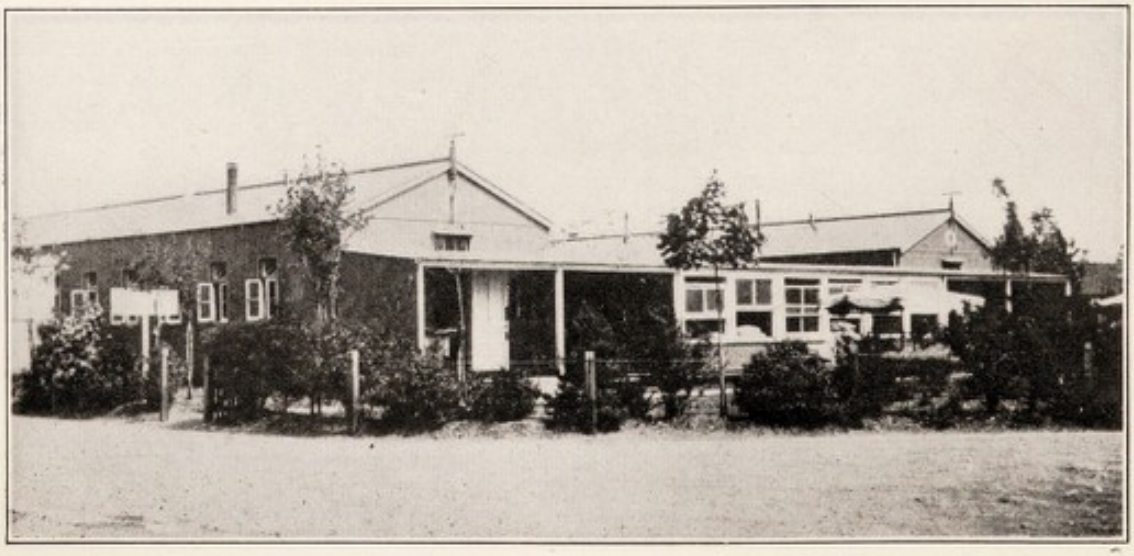


Netley





Netley.



Officers' quarters, Netley.

automatic controls, cost about £1,500, and are expensive to run. The results obtained are, however, extremely good, very dirty burns and wounds cleaning up rapidly, while the degree of comfort to the patient is very remarkable. I consider that the method is a very great asset to a hospital receiving patients within a few days of injury.

2. *Fractures.*—Fractures of the humerus as received by us are usually put up in a Thomas splint, with the elbow fully extended, and with some extension applied. This is a good and comfortable position for transport, but if maintained for more than 10 days a stiffness of the elbow will result which is very difficult to free. At the end of that time we therefore bend the elbow to a right angle, under gas if necessary, and place the limb on a bracket splint with the arm well abducted and pointing forward. The splint we use is made of thin vulcanized fiber; it is very light, and it provides a flat surface on which the limb rests and on which it can be moved about for the purpose of massage or dressing. This flat surface is supported by a body piece which comes well down below the iliac crest and is attached to the chest by straps. Two wooden struts maintain it at any inclination desired. In some cases, or when some degree of union has been obtained, a wedge-shaped piece attached to the chest by straps will be found more satisfactory. In all injuries near the shoulder the full abduction given by the bracket is of great advantage.

Fractures of the femur and of the tibia, we treat on a Thomas or a Wallace-Maybury splint. The latter possesses the advantages that the degree of extension can be readily adjusted and that the greater width of the frame facilitates dressing. We have used a glued-on extension entirely and we have found it satisfactory.

3. *Nerve injuries.*—From the number of these cases and their gravity, they form one of the real problems of war surgery. As a special center for their treatment we have had exceptional opportunities of seeing the difficulties and of meeting them. We are preparing for publication a report on our work. In our report we draw the following conclusions.

Nerve injuries should only be treated in special centers, and by surgeons specially trained for this work. Without such special training we consider that no surgeon, however skilled in other fields, has any right to undertake nerve suture. The problems both of diagnosis and of operation are too intricate, and the results of any error in technique are of too serious consequence to the patient. On the other hand the after treatment of these cases is very prolonged and involves the use of expensive and complicated apparatus which can only be economically used on a large scale.

In most of these cases there is a long period before suture can be performed, and after operation there is always a long period, varying between 6 months and 2 years, during both of which skilled physico-therapeutical treatment is essential for recovery. During all this time it is important that occupation, mental and physical, should be provided for the man who, apart from his particular injury, is probably in full health. Workshops of all kinds should be provided for the mechanics, and farms and gardens for the open-air workers. With proper organization these should be self-supporting and they should provide training as well as occupation for the men, many of whom have never learnt any trade.

4. *Physico-therapeutical department.*—As soon as his wounds are healed every man passes into this department, where he is under the charge of a medical officer specially skilled in this branch. It includes electrical, massage, mechanical, and whirlpool bath sections. In general, each man passes every day through a section, thus obtaining a maximum of treatment with a minimum of tedium. The baths soften the limbs and prepare them for the massage and electrical treatment which follow. The mechanical section aims especially at

developing volitional power and movement. Each department can deal with 16 to 20 men at one time, and in each the treatment occupies either 10 or 20 minutes.

In the electrical section we have 8 sets for faradic and galvanic current, 2 multostats, 1 Wilson modulator, 2 diathermy sets, and a large static machine. This appears to be sufficient for a hospital of 1,000 beds. The faradic-galvanic sets and the modulator are indispensable for the treatment of nerve injuries; the multostats may also be used for sinusoidal work, as in the treatment of trench feet, and the diathermy sets are of great use in relieving chronic pain in the limbs.

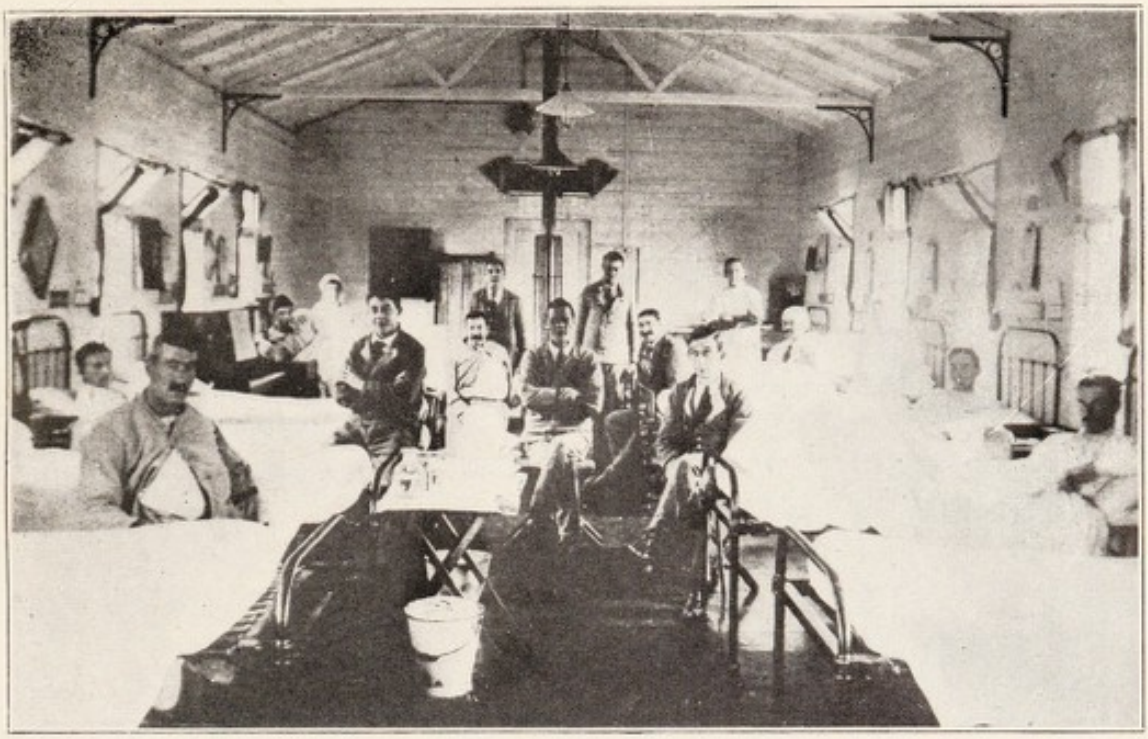
The mechanical section has a full set of Zander machines, of the French type, two rowing machines, mariner's wheel, etc. These are of use in developing the mobility and power of limbs in which the voluntary action of the muscles is already present.

The whirlpool bath is an extension of the *eau courant*, which has been used with such success in France. We regard its use as of the highest value, and as our system is somewhat different from those in use elsewhere, I shall describe it at length. Our baths have now been at work for 18 months, and we can therefore speak of them with some confidence.

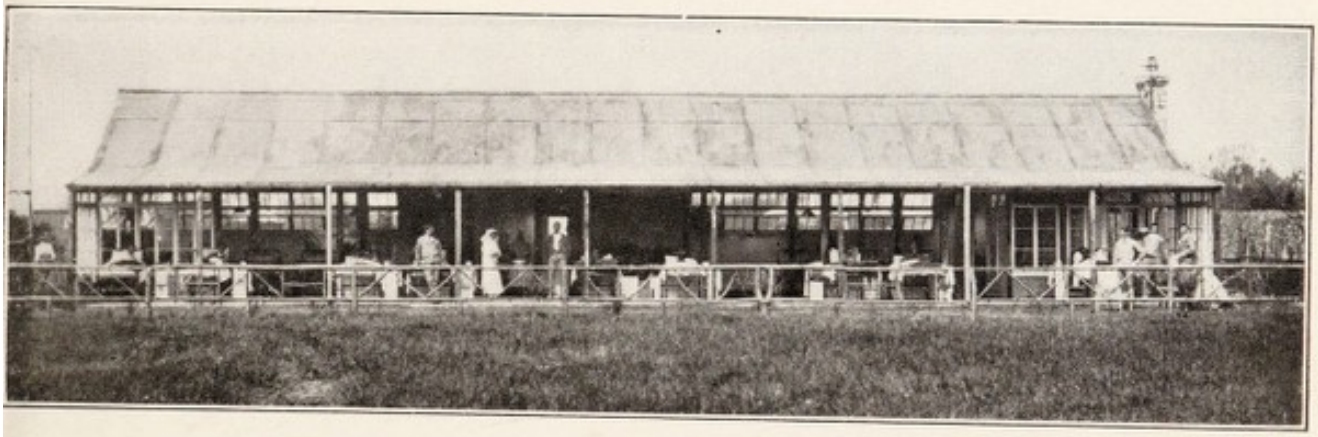
They are so arranged that heated water from a tank is driven by a centrifugal pump through the baths, and returns to the tank by gravity. The temperature of the water is maintained by a small gas heater through a separate circulation. This system is extremely economical, both in construction and in use, for only about 300 gallons of water are required to operate 11 baths, and the loss of heat is so small that only a by-pass is used for the gas after the water has once been heated. As 4,000 gallons of water per hour are driven through the baths, the economy of water and of heat will be obvious. The water is changed once a day and this appears to be quite sufficient. No inconvenience has arisen from the repeated use of the same water. One great advantage of the system is that it is self contained, requiring only a small water supply, a small source of heat, and a small source of energy. It can be controlled by an orderly of average intelligence and it is almost impossible to put it out of order. It is well suited to the requirements of a hutted hospital. The cost of our original installation of 11 baths was £200, and the cost of running it about 5 shillings a day. We are enlarging our installation and we shall shortly be running 20 baths at the same cost.

In these baths we have treated during the last six months a number of patients per day, varying between 100 and 150, the number of treatments per week varying between 500 and 730. It is our routine practice to give 20 minutes in a bath, followed immediately by 10 minutes' massage. The chief effects of the bath are a great increase in vascularity and a remarkble softening of the tissues, with the result that massage is greatly facilitated and much time and labor are saved. The freedom of movement of joints and muscles which follows immersion in a bath is very striking. In a few days the skin, from being glazed and atrophic, becomes soft and thick, the muscles become supple and elastic, and the mobility of the joints is increased. Even in the case of extensive nerve lesions the appearance of the limb becomes almost normal and the familiar trophic changes are almost entirely absent.

We regard the whirlpool bath as the most powerful curative physical method at present at our disposal. It facilitates other methods, softening the limb for massage, increasing its conductivity for electricity; it reduces pain and it produces in the patient a feeling of well-being in the limb, which stimulates him to those voluntary exercises without which no complete recovery can be obtained.



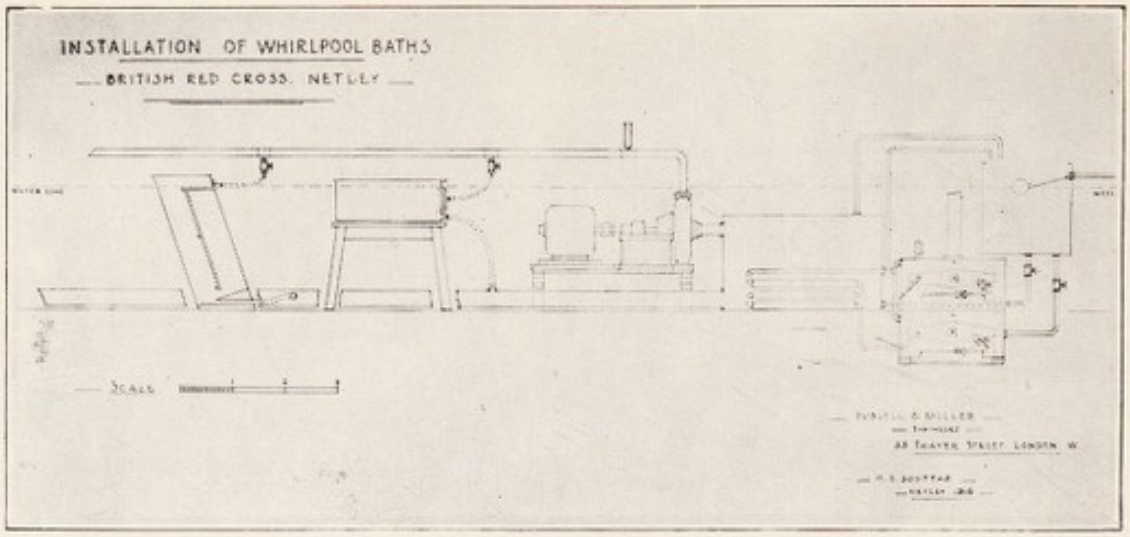
Ward. Netley



Red Cross Hut, Netley.

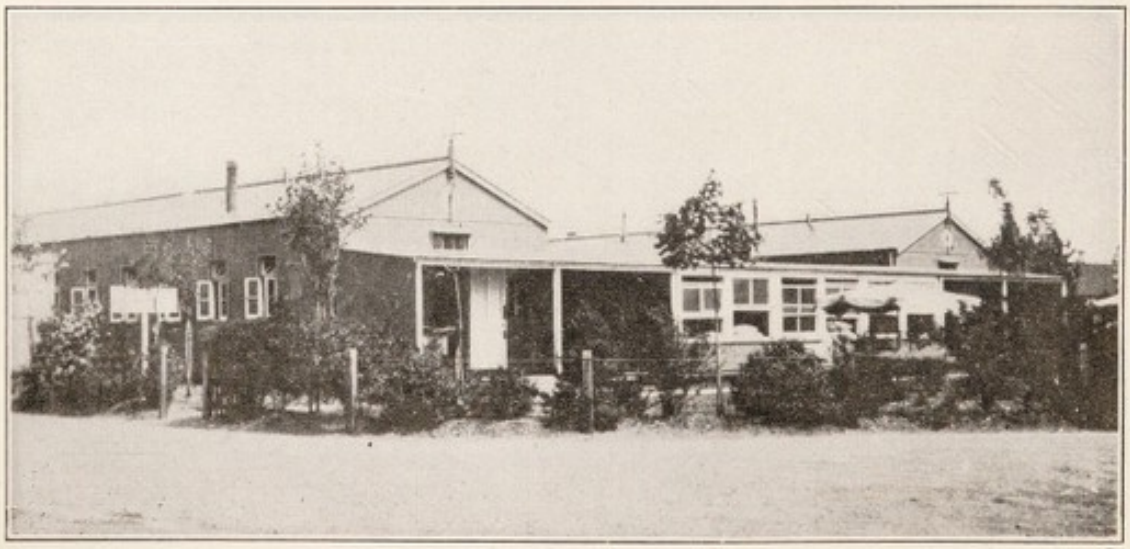


Netley.





Netley.



Officers' quarters, Netley.

SECOND NORTHERN GENERAL HOSPITAL, BECKETT PARK DIVISION.

(Lieutenant Colonel Harry Littlewood, In Command.)

A large hospital, within 3 miles of Leeds, caring for 2,500 cases, 1,700 of which are orthopedic.

A special feature here is the sanitary school for doctors, where a course covering five to six weeks is given. There is a small building housing an exhibit, consisting of pictures, charts, specimens, models, etc., graphically showing how disease originates and spreads. In a nearby lot are all the necessary sanitary arrangements for an army—trench latrines, closets, disposal furnaces, sleeping and cooking quarters, water carts, etc., etc. Actual trenches are made, defective as well as correct, with reasons clearly indicated. It is a very practical course. Thirty to fifty United States Army men may take this course at one time. When not engaged in the school the men spend their extra time in the wards watching the orthopedic work.

More American doctors could advantageously be sent here. I was told: "We could use twice as many; we are short of doctors. They could remain from 5 to 10 months and get real experience, at the same time helping man the British hospitals, with their lessening ranks of medical men.

Another feature of this center is the use of the paraffin bath. Colonel Littlewood said: "Paraffin is put in the large tub and by electricity kept hot as required. The injured part is put into the paraffin, when it is 130 F. or a little less, and kept there 15 to 20 minutes. This is a preliminary to massage, and patients are greatly relieved. It is better than electrotherapy in bad contractions and painful scars. The soft parts are made very pliable. We consider it much better than the whirlpool baths." (I put my hand into the bath and it became very supple.)

Other hospitals are adopting this treatment. Sir Robert Jones is introducing it in a number of orthopedic centers.

Sinclair's method of splint work is followed here. He came in person to demonstrate the use of the splints and explain the points of his splendid method.

In the large department for the treatment of jaw cases the secret of the successful results being obtained lies in the close cooperation between the surgeon and the dentist.

Dr. William Cuthbert Morton, a civil medical practitioner, one of the staff, is doing remarkable work in functional reeducation. The British Medical Journal for April, 1918, contains an article by him describing his work, and Colonel Littlewood said: "His results at this hospital bear out his statements."

Dr. Morton says that there are two types of so-called malingerers: true, pseudo. In the second class are those whose muscles and cen-

tral nervous system are incoordinated through no fault of the individual. The muscles have forgotten how to act and react. Educational training sets this right. The muscles must again interpret aright the brain cells' activity and their message. The patient is first assured that while his disability is real there is no reason why it should not yield to treatment. If any part of the disability is due to actual and permanent damage to the tissues he is warned not to look for any improvement in this direction. If an organic lesion is causing no trouble except through suggestion he is assured that this is not disabling him. Where there is no organic lesion, or one which causes no trouble whatever, he is told that through shock or otherwise he has lost control of his muscles, which require to be disciplined if he is to regain control. As far as possible he is trained to observe what muscles are at fault and wherein the fault lies, so that when the treatment is being carried out he may realize what he is to try to do, and above all when he has succeeded in doing it. Electricity, massage, gymnastic exercises, and drill all have their place in the treatment, the electricity being employed in the form of the faradic current with two terminals, or in a bath.

This is a most important field of work and should be carefully studied and developed.

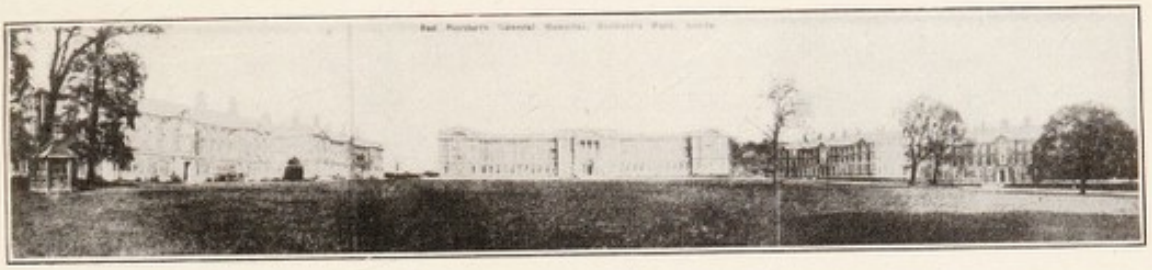
ALDER-HEY MILITARY ORTHOPEDIC HOSPITAL, LIVERPOOL.

This is one of the two representative military orthopedic centers which I was especially advised to visit, the other being the military orthopedic hospital at Shepherd's Bush, London. Both of these institutions are under the direction of Colonel Sir Robert Jones, C. B.

For a general discussion of the subject of military orthopedics, see special section.

The Alder-Hey Hospital is beautifully located on the outskirts of Liverpool, on high ground. It is well equipped as a general hospital, with added massage, gymnastic, hydrotherapeutic, and electric departments; also curative workshops, as they are denominated, where I found dozens of men learning trades and at the same time doing something which would hasten the restoration of function.

Captain W. H. Broad, R. A. M. C., in charge of the massage and gymnastic departments, with the approval of Colonel Sir Robert Jones, C. B., has lately drawn up rules for massage. These have proved so useful and admirably explicit for those who are beginning the work, as well as those somewhat familiar with the procedure, that it would seem that a copy of them, put into the hands of all of our nurses and aids rendering similar service in our Army and Navy, would be of distinct advantage.



Second Northern General Hospital. Beckett Park, Leeds.



Queen Alexandra's Hospital for Officers. The old house and north corridor.

The directions as given and practiced at Alder-Hey are appended in full:

RULES FOR MASSAGE.

Preliminary.—It is essential in every case for which massage is ordered that the masseur or masseuse, to whom the work is intrusted, should have a clear knowledge of the nature and extent of the injury, and also of the methods by which recovery is to be obtained. This is especially necessary in orthopedic cases. Consequently, an examination of the patient is made by the officer in charge of the massage department in the presence of the masseur or masseuse who is to undertake the case. A history of the case is taken on this occasion, with a detailed description of the present condition, movements, electrical reactions, and angles of affected joints. The X-ray photographs should also be examined when they are available, and the nature and object of any operation that may have been performed should be understood.

The officer in charge then suggests the particular massage movements suitable for the case, and where joints are involved, the extent and degree of manipulation advisable. Any abnormal condition of a patient occurring during treatment should be reported immediately to the officer in charge.

After the orthopedic surgeon has effected structural repairs or alterations, it is massage which can assist in restoring function as far as restoration is possible.

It is a privilege to have the opportunity of assisting in this restoration to health, activity, and usefulness of our wounded soldiers. The massage department of a military orthopedic hospital presents this opportunity as, perhaps, no other does; therefore, let the treatment and progress of each case be regarded with the keenest personal interest.

Lubricants.—Effective massage is impossible in the majority of cases without the use of a lubricant. The object of a lubricant is to make manipulation easy, to prevent chafing of the skin or dragging of hairs. What lubricant is used is immaterial as long as this object is attained. The slightest chafing or bruising of the patient's skin during treatment is inexcusable and is evidence of faulty technique. Ordinarily, French chalk or one of the talcum preparations is used, but where there is a considerable growth of hair, trophic changes, or an unusually dry skin, an oily material such as olive oil or white vaseline is indicated. The virtue of massage lies not in the lubricant but in the manual dexterity employed.

Muscle cases.—It is essential that a paralyzed limb should not be allowed to lie in a position in which the affected muscles are stretched, allowing the undisputed antagonism and possible contraction of the opposing healthy muscles. A normal, healthy muscle, even when at rest, is in a condition of slight contraction in order to respond instantly to an impulse. This condition of "tone" is absent in a paralyzed muscle. Paralyzed and weak muscles are kept from being stretched and elongated by a support applied to the affected limb. For example, a hyperextension wrist splint is worn in a case of musculo-spiral paralysis, a rectangular foot splint where the flexors of the ankle are weak, an abduction shoulder splint for a paralyzed deltoid muscle. The necessary massage can often be done in these cases without removing the supporting splint, but when its removal is essential the limb must instantly be passively supported by a pillow or sandbag as the splint is withdrawn to prevent any stretching of the affected muscles.

Heavy tapôtement, or percussion, movements should never be performed upon paralyzed or wasted muscles, as the attenuated muscles and weak nerves are

easily injured. The gentlest pétrissage, or muscle kneading, should be used, increasing in vigor as recovery proceeds.

Pétrissage is best performed with the muscles or group of muscles in a relaxed and supported position. To illustrate this, when working upon the extensors of the forearm, the patient's wrist should be "dorsi-flexed," with hand and fingers supported on a sandbag to secure relaxation of the muscles. In the case of the flexors of the forearm, the hand must be "palmar-flexed" to secure similar relaxation. Relaxation of the quadriceps may be procured by placing a large pillow or sandbag behind the knee. A similar pillow will also be found useful to secure semiabduction or semiadduction of the various joints where muscular relaxation is required.

Joint cases.—All passive movements should be performed by firmly grasping the limb just above and just below the joint. The necessary movements are made slowly, gradually, once only, and up to a point just short of giving pain.

Body weight will assist to immobilize the pelvis while the hip joint is moved.

Force is sometimes required to obtain additional movement of a joint, but should only be used when especially ordered by the officer in charge.

Pain, heat, swelling.—Any abnormal condition occurring in a joint such as pain, heat, or swelling should be immediately reported.

Bandages or splints which have been removed during massage should be carefully replaced in the same manner and position as worn before.

Bone cases.—When massaging cases of fracture, bone grafting, or other conditions producing callus, depletion movements should be employed to empty the main veins and lymphatic vessels, especially in that portion of the limb which is distal to the graft or fracture. Increased vascularization and consequently improved nutrition, essential to repair, will thus be promoted.

Tendon transplantation cases.—Encourage active rather than perform passive movements of the particular muscles upon which operations have been performed. Apply careful pétrissage to the transplanted muscle, and friction massage along the new course of the tendons, to prevent adhesions. It is essential that these newly transplanted muscles and tendons should not be stretched until they are able to perform their new functions. Similar precautions must be taken in the handling of these cases as with paralyzed or weakened muscles (see muscle cases).

Functional cases.—Massage of these cases should be accompanied by moral and mental suasion. The patient should be encouraged to think hopefully of his recovery, and be interested in his future possibilities. Try to convince him of the importance of making a real effort to use the functionally weak muscles, and the serious results if he neglects to use them.

Massage before operation—Diagnostic massage.—A course of massage is frequently ordered for cases before operation for bone grafting, tendon transplantations, or nerve suture in which there is old scar tissue near the site of operation. Moderately vigorous kneading should be applied to any fibrous thickening or scar tissue to liberate any latent infection which may possibly be lurking in it, which, if undiscovered before operation, would retard or prevent its success.

Note making.—When making the weekly or fortnightly notes on the clinical progress of a case, vague generalities should be avoided, such as "Patient seems better," or "Arm improved," and the like. Incorporate in a sentence or two a tangible, clear, and concise statement bearing on the progress of the case in the direction of the main object of treatment.

Examples.

The girth of the thigh muscles has increased 1 inch

The left quadriceps reacts well, with the exception of the vastus internus, which is lacking in tone and substance, as compared with the right.

The extensors of the toes show faint voluntary contraction this day, June 1, 1917.

Cutaneous sensibility noted over whole dorsum of hand.

Fingers of the right hand are now of the same color and temperature as those of the left hand.

Active flexion at the elbow is obtained to an angle of 90°, passive flexion to 100°, etc.

Nerve cases.—The lesion may be partial or complete.

A. Muscles: Note the complete (paralysis), or partial (paresis) absence of muscular activity, stating the particular muscle or groups of muscles affected.

B. Skin. 1. Cutaneous sensibility.—Note the areas of the loss of cutaneous sensibility. This is done with a camel-hair brush or with cotton-wool. The patient's eyes should be closed or bandaged while the tests are made.

2. Trophic conditions.—Note the condition of the skin, and state any trophic conditions, whether dull, shiny, or scaly, the presence of any trophic ulcers, etc.

3. Color and temperature.—Describe the color and temperature as compared with the corresponding sound limb, and state whether ischemia or cyanosis is present.

4. Return of power and sensibility.—After all nerve operations note the date of return of sensation to a previously insensitive portion of the skin, or return of voluntary power in a paralyzed muscle.

5. Electrical reactions.—The electrical reactions in nerve cases are periodically examined. Inquire of the officer in charge the results of these examinations.

MUSCLE CASES.

1. Measurements.—Frequently take the measurement of the circumference of limbs under:

Thigh: Seven inches above the upper border of patella.

Calf: Six inches below the upper border of patella.

Upper arm: Six inches above the tip of olecranon process.

Forearm: Four inches below the tip of olecranon process.

2. Muscular tone.—Describe the condition of the muscles with regard to the degree of resilience, firmness, and tone, i. e., their prompt response to a voluntary stimulus, and compare the amount of contraction with the corresponding sound muscle or group of muscles.

Note the absence or presence of spasm or tremor.

To test the power of grip use the dynamometer frequently and record the readings.

JOINT CASES.

1. Freedom of movement.—State whether the movements are free, and if not, whether accompanied by creaking, grating, or clicking. Also, note if the joint is swollen or not. In the event of a click being detected, state at which particular position of the joint it occurs.

2. Range of movement.—Measure the range of movement in the joint which is under treatment at intervals of a fortnight. The anglemeter is used for testing the degree of movement in the shoulder, elbow, wrist, knee, and ankle. State whether the degree of movement obtained is active or passive.

In the case of fingers or toes, state whether one-fourth, one-half, three-fourths, or full normal flexion or extension is obtained.

Ischemic hands and feet and trench feet.—Describe the color, temperature, amount of movement, and degree of pain compared with the corresponding hand or foot.

Any sign of retrogression should be noted at once.

Exercises.—When massaging a limb it is essential to perform full movements at the several joints.

In proportion to the amount of movement at the joints and the muscular condition of the limb, the exercise should, in the early stages, be passive in character; as improvement advances active movements should be practiced and later movements with resistance.

In this way a gradual sequence of passive, active, and resisted movements of the joints accompanies the increased range of movement and improved muscular power.

MILITARY ORTHOPEDIC HOSPITAL, SHEPHERD'S BUSH.

A large hospital, situated in a suburb of London, devoted to the same class of work as the Alder-Hey. The consultants come from the Middlesex and University College hospitals. Each ward has surgeon, physician, and resident. They have additional consultants in eye, nose, nerves, etc., all specialists in their respective fields, who come from London. It is somewhat larger in all departments than the Alder-Hey and is making a special feature of its workshops and splint manufacture. A great amount of apparatus is made here and much repair work is done. "We try to put the men back in their trade if they have any."

Both Sir Robert Jones, C. B., and Major Elmslie, R. A. M. C., who have direct charge, gave me every opportunity to see and to learn.

Major Elmslie said: "We do not use much Carrel-Dakin; we often use hypochlorite solution, twice daily in compound fractures, without typical Carrel. Bipp, flavin, and lately malachite green are employed. We found that scarlet red was too stimulating."

He classifies wounds sutured as:

1. Primary suture.

2. Delayed primary; excise and pack, then suture before granulation starts.

3. Secondary suture; after granulation has taken place.

Method of suture:

(1) Undercut and under-running suture.

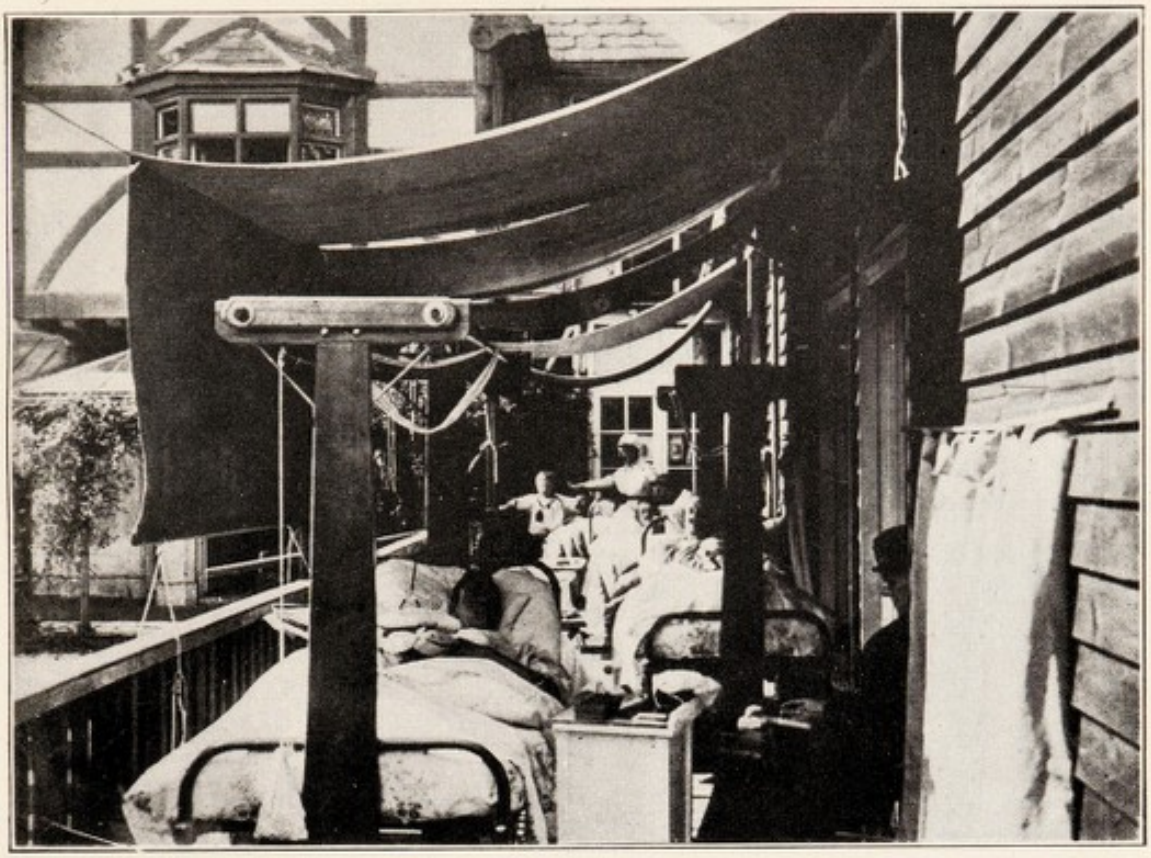
(2) Cut out scar and suture. A disadvantage here is that this means added loss of tissue.

On secondary stumps Major Elmslie advises the cutting away of dead tissue and the rubbing in of bipp.

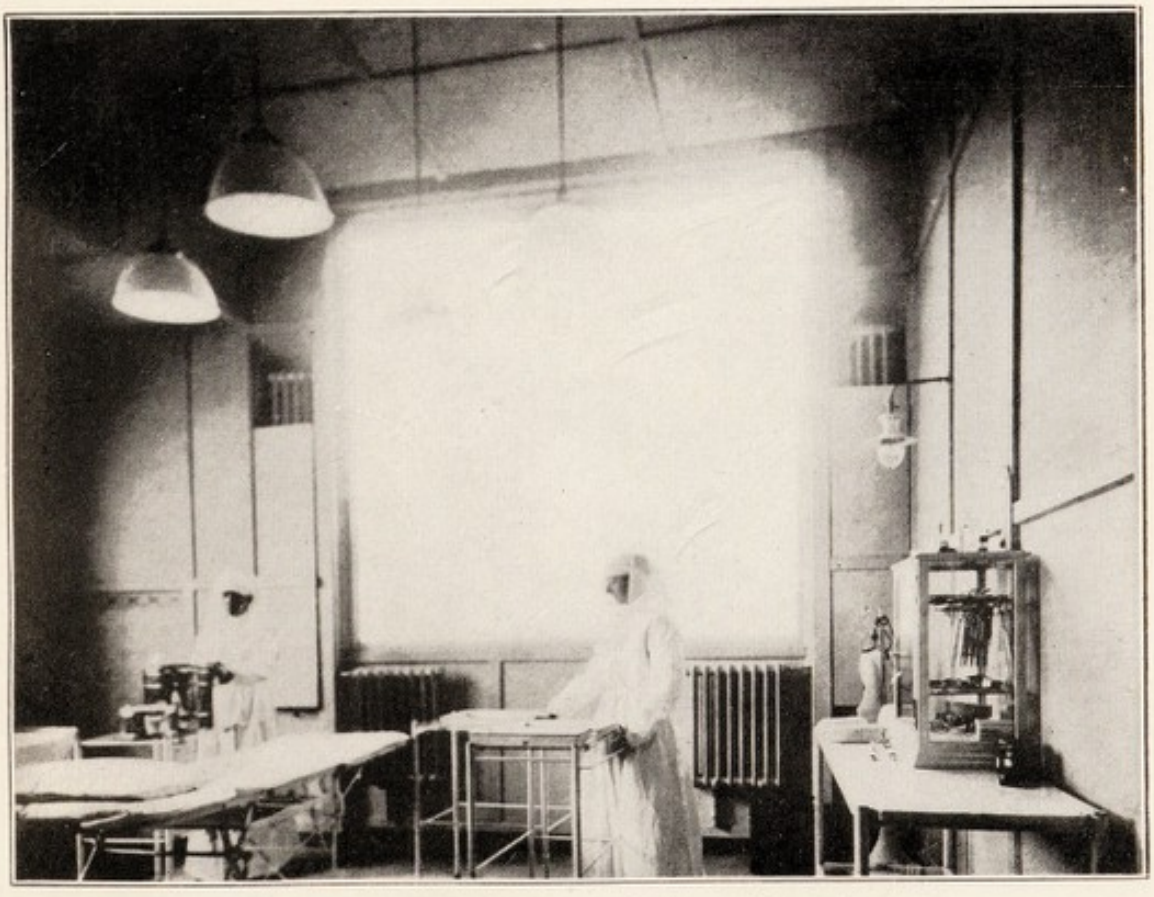
He added: "We use the following method for closing bone sinuses:

"1. Bevel the edges.

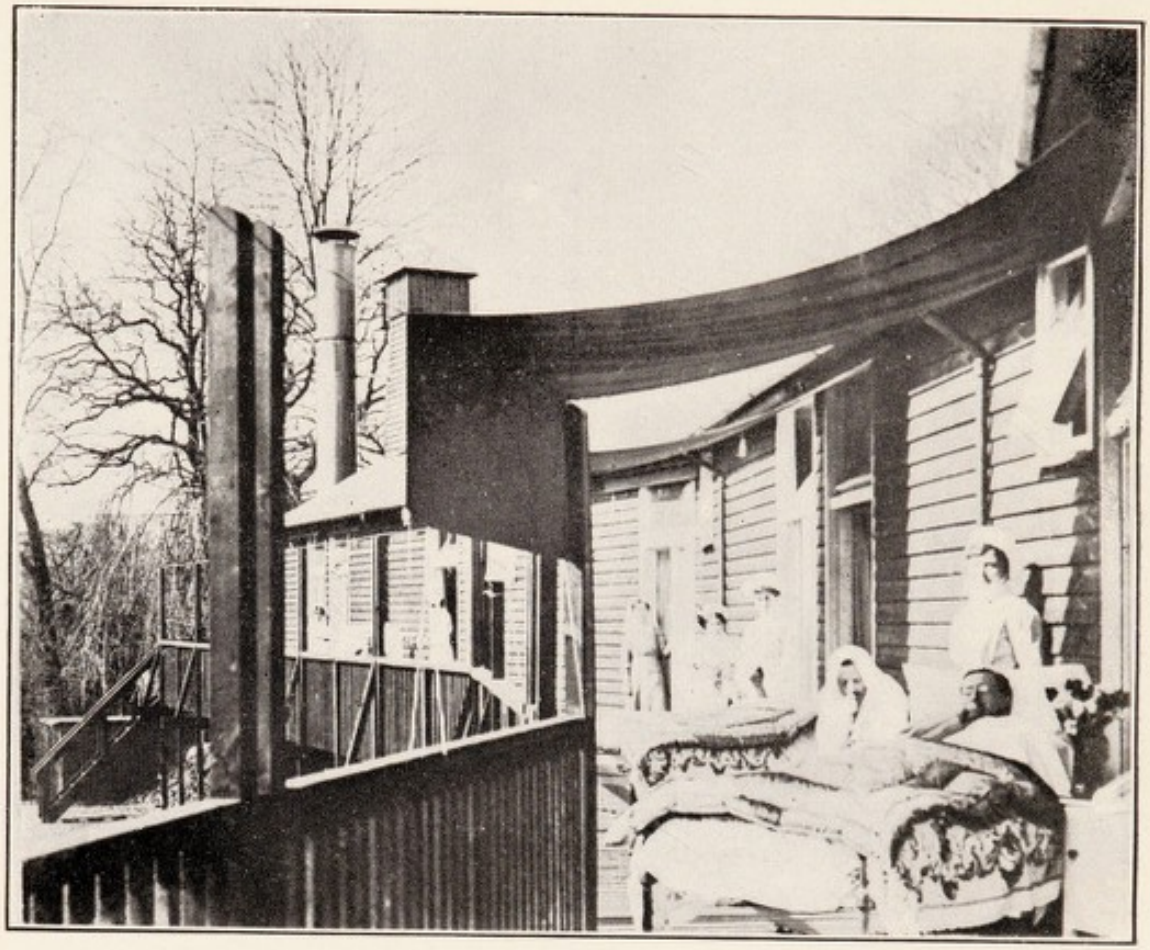
"2. Remove all sequestra and granulation tissue.



Queen Alexandra's Hospital for Officers. Patients on the veranda.



Queen Alexandra's Hospital for Officers. Operating room.



Queen Alexandra's Hospital for Officers. The south veranda.



Matron in one of the rooms of Queen Alexandra's Hospital for Officers.

"3. Place soft tissue, usually muscle, in cavity to fill up defect.

"Gas and oxygen is too expensive for general use. We usually use chloroform, followed by open ether. Gas and oxygen with ether increases the cost over ordinary ether £1 per case. Chloroform is cheapest."

In this hospital they consider Sinclair's fracture work excellent. However, they do not often employ the direct bone traction.

They are looking forward to more work after the war than they are doing even now. For long years to come the crippled and injured must have treatment and many must be supplied with apparatus. There will need to be permanent centers for this work. Years of treatment will bring results which hardly seem possible to-day.

ROYAL VICTORIA HOSPITAL, NEAR SOUTHAMPTON.

(Captain Crowell, R. A. M. C., In Charge of the Surgical Neurology.)

This hospital is beautifully situated on the bay and has accommodations for 1,700 patients. Here and at the British Red Cross hospital at Netley there is much excellent work being done in nerve suture. Captain Crowell has had a wide experience in this field and showed me a number of interesting cases. Where as much as 5 inches of the sciatic nerve has been destroyed, excellent results have been obtained by bending the leg for some days after suture, then gradually extending. In the arm, where there has been a loss of some inches of an important nerve, a section may be cut from the humerus and the severed nerve ends brought together without weakening the extremity.

I saw some cases in which this procedure had been followed and found that the muscles and tendons had contracted and there were excellent functional results.

The long time required for convalescence was emphasized, and the wisdom of making this clear to the patients in the beginning in order to save disappointment later was urged.

QUEEN ALEXANDRA'S HOSPITAL FOR OFFICERS.

(An example of improvised hospitals in private homes and estates.)

In Great Britain many wealthy people have shown their patriotic zeal by offering and wherever possible equipping their homes and estates in the country for hospital purposes. In consequence numerous small private hospitals have been established amid the most beautiful and healthful surroundings. A similar condition is likely to develop in the United States, as on every side there are those who

are ready to offer their homes for the use of convalescent soldiers and sailors. According to reports, we are soon to have scores of such places in various parts of the country, but the desirability of this is a mooted question.

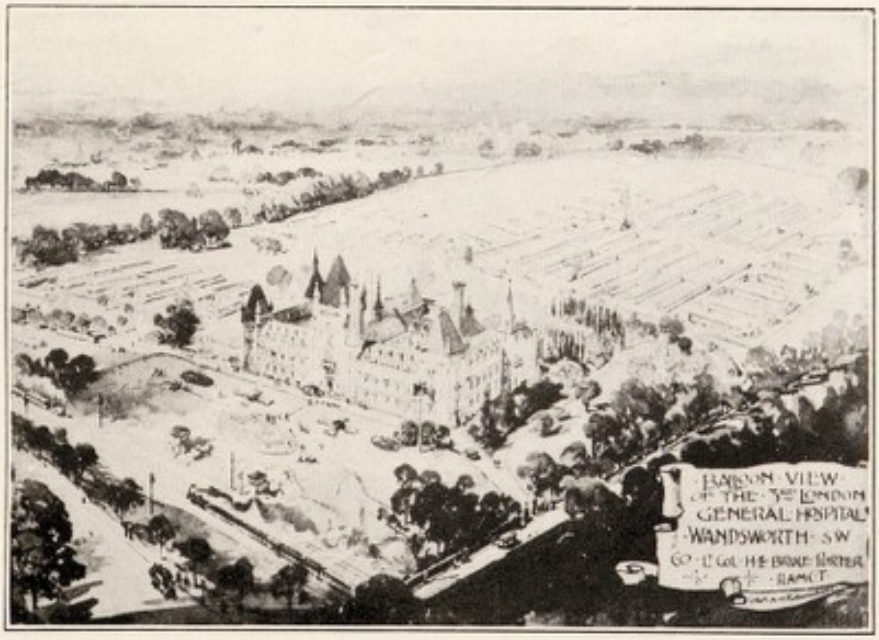
In England there are strong advocates of this system—those who maintain that the small hospital, beautifully located, with everything to take the minds of the patients from their injuries and the terrors of war, tends to shorten the period of convalescence, and that the results altogether are better than those obtained in large institutions, especially those in metropolitan districts.

A very successful hospital of this type, which has received much flattering comment and attention, is Queen Alexandria's hospital for officers, at Highgate. It is surrounded by some 3 acres of private grounds, is 300 feet above sea level, and adjoins Parliament Hill Fields and Hampstead Heath, which, with their 400 acres of open country, supply the patients with an abundance of fresh air. The old house on the grounds has been remodeled. The one-time drawing room is used as a ward; the adjoining winter garden as a smoking and sitting room. The hospital proper, a new wooden building, is connected with the old house, and contains the wards, operating theater, sterilization room, ward kitchen, X-ray room, sanitary annex, kitchens, and scullery. As this building is considered temporary and for use only during the war, it has been constructed as economically as possible, with due regard to efficiency. It is built on a foundation of wooden piles and in shape is like a modified Y, this form being adopted so that each ward would obtain the maximum amount of sunshine; in a day of 10 hours' sunshine, each ward obtains about 8 hours of it. Although everything has been kept plain and simple, the equipment is very complete. There is an adequate X-ray installation and an operating theater. The wards open on a broad verandah and the French windows are wide enough to allow the beds to be wheeled outside; even the worst fracture cases can be moved into the open air, and many patients sleep out of doors when the weather is suitable. The administration offices are located in the original house, as well as the matron's sitting room and bedroom, a sitting room for the nurses, the nurses' bedrooms (each nurse having a room to herself), and the maids' dormitories. There is a tennis court on the grounds for the use of the staff. The hospital has a total of 55 beds available for patients.

The honorary surgeon in charge, Mr. Herbert J. Paterson, M. C., M. B., F. R. C. S., frankly admits that he has here made use of many points which he gathered on his visits to the United States. He states very positively that he has come to the conclusion that "treatment in pure fresh air, amid quiet surroundings, means a lessening of the stay in hospital by at least 30 per cent. In other words, if in



Queen Alexandra's Hospital. Officers on the south veranda.



General Hospital, Wandsworth.

the case of a patient in a London hospital 100 days' stay would be necessary, about 70 days only would be necessary in a similar case under treatment amid country surroundings."

On the other hand, there are those who are very strongly opposed to the small hospital plan. They consider it poor economy, unnecessarily expensive, and that it tends to prolong convalescence, and favors "indolence in the lap of luxury." In fact, one of the leading members of the British war medical council said to me recently: "It is a great mistake to have these small hospitals; they demilitarize, they are a waste of money, and they do not allow of uniformity of treatment and efficient supervision." There are others, however, who believe that, with proper supervision, these objections can be eliminated and the benefits secured.

FIFTH LONDON GENERAL HOSPITAL.

(Formerly St. Thomas Hospital.)

Major Edred M. Corner, R. A. M. C., who is connected not only with this institution, but also with King George's Hospital, has been in active service for nearly four years. I requested him to epitomize the experience of himself and his assistants in war surgery, and he has done so as follows:

In many ways the war has changed the practice of surgery. For simplicity's sake the question should be divided for the consideration of those abroad and of those at home. Some surgeons have been sent abroad and some kept at home to treat such cases as are returned. In times of stress patients can not be kept in hospitals abroad but have to be sent home quickly. In consequence, far the greater part of surgery is done at home. All preparations must be made for that.

The war practice of surgery should be divided up into immediate and remote surgery.

Immediate surgery is practiced near the front. Its first and foremost consideration is infection. Many methods have been elaborated for combatting infection. All do well in the hands of their promoters and of enthusiasts, but none do well when carried out perfunctorily. Thus many antiseptics have gone or are going to the land of the forgotten—flavine, proflavine, hypochlorite, peroxide, etc., have had their day. All are successful if used well. It is not the drug but the dresser who does the good. Carrel taught us a great technique for cleansing the inside of the wound. It will ever remain with us. It will do well so long as the dressings are not left to the nurse in charge.

Antiseptics used at first help the patient at the beginning of his illness when he most wants help. Hypertonic saline can be used later when the patient is fit enough to be stimulated to help himself. Antiseptics may thus be abolished, but they will always help at the commencement.

Excision of the wound is excellent when the wound and the infection can be excised. It is of limited application and if used on a grand scale may inflict as much or more injury than the wound.

The great keynote for the immediate treatment of a wound is, firstly, use antiseptics, remove all foreign bodies and damaged tissues from the wound; later use hypertonic saline.

Immediate surgery has improved in many technical directions. Abdominal injuries are operated on as soon as possible. So are joint injuries and thoracic injuries. The same principles are employed and the wounds cleaned and closed. Enormous improvements have resulted.

Remote surgery means the surgery after the wound has healed. It consists of the excision of joints, amputation surgery, nerve suture, face surgery, jaw surgery, and so on. Its practice is colored, as is immediate surgery, with the possibility of infection. Even when a wound is healed, infection may lurk within its depths and may convert surgical success into failure and disaster to the patient. Therefore one never hurries before starting constructive surgery. A course of treatment with heat and mechano-therapy is an excellent thing before attempting constructive surgery. Just as the results of infection color the whole of immediate surgery, so the results of infection affect remote surgery. Let me quote only one case in which I grew micro-organisms from the nerve endings over three years after an amputation wound had healed and remained healed. To make the difficulties in the way of satisfactory remote surgery greater, I have a specimen of a nerve regenerating and neuratizing an infected coagulum. This is sufficient to say that the great surgery in the remote period is limited. The infection may get less and weaker as years go by. the body chemicals slowly winning. Hence, more and more can be done in the way of constructive surgery as time goes by. Thus we find in remote surgery the springing up of special technicalities, surgery of the face, the surgery of bones, amputations, and so on. It is part and parcel of what I have termed remote surgery to prepare a man to return to civil life and work. Orthopedic centers throughout the kingdom have sprung up and are doing great work. In fact, there is perhaps no department of remote surgery which has made greater advances and which has greater work.

Personally I have more conversance with amputation stumps and their troubles. These are quite typical of war scars elsewhere. The improvement in artificial limbs is often so great that it reintroduces the question of not deferring an amputation under certain circumstances. Certain operations have been condemned. The Chopart amputation should never be done, similarly the Pirogoff. Both have given way to a Syme's amputation. But the present artificial foot, which is fitted on to a Syme stump, causes more expense (socks, trouser, etc.) than does the amputation through the leg. Hence, we are likely to see more and more amputations just below the seat of election. These men walk practically as well as ever, provided the details and technique of the amputation are carefully performed. All through-knee amputations are gone, and an amputation through the lower third of the femur holds sway. Amputations about the region of the femoral trochanters are gone, because such men walk badly and less far than after an amputation through the hip joint. The artificial limb for an amputation of hip is a sound, practical apparatus. An amputation of the shoulder joint is popular on similar grounds. Amputations leaving behind the tuberosities are unpopular with instrument makers. In these cases the surgeon is merely the fashioner of the stump which is to be made useful by the instrument maker. The amputating surgeon is indirectly only a means to the end. The instrument maker is the direct means to the end.

Behind all, and clouding all results of remote surgery, is neurasthenia. This war has shown neurasthenia as it was never seen before. All our present patients have undergone many emotions, heard many hospital tales, seen men

die, have laid out wounded and been carried in, and so on ad infinitum. All are neurasthenic in degree, and, as time goes on, this will be found an increasing obstacle in returning men to civil life. It has always to be calculated on.

To recapitulate: The outstanding features are:

Of immediate surgery: Infection; technical advances in abdominal and joint wounds.

Of remote surgery: Orthopedic surgery; technical advances such as in facial, joint, amputation surgery, nerve surgery, etc.

Neurasthenia is the ill which pervades the results of all injuries.

Major Corner added:

The recommendations that I would make to those surgeons doing the amputations are:

1. Let technique be as surgically clean as possible. Much harm results from "lighting a fire" in a wound.
2. Use only absorbable sutures.
3. Cut all nerves as short as possible, using the "swing-door method" to close their mouths.
4. Cut all vessels short, as by them is the greatest channel for the spread of infection. By cutting them short "the door is closed."
5. Drain temporarily all amputation wounds, using a large tube and at least one.
6. Start the Carrel-Dakin treatment at the time of operation in dirty cases.
7. In clean cases close the deep wound with a few catgut stitches.

HYDE TERRACE HOSPITAL AT LEEDS.

(General Sir Berkeley Moynihan, K. C. M. G., C. B., Chief Surgeon.)

While an active member of the British Medical Advisory Board, Sir Berkeley Moynihan is also chief surgeon at the Royal Infirmary at Leeds (a large hospital given over in part to the care of the war wounded); and, in addition, finds the time to do a certain amount of private work in his own hospital at 9 Hyde Terrace, which I visited in his company.

In the treatment of war wounds, he advocates:

1. In cases received within 8 or 10 hours after injury (which is the period of contamination rather than of spreading of infection) thorough mechanical cleansing and excision followed by primary closure.
2. In infected early cases, mechanical exposure and cleansing followed by either physiological or antiseptic treatment directed to the removal of the remaining infection, and aimed to permit of the earliest prudent secondary closure of the wound.
3. In infected late cases, thorough mechanical exposure and cleansing, followed by immediate secondary closure if certain antiseptic pastes are used.

In certain cases of infection, while admitting the favorable results frequently following the use of antiseptics, he is strongly of the

opinion that "the natural defenses of the tissues already awakened are ample to deal with the infections then remaining."

As to the Carrel-Dakin treatment the conclusion which he apparently has reached is that the excellent results obtained are in large measure due not so much to the antiseptic value of the Dakin fluid as to the general care of the wound involved in the application of the Carrel technique.

> It is the natural defensive powers of the body fluids and tissues, of serum, and leukocytes that are the chief agents in finally subduing the bacterial infection in a wound. * * * Full emphasis must always be laid on the paramount necessity for the complete immobility of wounded parts at all times and on all occasions.

He points out that early in the war in treating joint wounds drainage tubes were almost universally employed, but that "there can be no longer any doubt that any form of tube introduced into the joint cavity in the early cases is productive of nothing but evil."

He said: "You in America will want to get your convalescent cases home. It is better to have them among their own people, better for the men, and good for the community to care for them and see the actual evidence of the war. It brings home to the people the facts. It is bad to have small, individual places care for the men who are to be returned to service, as it demilitarizes them and disturbs treatment. Of course, the question of feeding these patients over here is a serious one, and with the empty ships returning to America doubtless many of the convalescent will be sent home early."

An interesting matter of routine at Hyde Terrace, to save the eye strain of the operating force, is the employment of black sheets over the patients and dark-colored pads and red towels for the soiled instruments.

THIRD LONDON GENERAL HOSPITAL.

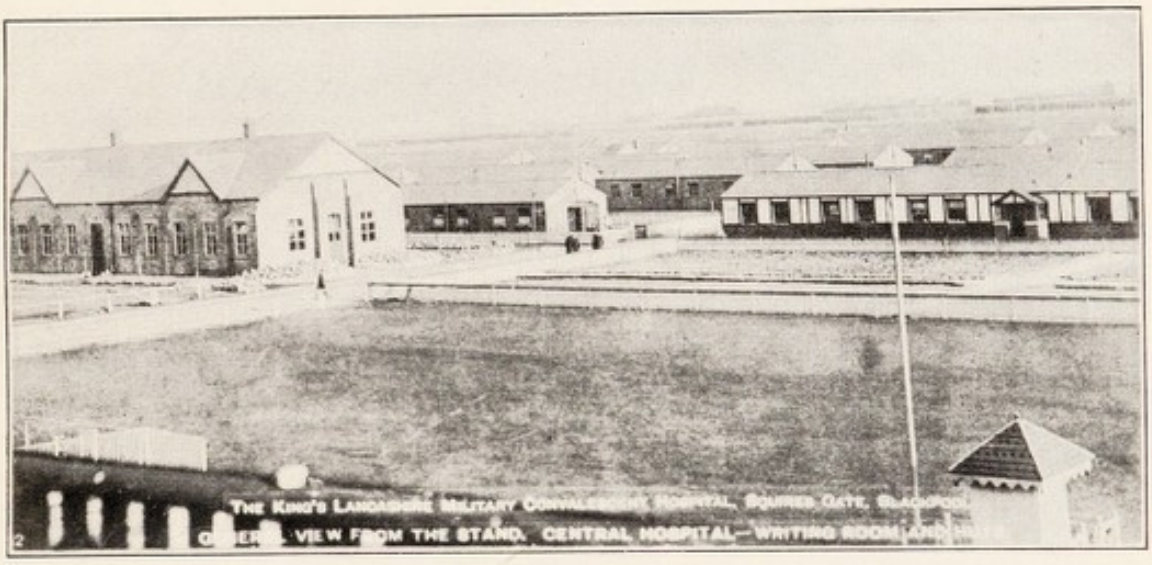
(Lieutenant Colonel H. E. Bruce-Porter, R. A. M. C. T., Commanding Officer.)

Located 5 miles from Charing Cross Station, at the time of my visit, this hospital was caring for 1,440 officers and 500 more patients. There are 30 acres of ground, with flowers and trees, and the location is excellent. In fact, this institution seems as nearly ideal as possible; no noise, no confusion, no odors. Stress is laid on the importance of harmony throughout all departments.

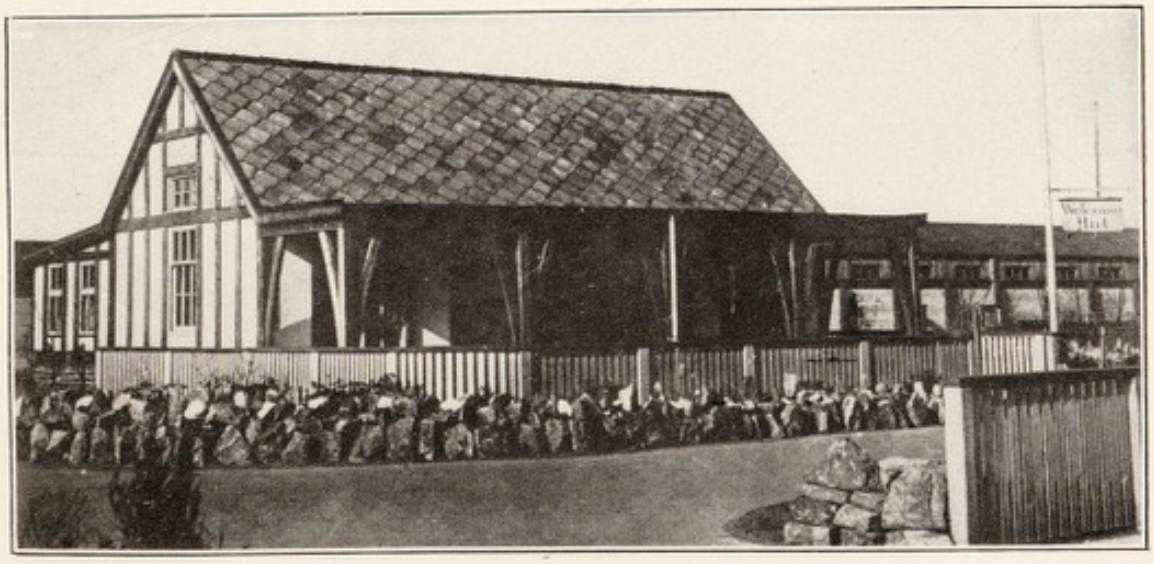
The whole atmosphere is that the patient comes first. All the patients are known and addressed by name. Colonel Bruce-Porter said: "An institution is a failure if the human side is left out. The official side alone squeezes out the human and the result is failure." The bath house is always open so that a bath may be had at any time.



Third London General Hospital, Wandsworth. Massage and electricity



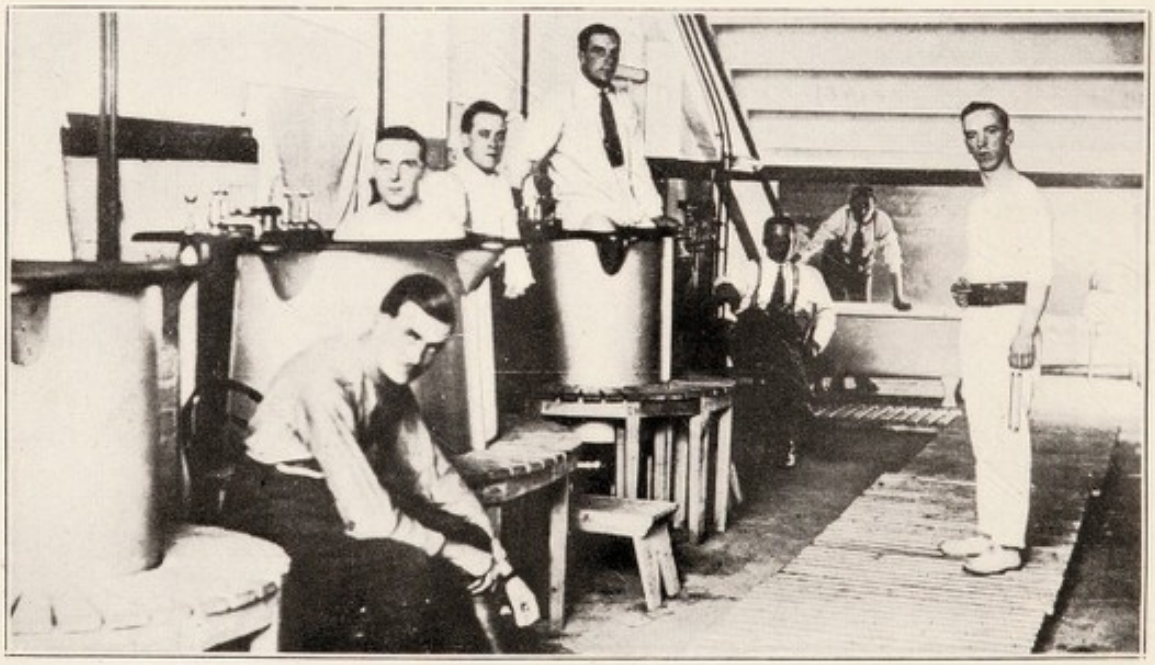
Convalescent Hospital, Blackpool.



Welcome Hut, Blackpool.



Interior of a hut, Blackpool.



Hydrotherapeutic: Whirlpool bath. Blackpool.

Every effort is made to eliminate the military aspect, and a feeling of fraternity and good will prevails. I heard a totally blind cavalry officer cheering up some others, saying: "We are not so badly off as those who have always been blind, for we know what things look like." Notices are not given in the form of orders but appeal to the reason. "These men are from the battlefield. Don't say 'must!' Don't drive!"

There are several types of ward huts here. In each an essential is that there be plenty of light and air, and there should always be a ward room or two for very bad cases. No patient should die in a ward. (This is a matter which is often neglected in the construction of civil as well as of military hospitals. Of course, under conditions at the front, it is frequently impossible to have such provision, but in a base hospital wherever possible it should be arranged for.)

All this has a far-reaching practical value and should be regarded *not as sentimentality but rather as psychotherapy.*

Sun and air are considered very important in bad septic cases. Through the generosity of his friends, Colonel Bruce-Porter has had erected a number of open-air shelters, each a unit for one patient and nurse, revolving to the sun. Those in use are giving such satisfaction that more will be added. They are cheap and made of wood.

He said: "In an institution like this there should always be a special fund at the disposal of the commanding officer. There are a thousand and one little things needed, and one should not be compelled to wait for official machinery. With a fund things go along well. I am always begging for my boys."

He also added, "My advice is to mix the men in the hospital. Put the Americans in with our men and those from all parts of the empire. This will result in better understanding all through. In the field this is not so easy, of course, for the men are brigaded together. By mixing in the hospitals they make friends, upset old antagonisms, and thus stimulate immigration and future trade."

There is a most remarkable system of conservation in effect here. Nothing is wasted. All bones are used for soup. Even the small pieces of bread left on the plate and the grease on the platter are used. By giving small portions little is left. The patients understand that they may have more and as much as they want. I examined the swill for 24 hours from 2,400 people—all in one small cart drawn by one horse—practically nothing that was usable.

Sir Alfred Pearce Gould is the senior surgeon. Every case requiring amputation is seen by him and he makes the decision; his is the responsibility. He decides and directs. Any serious medical case must likewise see the chief medical consultant.

Under the excellent system now in operation the British Army and Navy hospitals in and near London are enabled to have the benefit of

the services of such leading specialists as Sir Alfred Pearce Gould, Sir Watson Cheyne, Bart., Sir Arbuthnot Lane, Bart., Sir John Bland Sutton, and many others, while the general public is not entirely deprived of their expert knowledge. These men are commissioned and on active duty in the mornings at the several hospitals to which they are assigned, directing, operating, and advising. Each is placed in charge of that branch of work in which he is a master. In addition, a number of prominent specialists are devoting half of their time to inspecting the professional work in the hospitals, going from one institution to another as consultants, with sufficient Army or Navy rank to insure that their suggestions carry weight. Thus many of London's leaders in surgery and medicine in the various branches who are not at the front are doing a great work for the Army and Navy, while at the same time those at home are not deprived of expert advice and help in time of need.

This plan has proved most satisfactory and has resulted in uniformity of methods and a higher standard of efficiency, and a number of other centers have adopted the same plan.

It must not be thought, however, that this system was evolved without lessons having been learned from hard experience. Early in the war the British were confronted with such chaotic conditions in the assignment of physicians and surgeons that one would find, for example, a laparotomy being done by a general practitioner, assisted by an eye, ear, and throat specialist, while the anesthetic was given by a recognized leader in the field of abdominal surgery. Excellent orthopedic surgeons were given clerical work and an abdominal surgeon of international reputation was assigned to purely medical work. These and scores of similar instances were cited to me by those who were acquainted with the conditions prevailing. The situation finally became so serious that chiefly through the initiative of Sir Almroth Wright, the matter was taken up and the existing evils largely corrected.

May it not be that we stand in considerable danger of repeating the unfortunate experiences along this line of the British? Unfortunately, the bestowing of high rank frequently takes a surgeon out of active work in his own line and places him in a purely administrative position where his particular ability and skill are more or less wasted.

Of course, in the rapid expansion of our military forces, there is bound to be a certain amount of maladjustment, and instances of it in both our Army and Navy could be cited. Nevertheless, before there is an unnecessarily great wastage of talent and ability, might it not be well for us to take a leaf from the book of experience of our allies and make sure that there is a proper relation, at home as well as abroad, between the surgeon in the hospital and his task? It

would also seem to be the counsel of wisdom, in view of the heavy drafts being made upon the medical fraternity, that we take immediate steps to procure for the war hospitals here the benefit of the services and advice of such specialists as are available for part-time duty, without depriving the general public of their assistance in time of need.

MILITARY ORTHOPEDIC HOSPITALS.

It is to the conservative trend of modern surgery, more perhaps than to any other factor, that the development and extension of the field of orthopedics at this period of medical history is to be attributed. Made familiar by experience with the protracted suppurations of tuberculosis and osteomyelitis, and having learned the lesson that patience and perseverance often win the day in the face of apparently insurmountable obstacles, the orthopedic surgeon is as it were predestined to make the best of well-nigh hopeless conditions resulting from the traumatisms of "civilized" warfare. Amputations and mutilations of many kinds are often avoided through a timely recourse to orthopedic methods of treatment, which at the same time help to prevent or minimize the bodily deformities and functional disablement of the wounded. The wide scope of military orthopedic hospitals is suggested by Calot's statement (Orthopédie de Guerre, Paris, 1916) that two-thirds of the wounded brought to the first-aid stations fall within the domain of war orthopedics, including those who have suffered wounds of the bones, joints, muscles, tendons, nerves, or vertebræ; for injuries to all portions of the locomotor apparatus properly belong to the orthopedic surgeon. Military orthopedic hospitals are charged, furthermore, with the care of nine-tenths of the cases of war invalidism or infirmity, in the form of deviations, shortening, stiffness, ankylosis, paralysis, or loss of power, all of which conditions are subject to improvement through the therapeutic measures employed in these hospitals, such as massage, electrotherapeutics, mobilization, reeducation, and equipment with suitable prosthetic apparatus. It is generally conceded that the selection of the permanent prosthesis is perhaps best carried out in the orthopedic hospital, whereas the fitting of the immediate prosthesis should be left in many cases to the operating surgeon.

Military orthopedic cases are held by the British Army council to include the following:

(*a*) Derangements and disabilities of joints, simple and grave, including ankylosis.

(*b*) Deformities and disabilities of feet, such as hallux rigidus, hallux valgus, hammer toes, metatarsalgia, painful heels, flat and claw feet.

(*c*) Malunited and ununited fractures.

(*d*) Injuries to ligaments, muscles, and tendons.

(*e*) Cases requiring tendon transplantation or other treatment for irreparable destructiton of nerves.

(*f*) Nerve injuries complicated by fractures or stiffness of joint.

(*g*) Certain complicated gunshot injuries to joints.

(*h*) Cases requiring surgical appliances.

These cases naturally fall into two groups—those whose disablement is only temporary and who after treatment will be fit for military service again, and those who are so disabled that they must inevitably be discharged from the Army or Navy.

The wounded soldier receives immediate treatment in a general military hospital. If his case should come in the category of orthopedics, as defined above, he is then transferred to one of the orthropedic centers for special treatment.

If his disablement has been only temporary, he may be sent for aftertreatment to a command depot until ultimate recovery and return to military duty.

Colonel Sir Robert Jones, in an address delivered before the Hunterian Society on January 2, 1918 (reprinted in the Brit. Med. Jour., Jan. 12, 1918), classes the conditions which, taken together, create an orthopedic case under the following heads:

1. The mechanical injury to bone, joint, muscle, or nerve.
2. The atrophy and disease of these structures primarily due to the injury.
3. Incoordination of movement due to disease of the brain, a result of atrophy and disease of peripheral structures.
4. Psychological conditions which can be overcome by reeducational processes.

Mechanical-therapeutic aftercare of soldiers whose wounds have healed and whose condition has become stationary falls within the domain of the modern military orthopedic hospital. Another important sphere of usefulness lies in the relief and prevention of certain conditions which impair the fitness for service of unwounded soldiers; for example, flat feet and painful heels.

The most gratifying results have been obtained by the special methods of orthopedic surgery in a remarkably large number of war casualties, sometimes estimated at more than half of all wounds. In recognition of this fact, England has been particularly active in establishing and constantly adding orthopedic centers with an experienced operating staff and up-to-date surgical appliances of all kinds. On January 1, 1918, there were 16 orthopedic centers in Great Britain and Ireland, containing close upon 15,000 wounded; and of the men treated in these centers 75 per cent are eventually returned to the army. As types of the best of these institutions, which are distributed over various parts of the country, the assistant inspector general selected the military orthopedic hospitals at Shepherd's Bush, London W., and Alder Hey, Liverpool, the latter being the first orthopedic center established, having been started by Colonel

Sir Robert Jones with 250 beds. I visited these two, as well as others, some of which are especially mentioned.

The Shepherd's Bush Hospital is considered the headquarters of military orthopedics in the British Isles. The total accommodation for patients at present is 1,200 beds. Four auxiliary houses near by, run on the barracks system, receive convalescent patients. The officer in charge is Major Walter Hill, and the registrar is Captain Picton Phillips. The surgical staff of the hospital is large, and has recently been increased by the appointment of several American orthopedic surgeons.

The treatment employed is of a widely diversified character, and the different forms are applied separately or in combination, according to the requirements of a given case. In the introduction to a pamphlet entitled "Organization and Methods of the Military Orthopedic Hospital, Shepherd's Bush" (London, 1917), the various forms of treatment are grouped as follows: (*a*) Operation; (*b*) electrotherapy; (*c*) massage; (*d*) hydro-therapy; (*e*) fixation methods; (*f*) exercise; (*g*) manipulation; (*h*) curative manual treatment in workshops, etc.

The Shepherd's Bush Hospital offers a three months' course of instruction in military orthopedics. A program of demonstrations and lectures has been arranged to cover the whole work of the hospital, so that any one able to attend the whole course will see all the methods in use; but each individual lecture or demonstration is complete in itself for the benefit of those who are able to attend only at particular times. The departments covered include gymnasium and workshops, hydrotherapy, plaster demonstration, massage, and electrical divisions. The time-table shows a carefully arranged sequence of ward classes, operations, demonstrations, and lectures on topics of surgical and orthopedic interest.

The total number of patients discharged from the hospital since it opened in March, 1916, until September, 1917, is 1,737, and of these only 390 were discharged as permanently unfit, 325 were returned to duty, 507 were sent to command depots for further treatment, and 515 to light military employments. The new electrotherapeutic department of this hospital, under Captain W. R. Bristow, gave over 1,600 treatments during three months, and as many cases were treated in the massage department. In the hydrotherapeutic department, opened on July 24, 1916, an average of 79 patients are receiving treatment. At present 120 men are employed in the curative workshops and about 500 in the hospital generally. The new workshops which are being completed will provide places for 100 more men. The courses include engineering, electrical work, metal grinding and polishing, felting, tailoring, fancy leather work, carpentering, photography, art iron work, oxy-acetylene welding, French polishing,

painting and sign writing, metal engraving, coopering, motor-car overhauling, surgical bootmaking and repairing, and splint making. In the last named over 2,500 stock splints were made, and 339 special splints, and in addition, numerous repairs and alterations were carried out. Of 74 men who had passed through the workshops and been discharged from hospital to August 4, 1917, 10 had returned to duty, 35 to a command depot, and 20 to employments, making a total of 65 returned to the Army, leaving only 9 as permanently unfit. This hospital still needs a new operating theater, but when this has been built it will be complete.

The military orthopedic hospital at Alder Hey, near Liverpool, now has 800 beds. An excellent course in military orthopedics is given and a number of American surgeons are receiving instruction while acting as internes, and caring for the patients under the supervision of the British staff. There is also a considerable amount of plastic surgery, especially nerve suture, being done here. It has an annex in the Pilkington Special Hospital for disabled soldiers and sailors at St. Helens, well equipped and under the medical charge of Dr. J. R. Kerr. A hospital at Calgarth, beautifully situated on Windermere Lake, is approaching completion, and will be provided with electrotherapeutic, hydrotherapeutic, and massage departments, also curative workshops. It is planned to operate this as an additional annex to the hospital at Alder Hey.

The Second Northern General Hospital at Becketts Park, Leeds, provides accommodation for 800 orthopedic patients, a number which will shortly be raised to 1,000. It is composed in part of huts, and has two operating theaters devoted to orthopedic work, the one for aseptic operations, the other for surgical manipulations and the application of plaster splints. The curative workshops are nearly completed. New massage, electrotherapeutic and hydrotherapeutic departments and a gymnasium are required. The work at this hospital has been described more in detail elsewhere in this report.

At Oxford satisfactory progress is being made toward the establishment of an orthopedic center in connection with the third Southern General Hospital. Captain Girdlestone is the head of this center, which will provide 250 beds in the base hospital, the Wingfield Hospital, the Radcliffe Infirmary Hut, and a hut hospital about to be built.

It has been decided also to arrange for an orthopedic center at Newcastle-on-Tyne in connection with the first Northern General Hospital in the Royal Victoria Infirmary; the infirmary hopes to be able to use a large area of the town moor (Castle Leases) for the erection of an orthopedic department. In Newcastle also is the Cowen Home for the training of disabled men.

In Scotland there are three orthopedic centers; one at Bellahouston, Glasgow, with 500 beds, under Major Parry; in its curative workshops more than 100 men are engaged in learning various trades. The hospital possesses a fine hydrotherapeutic department and good massage and electrical departments.

The Bangour War Hospital, Edinburgh, provides 500 beds for orthopedic cases; the surgical work is conducted under the direction of Colonel H. J. Stiles, deputy inspector of military orthopedics in Scotland. At this hospital a large permanent hydrotherapeutic department is being erected, but it still requires new workshops.

At Oldmill Hospital, Aberdeen, there are 500 orthopedic beds, under the supervision of Prof. Marnoch. It has three large huts for use as curative workshops, and extensions are contemplated to provide more workshops, a gymnasium, and a hydrotherapeutic department.

At the Military Orthopedic Hospital, Blackrock, Dublin, there are 300 beds, with massage and electrotherapeutic departments and workshops for carpenters, smiths, tailors, and shoemakers, and a lathe house; in addition there are 6 acres of land on which patients are regularly instructed in the principles and practice of horticulture. This hospital, which is under the charge of Major Potter, was opened on May 19, 1917; it needs additional workshops.

The Ulster Volunteer Force Hospital, Belfast, was opened on March 1, 1917, in an entirely new building situated in the grounds of the Queen's University. It provides 194 beds for orthopedic and limbless patients, but the accommodation has proved inadequate. It also stands in need of electrical, massage, and hydrotherapeutic departments.

In this review, which has been adapted from the British Medical Journal, Volume II, September, 1917, page 469, the double function of curative workshops is more than once insisted upon; they are useful not only for the exercising of the injured limb and the training of the men to useful work, but also as a mental stimulus, helping the men to a more active life, both mental and physical.

The Hôpital de l'Océan, in La Panne, Belgium, has been called a wonderful medicosurgical laboratory, where everybody can learn something, and the attention of orthopedists is invited to this admirable educational center, under the direction of Depage. The work comprises orthopedic surgery, post-operative treatment, and the application of prostheses, provisional and pérmanent (Lamy, Paris médical, VII, 1917, page 505). Aside from the Belgian orthopedic surgical department of La Panne, regional centers were officially created in France by the French War Ministry, on June 2, 1916, for the equipment of mutilated allied soldiers with so-called military prostheses, as well as for reeducational training.

Italian orthopedic surgeons are entitled to credit for the performance of amputations, on a large scale, in such a conservative manner as to take advantage of the intrinsic powers of the formerly useless stump. According to recent statements (Popular Mechanics Magazine, September, 1918), this means that a man who has lost a hand, for example, can open and close the fingers of the artificial hand by means of tendons and muscles instead of cords and levers; or, with an artificial arm applied to a stump only 13 inches in length, the man is able to flex the forearm and extend the fingers; voluntary extension of the knee is also possible, etc. The tendon being best adapted for the transmission of muscular contraction, it is employed where possible. When it is missing, muscles must be utilized. The operation can be performed on healed stumps. "The work is known as kineplastics. Briefly, it consists of forming at the end of a stump what is known as a motor flap. This is covered with perfect well-nourished skin of normal sensibility. It is built of such muscular masses, tendons, and tissues as are available, and is of such shape and dimensions as to be suitable as a point of attachment for the hooks, wings, rods, or thongs to be used in transmitting movements of the muscles remaining in the stump to artificial limbs. The motor may be single, double, or multiple, and on this, of course, depends its degree of usefulness."

A single type of motor flap is being extensively utilized in Germany in imitation of the more advanced cooperative work of Italian surgeons and mechanics. The proverbial preparedness of the foe for the world war finds a further illustration in the summoning of German orthopedic surgeons, within the first weeks of the war, to the first-aid dressing stations for the most proficient treatment of gunshot fractures. A large orthopedic institute, known as Reserve Hospital XI, and comprising an orthopedic hospital as well as reeducational schools for invalided soldiers, has been established in Vienna by the military authorities and is under the administration of the Austrian Government. Another large orthopedic hospital is located in Nuremberg, southern Germany, and to this there are attached a number of workshops for reeducational training. Mechanical treatment is employed with appropriate temporary supports for cases of paralysis. German writers emphasize the favorable curative conditions of their hospitals, as illustrated not only by the high percentage of wounded soldiers who can be returned to the front but also by the extraordinary number of gravely wounded men who can be restored functionally to such an extent as to remain self-supporting through appropriate aftertreatment in orthopedic hospitals.

In the United States the organization of a national orthopedic reserve is now being worked out by the orthopedic surgeons of our country, together with detailed plans for an orthopedic base hospital.

As pointed out by Colonel Sir Robert Jones (loc. cit.), "The fact that about 50 per cent of the wounded of this war have received injuries resulting in impairment of locomotor function and usefulness of limbs has brought the importance of orthopedic principles and methods of treatment into a prominence which no one had foreseen."

Our indebtedness to the work of Buzaglo at the end of the eighteenth century for some of the methods reintroduced by Owen Thomas and Robert Jones is commented upon in the writings of McCrae Aitken on Orthopedic Methods in Military Surgery (Lancet, London, Vol. I, 1917, p. 10). An old engraving, dated 1783, shows the abducted position for the treatment of the shoulder and hip, the right-angled shoe, and a splint which is the forerunner of the Thomas knee splint, introduced at the end of the nineteenth century. This is naturally of interest in view of the tracing of immediate wound closure by sutures to the days of our forefathers, as mentioned in another section of this report.

CONVALESCENT CAMPS.

No survey of the care of the sick and wounded soldiers by our allies would be complete without including some description of the work of the two great British convalescent camps—the King's Lancashire Military Convalescent Hospital near Blackpool, and the Summerdown Military Convalescent Hospital at Eastbourne.

After a man has received at a general or special hospital the necessary medical and surgical care, there is frequently a long period during which he is unfit for active service and requires a certain amount of care, and the convalescent camp has been called into existence to meet this need.

The objects of such camps are well expressed by Lieutenant Colonel J. S. Bostock, in charge of the Eastbourne camp:

From the military point of view.—The main object is to obtain a quick return of fit men to the front. The patient is enabled to complete his treatment under medical supervision, and at the same time, to commence his hardening course of physical training, thus materially shortening his period of noneffectiveness.

From the medical point of view.—These hospitals relieve the pressure upon the more expensive beds in ordinary hospitals, as facilities exist for providing minor medical and surgical treatment. Further, in the Massage Institute, cases requiring more or less prolonged periods of massage and electrotherapy can be dealt with. Under these circumstances, from 3,000 to 5,000 cases can be cared for in each hospital.

The essential factor in all cases for transfer to a convalescent hospital is that, at the time of transfer, they shall be "fit to be up and about," able to eat ordinary barrack rations, and to fend for themselves.

It is a link between the general hospital and the military depot. The length of stay varies from two weeks to a year, or even more in special cases, the average stay being eight weeks.

We are finding it necessary to establish convalescent camps for our men, and we should therefore take advantage of the lessons learned by those who have developed this type of institution from its inception to its present high plane of efficiency.

General Thomas H. Goodwin, Director General of the British Army Medical Service, recommended that I visit the two hospitals above referred to, inasmuch as under the leadership of Colonel Netterville Barron at Blackpool, and of Lieutenant Colonel Bostock at Eastbourne, they have reached a standard of excellence which may well serve as a model. Word was sent ahead of my intended visit, and upon my arrival I was made cordially welcome at each place, and every facility was given me to inspect and observe in detail. I came away filled with admiration for what is being accomplished in restoring to physical and mental health those who are sick and wounded, and deeply impressed with the spirit of those in charge, which alone has made such success possible.

The problems confronting those who undertake this work were described by Colonel Bostock as follows:

> While a man is in hospital proper, in "blighty," with nurses and comfortable surroundings, all seems well; but on arrival at a convalescent hospital he recognizes the penultimate phase, and from that moment, with a vista of trenches before him, his outlook on life is a darkened one. And then his rheumatism (it may be) gets a little worse, and the wound, although healed and which had ceased to worry him hitherto, "aches, doctor," and who shall say otherwise.
>
> It is this mental disorder which it must be the care of those concerned to cure. It is one big psychological study, never to be lost sight of or to be unprovided for during the patient's progress in the hospital. It should be the aim so to restore his mentality that he may eventually again attain the high level of the normal-minded Britisher, where he recognizes his duty to the state and accepts the inevitable with good grace.
>
> For this purpose it is essential that a healthy atmosphere and tone should be infused, and it is contended that this can only be done by the persevering and unremitting attention of the commanding officer and his staff. It should be an accepted but untalked of fact that all will after a happy convalescence find their way back to the front.
>
> It is suggested that in some similar institutions concerned in dealing with temporary noneffectives this psychological study is lost sight of. The men, on entering, are confronted with a distant vision of a Hun with bayonet and rifle, and during each successive phase this picture looms larger and larger. Thus, it would appear that the patient's return to the condition of the healthy-minded Britisher is retarded. During convalescence the Hun with the fixed bayonet should be camouflaged and should not be allowed to obtrude; there is time enough for that when the patients return to their reserve units.
>
> An essential part of the convalescent treatment is that the men should be allowed as much freedom as is consistent with their treatment or duties.

Every encouragement should be given to games, recreations, and other pleasurable occupations, and these should be free, or as nearly free as possible. Theatricals, concert parties, etc., should be encouraged, and a wealth of talent may be found among the patients. A band is a sine qua non.

The patient, once convalescent, feels that he has a right to be amongst his relatives, and as this can not be permitted the next best thing is to provide facilities for these relatives to visit him. This can be effected by the provision of a hostel in the neighboring town, where relatives can obtain accommodations at a very low charge.

Colonel Barron's views agree with Colonel Bostock's, and he adds:

Make your camp as beautiful as possible. It is wiser to spend money freely on green banks and flowers than on works by standard authors.

Give free access to amusements outside the camp and encourage decent female society both inside and outside. The more women, the less venereal disease. The craving for feminine society is as natural in a soldier as it is in a civilian. Natural young women, with healthy bodies and healthy minds, are what is wanted.

Convalescents require better officers and noncommissioned officers to handle them than do soldiers in a training camp or depot. The officers need know less drill, but should know more of humanity. A convalescent should be under discipline, but should, as far as may be, be taken away from war and affairs military.

Colonel Barron's attitude toward the subject of venereal disease has created a great deal of discussion. As carried out at the Blackpool camp it is almost unique. The results, however, have been most remarkably gratifying and are certainly worthy of thoughtful consideration.

THE KING'S LANCASHIRE MILITARY CONVALESCENT HOSPITAL, BLACKPOOL.

This was primarily established by private enterprise and later enlarged and taken over by the War Office.

Colonel Netterville Barron, C. O., the presiding genius of the place, was a London physician with a large practice and conducting an electrotherapeutic establishment when he was selected by the War Office to make the experiment of building up this hospital. Success has crowned his efforts, and a model camp has resulted. There is provision for 4,600 beds; 3,100 for noncommissioned officers and privates, 1,500 for officers.

While the hospital is under military discipline, every effort is made to efface, so far as possible, that aspect. Newcomers are met by a sergeant, who greets them informally and conducts them to the "Welcome Hut." Here they are given tea, coffee, or cocoa and other refreshments by the staff of women volunteers from the locality, and then are assigned to their quarters. The barrack-like appearance of the camp is relieved by beautiful lawns, flower gardens, good roads, and green sward of the bowling grounds and cricket field. A 30-

acre farm under cultivation on the outskirts of the hospital gives the men exercise, and is a financial success as well. There is a well-equipped writing room, with free stationery, recreation and billiard rooms, and a large gymnasium with a stage for use in theatrical performances. A small hospital is provided for the care of the sick, but all surgical cases are at present transferred. It is expected soon to have a small surgical adjunct, so that in the occasional cases which require operation the men need not be removed from the camp. No cases of total incapacity are sent here, but only such as are expected to be made fit to return to military duty or to civil life.

The men are classified according to their physical condition, and the section in which they belong is indicated by a colored arm band. "Bands about the arm tell which section they are in and therefore we know how much they can do and what they should be at."—*Barron.*

In addition to general medical care and surgical dressings, the treatments include remedial exercises, electrical massage, apparatus work, psychic analysis, etc. Whirlpool baths are used and are commended where nerve endings are involved in a scar and as preparation for massage, but Colonel Barron thinks if this bath is to be used at all, there must be a cooling-off room to avoid taking cold.

An original and highly successful type of apparatus in use here is the special flat-foot ladder designed by Colonel Barron. Pictures of this ladder and of a few examples of the results obtained have been furnished by him and are reproduced in this report. His records show that, after 20 to 30 minutes' exercise each day for three weeks, practically every case of flat-foot has been cured. Wherever men are taken from sedentary occupations and given training which requires that they be on their feet for hours at a time and doing heavy work, tired arches and flat-foot are common developments. Therefore, every Army and Navy training camp could well be equipped with this device. Moreover, its use may well be extended so that hereafter it will be found in every gymnasium in civil as well as in military centers.

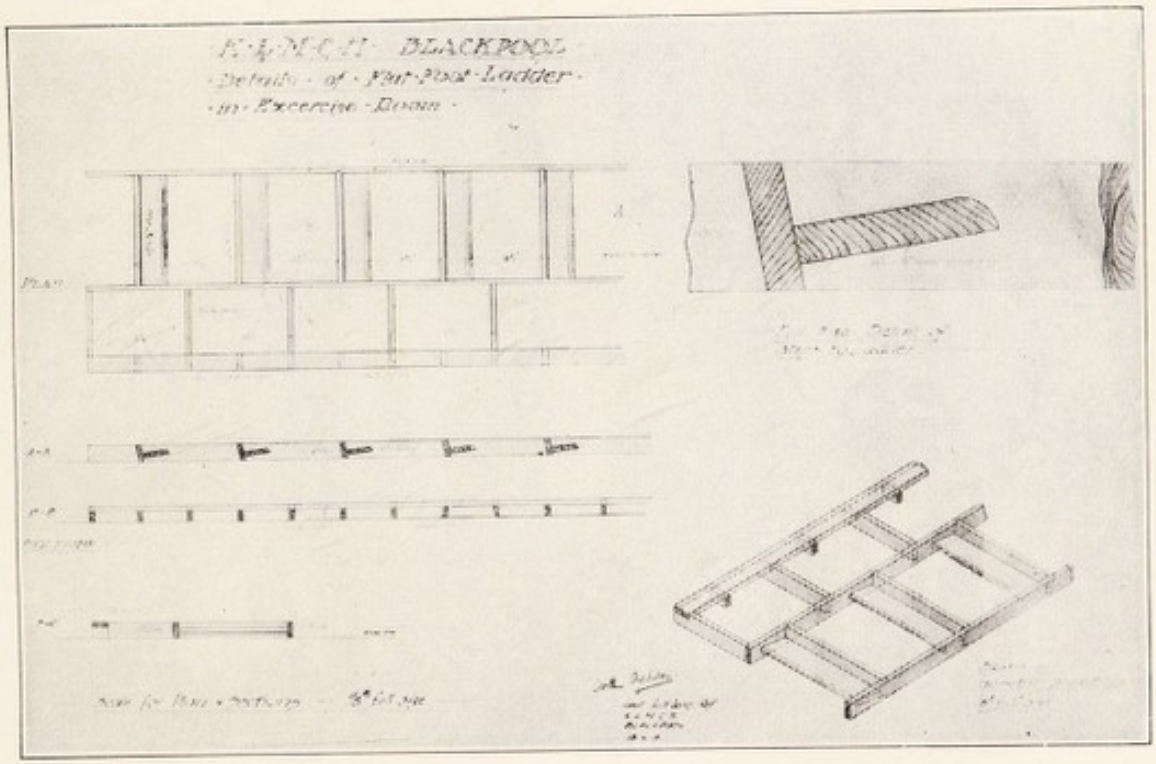
There is a wonderfully well arranged chart record room where the daily doings of the hospital are analyzed and charted and statistics compiled, and here also free railroad tickets are issued for relatives to come and visit the boys, or half-fare vouchers for those in better circumstances.

For a few months Colonel Barron kept a so-called blacklist, upon which were charted such diseases as are established to be preventable by care and the number of cases of each counted against each battalion in the British Army in France. The labor involved in compiling it, however, grew to such proportions, and the private funds from which it was kept up having been exhausted, the scheme was

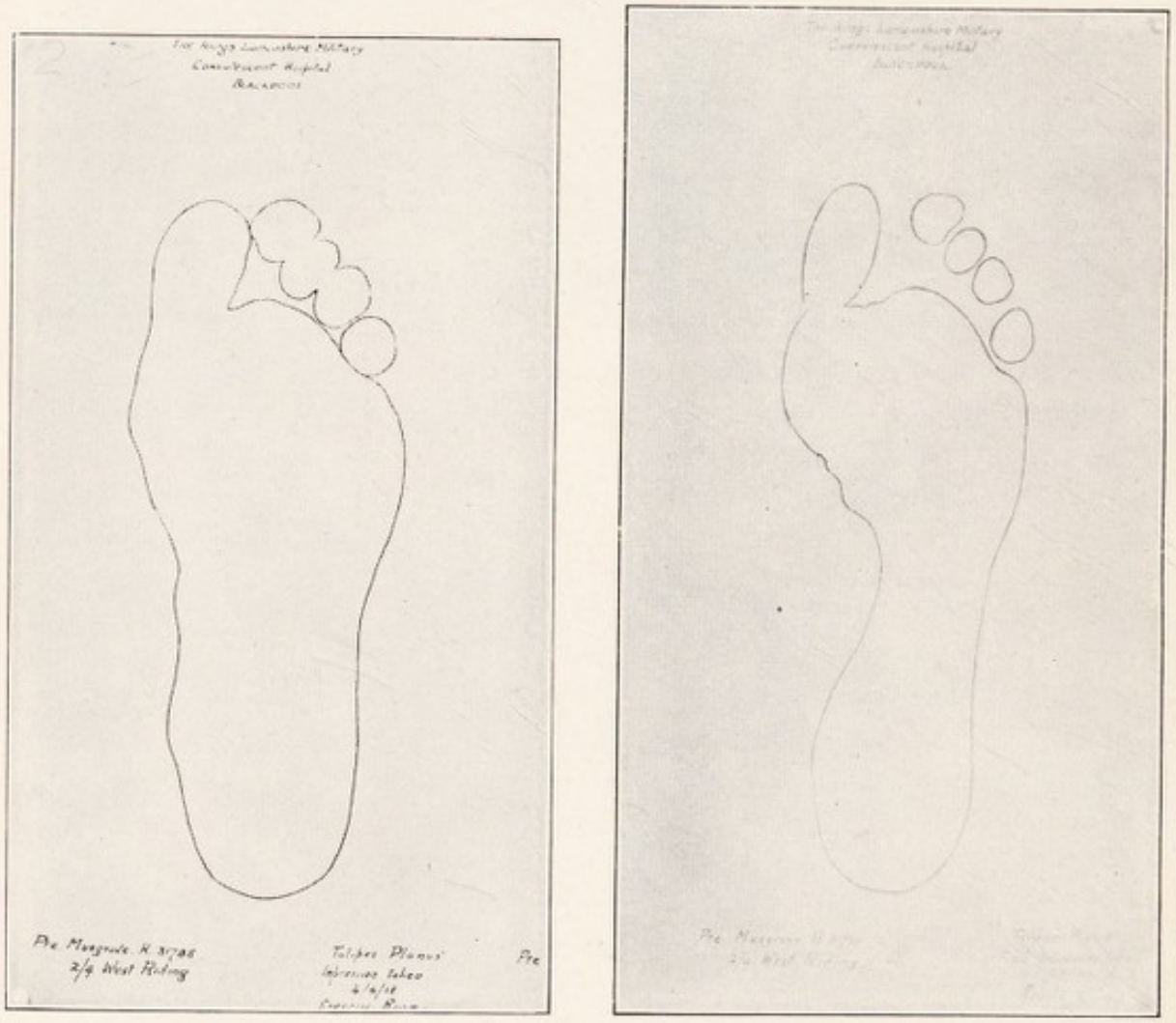
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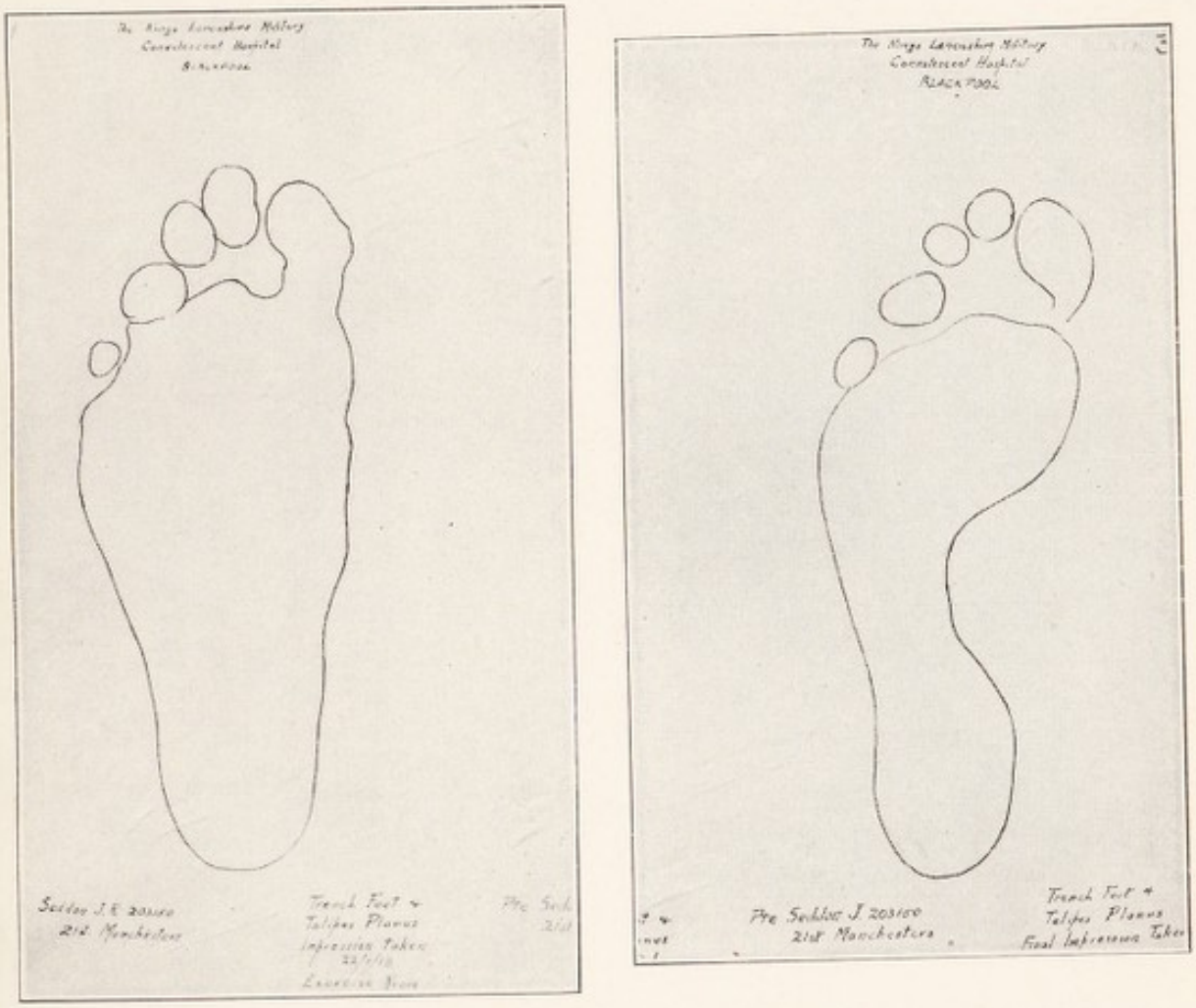
Convalescent ward, Blackpool.



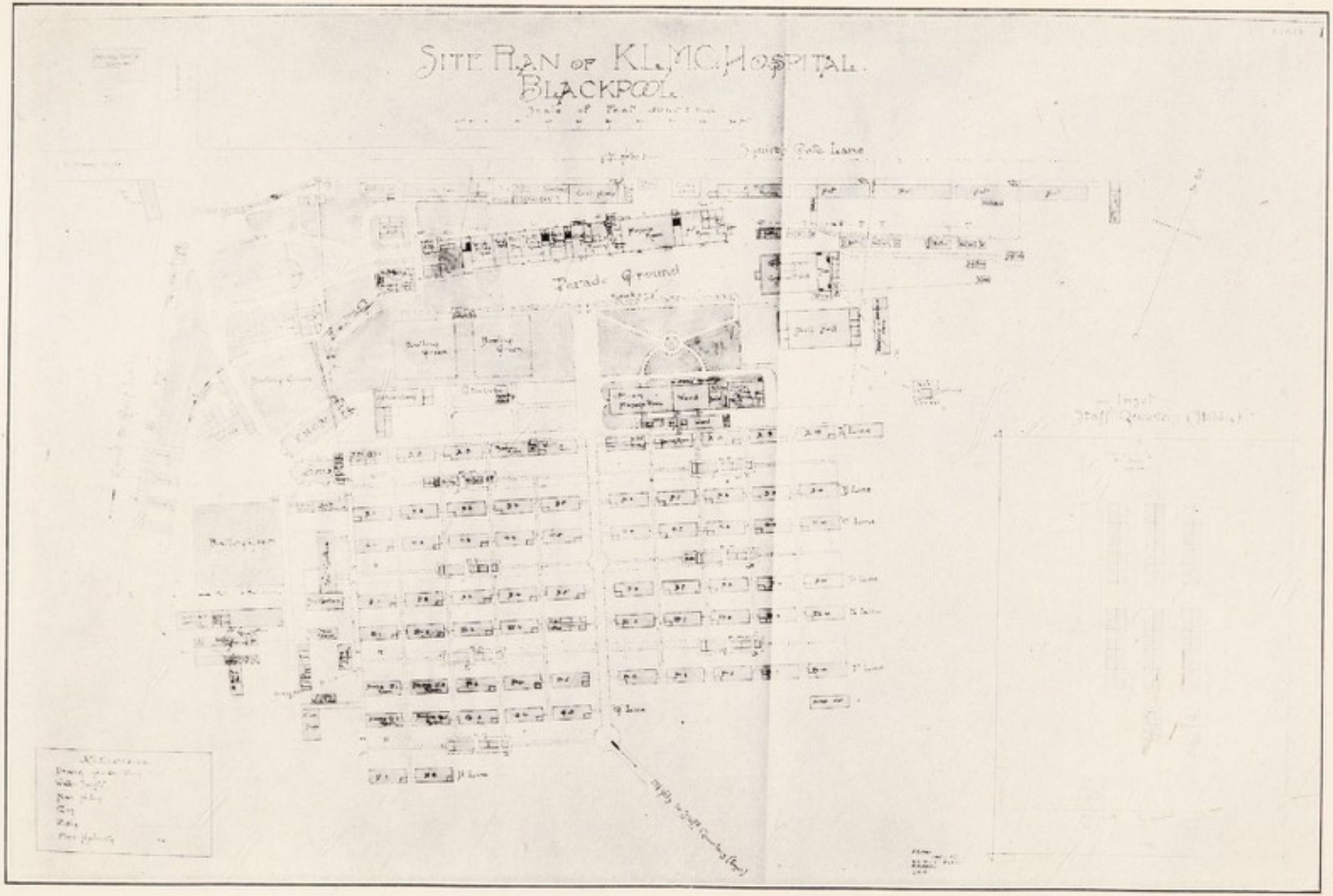
Ladder for exercising patients with flat foot.



Private Musgrave. Before and after treatment.



Private Seddon. Before and after treatment.



King's Lancashire Military Convalescent Hospital, Blackpool.

abandoned, but not before it had created a great stir and pointed many a serious lesson.

The diseases so charged as being due to exposure and dirt were:

1. Trench feet.
2. Infection of cutaneous tissue.
3. Myalgia.
4. Rheumatism.

(3 and 4: A large number of cases under these two heads are undoubtedly due to trench fever, which is P. U. O., or pyrexia of unknown origin but now thought to be carried by the louse.)

5. Skin disease due to irritation.
6. Dental caries.

Of the 9,503 men who passed through this camp in 1917, 42.4 per cent were returned to full military duty; 19.4 per cent to the command depot for further hardening (almost all of these later go overseas for full military duty); 28 per cent to employment (not overseas); 6.3 per cent to other hospitals for treatment; 2.62 per cent invalided out of the service; 0.03 per cent (3 men) died.

A recent development here, and one which is a step in the right direction, is the "Khaki College," established in February, 1918. A near-by technical school, St. Anne's, has arranged a number of courses, each extending over two months, covering the fields of commercial training, languages, mathematics, arts and sciences, any two of which a man may undertake. There are also evening classes in commercial branches and music at the camp itself. This is a very valuable addition to the hospital and one which is receiving enthusiastic support from the patients themselves.

Colonel Barron said: "We have found the Khaki College started here is popular because a man can learn Greek, or how to draw caricatures, or wood carving, and not be bothered by well-meaning visitors inquiring whether he is learning a new trade for after the war. Our professors are all drawn from the staff or patients. Any subject under heaven is taught excepting military subjects."

SUMMERDOWN MILITARY CONVALESCENT CAMP AT EASTBOURNE.

(Lieutenant Colonel J. S. Bostock, R. A. M. C., C. O.)

General Goodwin said: "A trip to Eastbourne Camp is most interesting and instructive; a meeting with Colonel Bostock is an inspiration. He is an institution in himself." And after my visit to Eastbourne I agreed with him.

The camp is delightfully situated on the downs near the sea, and everything possible is done to make the men forget the battle line and take a normal view of life once more. After noonday there are no

guards about. Equipment is furnished for every sort of game—base ball, bowling, fishing, golf, tennis, boating, billiards, marbles, cricket, etc. There are handball courts and squash courts and every kind of healthful sport is encouraged. Near by there are some links where the men can caddy if they desire. This gives them some pin money, as well as out-of-door life and exercise.

The whole atmosphere of the place is that of a club or fraternity. Here, as at Blackpool, there is a "Welcome Hut" at the entrance, where, on arrival, men are given a good meal. There are flowers all about and an atmosphere of cheer. Notices are posted on the walls of good times coming. The camp has well-equipped writing and recreation rooms, also a theater.

The treatment consists of:

1. Reeducation and massage.
2. Remedial exercises under medical officer in gymnasium.
3. Physical therapy, proper; army gymnastics.

Three thousand six hundred men were at this camp at the time of my visit. They wear a regulation convalescents' uniform of dark blue with red tie. There is a blacksmith shop, where, with volunteer labor, considerable money is saved. On the farm, all the plowing is done by hand by the men for the sake of the exercise. This year they are getting all of the vegetables for four months, for the entire place. There is a great variety of small flower beds which are voluntarily kept by the men, and there is much competition among them, each group striving to make its hut entrance the most attractive.

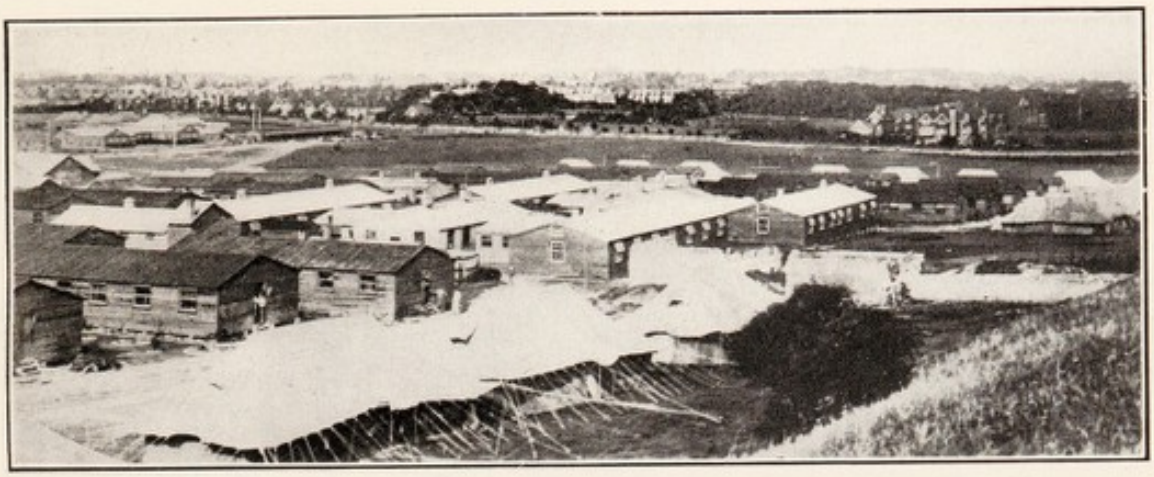
The basket making and other industrial work is in charge of Miss Samuel. She and the men divide the returns. Out of her half, she keeps up the work in manual arts, the art shop, and book bindery. A fortnightly magazine is published by the men, giving all the camp news.

Economy is impressed upon the men by example. Nothing useful is wasted. The grease from plates is collected and used for making soap and glycerine. They have saved 50 tons of pure fat in two years. Even the leaves from the tea are saved (a by no means inconsiderable item in a British establishment) and mixed with coal dust and used in the fire.

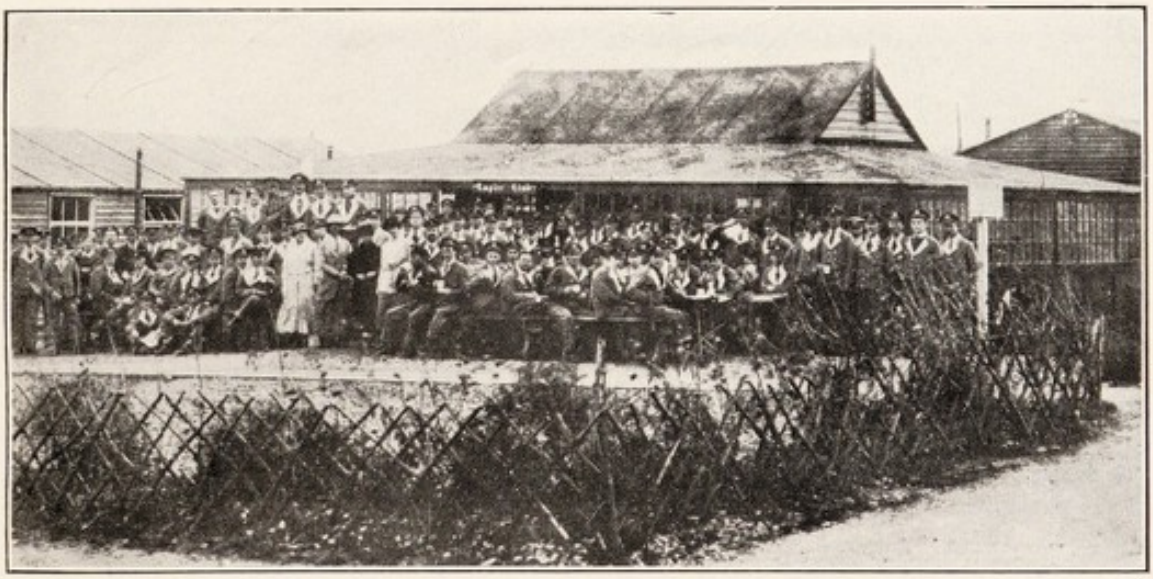
Colonel Bostock says: "We need 3,600 calories daily for each man. They must have plenty of proteid to refit them for fighting."

He thinks there should be two types of convalescent hospitals; one for men who can probably be sent back for military duty in two months, the other for those who require longer and more technical treatment. This latter type would be more of an auxiliary hospital.

The ordinary convalescent remains here from 27 to 30 days, while severe cases remain occasionally for a year.







Mess Hall.

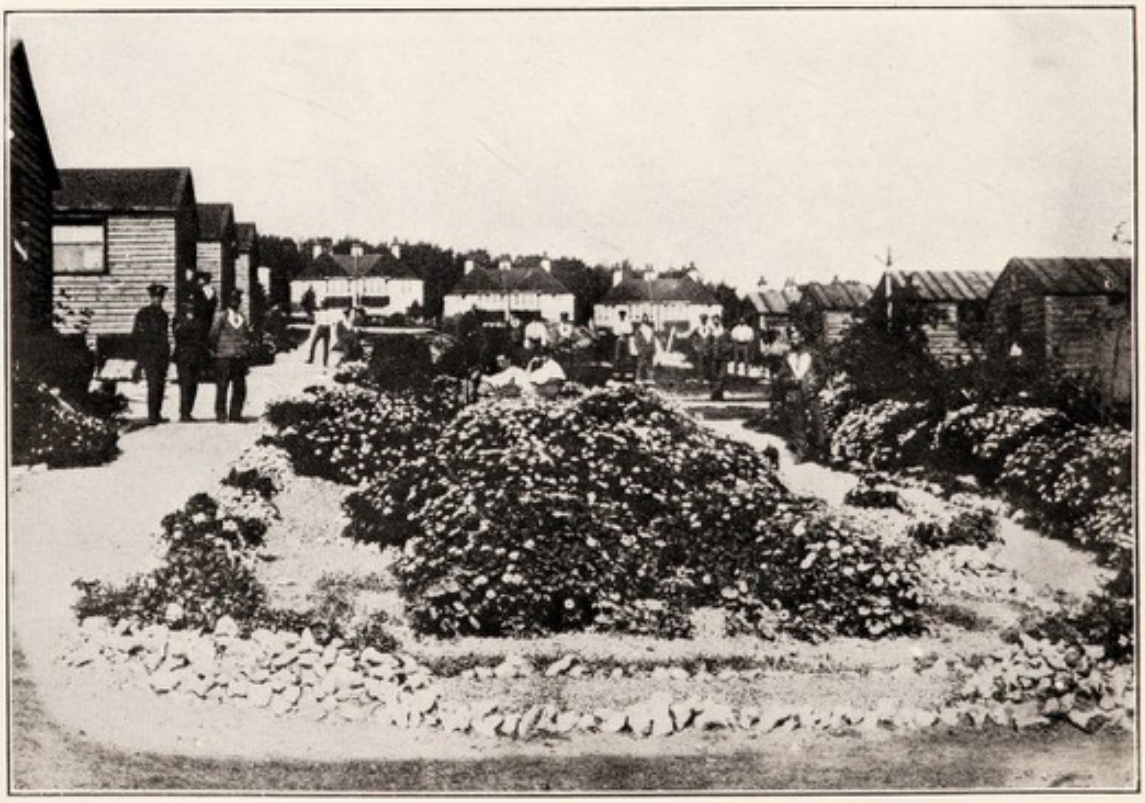


Eastbourne. The band.



Eastbourne. Patients from convalescent camp at work.



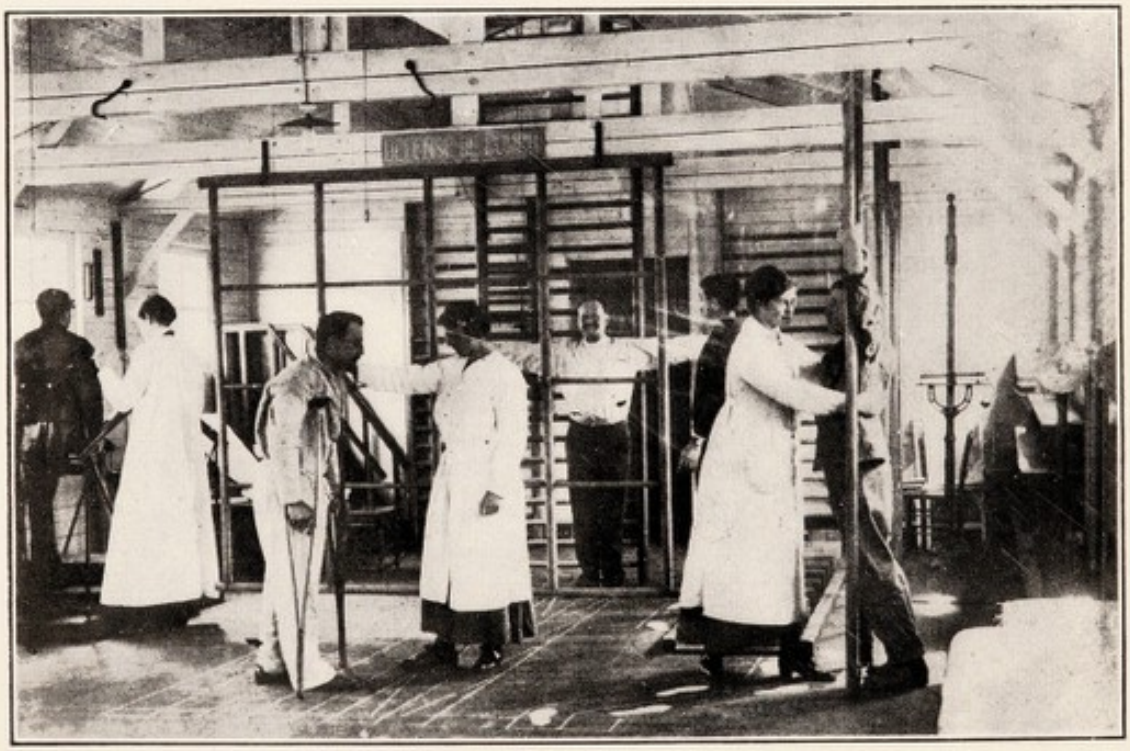


Eastbourne.

"We do not use the Red Cross sign; we found it of no value as a protection. The Red Cross brassards were used in the field ambulance for the first three days of the war, then done away with and never since used by us. The Germans use them always."

All through this institution there is apparent a carefully studied effort to make the men feel at home, cheerful and happy and proud of their camp. Many of them wear away rings bearing the name or picture of the place, and there is a bond of interest and fellowship, even in the trenches, among those who have been here.





Hospital Bon Secours, Rouen. Physical training of mutilés.

REEDUCATION FOR THE DISABLED.

John Galsworthy says in his foreword to the report of the second meeting of the Inter-Allied Conference on the aftercare of disabled men, held in London in May, 1918: "In every township and village of our countries, stricken heroes of the war will dwell for the next half century. The figure of youth must go one-footed, one-armed, blind of an eye, lesioned and stunned, in the home where it once danced. The half of a generation can never again step into the sunlight of full health and the priceless freedom of unharmed limbs."

Before so tragic a picture of the ruin wrought by war, the heart at first utterly fails. But youth still has some gifts and many powers, the more to be cherished because of what is gone. Science, education, charity in the Bible sense, gratitude for heroic sacrifice must rise up together to work for the stricken ones who return to our shores. Ours is the task of teaching them to look not at what is lost but at what remains and of helping them so to use the unharmed faculties and muscles that they shall become not mere onlookers but active participants in the great battle of life. There will be those disabled through amputation, through loss of sight or hearing, through facial wounds and through neuro-organic or neuro-psychic wounds, and many others who must have special care and training.

France and Britain recognized their responsibility in this field early in the war and we, the newcomers, may well learn from them and Belgium the lessons that four years of experience have taught with the idea of ascertaining what is the utmost we can do toward the physical and economic rehabilitation of those who return to us cripped and maimed.

Terribly significant is the fact that no country now at war permits the publication of official statistics as to the number of amputations performed, but in every center where the wounded are treated one hears the same story. Early in the war there was much sacrificing of limbs which more recent developments indicate could have been avoided. Even with the improved methods now in vogue there is necessarily a large amount of amputation, and public sentiment is being aroused to solve the problem of how to give to those who have suffered loss of limb such aid—surgical, mechanical, and educational—that they may be returned to the ranks of the self-supporting. To this end, there must be the closest cooperation between the

surgeon, the artificial limb maker, and those who shall be entrusted with the economic reeducation of men who are unable to resume their prewar occupations. In deciding the point at which a limb should be severed, the good surgeon will bear in mind not only the question of the speedy healing of the wound, but the type of artificial limb best adapted to the needs of the patient in his future occupation and the kind of stump which is necessary for the fullest use of such apparatus. Comparatively few of our surgeons now caring for the wounded are fully informed as to the work in reeducation already being done in France and Great Britain, and the first step which should be taken by those in authority should be the immediate disseminating of this information among our Army and Navy surgeons and hospital corpsmen. The inspiration which will come to them through a full realization of the possibilities in the future for the disabled men will enable them to encourage and cheer the patients and bring an atmosphere of hope to replace the darkness of despair which comes when a man looks forward to a future of enforced idleness and dependence. The psychological effect can hardly be overestimated and the earlier in his convalescence that a patient is furnished with provisional apparatus, taught to use it and his unharmed muscles to the fullest extent, and aided and encouraged in selecting a new trade or profession in case he is unable to take up his prewar occupation, the more quickly will he recover physical and mental health.

As stated in another part of this report, the subject of the construction of artificial limbs has been given much consideration and study by all of the warring nations, and each has produced apparatus more or less satisfactory. The American Red Cross has perfected a leg with a centrally controlled knee, which is generally considered the best so far evolved. It is lighter than the others, and has better action at the knee and ankle, and some motion at the junction of the toes and tarsal bones. The English arm is considered best for the workingman as it is stronger and lighter, while for clerks the more complicated French arm is better adapted.

For years there will be much work in this field, as we must furnish not only the best possible provisional and permanent apparatus, but also keep these artificial limbs in repair. There is some question as to whether this should be done for the Government by private enterpise, or whether the Government should establish centers under its own control. Whichever course is pursued, it is imperative that the limbs be made and fitted by skilled workmen at the center where the patient is, in order that there may be close cooperation, as said before, between the surgeon and the artisan.

In former days men, who had lost limbs in the service of their country, were given such surgical treatment and meager equipment



Hospital Bon Secours, Rouen. Physical training of mutilés.



Lord Mayor of London and group of delegates at the Interallied Conference, London, May, 1918.

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L. C. Cook, aged 29, wounded at Verdun. Both forearms amputated.



L. C. Writes legibly by means of wooden hand and jointed thumb after a three months' course of reeducation.

in the way of artificial limbs as the times afforded, and then turned back upon the community with a pension or placed in a soldiers' or sailors' home.

In our day no enlightened nation would be satisfied with so limited a course. Economically, the waste of man power would be unthinkable; ethically, the failure to recognize a wider responsibility would be inexcusable. The heart of the world, stirred by the tremendous sacrifice that youth is making, demands that such poor reparation as is possible be made. In addition to surgical care and artificial limbs, the disabled man must be given, first, functional reeducation, in order that he may make the best possible use of the unharmed muscles and of the new prosthetic apparatus; and, second, vocational reeducation in order that he may become economically independent in case he is not able to return to his former occupation.

I. FUNCTIONAL REEDUCATION.

Experience in England and elsewhere has already shown that it is unwise to leave this reeducation to the time after the wounds have entirely healed and the patient is ready to leave the hospital. Habits conducive to permanent helplessness and reliance on others, difficult of eradication, have then been formed, and the self-assertion and energy of a man who has once resigned himself in despair to what he deems his lot as a war cripple, are not easily aroused for the overcoming of his infirmities. It is important to prevent this more or less subconscious psychic adjustment to the supposedly inevitable, and thereby to keep the man's will power at a high standard. There is not much more to be done with a broken spirit than with a broken back. We must remember that it is a human trait, fostered by generations who have extended pity to the maimed and crippled, to exaggerate rather than to make light of a loss of bodily health and strength.

This attitude of weak sentimentality toward invalids of all kinds requires changing, in their own best interest. While it is never a disgrace to be sick or disabled, it is one to remain unnecessarily a burden to the community. In our enlightened days, much can be and is being done to save our gallant soldiers from the gloomy fate of crippled war veterans.

Excellent suggestions along this line have recently been offered by Dr. M. Stassen, in charge of the work of reeducating the Belgian mutilés at Port Villez, in France, who emphasizes and in a personal letter repeats that this assistance ought to begin in the hospitals at the front immediately after the infliction of the wound or the performance of an operation, without waiting for anatomical repair and consolidation of broken bones. It is during this period of en-

forced inactivity that the prospects of a final cure, with functional efficiency, are often seriously damaged or even entirely lost by the patient's acceptance of what he deems a hopeless struggle against overwhelming odds. Of special bearing on the ultimate outcome is the loss of muscular tonus in the fleshy coverings of the affected limb, in consequence of its functional disuse. The only remedy against this insidious deterioration, and incidentally a permanent loss in working capacity, is functional reeducation through the medium of work.

For the welfare of the disabled soldiers, this functional reeducation must not be postponed until anatomical consolidation has actually occurred. The educational treatment should begin directly after the traumatism or the curative intervention. Early mobilization is often of well-nigh the same importance in the treatment of war wounds as is wound sterilization. We improve the nutrition of the damaged limb by determining a healthy flow of blood to the part, and thereby activate the process of repair.

The correct application of work as a therapeutic measure for disabled groups of muscles naturally presupposes familiarity on the part of the physician in charge with the corresponding laboratory methods and mechanical manoeuvers.

The method of immediate active mobilization finds a promising field in a great variety of cases, such as amputations, fractures, injuries of joints or soft parts, etc., briefly, in the majority of all the ordinary wounds of war. Soldiers with injuries of the nerves or blood vessels, of the spinal cord and cranium, no matter how seriously disabled, will, with few exceptions, be likewise benefited by prompt functional utilization of all those muscular groups which have escaped destruction.

Postoperative treatment should be carried out under the collaboration of the operating surgeon, the bacteriologist, the mechano-therapeutist, and the specialist in prosthetic appliances. A very responsible part of the treatment devolves upon the physician charged with persuading the patient that his injured limb can and should be used from the first hours following the traumatism or operation. The patient must be taught the performance of the active movements needed to maintain the teamwork of the muscles and tendons as well as to preserve the suppleness of the articulations. Willing and intelligent compliance with these instructions is equivalent to the best possible functional utilization and reeducation of the limb. Simple and easily renewable prostheses should be provided and fitted within the first few days, thereby facilitating the functional activity to the highest possible degree.

Exercise rooms and laboratories of this type should be under the direction of experienced physicians capable of prescribing the work-



China decorating. Belgian reeducational school for war cripples, Port Villez.



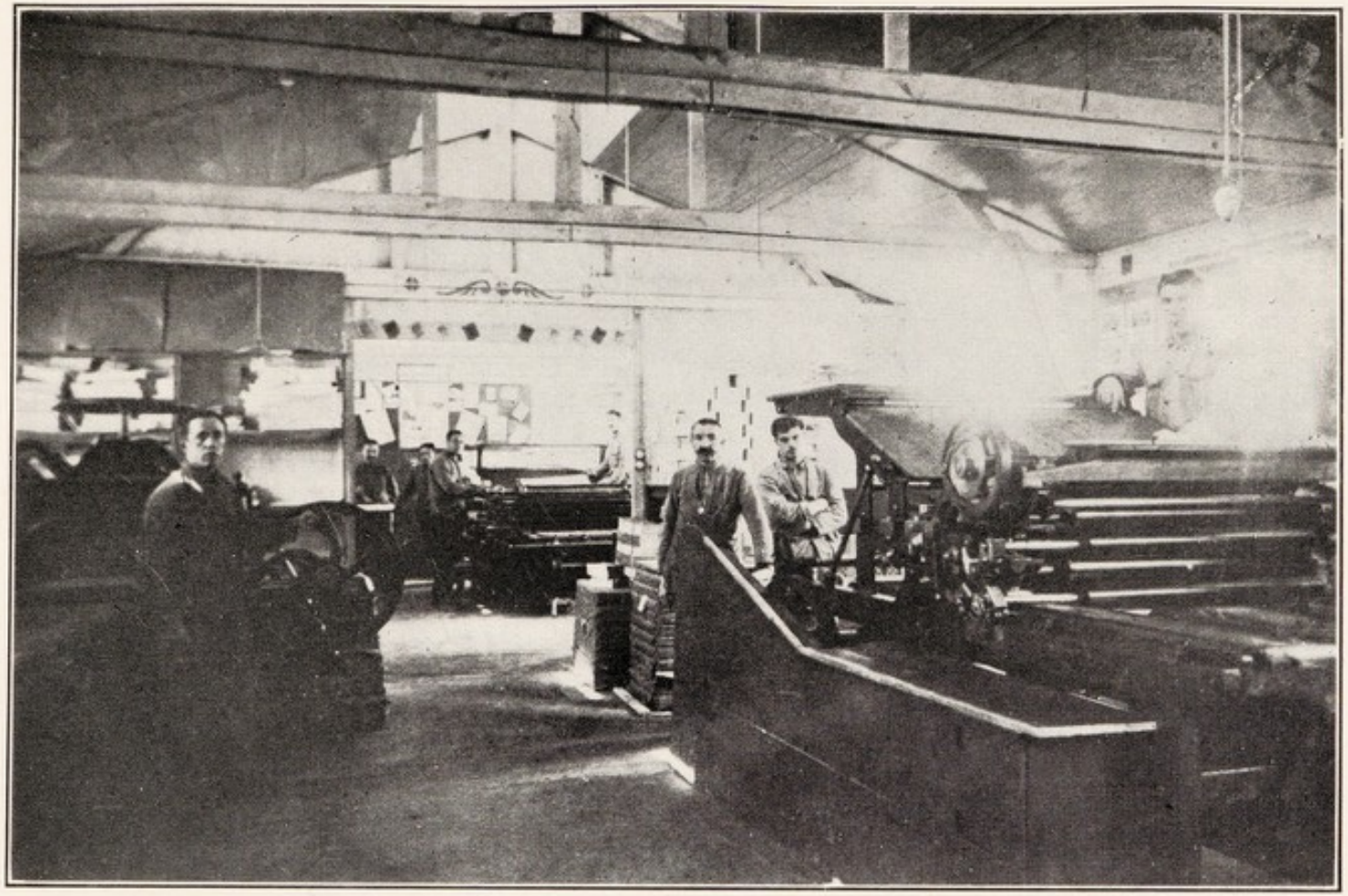
Training in plastic arts. Belgian reeducational school for war cripples, Port Villez.



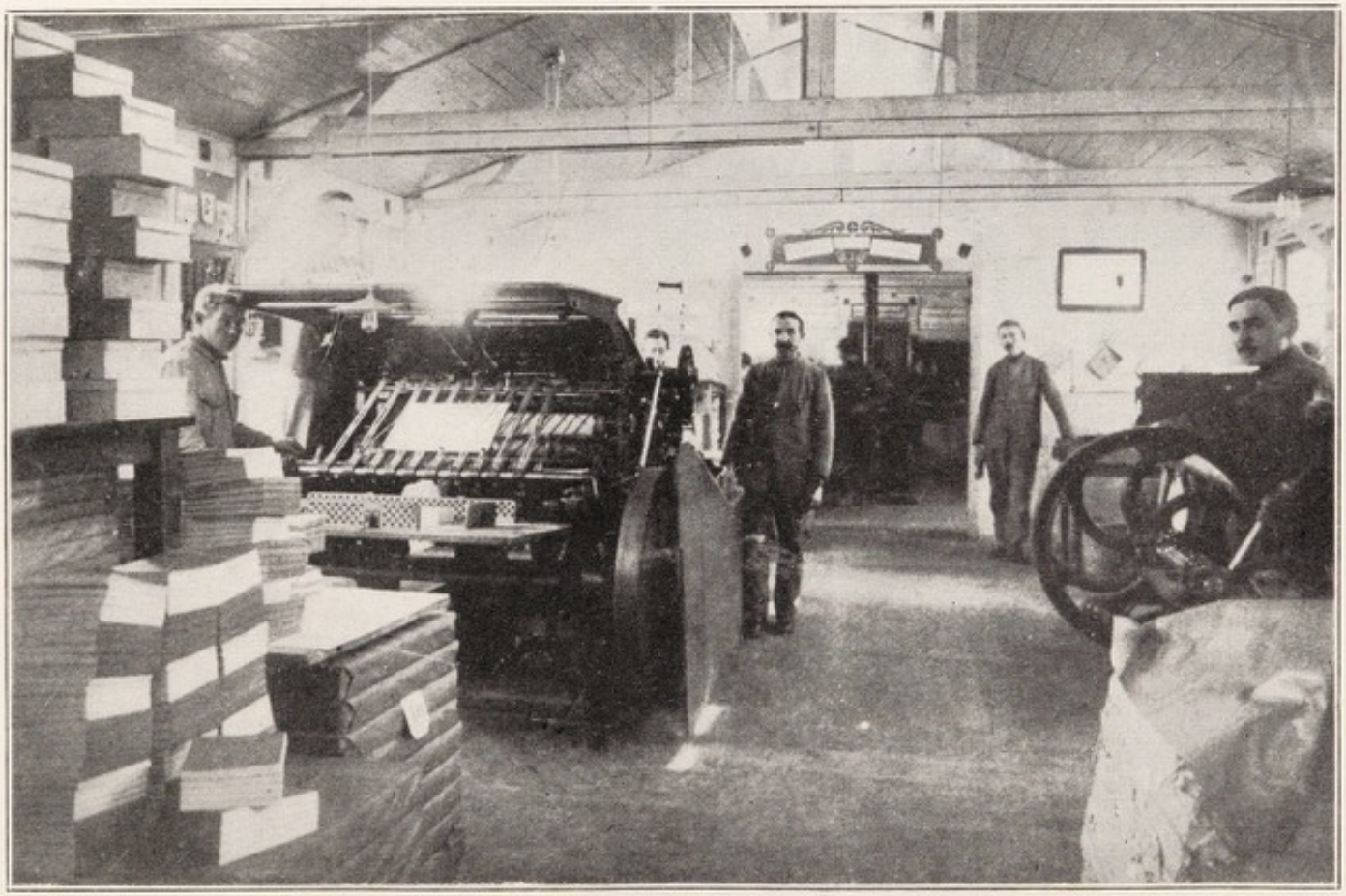
Harness-making shop. Belgian reeducational school for war cripples, Port Villez.



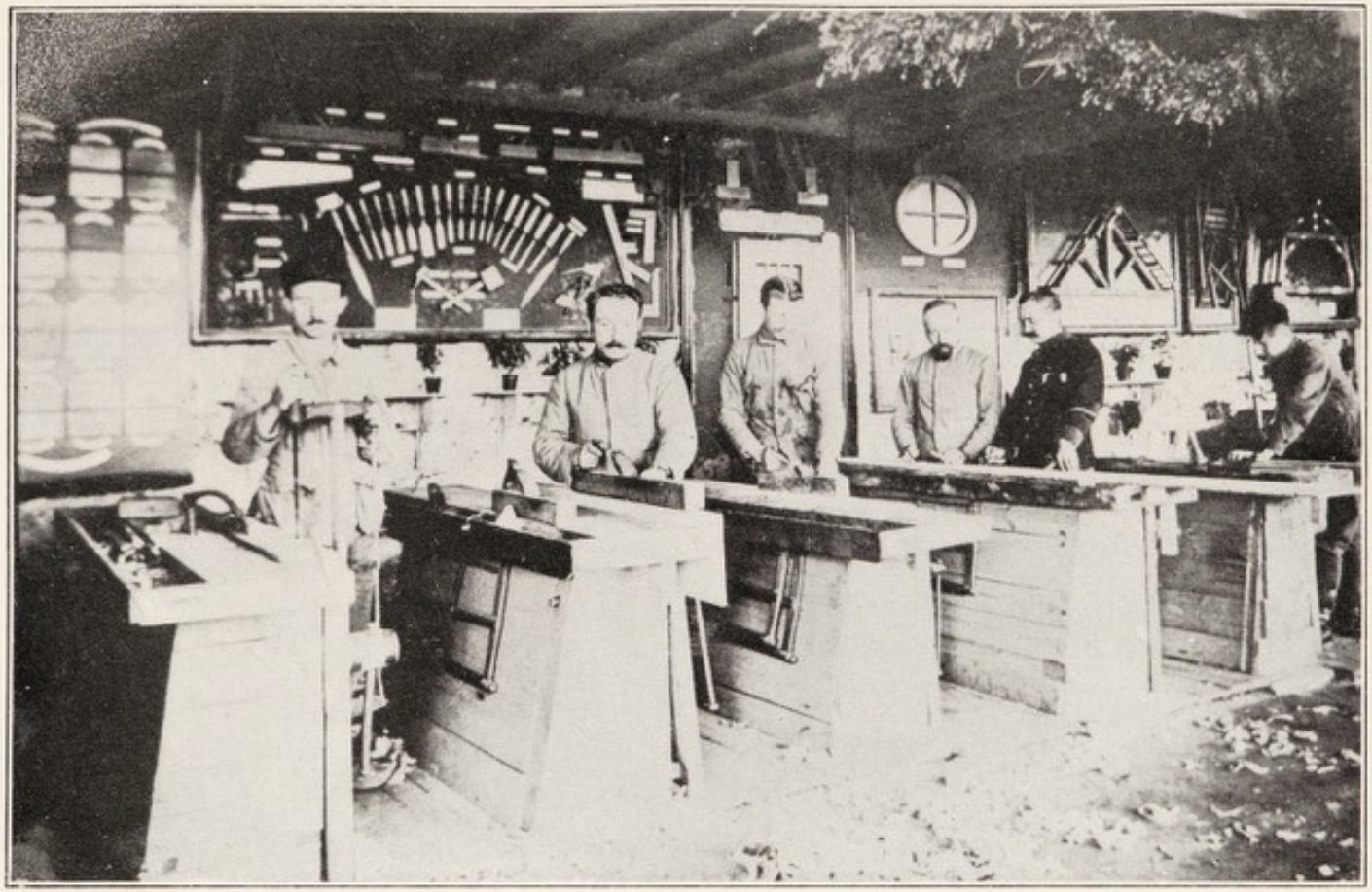
Wood-turning shop Belgian reeducational school for war cripples, Port Villez.



Printing shop. Belgian reeducational school for war cripples, Port Villez.



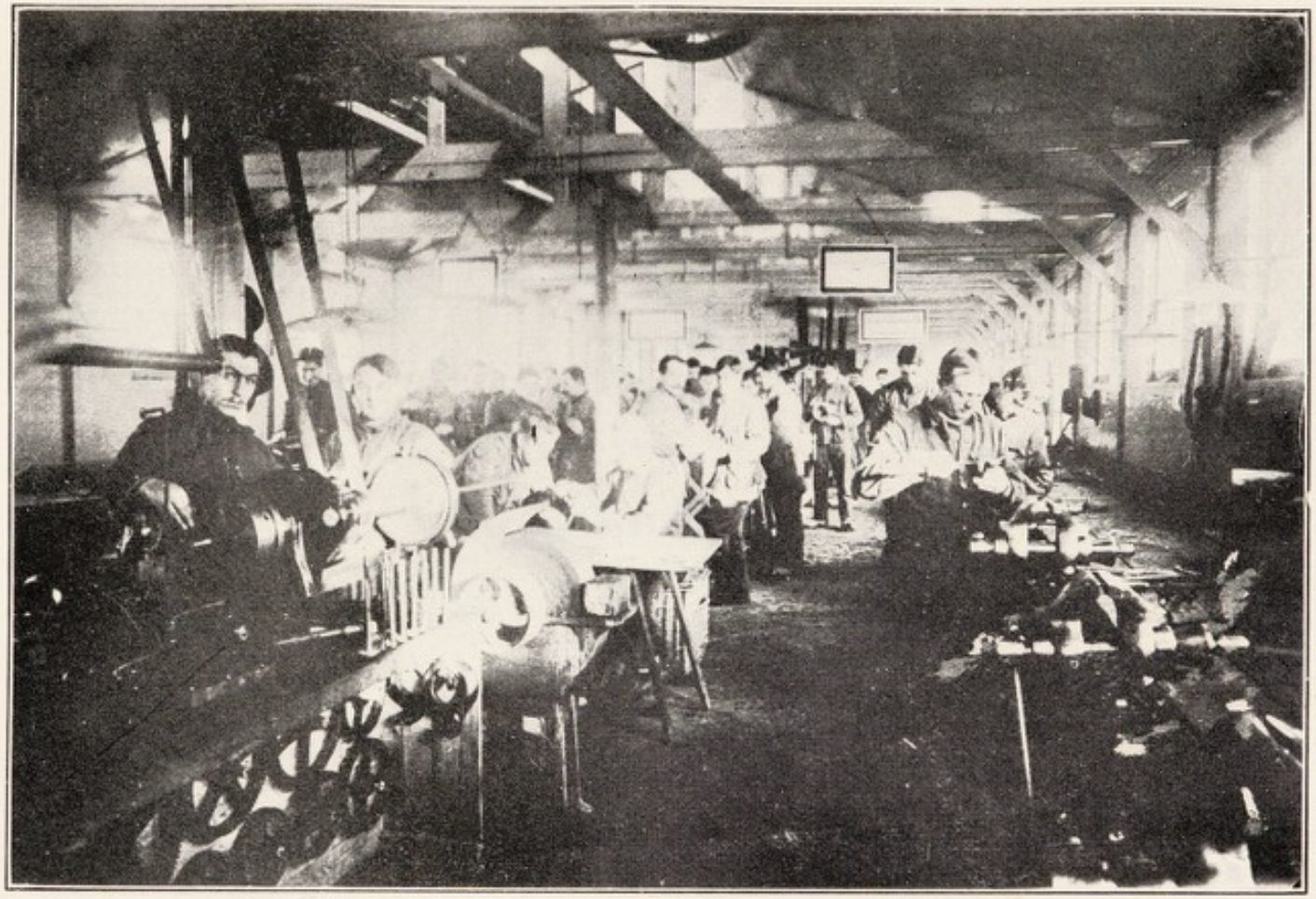
Printing shop. Belgian reeducational school for war cripples Port Villez.



Carpentry shop. Belgian reeducational school for war cripples, Port Villez.



Wood turning. Belgian reeducational school for war cripples, Port Villez.



Machine shop. Belgian reeducational school for war cripples, Port Villez.

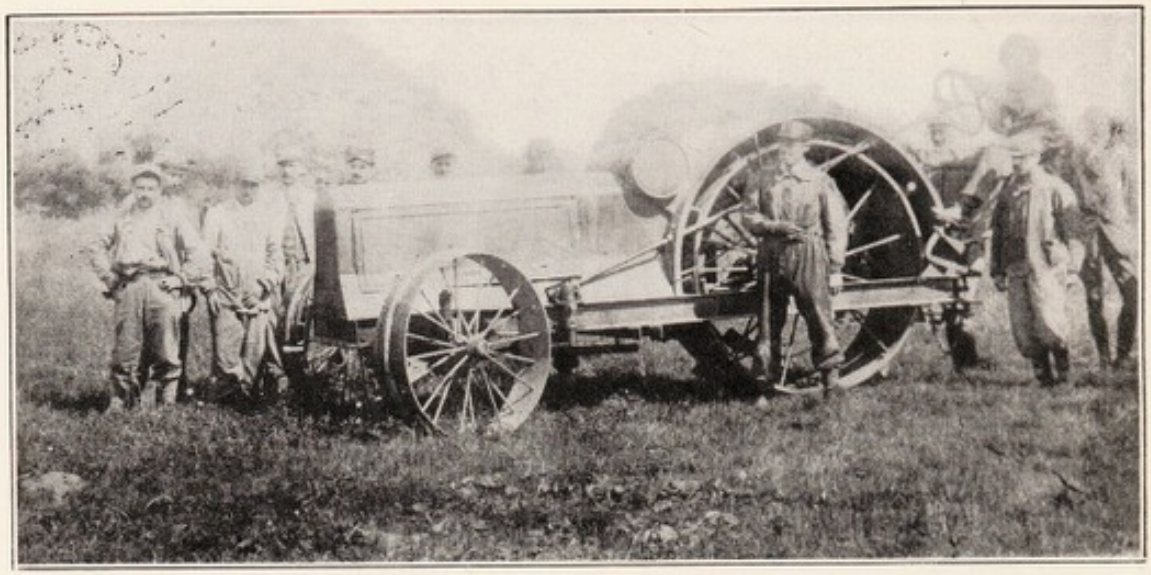


Bookbinding shop. Belgian reeducational school for war cripples, Port Villez.



Belgian reeducational school for war cripples, Port Villez. Linotyping.

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Agricultural school, Juvisy.



Agricultural school, Juvisy. Group of men who were farmers before the war. They are unfit for farm labor because of paralysis of the hand. Reeducation for light work.

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ing movements adapted to the different groups of disabled soldiers. For example, there exists a special series of selected and graded working exercises for those who have lost an upper extremity; another series is destined for resections of the elbow or shoulder, etc. Special walking and marching exercises, on peg legs, have been devised for cases of amputation of the lower extremity.

This physio-therapeutic method of treatment is distinct from the workshops which have been established for the vocational reeducation of the wounded, either to refit them for their occupation before the war, or to train them for other work, according to their personal inclinations or the exigencies of their physical condition. The mechanical movements under present consideration have no vocational but simply a therapeutic bearing. The selection of the curative exercises is governed exclusively by the lesion itself and aims at insuring the best possible working capacity of the man on his return to civil life.

The beneficial influence exerted by immediate active mobilization and functional utilization on the course of the injuries themselves is such as to reduce to mere accessories the ordinary mechano, electro, or hydro therapeutic methods of treatment.

Functional reeducation by work hastens consolidation in severe fractures, and the shattered limb accordingly reaches its permanent condition earlier than otherwise, with the result that the patients can be equipped proportionately sooner with their definite prosthetic apparatus, and can then be evacuated from the hospital to the institutions for vocational reeducation. Here it will prove advantageous and even indispensable, at least for certain groups of cases, to continue the functional reeducation started in the hospital.

In the Port Villez Military Institute, under the direction of Dr. Stassen, courses of general gymnastic exercises and reeducation in walking have been established for trephined patients with hemiplegia or paraplegia, as well as for cases of spinal cord lesion, etc. Patients with sutured nerves, which heal very slowly, are also given the benefit of routine reeducation exercises under medical supervision.

For the maintenance of the results achieved by functional reeducation Dr. Stassen has arranged a course in general gymnastics for men whose lower extremities have been amputated. Under the direction of an Army officer rapid marches are frequently made with the artificial limbs. Men whose upper extremities are paralyzed or have been amputated likewise take a course in general gymnastics. Another course, for the utilization of artificial so-called "automatic arms," under the direction of amputated men who are experts in the use of their prosthesis, is now under contemplation. For hygienic reasons, courses in physical reeducation are soon to be extended to mutilated men following sedentary occupations, such as shoe and harness makers.

An attractive adjunct to this system of physical reeducation consists in a large hall and open grounds for the enjoyment of games, outdoor sports, and similar healthful activities.

II. VOCATIONAL REEDUCATION.

In repairing the ravages of the war probably no measure will make a stronger appeal to the sympathies of the American people than this one of vocational reeducation. If by reason of injuries received in the service of his country a man is debarred from returning to his former occupation, he must be given every opportunity to learn some other trade or profession which will enable him to become at least self-supporting. The welfare of the Nation no less than the welfare of the individual demands it.

While the general public in this country is not yet fully awake to the need of taking energetic steps to prepare to meet the requirements in this field, small beginnings are being made in various centers, and the periodicals of the country are giving considerable space to the question of what must be done. The old feeling that these unfortunates should be hidden away in obscure corners has given place to the belief that by facing the question squarely and inviting public discussion and cooperation much can be done toward bettering their condition and returning them to useful occupations. Much propaganda work is needed to enlighten those at home as well as those in the field as to what has been accomplished by the other warring nations, and by means of moving pictures and other publicity agents the interest of the people should be stimulated, in order to eradicate the present tendency to regard those suffering from loss of limb as permanently out of the ranks of labor. To this end the Red Cross has epitomized for us in four cinema reels the work that is being done in restoring to economic independence the disabled, and these reels are herewith presented to the Navy Medical School.

The French Government has found it advisable to institute a similar campaign of education in order that not only the general public but the mutilés themselves may learn of the work that is being done in this field. At the cinema a few pictures are "sandwiched in," and the official army photographers have prepared many photographs of mutilés actually at work.

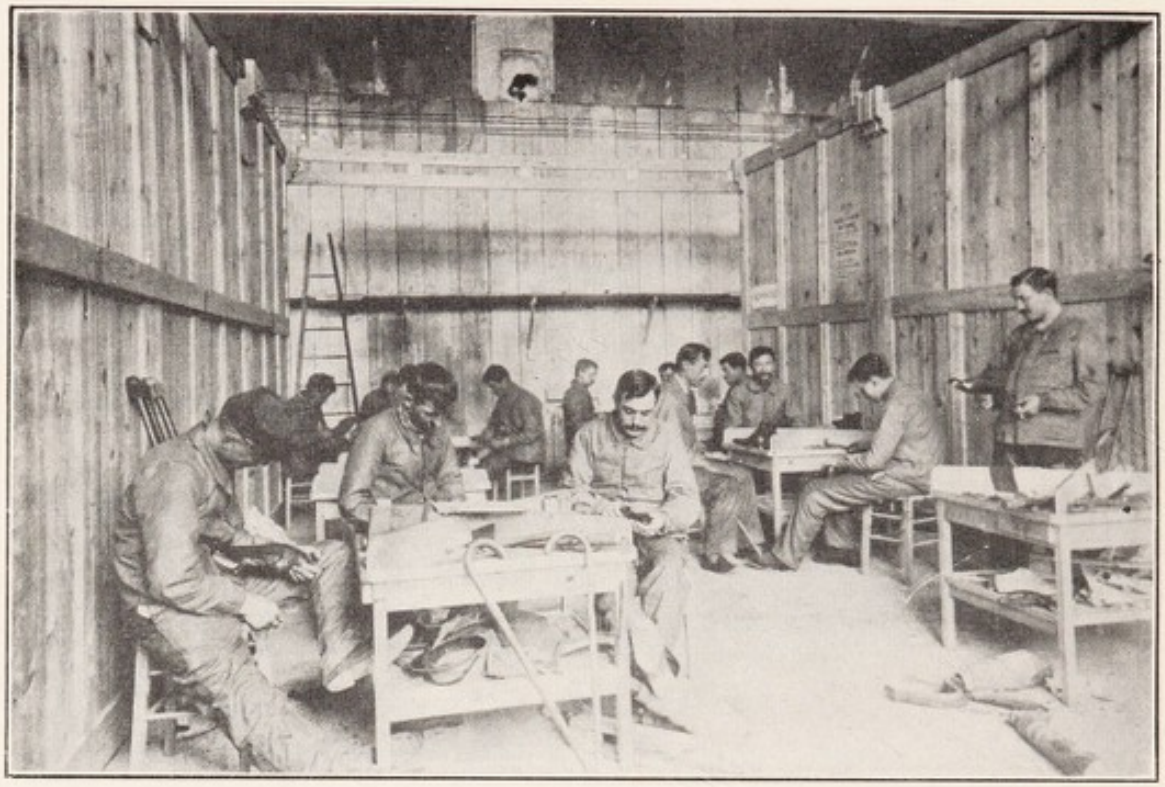
In Europe almost from the beginning of the war the importance of reeducation has been recognized. Two interallied conferences have been held to consider the "Aftercare of disabled men," the last of which I was privileged to attend, in May, 1918, when delegates from Belgium, France, Great Britain, Italy, Portugal, Serbia, Siam,



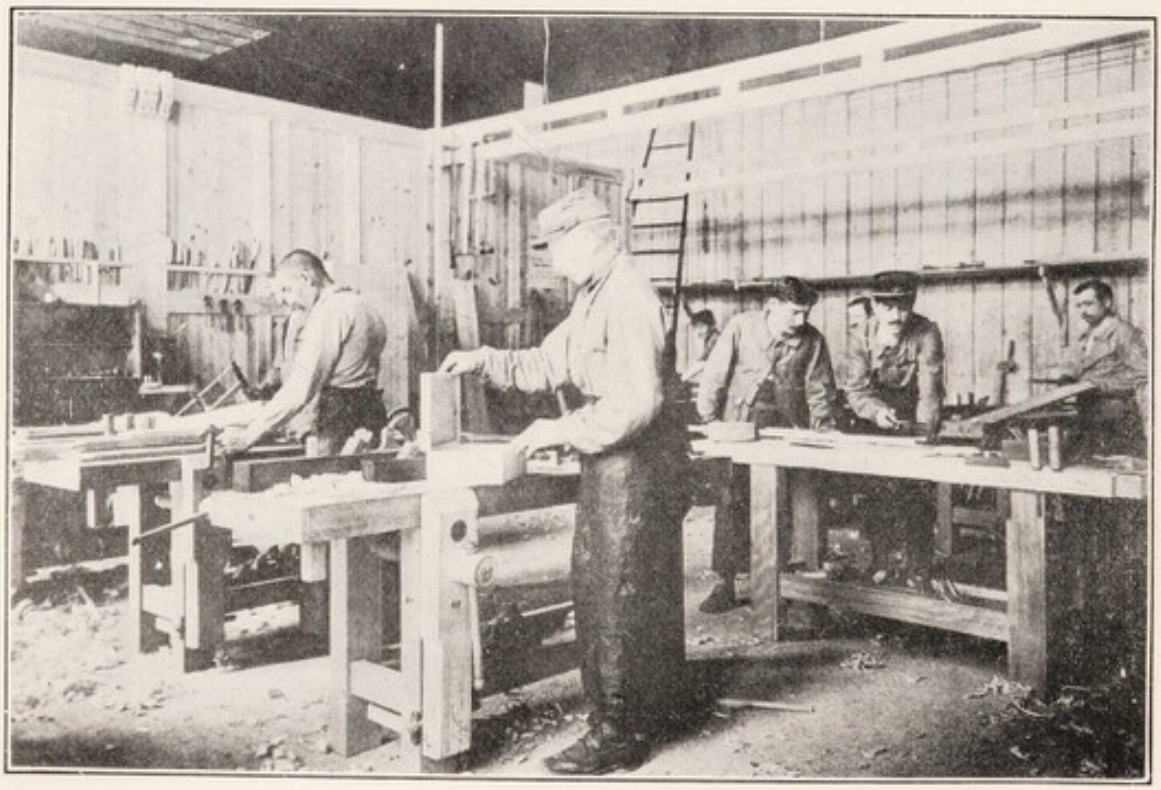
Grand Palais, Paris.



Tinsmith workshop at the Grand Palais.



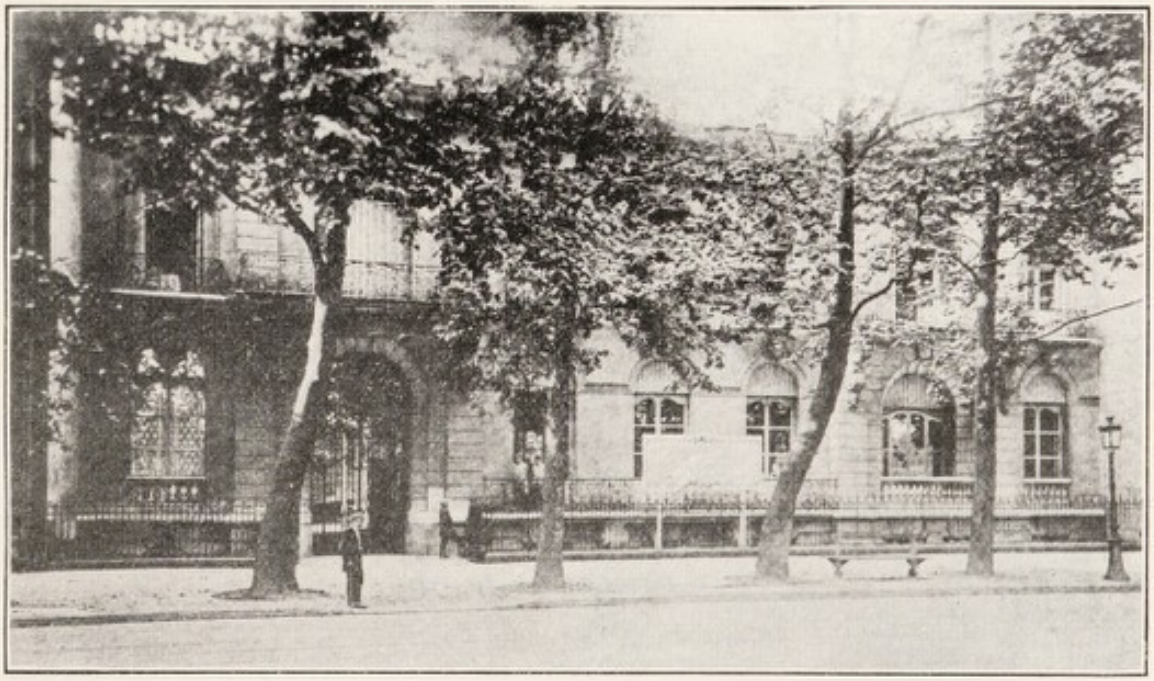
Shoemakers' workshop at the Grand Palais.



Carpenters' workshop at the Grand Palais.



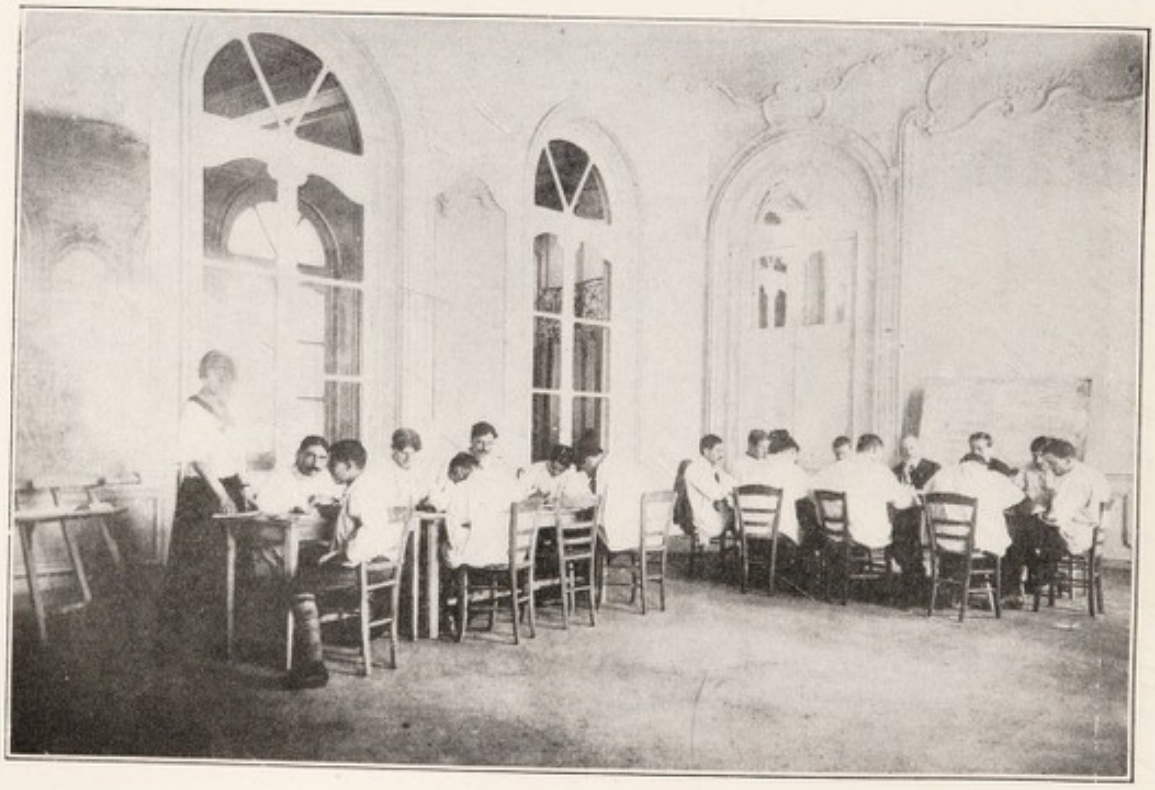
"The Boarding School," 28 Quai Debilly, Paris.



Front of institute on Quai Debilly, Paris.



Bookbinders' shop, Quai Debilly.



French course, Quai Debilly.



Crippled Serbians preparing vegetable garden.



École Professionnelle des Mutilés, Tourvielle, Lyon. Fur industry workshop. This is an unique industry as applied to retraining of war cripples.

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École Professionnelle des Mutilés, Tourvielle, Lyon. Mutilé wearing mechanical-arm apparatus and carving wooden shoes.

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United States, and the British overseas dominions met and discussed the work being done in their several countries.

A monthly magazine, the Revue Interalliée, is being published, devoted to the study of questions relating to war cripples, and the American Red Cross, always alert to encourage and carry on any enterprise which will be of benefit to mankind, has organized in France a bureau for reeducation of mutilés, under the charge of Miss Grace Harper, and is aiding and supplementing the work of the French. The Union des Colonies Étrangères, largely composed of Americans, has also taken an active part in the development of these measures, and hundreds of centers have been established where reeducation is being carried on.

Through the foresight and vision of M. Edouard Herriot, mayor of Lyons, France, was the first country to recognize officially the wisdom and necessity of training its mutilés to become self-supporting. A little over three months after war was declared, M. Herriot proposed to the city council that it should organize a school where men incapable of resuming their prewar occupations should be taught new trades. On December 16, 1914, the school, called the École Joffre, was opened with three mutilés as pupils. By May, 1915, it was full to overflowing, and an annex was opened at Tourvielle, just outside the city. The work at these centers is described more in detail later herein. Well may the city of Lyons be proud of the initiative and progressive spirit which have made it the leader in this and other fields of war usefulness!

Shortly after the organization of the École Joffre, the French National Government took over the National Home for Convalescents and Industrial Cripples at St. Maurice, on the outskirts of Paris and converted it into the National Professional Institute for War Cripples. It has been made a model school, capable of training 300 men, under the direction of Dr. Maurice Bourrillon, one of the foremost experts in this field of education.

Over 100 other centers have been established in France, some through private initiative and others through the use of civil schools adapted for professional reeducation. They are scattered throughout France and vary greatly in the number of pupils accommodated and the training given. This has resulted in a lack of uniformity in methods and standards, and in establishing our own centers we should profit by the lesson and see that under Government administration they all have the same high standard.

Some indication of the number of disabled who require such training may be gained from the fact that between June 30, 1916, and July 1, 1917, over 17,000 French mutilés completed courses in these schools. This does not include British, Belgian, or Italian soldiers.

In Great Britain also this work had its inception through philanthropic enterprise, the Soldiers' and Sailors' Help Society opening workshops in London, and later throughout the country, for the employment of disabled men. They were called "Lord Roberts Memorial Workshops." Later the Government took up the question of systematic reeducation, and the royal warrant of 1917 provided in detail for pensions and occupational training. The numerous trade and technical schools throughout Great Britain are being utilized in this work, the cost of tuition being defrayed by the Government, and the disabled soldier or sailor is now cared for from the time he is wounded until he is again, if possible, established in civil life as a trained worker.

Belgium, Italy, and the British colonies are likewise engaged in solving the same problem, while Germany, with its preparedness, had the matter excellently in hand long before any other country.

In order to learn at first hand what was being done in France, where this work has reached its greatest development, I visited a number of the leading centers, and, through the courtesy of the American Red Cross in Paris, made a trip of inspection in company with Miss Grace Harper, chief of its bureau for reeducation of mutilés, to certain institutions which she chose as those from which I could learn the most in the short time at my disposal. They were:

Institut National Professionnel des Invalides de la guerre at St. Maurice, near Paris.

Maison Blanche, at Neuilly-sur-Marne.

École Nationale Belge des mutilés de la guerre, at Port Villez.

École Joffre and Tourvielle, at Lyons.

Hospital No. 40, French Army, at Lyons.

École de l'Union des Colonies Étrangères, Grand Palais, Paris; Quai Debilly, Paris; Hôtel des Invalides, Paris; Juvisy Farm.

A special car was placed at my disposal and all arrangements were made in advance for our trip. Everywhere we were received with the greatest courtesy and attention and had the work of the various institutions explained in detail. Miss Harper has been in charge of the American Red Cross bureau for the reeducation of mutilés for over a year, and her thorough acquaintance with the work made it possible for me to see much in a short space of time.

ST. MAURICE.

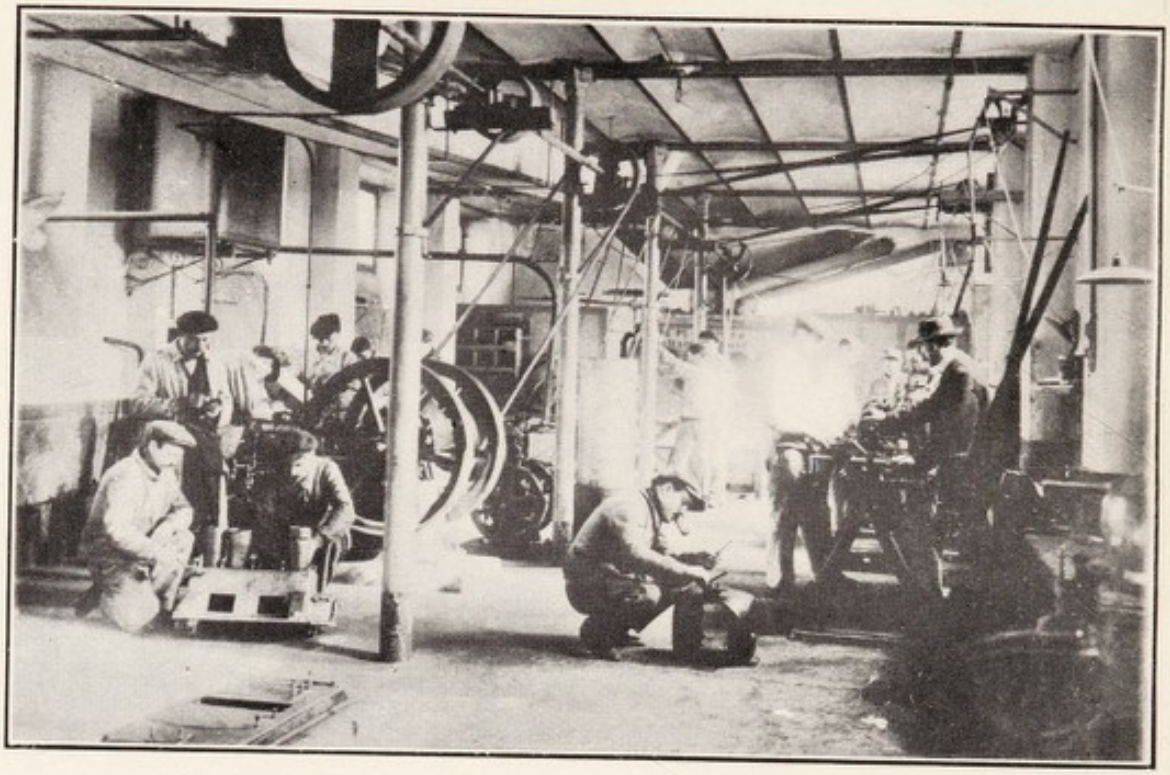
We left the hotel in Paris early in the morning of March 18 and motored to St. Maurice, 30 kilometers away, where we were received by Dr. Maurice Bourrillon, the director of the institution. Before the war this was the national home for convalescents and the national asylum for industrial cripples. It was therefore peculiarly well adapted for its present use, and Dr. Bourrillon, for many years in



No. 1.—National Institute for War Cripples, St. Maurice, Paris. Machine shop.



No. 2.—National Institute for War Cripples, St. Maurice, Paris. Tailoring shop.



No. 3.—Machine shop at National Institute for War Cripples, St. Maurice, Paris.



No. 4.—Mutilés receiving instruction in stenography and typewriting, National Institute for War Cripples, St. Maurice, Paris.

charge of the training of the disabled industrial workers, is one of the foremost authorities on the subject. Through private beneficence the institute was enlarged after the war began, and now it has 750 patients under treatment for deformities of all kinds and provision for the vocational training of 300, many of the latter still undergoing treatment while learning trades. The hospital section is thoroughly equipped for restorative work, having departments for hydrotherapy, mechanotherapy, and electrotherapy, etc. The patients who are having industrial training spend an hour or two a day in receiving necessary treatments tending to increase functional activity and devote the balance of the day to the vocational training. Dr. Bourrillon advises and guides the men in selecting the line of work for which they are best qualified. Shoemaking, tailoring, leather work, harness making and repairing, machine work, bookkeeping, mechanical drawing, industrial design, farming, and many other branches are taught. Instruction is being given in the repair of farm and automobile machinery. This course in farm mechanics takes from five to six months and gives the pupils a thorough understanding of gasoline and electric motors for farm use and their repair. The American Red Cross has recently donated a tractor for training purposes, and at the time of our visit was erecting two buildings, one for instruction in wireless telegraphy, the other for all kinds of electrical work. Before the war the Germans had a practical monopoly of such work in France, and therefore an excellent field is now opened up for the men who are being instructed in this branch.

We saw the men busily engaged in these various industries, and found them cheerful and apparently interested. We were told that the average length of time required for each of the various industries is as follows: Bookkeeping, 4 months; tinsmithing, 6 months; shoemaking and agricultural mechanics, 8 months; harness making, 10 months; and a year for primary instruction for the illiterate, as well as industrial design. The men are paid a franc a day while learning, and, if they have saved their wages, are given a small bonus when they leave. They are also provided with a full set of tools, sometimes costing as much as 500 francs, and thus equipped are ready to start life again.

The school gives diplomas when courses are completed and places the men in positions. With labor at a premium, this is at present an easy matter.

Miss Harper has recently published a "Report on Professional Reeducation for War Cripples in France," which gives many details relating to this institution, particularly as to administration, etc., which are most instructive and valuable.

MAISON BLANCHE.

From St. Maurice we motored to Neuilly-sur-Marne, where the Maison Blanche is located. This is one of four centers for reeducation organized by the Union des Colonies Étrangères, a group of foreign residents in France, including members from all of the allied and neutral nations who have raised large sums for the establishment of schools for French soldiers. The others are at the Grand Palais, in Paris, where many of the patients are injured and deformed; No. 28 Quai Debilly, Paris; and Juvisy Farm, about 10 miles south of the French capital. At Maison Blanche most of the pupils come from the adjoining convalescent depot for amputation cases.

Before the war the buildings were used for an asylum, but through the beneficence of an American 700,000 francs were procured for the enlargement of the plant. While there is provision for 350 pupils, there are many vacancies. This is true in practically every center of reeducation, and the main reasons are said to be:

(1) The natural desire to return home at the earliest possible moment.

(2) The ease of obtaining employment in war industries and the like, owing to present lack of labor.

(3) Hope of obtaining a Government position (preference being given to wounded soldiers in many lines).

(4) Fear of a decrease in pension owing to increase in earning capacity. (This is unfounded, but belief in it is widespread among the French soldiers.)

The mutilés come here not for treatment (except in so far as any manual training will improve the physical condition) but for vocational training. Dr. Hubert Kresser is the director and in charge of the work. There are 50 acres of land under cultivation by the mutilés, whom we saw at work, some with artificial arms and many also with artificial legs. Scores of these men are working in the grounds and even operating machinery. Gardening, basketry, drawing, bookkeeping, stenography, and typewriting are taught, as well as many other branches.

PORT VILLEZ.

On the following day, after a delightful motor trip along the Seine, we reached Port Villez, near Vernon.

This institution is for the reeducation of the Belgian mutilés, and is under the supervision of the Belgian military authorities. It was erected on land presented to the Government by a Belgian gentleman and is beautifully located. The buildings are wooden "huts" with double walls and cement foundations. There is a steam saw-



Maison Blanche. Farmer, age 23 years, wounded at Verdun. Both thighs amputated very high. After six months' reeducation is able to support himself as a basket maker.



Maison Blanche, agricultural division. Haymaking time.



Maison Blanche. Mechanic, age 25 years. Wounded at Rheims; left forearm amputated. After one month's reeducation begins work at the vise.

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mill, carpenter shop, garage and repair shops, poultry yard, stables, and a large garden. Dr. M. Stassen, formerly practicing in Liège and in charge of the surgical work in connection with a large industrial center there, is medical director of this institution. He received us most cordially and took pains to show us the work in detail. This is a splendid plant and is doing great work. Within a year after its completion, 1,200 men were being trained here.

In the medical department, functional reeducation is carried on systematically. I have already referred to Dr. Stassen's excellent work along that line. While this functional reeducation is proceeding, a man begins a course of general schooling, being classified according to his preliminary education, and also takes up such branch of technical training as he may select. The workshops fill orders for the Belgian Government and the men are paid half a franc or a franc per day while learning. There are courses in toy making, wood carving, leather work, mechanics, plumbing, electrical work, wireless telegraphy, shoemaking, tailoring, saddlery, typesetting, engraving, dairying, truck gardening, and in all the commercial lines. The accompanying pictures give a far better idea of the scope of the work than can mere words.

Considerable success has been attained in teaching massage to the blind. They learn the positions of the muscles by means of wax casts with the muscles elevated. This has been found to be a particularly satisfactory field of work.

GRAND PALAIS, PARIS.

This great art center, occupying a full square on the Champs Élysées, has been taken over by the French Government and has been made the model center of physiotherapy in France. In connection with this hospital, the Union des Colonies Étrangères has organized a school for the industrial reeducation of the disabled. Nowhere is the work of coordinating functional and vocational instruction more successfully carried out. It is an inspiring example of French activity assisted largely by American money. The hospital is excellently equipped, having departments for hydrotherapy, mechanotherapy and electrotherapy, everything which modern science can suggest for making over the damaged body. The guiding principle is to use the muscles and nerves to the fullest extent, increasing the work as the strength returns, and inspire the patients to ever greater effort. And while this physical develpoment is going on, many patients are learning trades and professions, and the mind, as well as the body, is being encouraged to work.

In a great central court the general and special exercises are carried on. There is every variety of apparatus, in the use of which the men are instructed, and equipment for games and sports. Mechanotherapy alone, however, is not sufficient and must be supplemented by hot air, steam, electricity, massage, etc., which have been highly specialized by the French. Blind soldiers who have been trained through the use of plaster casts work in the massage department under supervision. Whirlpool baths are used extensively and highly valued, and electrical treatments, including high frequency, galvanic and faradic currents and violet rays are given by special nurses under medical direction. Radium is used quite extensively and the X-ray is indispensable. The walls of the great halls in which these special treatments are given are hung on one side with patriotic paintings, full of inspiration and appeal to the imagination. On the other side are anatomical charts and drawings showing the gradual steps by which the body is restored and developed from its first state of injury until the patient is able to return either to civil or military life. Hope, encouragement, and patriotism are infused and the effect upon the men is stimulating.

The first treatments given are remedial, followed as soon as the condition permits by remedial and mechanical work with special apparatus, and later supplemented by vocational training. The place is a veritable beehive of activity, the men devoting two or three hours daily to the necessary physical development and the balance in learning trades or professions. There is provision for vocational training for 400 patients at one time, and a wide variety of subjects are taught, such as soap making, glass blowing, shoemaking, tinsmithing, hair dressing, cabinet making, basketry, making and repairing of artificial limbs, commercial branches, such as bookkeeping, stenography, and typewriting, and some of the fine arts, portrait painting, and sculpture, for those who display talent.

The Union des Colonies Étrangères has also established a school for mutilés at 28 Quai Debilly, Paris, one at the Hôtel des Invalides, Paris, and a farm at Juvisy, 10 miles southeast of Paris.

At the Quai Debilly, Dr. Lines, an American, is devoting much of his time to this work, together with M. Binnet. Weekly conferences are held here to determine what the newcomers shall be taught, and where they should be sent for the best training. This is a valuable feature. About 100 pupils are provided for and many branches are taught, but the place is largely used as a sort of clearing house from which the men are sent to other centers for training.

One of the problems confronting those who are engaged in this work is what can best be done for the trephined cases. Dr. Lines says that they are most unsatisfactory as they seem unable to be helped much. They do not seem to fit in anywhere.



Centre d'Appareillage et de Rééducation de Lyon, Hôpital No. 40 Crippled Serbian, left arm amputated, wearing special arm apparatus.

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Centre d'Appareillage et de Rééducation de Lyon, Hôpital No. 40. French mutilé who has lost part of each arm. Pen secured by elastic band.



French mutilé writing by means of special apparatus which holds his pen.

My observations led me to believe that an attempt should be made to repair the defect in the skull in a larger number of these cases, especially where the skin is adherent to the scar of the dura. (See section on trephining.) In going through the various centers it was also apparent that much more could and should be done to increase the efficiency of certain of the mutilés by further plastic surgical work. With the press of other war work, doubtless these must wait for operative treatment until later.

At the school established in the old Hôtel des Invalides, the disabled are being taught drawing, painting, sign making, typewriting, and other branches not involving much physical effort. Many of the patients are chronic cases and too ill to do very much.

The farm at Juvisy, near Paris, provides scientific training in agriculture, stock raising, and machine work. It is an excellent and well-conducted center and one which is doing most valuable work, for after the war France will need trained agriculturists more than almost any other class of labor.

These are but a few of the centers in France where educational work is being carried on and prosecuted vigorously even in the midst of the conflict.

In Great Britain, as said before, the training is being largely undertaken in connection with the trade and technical schools, but this is possible only because of the vast number of such schools scattered throughout the country. Special centers for teaching the blind, such as St. Dunstan's Hostel and its annexes, are achieving great success. In addition to being taught to read Braille, the men learn many special occupations, such as telephone operating, typewriting, massage, basketry, mat making, and poultry farming.

In our own country, using the Grand Palais as a model, such centers should be established as will combine the most advanced methods of functional and vocational reeducation. The value of beginning the latter while the patient is being taught the former is summed up by the experience of France and Great Britain as follows:

(1) Manual work of some kind is chief among the therapeutic agents in restoring functional activity and preparing the stump to use fully the artificial limb.

(2) An interesting occupation tends to restore a normal frame of mind and eliminate moroseness and brooding.

(3) In the selection and fitting of an artificial limb, the surgeon and instrument maker will be greatly aided by knowledge of the special line of work which the patient intends to take up.

(4) After a man is discharged from a hospital and returns home, it is difficult to get him to return to a school for vocational training. The tendency is for him to become *demoralized through the pity*

and adulation of his family and friends and to take the attitude that nothing more should be expected from a man who has sacrificed so much for his country. The insurance to be paid by the Government will seem to many of these sufficient for their maintenance without further effort.

(5) Time is saved and the disabled man becomes a producing factor at an earlier date.

The advice or suggestions of those who are leading in this work would be that while such schools must probably be under military discipline, this should be camouflaged as completely as possible. It should be borne in mind that these men are broken in body beyond complete repair and their future looks most gloomy and dark. They are sick of military routine and resent control. Everything possible should be done to cultivate an atmosphere of cheer and hope. The schools should be near enough to a town or city for entertainment and as much liberty granted as is possible. In selecting the sites it is wise to have not only good sanitary surroundings but, as far as possible, beauty of outlook. The centers themselves, in addition to thorough equipment in every department, should be made homelike and attractive, with amusements and games of many kinds provided. Only thus can the greatest amount of physical and mental health be restored to war cripples.

Miss Harper's report on professional reeducation, above mentioned, contains many suggestions which will be found valuable to those who are considering the system of control and the plan and scope of this work.

ÉCOLES JOFFRE AND TOURVIELLE, LYONS.

As noted before, the École Joffre was the pioneer in this field in France, having been opened with three pupils in December, 1914, through the efforts of M. Herriot. So rapidly did it grow that in 1915 an annex was opened, the École Tourvielle, in the suburbs, and the two schools now accommodate 365 men. École Joffre, in the city, now specializes in commercial training, bookbinding and in the manufacture of toys, while the École Tourvielle, with its charming country surroundings, teaches horticulture and many industrial pursuits. M. Gustave Hirschfeld is the director of the Tourvielle school, and is an authority on the subject of reeducation. The pupils are not undergoing any surgical treatment, but devote their entire time to vocational training. There is no military discipline, and the men appear happy and busy. If a man's conduct is not satisfactory he is dismissed from the school. At Tourvielle tailoring, fur-making, shoemaking, cabinet work, wire-



Centre d'Appareillage et de Rééducation de Lyon, Hôpital No. 40. Mutilé cutting grain.



Centre d'Appareillage et de Rééducation de Lyon, Hôpital No. 40. Arm amputated above the elbow. Mechanical apparatus adjusted to a scythe.



Centre d'Appareillage et de Rééducation de Lyon, Hôpital No. 40. Mutilé using a scythe by means of a mechanical-arm apparatus.



Special seat adapted to leg amputation.

less telegraphy, etc., are taught. The men are paid 1 franc a day while learning, and the profits from the sale of the products of each shop are divided among the workers.

HOSPITAL NO. 40, FRENCH ARMY, CENTRE D'APPAREILLAGE ET DE RÉÉDUCATION, AT LYONS.

After leaving the École Joffre, we visited hospital No. 40, under the Service de Santé of the French Army. This is a large center, and we were accompanied on our inspection by the chief surgeon, Dr. Chatin. Here Serbians, as well as French, are being reeducated. We also visited one of their large farms, just outside of the city. The men are instructed in farm and garden work and many interesting examples were seen of special apparatus adapted to the particular needs. Cabinet work is taught and the blind learn massage.

We saw an Algerian, blind and having lost both arms. When the American money came that was to double the pension of the blind, he requested that it be allotted to his aged mother in Algeria.

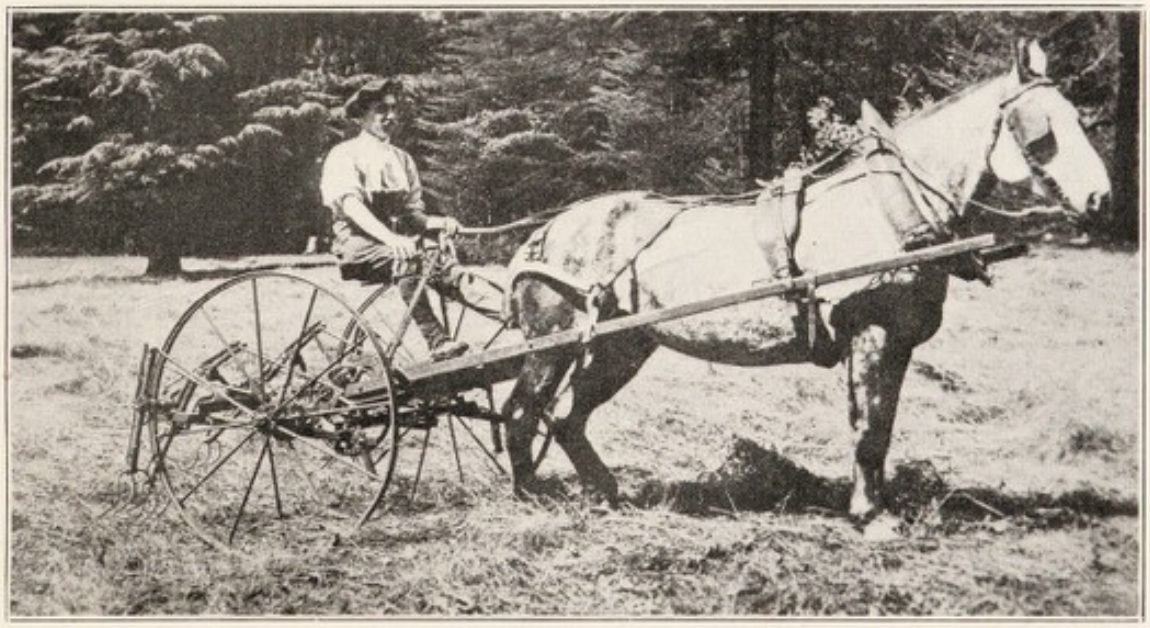
Another man, with his right arm shot away above the middle, is being given special aid by the Red Cross in drawing, as he shows talent. This policy of helping in selected cases has been adopted by the American Red Cross, and is warmly appreciated by the French.

Later we visited the University of Lyons, where there is an exhibition of war surgery, showing wonderful examples of plastic work and special apparatus invented by Julien and Lumiere, the latter of whom invented colored photography. Lyons is justly proud of these men and of its pioneer work in the field of reeducation.

At the Neurological Institute, which we also visited, they are treating cases of shell shock and nerve disorders. Toy making is taught in order to give light and interesting occupation and to divert the minds of the men.



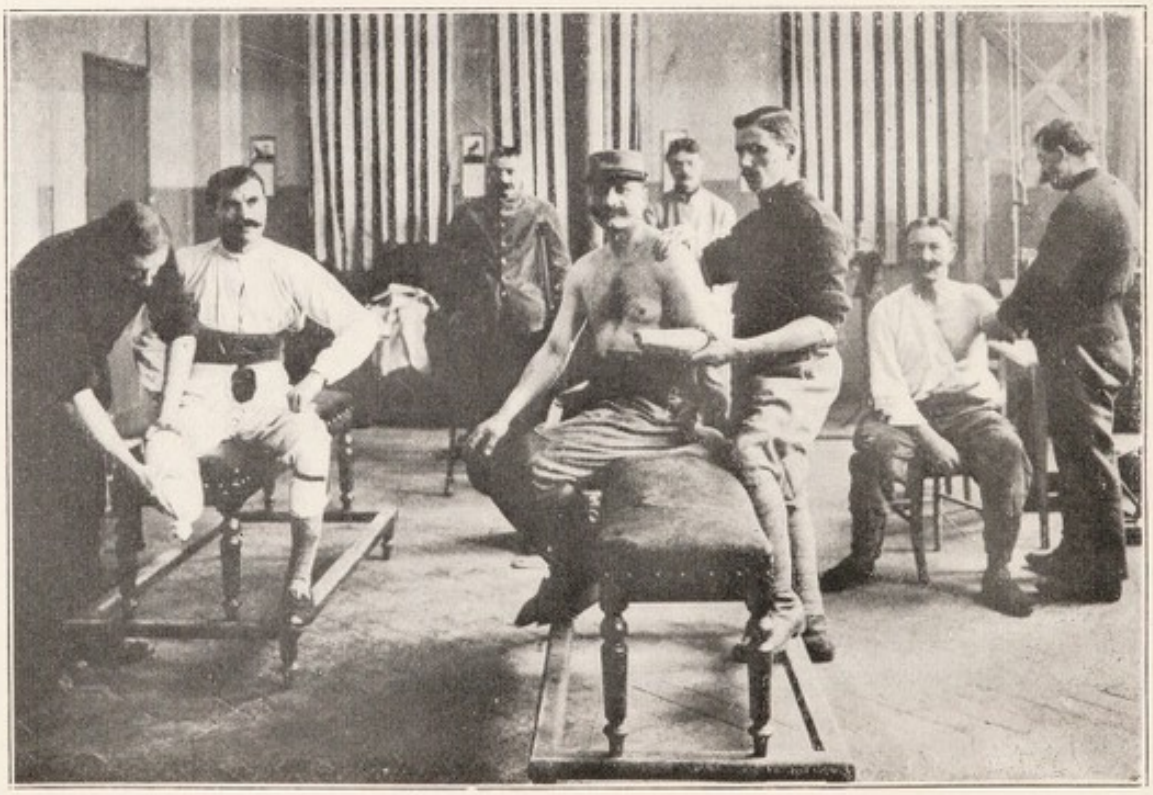
Centre d'Appareillage et de Rééducation de Lyon, Hôpital No. 40. Crippled Serbian, right arm amputated, operating a plow.



This machine has a seat especially adapted to the driver, who has had one leg amputated.



Mutilé driving a plow by means of a mechanical arm replacing amputated limb.



Manipulation of muscles and joints by blind war cripples. Functional reeducation at Centre d'Appareillage et de Rééducation de Lyon, Hôpital No. 40.

CONFERENCES OF SURGEONS.

The undoubted value in peace times of meetings and conferences of physicians and surgeons for the purpose of comparing methods and results is greatly increased to-day by reason of the war. Surgery and medicine are learning many valuable lessons and the fighting forces should have the immediate benefit thereof.

To this end the American Red Cross, through Major Alexander Lambert, chief surgeon, has organized a research society, open to all physicians and surgeons of the allied nations, which meets monthly in Paris, and through papers, discussions, and demonstrations seeks to keep its members closely informed. A journal is published monthly giving the substance of the matters discussed, and a medical library has been established at 12 Place Vendome, Paris, where many of the latest medical books and papers are to be found. Upon request, these are loaned to the various base hospitals.

With the same object in view—that is, the discussion and dissemination of all new ideas in the fields of war medicine and surgery—the inter-allied conferences of surgeons were inaugurated. Delegates from all of the allied countries meet and exchange views and publish their conclusions. There have been four such meetings, and the conclusions of the first and second conferences are annexed hereto; also preliminary outlines of the conclusions of the third and fourth conferences. The full reports of these two have been promised, and when received will be forwarded to the Bureau of Medicine and Surgery.

These conferences have been very valuable and helpful. However, as the speed of a convoy is that of the slowest vessel, so the formal conclusions of a conference are limited to those facts which have been established to the satisfaction of the most conservative member. In general it is well that this should be so, but in this time of great need, when we are reaching forward eagerly toward anything which promises to be of assistance, it seems advisable also to keep in touch with the newer developments and not wait to try them until their value has been proven through long use. For this reason many of the ideas which are still in the experimental stage have been described in this report although not as yet indorsed by the inter-allied conference.

GENERAL PRINCIPLES GUIDING THE TREATMENT OF WOUNDS OF WAR.[1]

I. THE GENERAL PRINCIPLES WHICH SHOULD GUIDE THE TREATMENT OF THE WOUNDS OF WAR, ESPECIALLY WITH REGARD TO THE PREVENTION OF INFECTION AND THE DISINFECTION OF THE WOUND.

1. The medical service should be organized in such a manner as to provide for continuity in the treatment of the patients.

2. At the first-aid posts and to a still greater degree in the trenches, surgical intervention should be reduced to a minimum. It should be restricted to dealing solely with complications likely to prove promptly mortal, and to protecting the wounds from contamination. Wounds at this stage should never be explored or washed, but simply covered with a dry aseptic or antiseptic dressing.

3. It is essential that the patients be transferred as quickly as possible to a field ambulance or casualty clearing station 10 to 20 kilometers from the front.

4. It is of great advantage to establish in connection with the casualty clearing stations one or more special hospitals nearer the front, for the reception of the most serious cases (those of severe shock, grave hemorrhage, and wounds of the thorax and abdomen) at the earliest possible moment.

5. Speaking generally, every wound of war should be regarded as either contaminated or already infected.

6. The aims of treatment should be:

(*a*) To prevent the development of infection if the wound is merely soiled, or to sterilize it if infection has already developed.

(*b*) To close the wound secondarily by suture when "clinical" sterilization has been obtained.

7. The general rule governing the treatment should be free opening up of the cavity combined with resection of all contused and contaminated tissues, and removal of all fragments of clothing or other foreign bodies. No deviation from this rule is justifiable except in certain instances of apparently clean wounds, and then the closest after attention is essential.

8. The procedure above outlined (7) may be followed in some instances by primary closure of the wound, notably in the case of wounded joints. Primary suture is only justifiable when the wound is of some hours' standing only (at the most eight hours), and under circumstances which allow the patient to remain under the observation of the same surgeon for 15 days.

9. If primary closure be not attempted, secondary suture should be performed, when the "clinical" sterility of the wound appears to warrant it.

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[1] Conclusions adopted by the Inter-Allied Surgical Conferences held in Paris, March and May, 1917, delegates from Great Britain, Belgium, France, Italy, Japan, Portugal, and Serbia being present. Published by His Majesty's Stationery Office, London, 1917.



Centre d'Appareillage et de Rééducation de Lyon, Hôpital No. 40. Shoemakers' shop.

10. The progress of the wound should be systematically controlled by a series of bacteriological examinations; thus, a bacterial chart may be usefully constructed and the degree of sterility determined.

11. When circumstances demand the prompt evacuation of patients after the primary cleansing operation, a form of dressing capable of providing a continuous antiseptic action during the period of transport is desirable.

Further researches in the direction of the most suitable form of dressing are highly desirable.

12. Several methods of progressive sterilization of the wound are available, which permit of habitual resort to the method of secondary suture.

II. THE PLACE OF LABORATORY METHODS AS AIDS TO THE SURGEON IN DETERMINING THE ADVISABILITY OF ACTIVE INTERVENTION.

1. An experienced bacteriologist should be attached to every surgical unit of importance, together with capable assistants and a properly equipped laboratory.

2. In the treatment of wounds of war intimate collaboration is necessary between the surgeon and the bacteriologist. The latter should observe the patient's wounds himself, and discuss with the surgeon the researches to be made and the course that should be taken.

3. The researches likely to prove most generally useful are bacteriological, cytological, and humoral.

4. The researches should not be restricted to a narrow scope, but, as a general rule, the following directions are suggested as likely to prove fruitful:

(*a*) The bacteriological condition of wounds immediately after their infliction.

(*b*) The bacteriological condition of wounds before and after surgical intervention, also before and after a prolonged period of transport of the patient.

(*c*) The bacteriological condition of wounds which continue to suppurate, or of those in which complications occur during the course of healing.

(*d*) Bacteriological control of the progress of sterilization of wounds with a view to determining their fitness for closure.

(*e*) Bacteriological and biological control observations of the course of healing of wounds, made with a view to determination of the most efficacious methods of treatment.

(*f*) Examinations of the blood; cultures, counts, tests of coagulability, investigation of defensive properties; the indications for transfusion of blood.

(*g*) Special infections of certain anatomical regions; joints, serous membrane, connective tissue, muscle, brain, cerebro-spinal fluid; bacteriological cytological, and humoral examinations.

(*h*) The general indications for, and application of, vaccine therapy.

5. In addition to these laboratories attached to surgical units to aid in the ordinary practical treatment, laboratories for scientific

research and the study of general questions of military surgery need to be created, or where already existing to be more highly developed.

III. THE COMPARATIVE VALUE OF DIFFERENT METHODS OF LOCALIZATION AS FACILITATING THE EXTRACTION OF PROJECTILES.

1. A complete radiological examination should be made of every wounded man as soon as his general condition warrants it.

2. The extraction of projectiles should not be attempted in the absence of localization by radiology or other means.

3. In hospitals in the front lines, and especially under the press of heavy work, radioscopic methods are the most valuable.

4. It is indispensable that the surgeon should have at hand during an operation some one of the means of localization and control—radiography, stereoscopy, electrovibrator, compass, telephone probe, etc.

5. Radiographic methods are the most useful in permanent hospitals and in times of moderate work.

6. The conference draws attention to the stringent necessity of providing every radiological installation with all the means indispensable for the protection of the radiologist and surgeon from the action of the X-rays.

IV. PATHOGENESIS AND BACTERIOLOGY OF GAS GANGRENE.

(A) *Pathogenesis.*—Under this heading the predisposing causes are considered.

For the moment and from a surgical point of view the most important rôle must be assigned to predisposing causes, because certain of these are more or less amenable to therapeutic measures. They may be divided into two classes: (*a*) General; (*b*) special.

(*a*) *General causes.*—1. Geographical distribution. The frequency of the clinical entity known as gas gangrene is to a considerable extent dependent on the locality in which patients may be wounded.

2. Wounds inflicted by fragments of shells and bombs are the most dangerous variety.

(*b*) *Special causes.*—1. Localization of the injury in the fleshy parts of the limbs, especially in the lower extremity.

2. The special characteristics of the wounds, such as narrow orifices associated with serious deep lesions.

3. The impaction of foreign bodies, especially débris of clothing, which may carry soil with all its contaminations or fecal material with them.

4. Extensive contusion of the tissues leading to mortification.

Other predisposing causes, although of inconstant occurrence, are none the less frequent.

5. Severe comminution of bones, or of fractures implicating joints.

6. The ischemia dependent on injury to large vessels, obliteration of large vessels by ligature, or the prolonged application of the tourniquet.

7. Multiplicity of wounds.

8. The presence of a hematoma.

9. Traumatic shock.

10. The risks of gas gangrene diminish in direct proportion to the efficiency with which surgical measures are carried out, and the promptitude with which the measures are undertaken.

11. Even when surgical intervention has been both prompt and efficient, the occurrence of gas gangrene may be favored by too early evacuation and transport of the patient; or, by the employment of unsuitable methods of treatment, especially dressings which allow the wound to rapidly become dry.

12. Attention should be directed to the investigation of certain factors in the toxemia accompanying gas gangrene, especially acidosis, local or general. Researches in this direction may result in the establishment of indications for treatment.

(B) *Bacteriology.*—1. Researches carried out since the commencement of the war have confirmed the infectious origin of the process, and the anaerobic nature of the organisms that give rise to it.

2. Among the organisms met with, special importance should be attributed to the vibrion septique, *B. bellonensis* (the exact relations existing between *B. bellonensis* and *B. œdematiens* are not yet determined) and *B. perfringens.*

3. The anaerobic infection is often aggravated in its effects by the association of other microorganisms, especially the streptococcus.

4. In consonance with the general principles of bacteriology, attempts should be made to obtain sera active against the organisms enumerated above, with a view to serum-therapy. Such sera have been prepared, and their activity in the case of animals has been demonstrated.

V. TREATMENT OF GAS GANGRENE.

1. Gas gangrene is most often the consequence of delayed or insufficient primary surgical intervention.

2. Prophylactic treatment is of the first importance; it includes rapid evacuation to a surgical unit in order that proper measures may be promptly undertaken, free exposure of the wound cavity in its whole extent, excision of contused or sloughing tissue, removal of all foreign bodies, and careful hemostasis.

3. When the process is localized, whether the tissues are already infiltrated or not, the curative treatment consists in—

(*a*) Complete exposure to the air of all deep recesses of the wound.

(*b*) Excision of all tissue already gangrenous or even open to suspicion.

(*c*) Free incisions in the zone of infiltration, and at the limit of that zone.

4. Amputation is imperative; in the presence of acute massive gangrene, especially when complicated by lesions of the bones, or serious injury to the vessels; also in instances of very rapid extension with threatening general symptoms (rapid fall in tension of the pulse, is a valuable symptom in this respect). The method of choice is the "flush" amputation.

When the amputation can be carried through healthy tissue, English surgeons prefer to fashion short flaps fixed by suture in a position of complete eversion.

When the amputation is carried through infiltrated tissues, additional incisions should be made in the infiltrated zone, extending upward to the limits of the limb or even on to the trunk.

5. Anesthesia procured by a mixture of nitrous oxide and oxygen is the method of choice; failing this, ether should be preferred.

6. When secondary operations or the late removal of foreign bodies are undertaken, the danger of reawakening a laten anaerobic infection must be borne in mind.

To these conclusions M. M. Depage and Derache wish to add that interstitial injections of oxygen, both superficial and deep, above and below the wound, and sufficiently abundant to distend the integument form a useful addition to operative intervention.

VI. TRAUMATIC SHOCK.

Traumatic shock is a disturbance in functional equilibrium, characterized by reactions of the depressing class, which may even extend to death. A fall in the body temperature and in the arterial blood pressure constitute its essential elements.

It is often associated with profuse hemorrhage, or with very acute toxemia, which make it difficult to recognize the part which the shock itself has contributed to the patients' condition.

It may be caused or aggravated by pain, by exposure to cold, or by exhaustion.

If the diastolic blood pressure remains below 60 millimeters of mercury, independently of hemorrhage or toxemia, the patient is in a state of severe shock, and treatment is imperatively indicated; the sphygmo-manometer will afford useful guidance in carrying it out, and the treatment may be summed up in the following propositions:

(*a*) In regimental aid posts, and in advanced dressing stations:

1. Stimulant injections, especially of camphorated oil, in doses of 10 cubic centimeters, repeated every two hours, are often the only resources available for the surgeon.

2. The wounded should be evacuated as far as possible in warmed carriages.

(*b*) In main dressing stations or clearing stations.

The position in which the patient is placed, aids to the recovery of his natural heat, and the reestablishment of his blood pressure are the three essential points of treatment.

(1) The patient must be laid horizontal, or with the head slightly downward; this position will, of course, be avoided in wounds of the chest or brain. Compression may be applied to the limbs by a roller bandage.

(2) It is most important to get the patient warm. Care must be taken that the surface of the body be kept in an atmosphere of about 40 C. (104 F.).

(3) The patient must be kept absolutely at rest. Every useless movement and every source of pain and irritation must be avoided.

(4) Intestinal irrigation drop by drop of isotonic solution with the addition of 10 per cent alcohol is to be recommended.

(5) Attempts should be made to reestablish the arterial pressure by intravenous injections of saline solution either in one massive or in repeated smaller doses. Small doses (250 cubic centimeters at the most) are more useful in true shock without notable loss of blood. The action on the arterial pressure is more lasting when the injection is made at the end of an operation. The later injections will be indicated by the curve of blood pressure, which should be taken every half hour. A fresh injection should be made each time that the blood pressure falls.

As an isotonic solution for injection, the best to use is Locke's liquid:

	Grams.
Sodium chloride	8.0
Potassium chloride	.2
Sodium bicarbonate	.2
Calcium chloride	.1
Glucose	1.0
Water	1,000

The injection is carried out slowly, taking about 10 minutes. In cases where a second injection becomes necessary, a solution containing a higher proportion of calcium chloride than Locke's liquid (hypertonic solution) may be employed. If the pressure falls markedly, the third injection should contain some adrenalin. At the moment of injection mix 0.5 ccm. of a 1-per-1,000 solution of adrenalin with 50 ccm. of the isotonic fluid. The injection is made slowly, never in less than 10 minutes. Every solution of adrenalin must be rejected which is not perfectly colorless. The action of adrenalin or pituitrin is transient. Transfusion of blood seems also to be without effect save in cases of hemorrhage.

IS SHOCK AN INDICATION FOR OPERATION OR A CONTRAINDICATION?

In answering this question, both the gravity of the shock and the nature of the operation must be taken into account.

In a severe case of true shock, without hemorrhage, when the patient is cold and pulseless, the shock must first be treated. The same is true if the operation that is to be practiced is long or complicated, as is the case in abdominal operations. Extensive destruction of limbs necessitating amputation is, on the contrary, an indication for operation.

Local anesthesia, or general anesthesia with nitrous oxide and oxygen gas are the methods of choice. Intraspinal injections have given results varying with different surgeons, especially for amputation of the lower limb. The use of chloroform is dangerous.

The state of shock demands a rapid and simple operative procedure. Care should be taken that before operation, all hemorrhage be stopped, at any rate, for the time.

VII. AMPUTATIONS.

1. Amputation is only indicated when conservation of the limb would lead to the death of the patient, or if eventual loss of the limb is inevitable.

2. The two chief indications of amputation, are: (*a*) Extent of the injury, (*b*) infection.

3. Amputations for infection are always the more dangerous. French statistics of 29,139 amputations, show that the general mortality of 6 per cent is elevated to 28 per cent in case of infection. Again, a review of 3,633 disarticulations furnishes the same result.

4. Amputations of the upper extremity are less frequently indicated than those of the lower. This depends upon the facts that in the upper extremity serious infections are less frequent, resections are followed by more favorable results, and the prospects offered by prosthesis are unsatisfactory to both surgeon and patient.

5. The indications for primary amputation are found in the nature and extent of the injury; pulverization, crushing, partial avulsion of the limb, and especially rupture of the main blood vessels.

6. The indications for secondary amputation are found in massive gangrene either ischæmic or infective. Other extending infections (superficial gangrene) may be treated by conservative measures.

7. Late amputations are most often indicated in cases of chronic infection with cachexia, which do not respond to any form of treatment. Primary amputations or those delayed for 24 or 48 hours, should (having due regard to the gravity of the lesions) as far as possible be made to correspond with the site of the fracture, the soft parts being simply divided and the bone trimmed or rounded off, if necessary. In less serious injuries, the site of the amputation should be as near the seat of fracture as possible. Amputations called for by infection should be performed by the "flush method," or with short everted flaps fixed by suture to the skin of the limb above. When the wound has become sterile and the soft parts have been drawn down as far as possible by extension methods the amputation flaps may be refashioned if it be required.

The technique of late amputations should be guided by the method most likely to adapt itself to prosthetic necessities.

When long fissures run upward from a fracture, the amputation may still be carried through the point of complete solution of continuity, and the fissured portion of the bone retained, due care being exercised in the disinfection of the wound.

1. When shock is severe, nitrous oxide combined with oxygen is the anesthetic of choice; if this can not be obtained, ether should be substituted.

2. As a general rule, shock is not to be regarded as a contraindication to amputation.

3. Provisional hemostasis (by a tourniquet or by preliminary ligature of the main vessel) is necessary and should be complete.

4. The periosteum should be divided at the exact seat of section of the bone, and periosteal flaps should not be raised.

5. In primary amputations, especially those indicated by infection, the wound should be left widely open. Care should be taken not to open up the intermuscular planes. With this object the vessels and nerves should not be followed into the intermuscular clefts but should be cut long.

6. Post-operative measures are mainly directed (1) to disinfection of the field of operation, which should obviate the occurrence of osteomyelitis; and (2) to controlling cicatricial contraction of the flaps.

7. The length of the resulting stump is of more importance than perfection of its coverings.

AMPUTATIONS OF THE LOWER EXTREMITY.

Disarticulation of the hip joint is a more serious operation than amputation through the neck of the femur, even when performed by a racquet incision and with preliminary ligature of the vessels.

For satisfactory fitting of an artificial limb an amputation through the thigh should leave a stump extending 12 to 14 centimeters below the trochanter.

Amputations through the upper fourth of the thigh are difficult to accommodate with an apparatus, in consequence of the abduction of the femur which takes place.

Amputations through the middle and lower thirds of the thigh give good results. The great sciatic nerve should be divided above the level of the flaps.

Gritti's method is only suitable to late amputations.

Disarticulation of the knee joint is a useful provisional procedure.

Amputation through the tuberosities of the tibia gives a good result, as the patient can wear an apparatus fitted to the flexed knee.

Amputations of the leg should be performed at the lowest practicable level. A posterior flap appears to be preferable.

The fibula should be cut an inch shorter than the tibia.

Tibio-tarsal disarticulation with removal of the malleoli, subastragaloid amputation, Lisfranc, Syme, and Pirogoff, all give excellent results.

Chopart's method is only suitable for secondary or late amputations.

Any resection of the bones of the foot which insures a perfect sole and preserves the normal axis of the leg should be preferred to any amputation.

AMPUTATIONS OF THE UPPER EXTREMITY.

In amputations of the shoulder the head of the humerus should be preserved, if possible.

Amputation of the arm should be performed at as low a level as is practicable. Either the circular or the flap method may be employed. Ten centimeters of the humerus are necessary for a useful stump.

In the forearm every effort should be made to preserve a lever at least 10 centimeters in length below the elbow joint and to maintain the movements of pronation and supination.

In the hand, whenever possible, trimming operations should be adopted, since every segment which can be preserved may prove of great service.

Movements of the joints above an amputation and attention to the nutrition and mobility of the muscles should be maintained during the whole course of cicatrization.

The application of artificial limbs should be prompt and a provisional apparatus should always be insisted upon, especially in the case of the lower limb.

The "cinematic method" may sometimes be indicated in amputations of the arm and forearm.

VIII. PROSTHESIS.

1. The aim of prosthesis (of mutilated men) should be both functional and esthetic, that is to say, function should be reestablished and, if possible, the form of the missing member also. The mutilated man needs to be reeducated both functionally and professionally.

2. Prosthesis should be prompt. For the lower extremity measures should be commenced as soon as the state of the amputation wound permits. The use of crutches should be restricted as far as possible. To allow the patient to walk before cicatrization of the stump is completed provisional apparatus should be worn in place of crutches. The best of such apparatus are those devised by the surgeon himself.

3. For the upper extremity the apparatus should be made of leather strengthened with metallic bands.

They are of the following varieties:

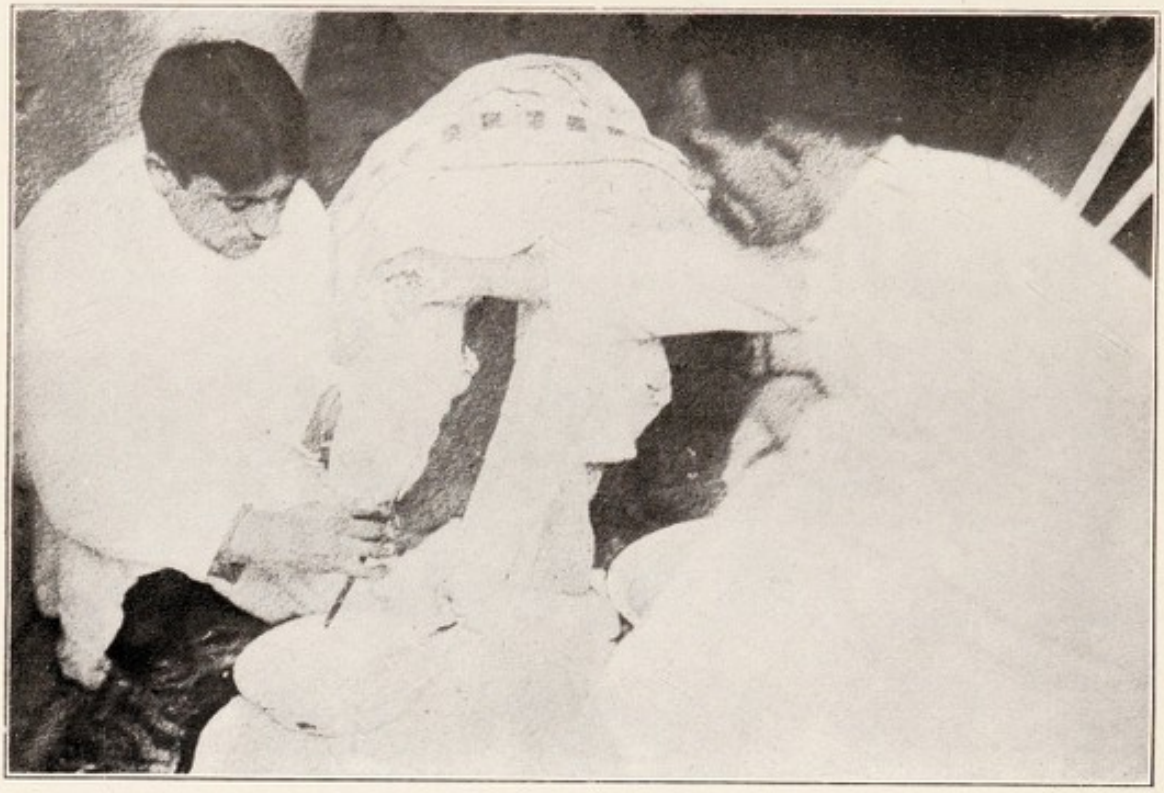
(*a*) Provisional (bras de secours). A working apparatus, simple, light, and cheap, which may be worn by a craftsman until his amputation stump is perfect.

(*b*) A permanent apparatus (bras de travail-parade), more esthetic and more complicated than (*a*), but at the same time stronger and more useful.





Preparation of temporary artificial limbs.





Preparation of temporary artificial limbs.

These include: (1) Means of attachment to the shoulder and thorax (leather shields, corsets, waistcoats, furnished with straps and buckles), to which an armlet of leather is added for amputation stumps of the forearm; (2) a bucket which ensheathes the stump, to which tools can be attached and onto which an artificial hand with a mobile thumb (automotor) can be fixed.

4. For the lower extremity the form of apparatus differs as to whether the stump has not already assumed its permanent shape and proportions (a period of 12 months may be required for this change), or whether this stage of development has been reached.

(*a*) For stumps during the period of evolution the apparatus should be of leather strengthened by metal bands, which have the advantage of being able to be adapted to changes of shape as they develop. These include: (1) Means of suspension and fixation (pelvic band, braces for thigh amputations, thigh bracelets for amputations of the leg). (2) A bucket which ensheathes the stump and by which the weight of the body is received and borne during walking; the upper margin of the bucket must be padded and exactly fitted to the points of support; to the bucket either a pin leg or an artificial limb is attached, provided with a foot and articulated at the knee, movements of the joint being either free or controlled by a bolt.

In the Belgian Army no intermediate apparatus is provided, the provisional apparatus being retained until the stump is fit for a permanent artificial limb.

(*b*) For fully developed stumps the bucket of leather, strengthened with metal, is replaced by one of more rigid material (wood in American apparatus; wood shavings built up with a special cement in Belgian apparatus; poroplastic, sheet iron, etc). These buckets are much lighter, simpler, and more durable than those of leather reinforced by metal bands. The interior of the bucket must be exactly modeled to fit the surface of the stump and the prominences which serve as points of support for the limb when the apparatus is worn. The artificial limb should reproduce accurately the form of that removed, and thus serve to preserve the normal balance and attitude of the body. It should also be provided with joints permitting movements approaching those normally possible.

IX. FRACTURES.

(A) CHOICE OF SPLINTS.

1. In the treatment of fractures of the shafts of the bones fixation takes priority over reduction.

2. The mode of immobilization to be chosen is of three varieties, thus:

(*a*) Provisional immobilization at first-aid post.
(*b*) Definite immobilization at the casualty clearing station.
(*c*) Immobilization for purposes of evacuation and transport.

The provisional method should as far as possible coincide with that to be definitely adopted, and the latter should be such as to allow of safe transport of the patient.

3. Fixation apparatus should be of such nature as to permit the employment of mechanical extension of the limb, free access to the wound, if present, and safe evacuation of the patient.

Fractures of the arms.—(*a*) Provisional immobilization of the first-aid post. Splints of the Thomas type, or crutch splints (bequillons), afford excellent results. Their general employment throughout the armies is much to be desired.

(*b*) Definite immobilization. The provisional splint may be retained, or splints permitting abduction of the limb and capable of adjustment (les bequillons extensibles) are useful for the definite immobilization.

Fractures of the fore arm.—(*a*) Provisional immobilization at the first-aid post. A metallic gutter splint flexed at a right angle at the elbow, or a simple wooden splint suffice.

(*b*) Definite immobilization. The fore arm should be fixed in a position of supination, the apparatus should allow of the application of extension, and variation in the degree of flexion of the elbow.

These indications are fulfilled by splints of the types of Thomas, Sinclair, or Hey Groves, interrupted plaster of Paris with metal bands, or Vamelvede's splint.

Fractures of the thigh.—(*a*) Provisional immobilization at the first-aid post. The best splint is the Thomas. An arched support should be attached to the foot of the stretcher and the limb slung in order to avoid the heel resting on the stretcher and being pushed forward.

(*b*) Definite immobilization. The apparatus chosen should allow extension, abduction, and flexion of the limb (splints of the Thomas type, suspension apparatus such as Sinclair's or the Anglo-American. The apparatus of Delbet or Alquier). Delbet's apparatus allows the patient to walk at a very early date. The presence of multiple wounds, an inconvenient seat of fracture, extent of the lesion, or intolerance of any of the ordinary splints, justify the employment of Finochietto's stirrup. When combined with a Thomas splint, this stirrup permits transport of the patient with a properly extended limb.

Fractures of the leg.—(*a*) Provisional immobilization at the first-aid post. Thomas splints, metallic gutter splints, or wooden splints are suitable.

(*b*) Definite immobilization. The apparatus chosen should permit the application of mechanical extension. Interrupted plaster splints with lateral metallic-screw extension supports and a movable posterior metallic band; all the suspension methods in which mechanical extension can be maintained; and Thomas splint are suitable.

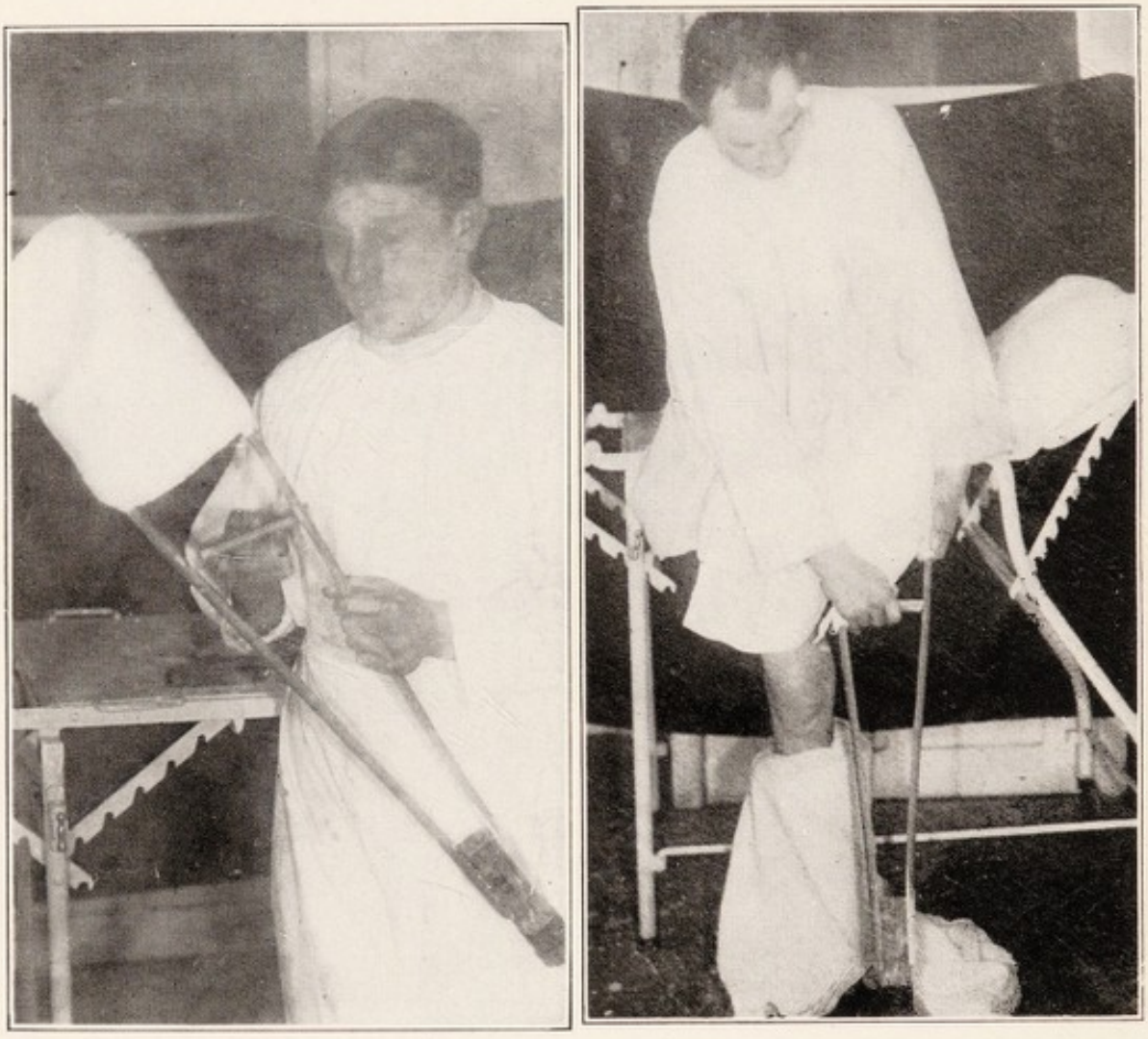
It is of advantage to allow the patient to commence to walk at the earliest possible date. The apparatus which most surely attains this object is that of Delbet, in which, if necessary, one of the lateral plaster bands can be replaced by an arched metal support to allow of proper access to a wound. Finochietto's stirrup alone or in combination with a Thomas splint is indicated for employment in fractures of the leg under the same conditions as those above enumerated for fractures of the thigh.

Fractures of the wrist.—(*a*) Provisional immobilization at the first-aid post. A grooved metallic splint, or one of wood, serve to secure the necessary immobility.



Preparation of temporary artificial limbs.

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Preparation of temporary artificial limbs

(*b*) Definite immobilization. Robert Jones's splint is excellent.

Fractures of the ankle.—(*a*) Provisional immobilization at the first-aid post. A metallic gutter splint is the best.

(*b*) Definite immobilization. An interrupted plaster splint with loops across the gap obtains perfect immobility, and the same splint allows the patient to walk.

Robert Jones's metallic splint serves the same purpose. If the definite apparatus requires to be removed for purposes of transport, it should be replaced by a plaster-of-Paris splint.

(B) SURGICAL TREATMENT OF FRACTURES.

1. At the first-aid post the treatment comprises:

(*a*) Dressing the wound.

(*b*) Immobilization.

(*c*) Immediate treatment of such complications as shock and hemorrhage.

Immobilization of the limb is attained by provisional means (see "Choice of Splints")—blind laths, wooden splints, metallic splints.

2. At the casualty clearing stations every fracture should be examined radiologically or otherwise, and the wounds cleansed by operation if necessary.

(i) Limbs hopelessly damaged and gangrenous parts should be amputated; when practicable, through the seat of the fracture.

(ii) In traversing bullet wounds with small openings of entry and exit, without intervening swelling or lesions of the large blood vessels, the fracture should be immobilized by the application of a Thomas splint, a metal gutter splint, or plaster of Paris. The wound should be treated aseptically. The patient should be kept under observation for seven days, and if signs of either local or general infection appear the fracture should be exposed.

(iii) Every other form of fracture should be submitted to primary operation.

(*a*) Treatment of the wound: The soft parts should be sufficiently opened up to thoroughly expose every extension of the wound, and contused and contaminated tissue and all foreign bodies must be removed (see "Section on Wound Treatment in General").

(*b*) Treatment of the bones at the seat of fracture: Treatment of the comminution is the main task; splinters absolutely free or those lightly attached and driven into surrounding muscle should be cautiously removed. In every case the periosteum should be respected and preserved. Irregular bone ends which may endanger neighboring vessels should be rounded off with cutting forceps. The choice of the solutions employed for washing the wound is left to the surgeon concerned, but Dakin's fluid or ether are the two most generally relied upon.

The wound may be closed primarily or secondarily by suture.

In point of fact, primary suture is rarely resorted to, and only under the following conditions: A really experienced surgeon, proper equipment, a period of military calm, a wound of not more than eight hours' duration, slight

damage to the bones and soft parts, even if excision of all the contused tissues has been carried out, ready approximation of the wound surfaces without tension, and conditions which allow the same surgeon to take charge of the patient until the wound is firmly united.

The most favorable regions for primary closure are the face, the scalp, the flat bones, the patella, the hand, and the foot.

On the first sign of any trouble the wound must be opened up and disinfected.

Secondary suture should follow a progressive sterilization of the wound.

The Carrel-Dakin method, and also that of Rutherford Morison have been successfully employed with this object.

3. Fractures should not be evacuated during the period of acute infection.

4. Reduction of the fragments into good position is effected either by operation, position of the limb, or extension, and the result should be controlled by X-ray examination.

5. Fractures which it proves impossible to maintain in good position may be treated by direct mechanical fixation. These operations should not, as a rule, be undertaken until the seat of fracture is free from infection.

6. Uniformity in the methods of treating fractures in the hospitals at the front and on the lines of communication is essential, if the best results are to be obtained.

7. Mobility of the joints, muscles, and tendons of limbs which are the seat of fractures, should be striven for during the whole duration of the treatment, and efforts to maintain these conditions should be commenced at as early a period as possible.

X. WOUNDS OF JOINTS.

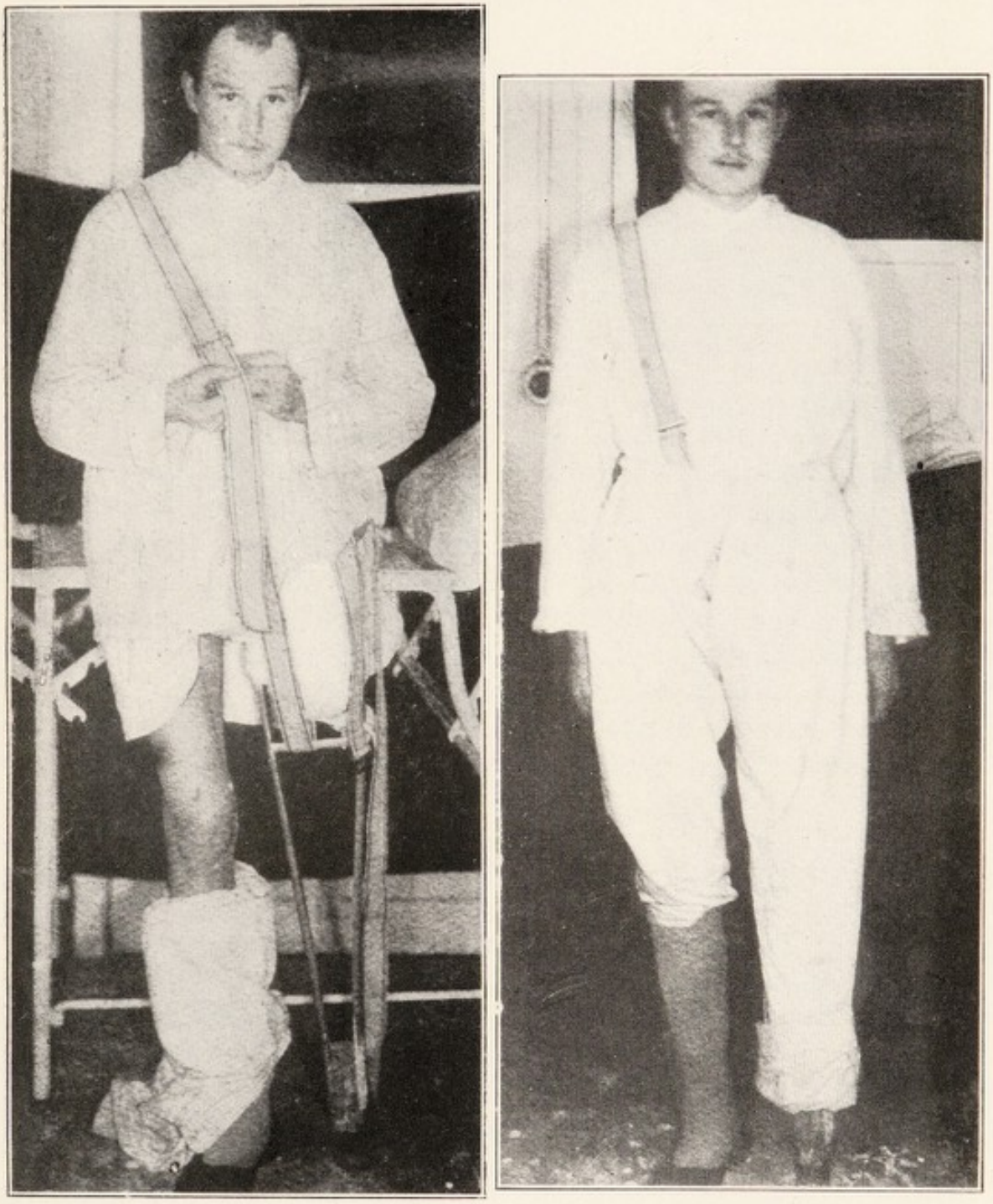
1. At the dressing station wounds of the joints should be immobilized with great care, in an appropriate apparatus.

2. At the clearing station all injured joints in which the wound is extensive, the joint tissues are lacerated, or the missile is retained, and especially when a fracture is present, should be operated upon, if possible, in the first six or eight hours. The French surgeons extend this rule to all cases, except certain bullet wounds with a punctiform orifice and without fracture.

3. Radioscopy is indispensable in every case.

4. The operation should include a wide aseptic arthrotomy, with excision of the track, complete exploration of the joint, systematic removal of foreign bodies and splinters, and cleaning and curetting of the lesion in the bone. This should be followed either by complete closure or by closure of the capsule with superficial drainage. A compressing dressing should be applied.

5. Resection, typical or atypical, should only be practiced when there is considerable damage to the bone. In the knee the operation



Temporary artificial limb.

should be primary, whereas in the elbow and shoulder secondary operation is preferable.

6. In severe suppurative arthritis the first measure should be a wide arthrotomy with complete immobilization and progressive disinfection of the wound. If this treatment fails, then resection should be practiced, with at first, separation of the articular surfaces by extension. In very grave cases immediate resection is required. M. Gosset recommends a simple operation, with a compressing dressing by cotton-wool pad, without immobilization. MM. Depage and Tuffier recommend rigorous immobilization for 8 or 10 days, after which mobilization should be begun. MM. Willems and Derache consider that mobilization should be begun much sooner.

XI. WOUNDS OF THE BLOOD VESSELS.

The projectiles of war may give rise to (*a*) contusions; (*b*) wounds of the blood vessels. The wounds may consist in complete severance, lateral wounds, or pure perforations. Contusions may be followed by thrombosis, which accident often remains undiscovered until it is manifested by the occurrence of an embolism or a secondary hemorrhage. Wounds of the vessels are usually indicated by severe external hemorrhage if the wound of the soft parts is open and extensive. When the wound is situated in the course of a narrow track a diffuse hematoma commonly results. At a later date, when the patients arrive in the hospitals on the lines of communication or at the base, traumatic arterial and arterio-venous aneurysms may develop as a consequence of vascular lesions which have been previously overlooked or have escaped treatment.

Treatment.—1. Arterial thrombosis should be treated by ligatures placed upon the vessel above and below the limits of the clot. Arteriotomy and evacuation of the clot should not be performed.

2. Wounds of the vessels accompanied by external hemorrhage demand treatment which commences at the first-aid post and is completed at the field ambulance or casualty clearing station.

At the first-aid post the procedure is governed by the severity of the bleeding. If the amount of blood escaping be small, compression may be made above or over the wound itself. If the hemorrhage is severe a tourniquet may be applied.

Every patient on whom a tourniquet has been placed must be marked with a distinctive label and evacuated promptly to either the field ambulance or casualty clearing station for immediate operation. When conditions render the period likely to be occupied by transport uncertain, or the journey is long, the bleeding vessel should be controlled at once either by ligature or forci-pressure.

At the field ambulance or casualty clearing station, as a general rule, the bleeding point should be exposed and a ligature placed

above and below the wound of the vessel on undamaged tissue. The ideal procedure is to restore the integrity of the vessel by suture, either lateral or circular as the conditons may demand. The circumstances favorable to the method of suture are, a limited and easily accessible lesion, and an aseptic wound suitable for immediate and complete closure.

3. Secondary arterial hemorrhage should be treated by ligature of both ends of the injured vessel. If this be impossible, forci-pressure may be resorted to, or proximal ligature of the main artery. If all these methods fail, amputation is the ultimate resource.

4. In cases of diffuse arterial hematoma, provisional hemostasis should first be effected by a rubber tourniquet, or by exposure and temporary occlusion of the main vessel above the arterial lesion; the hematoma is then opened freely and the wound in the vessel sought for. Ligatures are applied immediately above and below the wounded point, or, when possible, the arterial wound should be closed by suture. Conditions favorable to the latter procedure are rare.

When the lesion is seated on an artery the occlusion of which may be followed by insufficient establishment of the distal circulation (axillary, common carotid, common femoral, popliteal), the two ends of the wounded vessel may be connected by a silver tube coated with paraffin. The tube is tied in position and removed at the end of four or five days, after ligature of the artery above and below. This procedure gives time for a progressive enlargement of the collateral circulation, and thus diminishes the risk of gangrene.

Diffuse hematomata are not rarely complicated by gangrene. Contrary to what has until now been believed, simultaneous ligature of both artery and vein when both vessels have been wounded, does not give rise to increased risks of gangrene, in fact, it diminishes them. Facts tend to prove even when the wound is limited to the artery, that simultaneous occlusion of the unwounded vein is to be recommended.

5. For traumatic aneurysms, after effecting provisional hemostasis, the sac should be laid open. This procedure gives direct access to the primitive lesion and allows the vessel to be ligatured immediately above, and below it, thus insuring the safety and non-exclusion of collateral branches which may arise in close proximity to the injured point.

(*a*) For arterial aneurysms; ligature above and below the point of communication with the vessel should be followed by complete, or when not practicable, partial removal of the sac. Here, again, suture of the opening in the arterial wall is the ideal procedure if it be realizable.

(*b*) For arterio-venous aneurysms; a more frequent and less dangerous form than the arterial, and less frequently complicated by gangrene, the ideal operation consists in extirpation of the sac, and reestablishment of both the arterial

and venous channels by suture. In practice, complete or partial extirpation of the sac followed by ligature of the four ends of the implicated vessels, is more commonly resorted to.

XII. INJURIES TO THE NERVES.

1. It is indispensable that all lesions of the peripheral nerves should be investigated with the greatest care in the hospital at the front when the wound is subjected to primary treatment; both with regard to the clinical signs present, and direct examination of the nerve trunk itself.

2. Whenever a divided nerve trunk is discovered, it should be united by primary suture, if the condition of the wound permits. A special note describing the operation performed should accompany any patient so treated when he is evacuated.

3. If primary suture is impracticable, or if the lesion has been overlooked, the nerve should be united at the same time that secondary suture of the main wound is undertaken.

4. Either the primary or secondary operation may suffice to obtain restoration of function; but should they fail, the operation has, at least, insured that the trunk is placed under the best conditions for later intervention.

5. At a still later date, any functional deficiency due to a nerve lesion may be a proper subject for operation by the surgeon after consultation with a neurologist.

6. During the whole course of treatment, care must be exercised that the limb is kept in good position, and that the mobility of the joints and the nutrition of the muscles is maintained.

7. Operations on the nerve trunks of whatever character (freeing from adhesions, neurolysis, suture, etc.), demand the maintenance of perfect asepsis, and punctilious care and delicacy in the manipulation of the nerve itself.

8. For purposes of suture the nerve ends require to be refreshed or resected until healthy tissue is exposed; the peripheral end should appear normal and free of all fibrous tissue which would be an obstacle to regeneration.

9. Direct contact of the refreshed nerve ends appears necessary for regeneration; but in the present state of knowledge, suture of approximated ends or union obtained by splitting off a part of the peripheral end is still worthy of trial.

10. Nerve grafting has not up to the present time afforded any striking results.

11. Under certain circumstances nerve suture may be replaced by tendon transplantation: (1) When nerve suture is impossible; (2) when the functional result attained by nerve suture is unsatisfactory.

XIII. WOUNDS OF THE SPINAL CORD.

1. At the dressing station apply the usual dressing and combat the shock phenomena which cord injuries frequently present.

2. At the clearing station:

(*a*) If there is a bullet wound with punctiform orifice, the wound should be dressed and an expectant line of treatment adopted.

(*b*) If there is a shell wound with a large wound of entry, it is best to treat the wound in the usual manner, but not to interfere with the spinal lesion.

Evacuate the patient as soon as possible. French surgeons recommend a "bonnet-gutter splint."

3. At the base: From the therapeutic point of view, here are two quite distinct categories of cord injuries:

(*a*) Those with complete section of the cord for which surgery is of no avail.

(*b*) Those with compression of the cord by the projectile, by splinters, by dislocation, or by meningeal hemorrhage. These form the only class in which operation can be of assistance.

From the point of view of prognosis, a complete distinction should be made between lesions situated at the level of the cord itself, or those at the level of the cauda equina.

Intolerable pain is a factor to be taken into account when considering the question of operation.

4. When to operate:

(*a*) In the majority of cases primary intervention should be rejected. In the Italian Army they have adopted, in cases of bony compression or of retention of the projectile in the spinal cavity, the principle of intervention at the earliest moment possible for removal of projectiles, pieces of clothing, clots, and splinters in order to free the cord and the spinal veins. The mortality of these primary operations is very high. To diminish the severity of the operation and to preserve the stability of the spinal column, surgeons in the Italian Army prefer to practice unilateral laminectomy.

(*b*) Secondary operation should be performed after healing of the wound.

XIV. WOUNDS OF THE BRAIN.

1. At the dressing station wounds of the brain should be covered with a simple aseptic dressing.

2. Men wounded in the cranium and brain should be evacuated according to the apparent gravity of their lesions:

(*a*) Where there is large loss of substance with severe general symptoms, to the nearest possible hospital.

(*b*) If the lesion appears less severe and the general symptoms are not threatening, the patient should be evacuated to an operating center provided with a surgeon and a neurologist, where he can be retained for a considerable time.

(*c*) The operation should be undertaken early.

3. A brain case should not be evacuated under three weeks after being trephined for cranio-cerebral injury.

4. The skull must be submitted to radiological examination and the projectile and fragments of bone carefully located.

5. When fracture is not manifest and there is no cerebral symptom, the indications for operation are still disputed.

6. Local anesthesia for the operation is the method of choice. The sitting position has the advantage of diminishing hemorrhage; it is specially suitable for secondary and late operations.

7. The wound is freed by resection of its edges. It is enlarged according to the seat, the direction, and the form of the bony lesions.

8. The breach in the bony substance must be enlarged beyond the limits of cerebral contusion with a gouge forceps, or exceptionally with a trephine, never with a mallet and chisel.

9. If the dura mater is intact it should be left alone, and, in favorable cases, the wound may be united by first intention. If the dura is torn, its edges must be trimmed and the opening enlarged to the limit of the focus of cerebral lesion.

10. Clots, diffluent cerebral matter, and superficial foreign bodies must be removed under a current of warm saline solution. Deep splinters and projectiles easily accessible must be removed with the greatest possible precaution.

11. Very small projectiles deeply situated and difficult of access, projectiles of larger volume lying on the base of the skull or in the ventricles, and those which lie in the hemisphere of the opposite side to the lesion should in primary operations be left alone.

12. In through and through wounds, each orifice should be suitably treated and the deep portion of the track left alone.

13. It is best not to put any tube or gauze plug in the cerebral substance. A cranio-cerebral wound can be treated by primary suture or by secondary suture after sterilization. Further research is needed to show which of these two methods best protects against immediate, secondary, and late septic accidents.

14. When the patient recovers from the shock of the operation he should be placed in a half sitting position.

15. Early cerebral hernias without deep infection should be treated by enlargement of the breach in the bone.

16. Thin scars with large losses of bony substance, and those which give rise to cerebral troubles, should be treated by plastic operation.

17. Secondary accidents should be treated according to their origin (cerebral abscess, foreign bodies, adherent cicatrix) by operation appropriate to each of these conditions, and after consultation between a neurologist and a surgeon.

XV. PENETRATING WOUNDS OF THE CHEST.

1. The mortality attendant on penetrating wounds of the chest in military hospitals may be estimated as 20 per cent.

2. The immediate mortality in the front lines is greater in consequence of deaths from hemorrhage and asphyxia.

3. The later mortality is usually a result of infection and consecutive pleuropneumonia.

4. The anatomical lesions of the lungs resemble those met with elsewhere as a consequence of gunshot wounds. The mechanical damage is the same; the infections are the same, except for the fact that the pulmonary tissue is more resistant than any other; but the gravity of the pulmonary lesion is greatly aggravated by coexisting infection of the pleura, whether extending from the external wound or the lung.

5. The treatment is dominated by two factors, (1) early intervention and (2) absolute rest for the patient.

While the primary condition of shock persists, the general treatment of shock should be adopted.

A large number of patients suffering with these wounds recover as the result of medical treatment alone, and no complications, either early or delayed, develop.

Surgical treatment should be directed to care of the wound in the thoracic parietes and to dealing with early or late complications.

In every instance thorough treatment of the injury to the thoracic parietes (wound of the soft parts, fractured ribs, etc.) is, as in the case of all other gunshot wounds, absolutely necessary.

(1) *Early complications.*—(*a*) Open thorax: Prompt closure of the aperture in the parietes either by plugging or direct suture is essential.

(*b*) Hemorrhage: When the chest is open, bleeding must be arrested either by plugging or direct suture of the lung.

When no patent opening exists, if the arterial tension falls progressively, and it is proved that the fall does not depend upon shock but must be attributed solely to internal hemorrhage, the ideal procedure consists in thoracotomy and direct hemostasis of the bleeding lung. The necessity for intervention of this character is extremely rare, and such operations must not be undertaken except by a highly skilled surgeon with access to every operative convenience.

(*c*) Hemothorax: Puncture or aspiration of a recent hemothorax is indicated only when it is necessary to relieve obvious signs of mechanical compression. It is advantageous to replace the evacuated blood, either during or after aspiration, by air or by oxygen introduced with the view of maintaining the collapse of the lung, with consequent decrease of the risk of recurrent hemorrhage.

When a hemothorax is accompanied by fever, it is justifiable to make repeated exploratory punctures for the purpose of bacteriological examination of the fluid.

(2) *Late complications.*—(*a*) Persisting aseptic hemothorax: This form of hemothorax should be treated by repeated aspiration with a view to facilitating expansion of the lung. Replacement of a certain proportion of the evacuated fluid by oxygen is a very useful measure.

(*b*) Infected hemothorax: When bacteriological examination proves infection to have taken place, a thoracotomy is indicated.

(*c*) Empyema: A purulent pleurisy is to be treated on the same lines as an infected hemothorax. When drainage of the pleural cavity is necessary, the opening should be located at a dependent point of the posterior part of the base of the thorax.

6. Treatment of purulent pleurisy by progressive sterilization of the pleural cavity.

Either recent or chronic empyemata may be treated by progressive sterilization of the pleural cavity and secondary suture of the drainage aperture. There is no reason to fear the result of closing the opening in the thoracic wall before the lung is expanded and the cavity filled up, for this procedure is the most successful method of inducing rapid expansion of the lung and obliteration of the pleural cavity (Depage).

7. In cases of urgency demanding operative intervention, retained projectiles should be removed when they can be readily found.

8. The prophylactic treatment of pleuropulmonary infections by direct surgical treatment of the wounded lung (extraction of foreign bodies and suture of the pulmonary wound, with or without excision of the bounding tissue), seems a logical procedure in any circumstances. The question merits attention and should be carefully studied.

9. Hemopericardium: Effusions of blood into the pericardial cavity are susceptible of treatment on the same lines as have been laid down for those into the pleural space.

XVI. ABDOMINAL WOUNDS.

1. As a general rule all recent wounds of the abdomen should be operated upon systematically except when it is certain that the injury is limited to the liver or kidney and there are no symptoms of severe hemorrhage.

2. The operation should be performed as early as possible, except in patients in a state of shock. When there is a doubt between shock and hemorrhage it is better to operate than to refrain. Laparotomy should not be practised systematically later than 36 hours after the time the patient has been wounded.

3. Centers provided with full necessary surgical equipment, to which abdominal wounds can be quickly brought for operation by competent surgeons should be formed as near as possible to the line.

THIRD INTERALLIED SURGICAL CONFERENCE.

(November, 1917.)

At the Third Interallied Surgical Congress, which sat from November 3 to 8 at the military section of the Val-de-Grâce, under the presidency of M. Justin Godart, undersecretary of state for the Service de Santé, six questions were raised on which numerous conclusions were based, some of them of great importance.

With regard to the first, secondary, and delayed complications of wounds of the brain, surgeons agreed that delayed infection of such wounds is much rarer than was commonly supposed; that organic disturbances following wounds of the brain, e. g., hemiplegia, monoplegia, aphasia, visual disturbances, frequently have a tendency to spontaneous improvement; and that epilepsy, if amenable to surgical intervention when a foreign body or splinters of bone are present, is not so in other cases. In cases of cerebral hernia lumbar puncture should be avoided during the acute febrile phase in order to avoid the possible dissemination of a local infection. Foreign bodies tolerated by the brain may be left. Cranioplasty is only indicated in cases where the extension of the cicatrix is the sole cause for the symptoms observed, except in the frontal region for esthetic purposes.

The second question dealt with the later results of treatment in the case of fracture of the shaft of the femur. A primary sterilization of the wound is the chief factor to realize. Stiffness of the joints of the knee, hip, and foot can be avoided by early movement. Adherence of muscles to callus is the origin of many disturbances of function necessitating freeing by surgical methods. Strongly marked deviation is amenable to osteotomy, with resection of the callus if there is osteomyelitis.

The third question referred to operation for injuries to nerves. The congress admitted that the ultimate results are not generally satisfactory, especially in the case of total lesions, and when the operation takes place among suppurating tissues. Primary suture of a nerve in a milieu rendered aseptic by modern methods has given better results. Functional recuperation is slow, occupying months or even years, a fact which must be taken into consideration in working out compensation.

The treatment of fracture of the joints (fourth question) has made great progress since primary sterilization has been the object aimed at and operative measures initiated within 10 to 12 hours. Com-

minution of the epiphysis is to be treated by gouging out and cleansing followed by immediate suture of the joint. Early resection is only indicated in exceptional cases where severe comminution is present. Primary amputation is limited to cases of extreme contusion with destruction of the principal artery. Immediate active movement gives better results than immobilization.

The fifth question deals with the treatment of chronic osteomyelitis, which should be mainly preventive and completed either by immediate closure of the wound after removal of all sequestra or by chemical sterilization with secondary autoplasty.

With regard to thoraco-abdominal wounds (sixth question), the congress gave special attention to wounds of the diaphragm. Radioscopic examination is necessary to recognize hernia of the abdominal organs and determine the displacement of the heart. Operation is nearly always indicated, and a transpleural route by way of the thorax is generally to be preferred, associated with laparotomy when desirable. (Lancet, London, Dec. 15, 1917, p. 908.)

TREATMENT OF WOUNDS IN WAR.[1]

I. TRANSFUSION OF BLOOD.

The results obtained by the transfusion of blood justify its being looked upon as the method of choice in the treatment of serious hemorrhages.

(*a*) *Early.*—The clinical condition of the wounded man affords the main indications for transfusion, and in the advanced posts must alone be depended upon, but additional information may be obtained from repeated observation of the blood pressure, and by red blood cell counts which are of value in wounds of the limbs. In circulatory collapse due to a very acute infection (gas gangrene) no favorable result has been observed after transfusion. The indications for transfusion in the treatment of shock have not yet been sufficiently defined.

(*b*) *Later.*—Corpuscular anemia after hemorrhage is generally well borne, and does not justify transfusion if the general condition of the wounded man is satisfactory. On the other hand, secondary hemorrhage, diminution in the coagulability of the blood, failure of regeneration of the corpuscles, and chronic infections causing anemia, may afford indications for transfusion.

PRELIMINARY PRECAUTIONS.

(*a*) *Risk of transmission of diseases.*—Donors should be examined and classified in order to avoid transmission of diseases such as syphilis or malaria.

[1] Fourth Inter-Allied Surgical Conference held at the Val-de-Grâce, March 11–16, 1918. From Brit. Med. Jour., April–May, 1918.

(*b*) *Incompatibility of corpuscles.*—Fatal results have been observed in cases in which the corpuscles of the donor were agglutinated by the plasma of the recipient. Such results are rare, and can be completely avoided by agglutination tests which can easily be extemporized. This being so, it is indispensable to examine the agglutination in all cases in which the circumstances render it possible or to have the donors classified beforehand. At advanced posts it is justifiable to resort to transfusion, even if it be impossible to test the agglutination, as the risk of serious results is relatively small; but it should be tested in all other units.

(*c*) *Asepsis.*—Transfusion should never be undertaken unless an appliance in perfect condition is available and unless strict asepsis is possible.

METHOD.

The method of transfusion employed should make it possible to measure the quantity of blood transfused. The use of blood which has been preserved for several days has given satisfactory results, and has proved specially valuable in advanced posts during intense military activity. Indirect methods for the transfusion of fresh blood are more easy to employ than vascular anastomosis. The three indirect methods have all given good results, namely, the use of citrated blood, the aspiration of pure blood into an ampoule treated with paraffin, and its aspiration in a syringe. The general principle should be to practice transfusion as early as possible after the receipt of the wound, but it must not be employed until hemorrhage has stopped. In hemorrhage from thoracic or abdominal wounds or wounds of the limbs, transfusion should be practiced either before or during the operation, the time of transfusion depending on the condition of the wounded man.

II. TRENCH FOOT.

1. Trench foot is a pathological condition provoked by moist cold and complicated as a rule by secondary infection.

2. The disorder presents four stages, as follows: (1) Painful anesthesia; (2) œdema; (3) phlyctenules; (4) sloughing. Three clinical forms may be described: (*a*) Slight (85 to 90 per cent of the cases), characterized by painful anesthesia, œdema, and redness; (*b*) moderate (13 to 14 per cent), characterized by phlyctenules and limited sloughs; (*c*) severe (1 per cent on an average) characterized by extension of sloughing and the appearance of septicemic complication. This form may produce serious mutilation or death.

3. Trench foot, especially the more serious forms, is not infrequently complicated by tetanus or gas gangrene, and relapses and recurrences may take place. Trench foot occurs almost exclusively in

soldiers who live in the trenches, more particularly in certain trenches. Soldiers coming from hot countries, dark-skinned races particularly, are more frequently attacked than Europeans. (In Italy soldiers from the south have suffered more often than soldiers from the north.) Youth, hyperidrosis, and a previous attack are predisposing causes.

4. Blood stasis due to prolonged standing, to long immobility, and to a bad attitude (stooping), compression of the leg and interference with the venous circulation, particularly by puttees, and more especially remaining long in cold and damp (muddy and flooded ditches and shell holes), are the principal causes of trench foot.

5. Trench foot may be confused with true frostbite and with chilblains. True frostbite is characterized by sudden massive mortification of a part of a limb (the front of the foot, the whole foot, etc); trench foot, on the contrary, is characterized by limited destruction (gangrenous patches on the dorsum of the foot, the sole, or the toes) and by progressive invasion of the tissues of the foot. Frostbite is met with in severe dry cold, especially in mountainous regions. Trench foot occurs only in damp weather and at low altitudes (valleys, plains); it disappears in frost. Chilblains are characterized, at any rate in their early stages, by very severe itching, whereas those forms of trench foot—that is to say, the slight forms—which are liable to be confused with chilblains produce painful anesthesia without any itching. It has to be admitted, however, that sometimes the diagnosis between ulcerated chilblains and the ulcerated phlyctenules of trench foot may be doubtful.

6. The treatment of trench foot is preventive and curative. Preventive treatment energetically applied and supervised may be followed by the disappearance of cases of trench foot, or may at least render them very rare. The treatment includes (*a*) collective measures, hygiene, and draining of the trenches, gratings, trench boots, dry warmed shelters, with, if necessary, frequent reliefs; and (*b*) individual preventive precautions taken daily (drying, cleansing, and massage of the feet, change of socks in the shelters, supervision of puttees, and of everything which can cause compression of the lower limbs). Belgian medical officers attribute the extreme rarity of cases of trench foot in their army to the disuse of puttees. The curative treatment of trench foot includes the following measures: (*a*) Slight cases; a warm foot bath should be taken every two or three days and the feet washed with boric camphor soap. A large moist boric camphor dressing should be applied to the foot every day. (*b*) Severe cases; when phlyctenules only are present they should be opened and touched with camphorated ether, and a moist boric camphor dressing applied. If there are sloughs the same treatment should be persistently applied. Sloughs should not

be removed with the knife; they should only be scarified, without causing bleeding, so that the drugs used may act on the subjacent tissues. Spontaneous separation must be awaited, and complications carefully watched and thoroughly treated surgically and fully at their onset. The principle by which operation ought to be guided is that it should be late and confined to the rectification of stumps which are defective from a functional point of view. Amputation should be performed only in cases in which the surgeon's hand is forced by serious general complications. In every case preventive antitetanic treatment should be used (injection of antitetanic serum repeated every week until the wound is cicatrized).

III. THE TREATMENT OF WOUNDS OF THE PELVIS, AND OF THE BLADDER AND RECTUM IN PARTICULAR.

Of the pelvis alone.—The general principles are the same as for war wounds of soft and bony parts. Comminuted fractures of the ilium call in particular for large trephining. The removal of projectiles or bony fragments which are often driven into the psoas and iliacus muscles is particularly difficult, and must be carried out systematically.

Of the bladder.—(*a*) Intraperitoneal wounds are amenable to laparotomy and suture; (*b*) extraperitoneal wounds, if suprapubic, should be treated by primary suture of the bladder. Wounds of the walls or base of the bladder inaccessible to operation do not entail immediate cystotomy as a matter of routine. Surgical treatment of the wound of entry and of its track will assure sufficient drainage. Later on tying in of a sound will favor the closing of the urinary fistula. Primary cystotomy should be reserved for wounds of the bladder with retention or progressive perivesical infiltration. Serious hematuria or the presence of a foreign body in the bladder justify early cystotomy. Secondary infection of the bladder calls for cystotomy with drainage.

Of the rectum.—(*a*) Intraperitoneal wounds, like all other wounds of the intestines, are amenable to laparotomy with suture; (*b*) the majority of cases of extraperitoneal wounds should be treated by the laying open of the traumatic center, followed by plugging of the rectal wound. An indispensable adjuvant to this treatment is to keep the bowels constipated. In rupture with extensive detachment the method of choice is free opening up, with, if necessary, posterior rectotomy. Primary colostomy is only exceptionally required.

Combined wounds of bladder and rectum.—The greater number of cases will recover under surgical treatment of the extravesical tract of the projectile. Colostomy should be reserved for cases in which the communications between the bladder and rectum are very exten-

sive. Primary cystotomy is often useless; the tying in of a sound, ventral decubitus, and micturition in the genu-pectoral position favor spontaneous closure of the vesico-rectal fistula.

IV. TREATMENT OF PSEUDARTHROSIS.

1. The unavoidable cause of false joints in war fractures is the primary destruction of a part of the diaphysis. The other causes which actually have to be taken into account are infection, excessive removal of splinters of bone, and bad reduction, and these ought to disappear. A certain number of false joints can be avoided by sterilization of the seat of fracture, prudent removal of fragments of bone, good reduction carefully supervised, and in certain well-defined cases by immediate or early fixation of the bones.

2. Save in exceptional cases, false joints should only be operated upon after a considerable interval, when the skin wound is completely cicatrized, and when clinically the existence of buried organisms should be investigated by all means at our disposal, such as forcible active and passive movements, elastic bands, vigorous massage, etc.

The following note is added at the request of Sir Arbuthnot Lane:

(*a*) In cases in which the lower end of the femur, or the upper end of the tibia, or both, are removed, the treatment may differ according to the occupation of the wounded man. In workmen an attempt should be made to obtain ankylosis between the femur and tibia either directly or by means of a graft; in men following sedentary occupations a false joint fixed by an apparatus which permits of flexion may be more advantageous. Either of these two conditions is preferable to amputation of the thigh and an artificial limb.

(*b*) In a case in which there has been extensive loss of substance of the lower end of the humerus, the elbow being intact, it is often desirable to obtain a false joint permitting flexion between the humerus and its shattered lower end, leaving rotation to be produced at the radio-humeral articulation. This condition is more useful and permanent than that given by resection of the elbow.

3. From the point of view of treatment two conditions are to be distinguished: (*a*) In simple false joints and in certain examples of false joint with a loss of substance in the part of a limb containing only a single bone, it is possible, after freshening the bone in the manner that pathological anatomy suggests, to unite the bones by a metal plate. The best method appears to be fixation with a metal plate, using screws, the screws being placed as far as possible from the false joint. The combination of the use of the metal plate and of an osteo-periosteal graft has given very good results. (*b*) A false joint with loss of bony substance usually requires a bony or osteo-periosteal graft.

4. Perfect asepsis. Complete excision of the fibrous tissue which surrounds the fragments and of any diseased portions of the bones are conditions indispensable to success.

The following note is added at the request of Sir Arbuthnot Lane: An additional means of detecting and eliminating the persistence of infection is the use of autogenous or stock vaccine.

V. CONSERVATIVE OPERATIONS ON THE FOOT.

As it is very desirable to maintain the integrity of the sole, incisions or resections through it should only be performed when absolutely necessary. Every endeavor should be made to obtain primary union in every case. The same considerations apply to the dorsal surface of the foot when cicatricial contraction might interfere with the functions of the sole of the foot. It is even justifiable to resect certain bones in order to permit primary or secondary union and the maintenance of the skin of the sole in its normal condition. Amputation of one or several toes causes little inconvenience. The preservation of one toe, especially the first or the fifth, is often embarrassing. Disarticulation of the metatarsal bones, with preservation of the corresponding toes, generally gives bad results. Resection of the first and fifth toes, with their metatarsal bones, generally gives a satisfactory result. The result of preservation of the great toe alone, with its metatarsal bone, is not generally good. Excision of the second, third, and fourth metatarsals produces a narrow foot, and walking and standing are seriously impeded. As a general rule the loss of three metatarsal bones seriously upsets the mechanism of the foot. The results of amputation through the metatarsus with a good plantar flap, whether performed through the anterior or posterior part of the metatarsus, are very favorable. After Lisfranc's disarticulation walking may be easy and even elastic if the remainder of the foot is in good condition. As it is a difficult operation, it may be simplified by leaving the bases of the metatarsal bones. Prescaphoido-cuboid amputation gives good functional results. In short, all the operations through the front of the tarsus give good results if there be no complication due to the cicatrix or the conditions of the articulations. Chopart's amputation when done under good conditions and carefully watched may give a good result, but the equinism and the displacement of the stump often cause functional troubles which render it inferior to the amputations of Lisfranc and Syme. Partial resections of the astragalus and calcaneum, or horizontal resection of the calcaneum, check the tendency to equinism. Amputation below the astragalus (Pirogoff's amputation and more especially Syme's) leaves the patient able to walk easily and quickly. On the other hand, operations on the posterior tarsus are very often

followed by functional difficulties. Total or subtotal excision of the astragalus gives good results, but they are not so good as those obtained in peace; the causes of failure are infection of neighboring tissues, stiffness of joints and tendons, and insufficient supervision of the attitude of the foot after operation. Excision of the whole or greater part of the calcaneum, if bony regeneration does not take place, leaves a bad condition, very frequently attended by tibiotarsal or mediotarsal ankylosis. Partial resections, whether posterior or inferior, give less unfavorable results if the foot is well maintained at a right angle during the whole course of treatment. Combined resection of the calcaneum and the astragalus gives usually a bad result.

Atypical operations.—Resections of the anterior part of the tarsus involving the scaphoid and cuboid are often followed by equinism, with valgus or varus, or falling in the arch of the foot. The functional condition can be greatly improved by an orthopedic boot. The seriousness of the consequences of excision of either of these bones seems to be about equally great. The results of atypical operations on several bones of the anterior part of the tarsus are determined much more by the degree of preservation of the arch of the foot, the strength of the points of contact of the sole with the ground, and the preservation of the action of joints and tendons than on the site of the operation itself. Vicious positions of the foot, if the joints be freely movable, can be cured or improved by the division or transplantation of tendons. Transplantations are particularly useful when certain tendons have been destroyed. Some vicious positions with ankylosis call for secondary operations on the bones (resection of the cuneiform or astragalus). In short, conservative operations on the metatarsus are good, but in the posterior tarsus excision of the calcaneum or resection of several bones often cause functional disturbances which are graver than those following disarticulation or a Syme's amputation.

(Prof. Depage points out that in suppuration of the joints of the tarsus persisting in spite of excision of the astragalus, an operation turning the foot forward and inward by extensive section of tendons and ligaments, and the maintenance of the position by means of a bandage, favors disinfection of the suppurating focus. The foot can be replaced in the normal position after a week or a fortnight.)

VI. FIXATION OF COMPOUND FRACTURES.

A distinction must be drawn between a primary operation for fixation of a compound fracture and an operation performed during the period of infection.

Primary fixation.—The possibility of applying primary suture or delayed primary suture to a great number of wounds complicated by

fracture justifies in principle the immediate fixation of compound fractures, but the indications for the operation are uncommon. They are:

1. In certain fractures of joints in which the operation appears to be a method of choice to obtain anatomical and functional restoration.

2. In fractures of shafts which are irreducible or can not be maintained in correct reduction (especially subcondylar fractures of the femur, fractures of the arm, etc.) and when large displaced fragments of bone are present.

Modern improvements in splints, however, render it possible in the majority of cases to obtain satisfactory adjustment without a fixation operation. Primary fixation is a difficult operation which exposes the patient to grave complications; it should be performed only by surgeons who have specialized, and at the present time the indications for it are uncommon. In the British Army it is not the custom to have recourse to a primary fixation operation, for two reasons: (1) The good results now obtained with splints; (2) the bad results which fixation operations have often given in the past.

Fixation during infection.—Operation for fixation during infection is accepted by some, but expressly rejected by others; those who accept it hold that it lessens the infection at the seat of fracture, is not accompanied by prolonged osteomyelitis, and is rarely attended by secondary sequestra. The results obtained, as a whole, are favorable. The indications for the operation would be the impossibility of reducing certain fractures of shafts or of maintaining them in correct reduction. Nevertheless, modern improvements in splints render possible such satisfactory reduction that fixation by operation is rarely indicated. Temporary fixation by means of plates and screws commands a majority of suffrages.

VII. ANALYSIS OF THE METHODS OF WOUND STERILIZATION.

These contributions, according to a note in La Presse Médicale, No. 21, 1918, page 194, are to be published only in extenso.

AUXILIARY FORCES.

1. AMERICAN RED CROSS.
2. Y. M. C. A.
3. KNIGHTS OF COLUMBUS.
4. Y. W. C. A.
5. SALVATION ARMY.
6. JEWISH WELFARE BOARD.
7. ROCKEFELLER FOUNDATION.
8. AMERICAN LIBRARY ASSOCIATION.
9. SERVICE UNITS IN FRANCE, BELGIUM, AND ELSEWHERE.
10. UNIVERSITY UNIONS.
11. AMERICAN COLLEGE WOMEN'S UNITS.
12. OTHER ORGANIZATIONS, USUALLY FOR CONSERVATION OF EFFORT AND EFFICIENCY, COORDINATED WITH THE ABOVE.

The Honorable Secretary of the Navy, Josephus Daniels, a short time ago, spoke of the Young Men's Christian Association, the Red Cross, and similar organizations as "part of the militant forces of the country second only to the men who meet the deadly fire of the enemy."

Through the broadening of our horizon, modern warfare has come to be recognized as a conflict between whole nations, every individual being intimately concerned in the struggle and its outcome. Anything which seriously affects the civil population is reflected directly in the morale of the fighting forces, and any potent factor which helps the allied peoples in the great struggle is an auxiliary force, whether preventing disease in the trenches, nursing the wounded, fighting tuberculosis in the crowded cities of France, or caring for the starving children of Belgium.

Inasmuch as it was my privilege to see the splendid work of many of these agencies, this report would be incomplete without some mention of them. If it were possible within the limitations of time and space, it would be a pleasure to endeavor to present by photograph and word picture an epitome of their work. But nothing short of a very considerable volume would be at all adequate for such an attempt. Everywhere the unselfish and humanitarian service of America through the Red Cross, the Y. M. C. A., and the many other agencies at work is recognized as a great source of help to our own fighting men as well as to our allies.

Working in the devastated districts, helping the homeless to reconstruct their habitations, caring for the destitute refugees, aiding the poor repatriated, conserving the health of the civil popula-

tion, carrying on an educational campaign of how to prevent tuberculosis and at the same time furnishing ways and means for the relief of those who have already contracted the disease, lending material assistance to local charities, acting as an emergency depot for Army and Navy, nursing the sick and caring for the wounded, affording healthful recreation and amusements, helping to keep the men fit for fighting, aiding those at home who are in need and thus relieving the soldier or sailor of worry, furnishing comradeship, giving useful information, opening opportunities for the study of what will be of value now and later, becoming the banker and the means of sending home money, furnishing food and hot drinks when needed, housing the men, saving the babies by proper care and adequate food, teaching the mothers how to do the best for their infants, even showing the children how to play and grow strong in war time, writing the last letters home, and often marking the grave or photographing the spot and sending the picture home to the family—all these and many other details of the vast work of these forces I met in my survey. On the ships, in the camps, along the railways, at the depots, all the way to the front, even up where real danger lurks were these same forces rendering services of which we may justly be proud and for which multitudes are devoutly thankful.

It would seem that nothing has been left undone, no stone left unturned to aid the men in the service and the great cause of humanity. It is an earnest, understanding, tireless civilian army that stands behind the men at the front; the hearts, brains, and hands of our whole country are seeking to serve in new and more helpful ways and to furnish everything that will make for efficiency. comfort, and mental and physical happiness. There is nothing spasmodic or uncertain about the movement. It is a concerted effort inspired by a pure love of service and with one great objective—*to win the war and establish a permanent peace.*

MISCELLANEOUS.

AMBRINE.

MODERN TREATMENT OF BURNS.

The modern treatment of burns is essentially a paraffintherapy and was introduced by Dr. Barthe de Sandfort. His "secret" consists of paraffin with an addition of succinite (oleum succini) or oil of amber, and belongs to the Ambrine Co., in Paris, France. Equivalent preparations have since been offered, notably Hull's "Paraffin Seven."

Application of ambrine.—Wash the burns with sterile water, and after drying cover or spray the surface with a layer of ambrine; place a thin layer of cotton wool over the parts and then apply a second coat of ambrine. Applied to the skin, the preparation immediately solidifies into a tough tissue-paper like film.

In the application of ambrine with a spray, as preferred by the originator of the method, the paraffin must be at a temperature of about 50 C. (122 F.). A metal spray producer is in use in the British Navy Medical Service (Brit. Med. Jour. I, 1917, p. 549). A small slat of the ambrine is put into the apparatus and heated, either over a spirit lamp or in a water bath, up to the temperture at which the ambrine melts. The bellows of the spray producer is then adjusted, and the liquid wax is pumped as a very fine spray onto the burnt surface, which has been previously dried thoroughly. A cake of wax forms over the surface, and is both air-tight, and from the heat at which it is applied, aseptic. A thin layer of cotton wool is then laid on this wax and the whole is again covered with the liquid wax by a brush.

The directions for the use of ambrine as they come with the original package are as follows:

According to the extent of the burn or wound, melt in the water bath 10 to 100 grams of ambrine in a small receptacle. Heat about 10 minutes in the water bath, then take out the receptacle with the liquified ambrine. After it has slightly cooled spread the ambrine over the lesion with a small soft brush, with a spraying not a sweeping motion. The ambrine should be used as warm as the patient will tolerate it. When applied it at once solidifies and will form an adherent layer. The brush dipped in ambrine should be passed several times over the same spot so as to produce a sort of varnish

of several superimposed layers. Cover this varnish with a layer of absorbent cotton, as thin as possible, moistening it likewise with ambrine, and again passing the brush over the cotton layer so as to drench it thoroughly with the ambrine. In case of large wounds, small surfaces should be treated in this manner and joined together. The crust formed by the ambrine and the thin layer of cotton promptly becomes solid and impermeable and is then covered like all dressings with a layer of cotton held in place by a bandage.

The remnant of ambrine in the receptacle will serve for the next dressing, as ambrine may be liquified several times in succession without losing any of its properties.

Certain precautions are to be observed, as follows: Guard against even a drop of water from the water bath penetrating into the ambrine. Do not place the layer of absorbent cotton directly on the wound, but first place several layers of ambrine on the wound. During the first days, in extensive burns, renew the dressing every 24 hours; later on, when the exudation diminishes, one dressing in 48 hours will suffice. To remove the dressing, cut with scissors the ambrine cast and the thin layer of cotton. Wash the wound with ordinary boiled water, using no antiseptics, or only in very weak solutions. Do not pack the wound with pledgets of absorbent cotton, but gently touch the surface with a cotton wipe so as to guard against bleeding from the granulations. Dry the wound if possible with a current of hot air or with absorbent cotton without rubbing, before beginning the next dressing. Do not mind a grayish appearance or unpleasant odor of the wounds; under the serous exudate, new skin is often seen to appear.

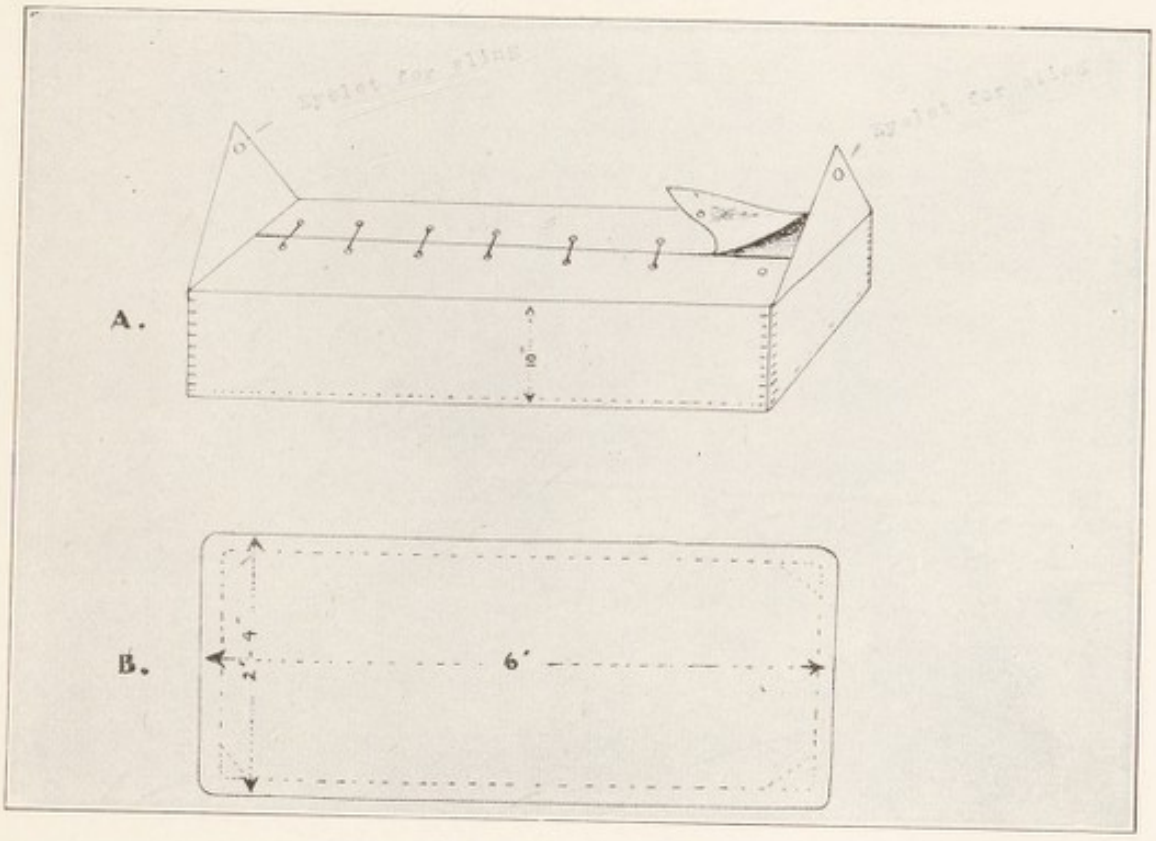
The employment of ambrine represents an important advance in the treatment of burns. While the preparation is not an antiseptic, and has no therapeutic effect upon the tissues, it at once relieves the severe pain and forms a film-like covering over the burned surface, replacing the epidermis and acting as both a protecting and purifying factor, for it tends to collect in its substance any foreign contaminating material to which such wounds may be exposed.

Plastic procedures in modern surgery are accomplishing most remarkable results in the serious deformities following the scars of burns, not only in the lessening of disfigurement, but also in the ultimate restoration of functional efficiency.

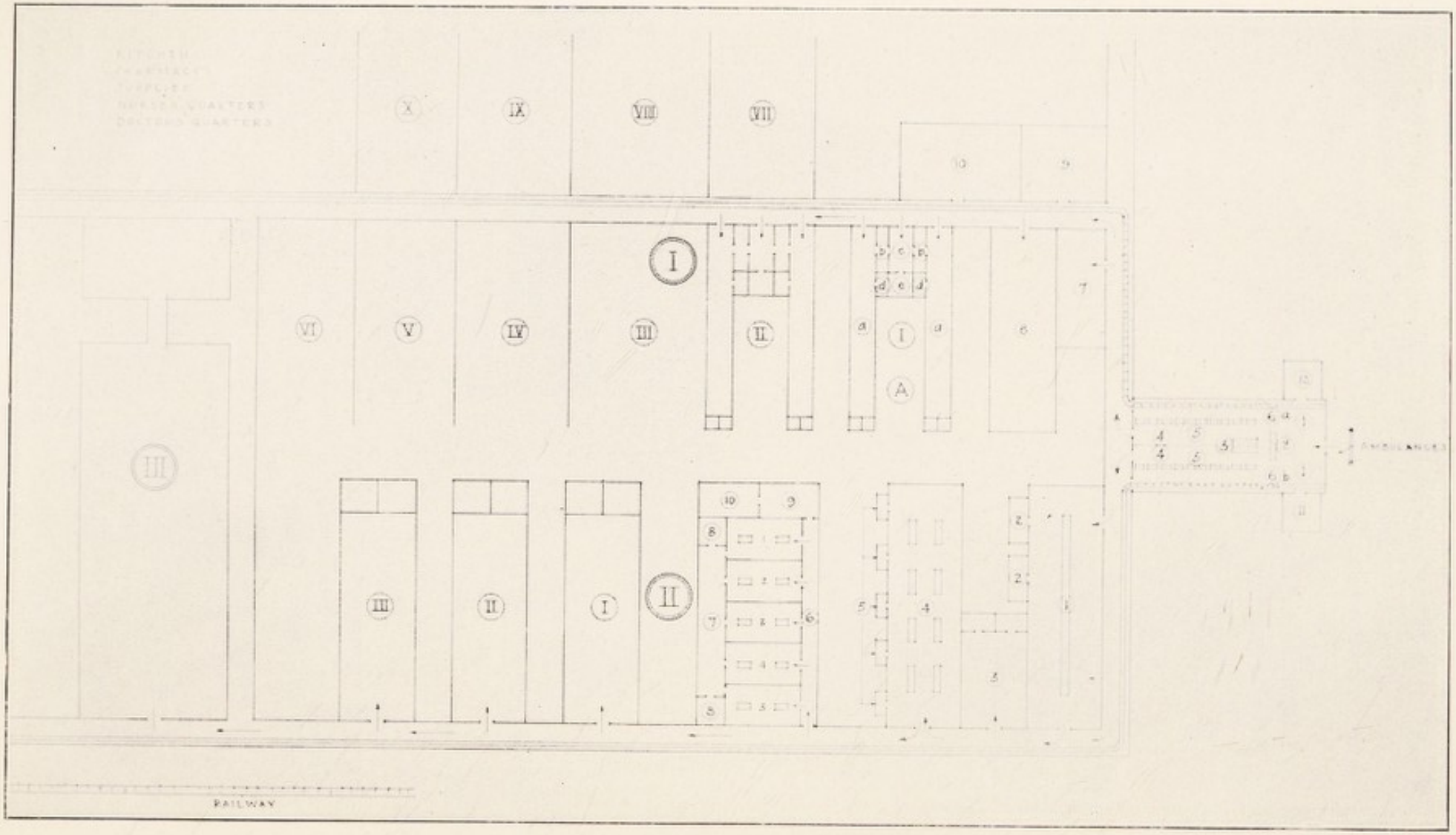
PROVISIONAL LEGS.

The great importance of early temporary apparatus for the amputated leg cases has been repeatedly emphasized.

The following pictures taken at the Hôpital Bon Secours, Rouen, show a simple and excellent method of making a proper provisional leg while the patient is still in the hospital under treatment.



Sketch of canvas cot.



Le Play's surgical evacuation hospital. Plan.

PLAN FOR SURGICAL EVACUATION HOSPITAL FORMATION.

The attached illustration of a plan for an evacuation hospital to meet the exigencies of the present war has been worked out by me from a sketch and data furnished by Lieutenant Albert E. Le Play, of the French Army, developed by him from his experience of over three years at the front in France, Roumania, and Belgium. By many the plan is considered to be the best so far evolved, and it has been recommended for adoption to the Bureau de Santé. It embodies the best features of the evacuation hospitals now in use in France, with some additional points of value. A study of the sketch will give a clear idea of the more important conditions and problems to be faced in a center of this kind.

It has seemed wise to include this plan in the report because of its value in affording a graphic illustration of some phases of hospital work in the war.

Dr. Le Play is now attached to the French-American Mission as liaison officer for sanitary service with the Fourth French Army at Chalons-sur-Marne.

The following are his views:

1. Such an evacuation hospital should be situated—
   - A. Twenty to 25 kilometers from the front line.
   - B. Not in a town, but only a short distance away from one.
   - C. Away from any railway.
2. Four red crosses, adequately large, should be placed at the four extremities of the hospital site.
3. It is best to have the section for the severely wounded on the unit plan so that the same staff of nurses and surgeon with assistants can take care of the cases and at all times know where they are without confusion and loss of time.

Colonel Gosset agrees with all of this scheme with the exception of the unit plan for the severe cases and of the situation of such a hospital, which he thinks should have its base 30 to 40 kilometers from the front, instead of 20 kilometers.

KEY TO SKETCH OF LE PLAY'S SURGICAL EVACUATION HOSPITAL PLAN.

1. Two or three doctors examining soldiers.
2. The bar, serving hot drinks.
3. Table, with doctors giving antitetanus; nurses, etc.
4. Walking patients.
5. Lines of tables, with clerks taking the names and data for the record and home.
6. Railways for stretcher cases.
   - 6a. Severely wounded cases, which must remain in the hospital—thigh, brain, abdomen, and lung cases.
   - 6b. Cases which may be evacuated.

(11) }
(12) } Depot for arms, etc.

I. Central for all Severe Cases.

7. X-ray room.
8. Warm ward for shock.
9. Laboratory.
10. Sterilization room.

One surgical unit:

(*aa*) Two wards—50 beds.
(*bb*) Two dressing rooms.
(*c*) One operating room with 2 tables.
(*dd*) Two small rooms for nurses.
(*e*) One small room—dressings and supplies for operations, etc., with a window as a door.

II. Cases Which Can be Evacuated in a Few Days.

1. Long table in a large room, with places for stretchers and chairs; this room is essentially for the soldiers to take off their clothes.
2. Depositories for soiled clothes.
3. X-ray room.
4. Washing and cleaning room.
5. For soiled underclothes.
6. Operating rooms—5 units (can have 6 or 7 if needed).

(A unit consists of 2 tables; 1 operator; 2 assistants. Three units can be used for operations and 2 for dressings.)

7. Central sterilization room for all operating rooms.
8. Supply rooms.
9. Plaster splints for fractures, etc.
10. Dining room for the surgeons. (They work often 8 to 10 hours at a stretch, and must have this room near at hand.)

III.

Large wards: One-half for beds; one-half for a sitting room; tables. Clean clothing is given here.

I, II, III, etc.: Wards, as many as desired; 24 with 50 beds each.

In an average rush time, about 5 to 10 per cent go to I; about 30 per cent go to II; and about 60 to 70 per cent go to III.

PROPOSED ORGANIZATION OF EDUCATIONAL SERVICE IN WAR SURGERY.

A personal communication from Prof. Tuffier, whose name is too well known to require introductory comment, contains a number of such valuable suggestions for the organization of war-surgery services that, although intended primarily to meet conditions as they exist in France, a brief summary of his plan can not fail to prove helpful on this side of the Atlantic, where the erection of sanitary institutes and reconstruction hospitals for our returning soldiers is already under way. The teaching possibilities of war hospitals are practically unlimited, and it is not only desirable but imperative that such facilities, be utilized to the fullest possible extent; aside from other considerations, for the reason that the exodus in search of

higher professional education on the part of medical students and post-graduates to European universities is probably largely a thing of the past. "The old order changeth" making place for the new.

Briefly commenting on the administration of the post-bellum establishment, as planned by Tuffier, it may be stated that at its head would be placed a director, with full administrative power, having under him two groups of assistants (two executive officers and two secretaries), and two operating surgeons, to be appointed by the director, with two surgical teams, in charge of the two surgical services. Provision could be made for as many demonstrators as might appear desirable. Consulting specialists would be called upon as required by the operating surgeon.

With special reference to the opportunities for instruction in medicine and surgery afforded by an institute of this kind, a feature of the highest importance would be the establishment of courses in operative technique and other branches. The work would include attendance at clinics and practical experience with methods of wound dressing, demonstration, and application of apparatus, with some special daily feature of surgical interest, for example, transfusion of blood and comparison of the different methods in use. Ample provision should be made for practical work along the line of bacteriological examination of wounds. Theoretical and practical instruction in the selection and preparation of material for dressings used in war surgery would be included in the course.

At the present writing, the teaching in Paris proposes to comprise also the treatment of wounds of the soft parts, fractures, and hemorrhages at the dressing stations and first-line ambulances.

In a general way, Tuffier's program is planned to cover the repair of the entire human body, including cranial, cervical, thoracic, and abdominal wounds, as well as peripheral injuries and wounds of the extremities.

The scope of operations performed in a war hospital of this character will naturally be almost unlimited. Familiarity, and the skill which comes with experience, will thus be secured by the attendants in procedures such as transfusion of blood; adequate incisions for free exposure of wounds; excision and removal of devitalized tissue; suturing of wounds; trephining of the skull; the modern treatment of penetrating wounds of the chest, and of abdominal wounds; the management of maxillary fractures; the methods suggested and adopted for the closure of vascular wounds, suture, and grafting nerves; resection of bones and joints; operations upon the upper and lower extremities. The immensity of the clinical material will insure abundant opportunities for the performance of both typical and atypical operations. In the course of a few months a young surgeon working in an institution of this kind will see and handle a number

of conditions of unprecedented variety, such as perhaps have never before been crowded into the span of the surgical experience of a single lifetime.

SPECIAL POINTS WITH REGARD TO DISPOSAL OF UNITED STATES ARMY CASUALTIES.

Major R. W. D. Leslie, R. A. M. C., D. A. D. M. S., embarkation, has for almost four years been in charge of the medical service of the war office in London which disposes of the incoming sick and wounded at Southampton, Plymouth, Avonmouth, etc. In July, 1918, he was transferred to France for the purpose of straightening out certain difficulties which had arisen there.

Major Leslie gave me some suggestions, based on his experience, for the disposal of our casualties, and these are quoted in full, together with a sketch of the naval cot referred to.

(1) Retention in France.
(2) Retention in United Kingdom.
(3) Return to United States of America.

The first two points do not require much consideration, as arrangements in connection with them have been or are in course of being made.

The third point is of great importance, and there are many difficulties to be overcome in connection therewith.

It is understood that a large proportion of foodstuffs for the Allies is brought from America, and, as economy in tonnage becomes more and more necessary, the feeding of noneffectives in this country or France, is not desirable. With the large United States armies which have already arrived and are expected to arrive, one can anticipate a large proportion of casualties from wounds and sickness, many of whom will be incapacitated for fairly long periods and some permanently. The retention of these cases in France or in England means an increased demand for food, which is not only more difficult to supply, but also in this case, wasted as far as fighting power is concerned. Transports bringing Americans to England return practically empty, and it would, therefore, appear feasible to send back in these ships as many as possible of these noneffective United States Army troops who are likely to be incapacitated permanently or for some time, say, two months or even less. At first sight this may appear comparatively simple, but there are several difficulties, of which the chief are:

(1) Selection of suitable cases.
(2) Fitting out of transports.
(3) Medical staff.

(4) Disembarkation and embarkation, including arrangements in connection with trains, etc.

(1) *Selection of suitable cases.*—Here we are confronted with one of the chief obstacles. To be of any value the selection must be done rapidly, and at the same time no cases returned who are likely to recover easily. Efficient medical boards would be required for this purpose, which would work in conjunction with each American hospital in England. These boards would see every case on arrival from France and decide whether they would be retained or returned by the first available ship. Nominal rolls of suitable cases with their disabilities would be returned daily to the medical embarkation staff (see 3), who, working in conjunction with the Quartermaster General's Department, would allocate the cases according to the accommodation in the ships and arrange for their collection and embarkation.

(2) *Fitting out of transports.*—Any elaborate or permanent structural hospital arrangements would interfere with the value of transports as ordinary troopships, which should be avoided. Therefore, some suitable method of rapid conversion from transport to hospital carrier must be devised.

I am of the opinion that this could most suitably be met by adopting the British naval cot. The fixtures for slinging these cots are simple, and when not required the cots can easily be stowed away. Each ship should be inspected by a competent officer with experience in this class of work, who would estimate the carrying capacity as regards invalids and arrange with the naval authorities for the fitting up of the cots and also make arrangements for the provision of a dispensary, emergency theater, etc. The ordinary sleeping bunks in the transport could be utilized for lying cases, the special cots being kept for more serious cases.

A sketch of the naval cot is attached.

(3) *Medical staff.*—A medical staff consisting of surgeons, nurses, and orderlies would be required for each ship returning with invalids to America. For this purpose, a transport medical service could be established. A suitable staff would be allocated to each ship at the port of embarkation in England, by the embarkation medical staff (see 4). The staff would return to England from America, at the first available opportunity, and report to the embarkation medical staff, for duty on another voyage. Use could also be made of medical officers, temporarily unfit for service in the field, to do duty on these ships.

(4) *Medical embarkation staff.*—This staff would be responsible for all medical arrangements in connection with the care of sick and wounded in returning American transports. They would receive

from the medical boards lists of patients as stated in (1). They would keep a list of sailings of ships with dates and carrying capacity of each. They would arrange in conjunction with the D. M. S., embarkation, U. K., for the entraining and transport by ambulance or ordinary train of all invalids selected to the port of embarkation. They would notify the port of disembarkation in the United States of the approximate date of arrival of invalids in America, giving numbers of lying down and walking cases, or any other special information required. They would arrange for the suitable staffing with surgeons, etc., of each ship, according to the number carried.

The above is only a very broad outline of a suggested scheme, but the details could be elaborated quite easily.

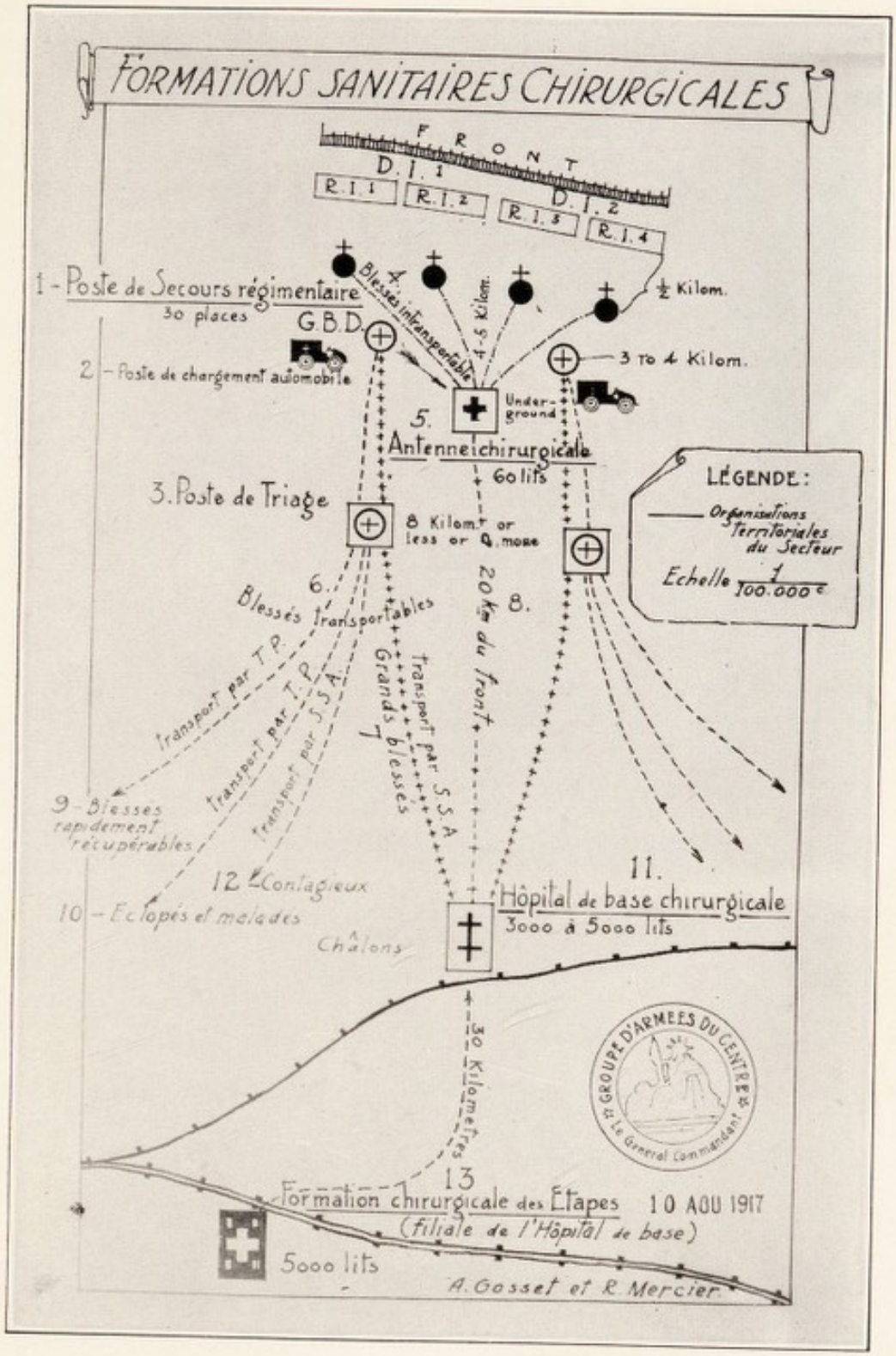
SURGICAL SANITARY FORMATION.

KEY TO SKETCH.

1. Regimental aid post.
2. Station for loading of automobiles.
3. Selecting station.
4. Nontransportable wounded.
5. Advanced dressing station (60 beds).
6. Transportable wounded.
7. Severely wounded.
8. Twenty kilometers distance from the front.
9. Wounded who will rapidly recover.
10. Disabled and sick.
11. Surgical base hospital (3,000 to 5,000 beds).
12. Contagious.
13. Surgical formation of stations, affiliated with base hospital.

D. Division.

R. Regiment.



Surgical sanitary formations.

RECOMMENDATIONS.

Throughout this report there will be found many suggestions from the experiences of our allies which might well form the basis for a long list of recommendations. For example, the adoption of certain methods of treatment, the testing of others, and the many questions relating to the establishment of special hospitals, convalescent camps, and centers for reeducation. It is not the purpose, however, at this time to go into such detail, but the following suggestions seem to require early consideration:

1. More system is urgently needed in the sending home of the sick and wounded. Each transport should take only such numbers of surgical, insane, tuberculous, and other cases as it is equipped to handle. Before embarkation, the patients should be sorted by a medical officer having full knowledge of their condition and requirements and of the accommodations on the various transports.

2. Transports carrying serious surgical cases should have proper operating room facilities, X-ray apparatus, assorted sizes of Thomas splints, and Carrel-Dakin equipment, as well as hospital corpsmen with special training. The surgeons in charge should be thoroughly familiar with the various methods of treatment now in vogue in order that they may intelligently continue such treatment as the case has been receiving, or, if occasion requires, change it to the advantage of the patient.

3. As gas and oxygen, with or without ether, is becoming largely the anesthetic preferred in war surgery, our base hospitals and ships caring for many surgical cases should be equipped for its use. The apparatus recently devised by the American Red Cross is simple and cheap and has been ordered in large quantities for the Army, and, as pointed out by Gwathmey, is easily adaptable for ships.

4. On all large transports and at the Navy base hospitals there should be provided for the surgical personnel the following books:

(*a*) Military Medical Manuals (21 vols.); Sir Alfred Keogh, G. C. B., L. L. D., F. R. C. S., editor.

(*b*) Report on the Medico-Military Aspects of the European War, by Surgeon A. M. Fauntleroy, United States Navy.

(*c*) Manual of Military Urology, published for the American Expeditionary Forces by the American Red Cross.

(*d*) The Medical Bulletin, published monthly by the American Red Cross Society in France.

(*e*) Certain new books, published or to be published by leading surgeons engaged in war surgery, such as Blake's book on Fractures, Willems on Septic Joints, Souttar on Nerve Suture, Robert Jones on Orthopedic Surgery, Lockwood on Surgery of the Forward Area, Sinclair on Fractures, and Williams on War Neurology, etc.

5. On such transports there should also be provided for reference use by our hospital corpsmen certain of the books now used for instruction in the best training schools for nurses.

6. Provision should be made at the ports of embarkation for the thorough elimination of lice from the persons and clothing of troops before they are taken on board.

7. At all naval training stations and base hospitals there should be installed the Barron ladder, or such modification of it as seems advisable, for the prevention and cure of flat foot.

8. The beneficial effect of the early use of provisional apparatus in amputated cases should be recognized and adequately provided for in all Navy base hospitals where such cases are under care.

9. More Navy surgeons and dentists might well be sent abroad to the special hospitals and centers where opportunity is offered for practical experience in the most recent developments in military orthopedics, plastic and oral surgery, nerve suture, the making and fitting of prosthetic apparatus, etc.

10. The value of blood transfusion in chronic sepsis, and the donor law in relation to skin grafting and transplanting of other tissues should be determined as promptly as possible.

11. Rules for massage, such as those in use at the Alder-Hey Military Orthopedic Hospital, should be printed and distributed among those responsible for the giving of such treatment.

12. By way of neutralizing the insidious effects of enemy propaganda, there might well be inaugurated for the Navy personnel a series of entertainments in the form of moving pictures, short talks, etc., with a view to familiarizing the men with the objects of the war and what is being done at home and abroad, and especially acquainting them with what is being done toward the physical reconstruction and vocational reeducation of those badly injured. The spread of such information will be beneficial not only to the enlisted men but to all with whom they come in contact.

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TECHNICAL INSTRUCTIONS IN VIEW OF THE IMPENDING MILITARY ACTIVITIES.

This instruction comprises the conclusions expressed by the different chiefs of the technical service of the Sixth Army.

Early surgical attention is the most powerful means to guard the wounded against all infectious complications. Uniformity and continuity of treatment are the important factors of success. They are secured through the technical connection between the surgeons of the different stages of the sanitary formations. The surgical service of the Sixth Army has endeavored to put these requirements into practice, as shown in the following:

RÔLE OF EACH SANITARY FORMATION.

1. REGIMENTAL AID POSTS.

The application of simple dressings, immobilization of fractures, control of hemorrhages, and as rapid evacuation as possible constitute their principal activity. Wounds are to be dressed by means of ordinary gauze, the surface application of Vincent's powder serving especially in those cases whose evacuation is delayed.

Hemorrhage is treated by simple packing of the wound, without constriction of the limb. The tourniquet is to be reserved for exceptional cases, and a special label must indicate its presence, the necessity of immediate evacuation, and a priority examination on arrival at the grouped ambulances.

Fractures are carefully immobilized by means of one of the apparatuses in the use of which each regimental surgeon has been instructed. (On the arrival of the wounded in an ulterior formation, the apparatus will be exchanged, one apparatus for another.)

For fractures of the *thigh*, it must be kept in mind that in order to be efficacious, every apparatus must reach from the axillary region as far as the malleoli.

Antitetanic injections should be administered as far as practicable.

Symptoms of shock are treated with tonic hot beverages, warming of the entire body, and injections of camphorated oil repeated every three hours.

Soldiers who have been "gassed" should be undressed, washed, and provided with a change of clothing.

Evacuation.—The *very severely* wounded, when the diagnosis is positive and the general condition sufficient to tolerate transportation, whose *treatment is extremely urgent*, must be at once forwarded, *directly and without any further sorting*, to the following formations:

Fourteenth Corps, Hôpital de Soissons.

Twenty-first Corps, H. O. E. de Vasseny.

Eleventh Corps, H. O. E. de Vasseny.

Thirty-ninth Corps, H. O. E. de Mont-Notre-Dame.

Severe fractures of the diaphyses are to be directly forwarded, with the following attached label:

For the Fourteenth Corps, to the fracture center of Vierzy.

For the Twenty-first, Eleventh, and Thirty-ninth Corps, to the fracture centers of Mont-Notre-Dame or to the center of Chateau-Thierry.

All other cases of wounds or intoxications are to be directed to the sorting posts constituted by the grouped ambulances:

For the Fourteenth Corps, ———.

For the Twenty-first Corps, Sermoise, ———.

For the Eleventh Corps, Courcelles, ———.

For the Thirty-ninth Corps, Cerseuil, ———.

GROUPED AMBULANCES, SORTING POSTS.

The part played by these is of the utmost importance. Antitetanic injections are here administered when these have been omitted at the aid posts.

1. *Sorting.*—This must be left in charge of experienced surgeons.

All dressings are to be removed. The diagnosis will be based upon direct examination of the lesion. After readjustment of dressings and apparatus, the wounded will be directed to a new previously designated sanitary formation.

All tourniquets should be removed when the origin of the hemorrhage can easily be seen. Hemostatic forceps are applied and left in place. When the hemorrhage is deep, the tourniquet is retightened and the patient is detained in the hospitalization of the same grouped ambulances, with a special recommendation to the surgeon in charge.

All nontransportable cases are detained in the hospitalization.

All gassed soldiers are likewise to be detained and treated, if not already treated in the aid post at the front.

These nontransportable wounded are, for the most part, cases of severe shock, with or without hemorrhage; wounds of the skull and brain, with escape of cerebral substance, and a bad general condition; extensive shattering of limbs requiring immediate amputation; penetrating wounds of the abdomen, wounds of the thorax with persistent hemorrhage or threatened asphyxia.

Cases of very minor injuries, and the slightly wounded, are likewise to be detained when they can not be accommodated in the evacuation hospitals.

2. *To be evacuated.*—1. The disabled, for the Fourteenth and Twenty-first Corps, to La Ferte Milon.

2. Urinary cases, to the center of Busancy.

3. Fractures, for the Fourteenth Corps, to the hospital of Vierzy; for the Twenty-first, Eleventh, and Thirty-ninth Corps, to the Fracture center of Mont-Notre-Dame or that of Chateau-Thierry.

4. Lesions of the face, jaws, and orbit, to the H. O. E. of Vasseny.

All other wounded are to be directed to the following centers:

Fourteenth Corps, H. O. E. of Soissons, with overflow to Busancy and Vierzy.

Twenty-first Corps, H. O. E. of Vasseny.

Eleventh and Thirty-ninth Corps, H. O. E. of Mont-Notre-Dame or of Saint-Gilles.

All apparatus removed in the grouped ambulances is to be returned to the corresponding aid post.

RÔLE OF HOSPITALIZATION OF THE GROUPED AMBULANCES.

1. *Service of nontransportable cases.*—It consists in the exclusive reception of nontransportable wounded, and of soldiers with very trifling injuries, only in case of overburdening of the evacuation hospitals.

These wounded are to remain in these formations no longer than the strictly necessary time to ascertain the harmlessness of their transportation before or after operation. Any delay in their evacuation is most prejudicial for these wounded. An appeal is made to the conscience of the surgeons in charge, who may always follow the results of their treatment in the sanitary formation to which they have evacuated their patients after operation. To detain a wounded soldier outside of these special conditions is to expose him to complications.

These wounded, having become transportable, will be evacuated to—

Fourteenth Corps, H. O. E. of Soissons.

Twenty-first Corps, H. O. E. of Vasseny.

Eleventh and Thirty-ninth Corps, H. O. E. of Mont-Notre-Dame, and, if necessary, H. O. E. of Saint-Gilles.

2. *Slightly wounded.*—Foreign bodies which can easily be extracted without great tissue destruction are to be removed. Wounds are to be freely opened, excised, dressed, and bandaged, directing the patients for suture to the surgical centers.

RÔLE OF THE H. O. E. OF SOISSONS, THE BUSANCY GROUP, AND THE H. O. E. OF VASSENY, MONT-NOTRE-DAME, SAINT-GILLES, AND VIERZY.

The selection and destination of the hospital to be allotted to the wounded in these centers will be determined and specified by the chief physician of each of these hospitals.

The management of the wounded will be prescribed by each of the surgeons at the head of the service.

Technical questions will be indicated, when necessary, by the heads of service in the centers, in accordance with the operating surgeons.

The evacuation of the wounded from these surgical centers, in order to establish a connection with the formations at the rear, will be carried out in the following directions:

The fractures of the Vierzy center and those of the H. O. E of Soissons are to be directed as soon as their condition permits, namely, when the cicatrization of the wound allows it, to the fracture center of Compiègne, by boat or rail.

Those of the H. O. E. of Vasseny and of Mont-Notre-Dame, to the fracture centers of Chateau-Thierry, and, when this does not suffice, to Paris.

Soldiers with wounds of the face, jaws, orbit, and eyes will be directed to the center of Paris as soon as their transportation involves no danger.

Wounds of the soft parts, after incision and exposure, for suturing, or immediately after their cicatrization, will be directed to ———.

In case of overcrowding of the wounded, evacuations of all kinds will be carried out by special trains to Paris.

REPORT OF THE SURGICAL TECHNICAL ADVISORY COUNCIL.

Composed of Medical Inspector General FEVRIER, Profs. HARTMANN and DELBET.

The surgical technical advisory council was consulted as to the best place for the evacuation hospitals. The absence of its president having caused a certain delay in the meeting of the technical advisory council, before the question could be taken up, a note was submitted entitled "General Indications to Serve for the Organization of the Sanitary Service According to the Regulations."

As the place of the evacuation hospitals is closely related to the general organization of the sanitary service, it appeared advisable to study this note as a whole. The evacuation hospitals, as originally planned, were based on the imaginary inviolability of the front. This place has been fixed at a distance of 18 to 20 kilometers from the fighting lines. This suffices to show that they are impracticable, as the front may actually vary for a more considerable distance in 24 hours. We have unfortunately learned the cost of fixedness of the evacuation hospitals located in this zone.

The altered character of the war demands a change in the organization of the sanitary service in the zone of the armies. The note submitted to us by the surgical technical advisory council aims at the establishment of a new régime and seems to be well conceived in its general outlines. The points which it seems to us might be modified are indicated in the following:

1. *Aid posts.*—This question is not considered in the note. We wish to suggest in this connection an organization already proposed by us, adopted in certain armies, and worthy of general introduction. For certain wounded, the diagnosis is so obvious as to render undesirable their passage through the sorting station, this passage being inconvenient for the patient, whose treatment is thus retarded, and inconvenient for the center, which is always overworked during a period of offensive. These wounded should be provided with special labels insuring their direct transportation, without interruption, to the place where they are efficiently taken care of. They belong in three groups, each of which should bear a special label, easily recognizable by its shape or color.

(*a*) One group comprises wounds of the abdomen, open thorax (perforating wounds of the chest), vascular wounds treated with a tourniquet. Soldiers with such lesions must be sent directly from the aid post to the advanced dressing station.

(*b*) A second group comprises gross fractures and also gross contusions of the soft parts (calf, thigh, buttock, axilla, shoulder), which expose particularly to gas gangrene. The wounded of this group must be taken directly to the primary evacuation hospitals.

(*c*) The third group comprises the fractures of the skull. Experience having shown that it is better to transport these patients before than after the operation, we hold that they should be taken directly to the secondary evacuation hospitals.

2. *Army formations.*—(*a*) These formations should be very movable. It seems, therefore, necessary to specify those which should be installed under tents.

(*b*) We hold that these formations should be divided into two sections: One sorting section and one surgical section, properly speaking. These two sections must be adjacent but independent.

The note under consideration indicates that these formations are to treat on the spot the grave nontransportable cases and those which are in need of emergency measures. There is nothing to add about the nontransportable cases, but "those in need of emergency measures" leaves too much room for different interpretations. A few explanatory words should be added without definite restrictions. It should be specified that abdominal wounds, perforating wounds of the thorax, vascular wounds associated with hemorrhage arrested by a tourniquet, are to be cared for in these formations. In the organization as proposed by us those wounded would be directly taken there.

(The submitted note anticipated for these formations an operating staff able to perform this major surgery.)

3. *Primary evacuation hospitals.*—We believe that these hospitals which are to be placed at the rail heads should likewise be installed under tents, as already requested by the technical advisory council in a preceding report (by Hartmann).

In our opinion these hospitals should take care of the gross fractures and gross contusions of soft parts, which will be sent to them directly from the aid post.

The note anticipates these evacuation hospitals to be equipped with a service capable of adjusting provisional maxillary-facial prostheses, an ophthalmological service, etc. Such equipments appear to us out of place in these hospitals. Patients with wounds of the face are among the most easily transported. A delay of a few hours is of no importance for them. They should be treated in the secondary evacuation hospitals.

One of the duties assigned by the note to the secondary evacuation hospitals is that of directing the lightly wounded, the sick who will promptly recover, and the disabled to special near-by destinations. Leaving aside the sick and disabled—emphasizing, however, that

the disabled must not be confused with the slightly wounded—we wish to call special attention to the latter.

The gravely wounded, whose lives are directly threatened, hold a predominant place in our preparations. They make a more profound appeal to our sympathy and they gratify our surgical pride. From the military viewpoint, however, it is evident that the slightly and moderately wounded are entitled to the same care and must be handled by skilled surgeons in well-organized formations. The serious question of man power is far more concerned with the slightly wounded than with the seriously wounded.

In 1915 we adopted Hartmann's formula that there are no slightly wounded; meaning that at the time of distant evacuations many slightly wounded died of gas gangrene or acute septicemia. The formula is now resumed in a modified sense. We mean to say that wounded soldiers with not intrinsically very severe lesions enjoy at least as much as others the great surgical progress achieved in the course of this war in the form of resection followed by suture.

Under insufficient care these wounded who represent the great majority of war casualties require weeks and often months to get well; they leave the hospital on convalescent leave; they regain their fitness very slowly. Some, entirely too many, retain fistulas, intramuscular fibrous nodules, adherent cicatrices, which induce functional disturbances, and they never again become fighters. Properly managed, with trimming of the wound and primary suture, they leave the hospital at the end of a dozen days with a leave (permission) of 10 days. In three weeks they are well.

All those who have visited a large number of sanitary formations know that the slightly wounded, when insufficiently treated at first, often require more time to recover than moderately or even certain severely wounded who are well taken care of.

Undoubtedly, at times of great inflow of wounded, surgeons are obliged to devote their efforts first to those whose lives depend upon their interventions. But it can not be overemphasized to the sanitary service that the slightly and moderately wounded be cared for in good installations and by competent surgeons.

There is neither necessity of nor advantage in having them treated in formations near the primary evacuation hospitals; no necessity because they can tolerate a slightly longer journey, and no advantage because one can extend to any hospital the right to discharge the patient on a 10 days' leave.

4. *Secondary evacuation hospitals.*—In these formations the majority of wounded will be operated upon, and it is on this subject that we have been specially consulted.

As to the importance attached to them we entirely agree with the note. It properly emphasizes the disadvantages of scattering the

wounded and cleverly expresses the situation of surgical staffs in small formations, where they are alternately overworked and in a state of inactivity. Strong organizations with a large material are accordingly needed.

They should be supplied by a special railway with branches permitting the yarding of several trains, and platforms facilitating the unloading of the wounded. As to the distance at which they should be placed, this question, specially addressed to us, still presupposes a certain stabilization of the front. This point does not fall within our domain. Moreover, as the wounded may be very numerous, as the neighboring regions have no organization permitting them to be properly cared for, it is imperative to create large surgical formations, and the position of these must necessarily be governed by the point where the wounds are inflicted, namely, starting at the front.

The note counts by kilometers (50 to 200). Time is not directly related to distance, for many other factors intervene. Not the kilometers, but the hours are of importance, meaning the duration of the transportation. It therefore seems preferable to count by hours.

Two necessities arise, which are to a certain degree contradictory—that of protecting these large formations against the ordinary fluctuations of active warfare, and that of managing the wounded as soon as possible. One demands removal, and the other approximation, of the surgical centers.

Our personal experiences in the course of the last offensives permit to conciliate proper care of the wounded with the safety of the secondary evacuation hospitals.

The period during which a medium-sized wound remains capable of being sutured is more extensive than was assumed to be the case. While suture was considered very risky after the eighth or tenth hour, practically all the wounded were systematically sutured who arrived unoperated in our Paris services. These wounds dated back 24, 36, 48 hours. Such remarks can at present be passed only with extreme caution. It always remains desirable for the wounded to be operated upon as promptly as possible, but it is certain that a competent surgeon should not omit suture for the sole reason that the wound dates back 24 to 36 hours.

Thus there actually exists a margin which permits placing the great surgical stations in an at least relative zone of security, for assuredly no organization can be established which is equally satisfactory at a time of great disaster or great victory.

Except the wounded of various groups, which have already been specified, as to be operated upon in the army formations (advanced dressing stations) or in the primary evacuation hospitals, we believe that nonoperated patients can tolerate a railroad transportation last-

ing at most 10 hours from the point of entraining. Counting that this point will be reached in an average time of six to eight hours, they will be operated upon within 24 hours, namely, during the period in which suture is possible in properly managed cases.

The first thing to be done in order to decide the location of the secondary evacuation hospitals is to ask the G. Q. G. to indicate the limits of the zone whose security is believed to be sufficient. The second point is to request the IV Bureau to specify the points of this zone where the roads can be made to converge, so that the trains coming from the most advanced stations can arrive here in less than 10 hours.

FIXATION OF THE BASE OF HOSPITALIZATION AND THE SURGICAL MEASURES NEEDED FOR AN ATTACKING ARMY CORPS IN AN OFFENSIVE.

The experience of the different offensives has shown the necessity for organizing a solid base of hospitalization well in advance for each of the working C. A., to receive the wounded, and a sufficiently complete surgical service to operate upon them with an average delay of 24 (exceptionally 48) hours.

The teachings of the present war permit to fix approximately the conditions which this base must meet for a C. A. of attack like the first C. A. C.

The essential points to determine are as follows: The number of beds and the surgical means.

These points rest on three essential factors:

1. The production or incidence of the wounded.
2. Their debit and their hospitalization.
3. Their surgical liquidation.

1. PRODUCTION OF THE WOUNDED.

Calculations concerning the production of the wounded are based on the losses sustained by the first C. A. C. in the course of the three great offensives in which it participated:

Battle of Champagne, September–October, 1915.

Battle of the Somme, July–August, 1916.

Battle of Soissonnais, April–May, 1917.

CHRONOLOGICAL DAILY AVERAGE OF WOUNDED PER DIVISION IN AN ATTACKING ARMY CORPS.

The average number of wounded must be established in chronological order for the total of the divisions of the army corps (aligned or in reserve) during the entire duration of the procedures. This is indispensable in order to arrive at an average calculation, for in offensive procedures, the divisions are almost invariably grouped in army corps and liable to enter in line at a given moment.

A calculation based solely on the divisions having sustained the greatest losses would no longer correspond to the medium figure of the chronological series, since all the divisions are never simultaneously engaged, and on the other hand the maximal losses are essen-

tially variable according to the difficulties of the terrain and the particular fluctuations of the fight.

The maximal losses in wounded of the divisions of the first C. A. C. correspond to the figures given below:

Champagne (September, 1915):						
September 25 (3 divisions)	309	1,200	0	Maroc.	1,434	478
September 26 (3 divisions)	543	391	500	Divisions	1,509	503
Somme (July, 1916):						
July 1 (4 divisions)	589	789	220	0	1,598	399
July 10 (4 divisions)	589	504	951	293	1,748	437
Soissonnais (April–May, 1917):						
April 16 (3 divisions)	546	386	220	387	976	311
May 5 (3 divisions)	546	589	951	387	976	325

Once only, on September 25, 1915, the average surpassed 500 (503); next day it was almost the same (478). The other averages are around 400.

Table A gives the detailed calculation in the divisions, and the graphic A1 permits following the oscillations of the daily average of wounded in the divisions as a whole, the average man power per division being 12,000 soldiers.

The curves A2 and A10 show the detailed variations for each division.

The study of these figures and graphics leads to the following conclusions:

1. The maximal losses always occurred on the days "J" and "J–1," then a diminution takes place with some sudden elevations due to counterattacks, and finally, on a variable day ("J–5" to "J–20"), there appears another ascent, often as important as the maximum at the beginning, and followed by the lowering which terminates in stabilization.

"J," general average of losses per division	384
"J–1," general average of losses per division	302
(Following days, fall with oscillations.)	
Day "J–x," second ascent	403
(Following days, fall with oscillations.)	

2. The maximal losses always taking place at "J" and "J–," these days must serve as the basis for determining the liquidation:

Offensive of Champagne	503	478	981
Offensive of the Somme	399	338	737
Offensive of Soissonnais, first attack	310	170	480
Offensive of Soissonnais, second attack	325	222	547
Average	2,745		685

AVERAGE OF WOUNDED ON DAYS "J" AND "J–1" IN ARMY CORPS AS A WHOLE.

In an army corps the divisions furnish the majority of the losses, but it is also imperative to consider the E. N. E., whose importance

steadily increases with the development of heavy artillery and with the necessity of renewing up to the first line the actively engaged troops (territorial elements).

These losses are especially marked in offensives followed by occupation of new nonorganized positions, as occurred on the Somme in July-August, 1916. The graphic B gives the figures, which can be estimated at an average of 30 per day.

In an Army corps of 4 divisions the number of wounded for the days "J" and "J–1" must accordingly be estimated as:

$$(685 \times 4) + 60 = 2{,}800.$$

MAXIMUM OF ATTACKING DIVISIONS ON DAY "J."

Besides the averages of wounded established in chronological order on the total of the divisions of an army corps (divisions in line and in reserve) it is of great interest to learn the maximum of wounded calculated exclusively for the attacking divisions.

These maxima (Table C) are significant only on the days "J" and "J–1," for the day of ascent "J–X" is too variable for the average, dating from "J–X," to possess value as regards the estimation of the yield in wounded.

The maxima of the days "J" and "J–1" have been as follows:

Battle of Champagne:		
Second D. I. C.	309	543
Third D. T. C.	1,200	391
Thirty-second D. I.	500	543
Battle of the Somme:		
Second D. I. C.	589	471
Third D. I. C.	789	626
Sixteenth D. D. I. C.	220	249
D. M.	215	446
Seventy-second D. I.	208	298
Battle of Soissonnais:		
Second D. I. C.	546	351
Third D. I. C.	386	159
Third D. I. C.	589	306
D. P.	387	359

The general average of the attacking divisions is thus seen to be 561 on day "J" and 506 on day "J–1," making 1,067 wounded for the two days "J" and "J–1."

This information is important for the provisions to be made when in the course of the procedures, a fresh division enters in line and prepares to attack. From this basis should be planned the required hospital accommodation and surgical facilities.

II. SUPPLY OF WOUNDED.

For the time being, the wounded are delivered in three stops:

1. Divisional aid posts (ambulance division).

2. Central sorting station of the army corps (gathering of ambulances).

3. H. O. E. (evacuation hospitals).

DIVISIONAL AID POSTS.

The divisional aid posts, provided they are sufficiently spacious and their service is strictly regulated, have an extremely important rôle in the first sorting of the cases.

1. Removal of disabled (lame) by T. M. for transportation to the depots.

Removal of slightly wounded by T. M. for transportation to the ambulance for recuperable cases.

2. Immobilization on the spot for absolutely untransportable cases.

3. Evacuation of the other wounded in the order of severity toward the sorting center of the army corps (gathering of ambulances).

Not mentioning the disabled, whose number is very variable, according to the conditions of fatigue, nourishment, and weather (influence of rain and cold), the divisional aid posts may be estimated to liquidate as follows:

Twenty-three per cent of recuperable slightly wounded; 1.21 per cent of very seriously and absolutely nontransportable wounded, equaling about one-fourth of the total of the wounded, so that the average of the two first days (J and J–1) drops from 685 to 513.

SORTING CENTER OF ARMY CORPS.

The sorting center retains the nontransportable wounded, directs to the service for recuperables the slightly wounded who may have escaped the first-line divisional ambulances, and evacuates all the remainder to the H. O. E.

Too much must not be expected from its quantitative yield, on account of the group of patients which it retains and also because its surgical facilities will always be limited.

Consequently, do not calculate from the number of beds but from the probabilities of operative material in the 24 hours.

Under these conditions it must not be relied on to retain more than 120 wounded. All the remainder will go to the "H. O. E.," making for the days "J" and "J–1," 513, 120, and 393.

Base of hospitalization.—Summarizing, the hospitalization base of the army corps consists of the following: The beds of the sorting center; the beds of the H. O. E, proportioned to the surgical resources.

As the outflow of wounded does not begin until day "J–2," this base must correspond to the number of wounded in these two days, deducting the slightly wounded recuperable (23 per cent) and the absolutely nontransportable (1.21 per cent), averaging 513.

But it is absolutely necessary to take into account the conditions of the debit and number of untransportable cases.

The debit, insignificant on day J–1, may be estimated:

At 10 per cent on day J–2; at 20 and 30 per cent on the following days.

With special reference to the nontransportable, whose proportion increases every day, and may reach one-fourth of the beds on days J to J–4, and even one-third of the beds on days J–6 to J–9; a place for them is practically guaranteed by raising to 800 per division the required total of 513 places.

Provisions for new attacks.—In case of an attack in the course of the procedures by a fresh division, it is advisable to refer to the figures of maximal losses sustained by a division which enters in line.

These losses may amount to 561, 506, 1,067 for days J and J–1. Hence, evacuate so as to have the necessary room and collect the surgical means which are indispensable.

SUMMARY.

1. A division yielding 685 wounded on days J and J–1: 25 per cent are removed by the first-line divisional ambulances; 513 are received in the sorting centers of the army corps and of the "H. O. E." (beds and surgical facilities to be provided).

2. In consideration of the duration of the back flow of wounded (10 to 30 per cent daily) and the number of nontransportable cases (one-fourth to one-third from days J to J–9) the total number of beds must be raised from 513 to 800.

3. These calculations are made for one division, on the total of the divisions of an attacking army corps, including the divisions held in reserve.

In case of the entrance in line of a new division it is necessary to tabulate above the maximum figure of losses of the divisions which have actually attacked, the days J and J–1, namely, 561, 506, 1,067.

Beds, surgical facilities, and debit must be accordingly provided for.

SURGICAL LIQUIDATION.

The divisional aid posts liquidate: 23 per cent of recuperable slightly wounded, who are directed to a special formation (ambulance or H. O. E.); 1.21 per cent of absolutely untransportable

cases, kept where they are, so that the total of days J and J–1, which amounts to 685 wounded per division, drops to 513, shared between the group of ambulances and the H. O. E.

Of this number, the average of inevacuable cases which must be kept "hospitalized" is 25 per cent; the others can be evacuated after operation and rest, making—

Inevacuable hospitalized	128
Evacuable transients	385

LIQUIDATION OF INEVACUABLES.

Of the 128 hospitalized cases, one-tenth are not operable; the others, amounting to 115, must be operated upon within 24 hours.

The average yield of a very efficient surgical service A rarely exceeds one wounded per hour. As the activity must be continuous for several days, it is not possible to count more than 12 working hours per service, making 12 wounded daily; the 115 grave cases of days J and J–1 (two days) accordingly require, per division:

$$\frac{115}{2} : 12 = 5 \text{ surgical services A.}$$

LIQUIDATION OF EVACUABLES.

The evacuable cases are partly recumbent and partly seated. The average duration of the operative interference is a little shorter in the recumbent than in the hospitalized, and the yield may be estimated as 15 instead of 12 per service.

For the seated evacuables the yield is much more considerable and often exceeds 50; by reducing it to the figure 45, one obtains for the two groups of evacuables a daily average of:

$$\frac{15+45}{2} = 30 \text{ operated per service A or B.}$$

The 385 evacuables of days J and J–1 (two days) therefore will require, per division:

$$\frac{385}{2} : 30 = 7 \text{ services A or B.}$$

TOTAL LIQUIDATION.

For the 513 wounded, to be liquidated by one division, will be required:

5 services A, for the inevacuables.
7 services A or B, for the evacuables.

Total 12 services, of which at least 5 must be of the first class (service A).

For an army corps of 4 divisions: 12×4=48 services, with 20 services A.

For an army operating with 5 army corps of 4 divisions each (20 divisions), the liquidation of all the wounded of days J and J–1, in the 24 hours following their arrival, will therefore require: 12×20=240, 100 of which to be A.

For the total, each army corps will provide one service per division and one for E. N. E., making for an army corps of 4 divisions 5 services, and for an army with 5 army corps 25 services. Of the necessary 240 services, 215 would still remain to be furnished.

In order to guard against disappointment, it is advisable to remember and ponder on these figures. With the progressive spread of the offensives, these needs can only increase, and the surgical services at the disposal of the armies will be more and more swamped.

It must be positively established that the H. O. E. will hospitalize only in the measure of its surgical facilities, and that its surgical output will be unable to meet the requirements of the inevacuable wounded. It is, therefore, useless to develop it disproportionately.

But on the contrary, it appears imperative to put it beforehand in close connection with a specially and very firmly organized surgical center, at no great distance, to which it will pass with the greatest system and with all desirable rapidity, the total of wounded which it can not handle surgically, meaning nearly all evacuable cases.

This arrangement must be provided for beforehand:

In the H. O. E.: Strengthening of the sorting and evacuating services.

In the transportation service: Collection of necessary trains (for seated and recumbent) since day "J."

In the receiving service: Detraining of the wounded, hospitalization, mobilization of surgical facilities (ready to functionate on day "J").

In this manner it will be possible for all the wounded to be operated upon at a delay never exceeding 48 hours since their departure from the aid post.

It does not seem possible, at the present stage of the war, to devise another solution.

(Signed) LASNET,
Medical Inspector and Army Physician.

JULY 12, 1917.

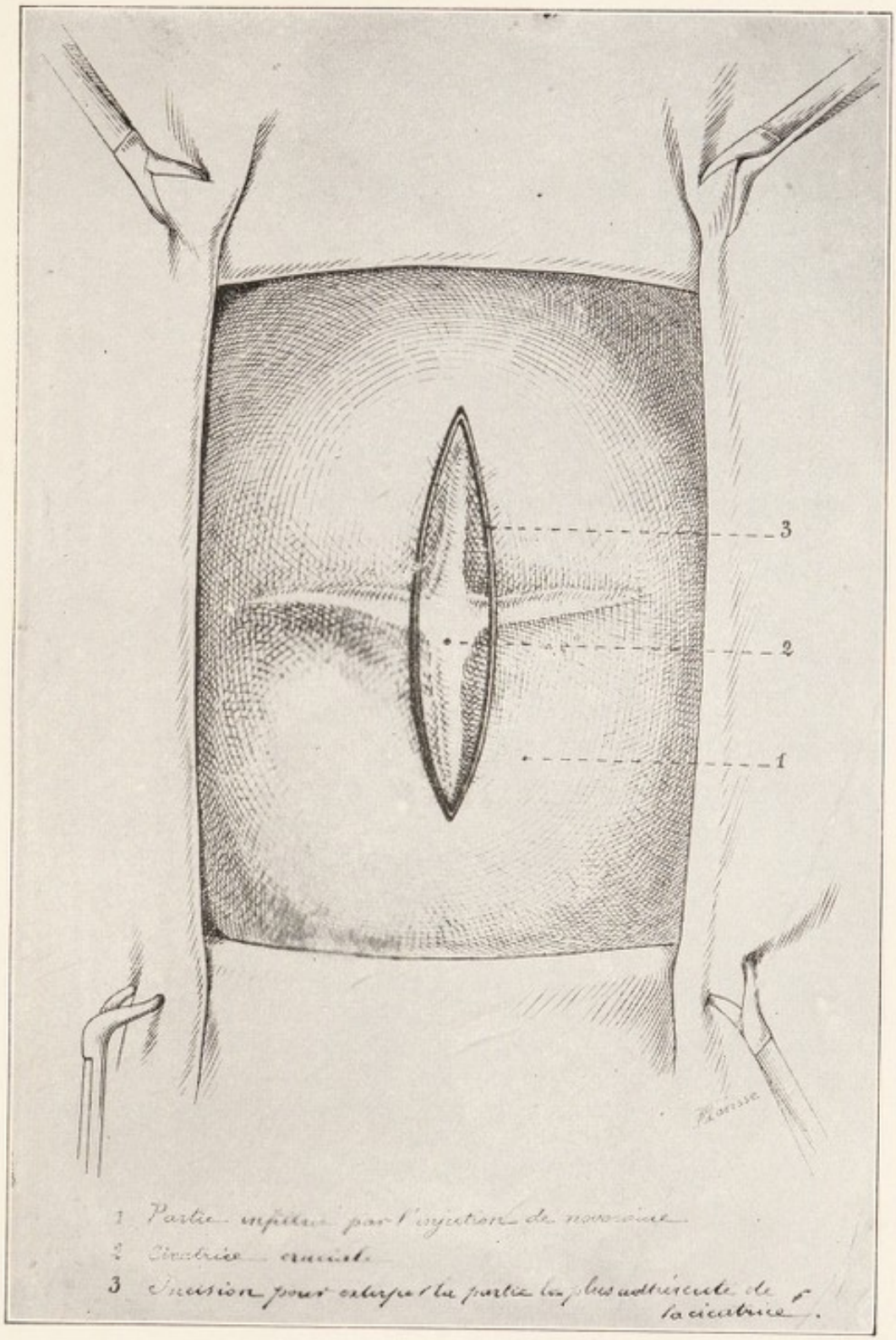


Fig. 1.—1, Infiltration with cocaine; 2, crucial cicatrix; 3, incision for removal of most adherent portion of cicatrix.

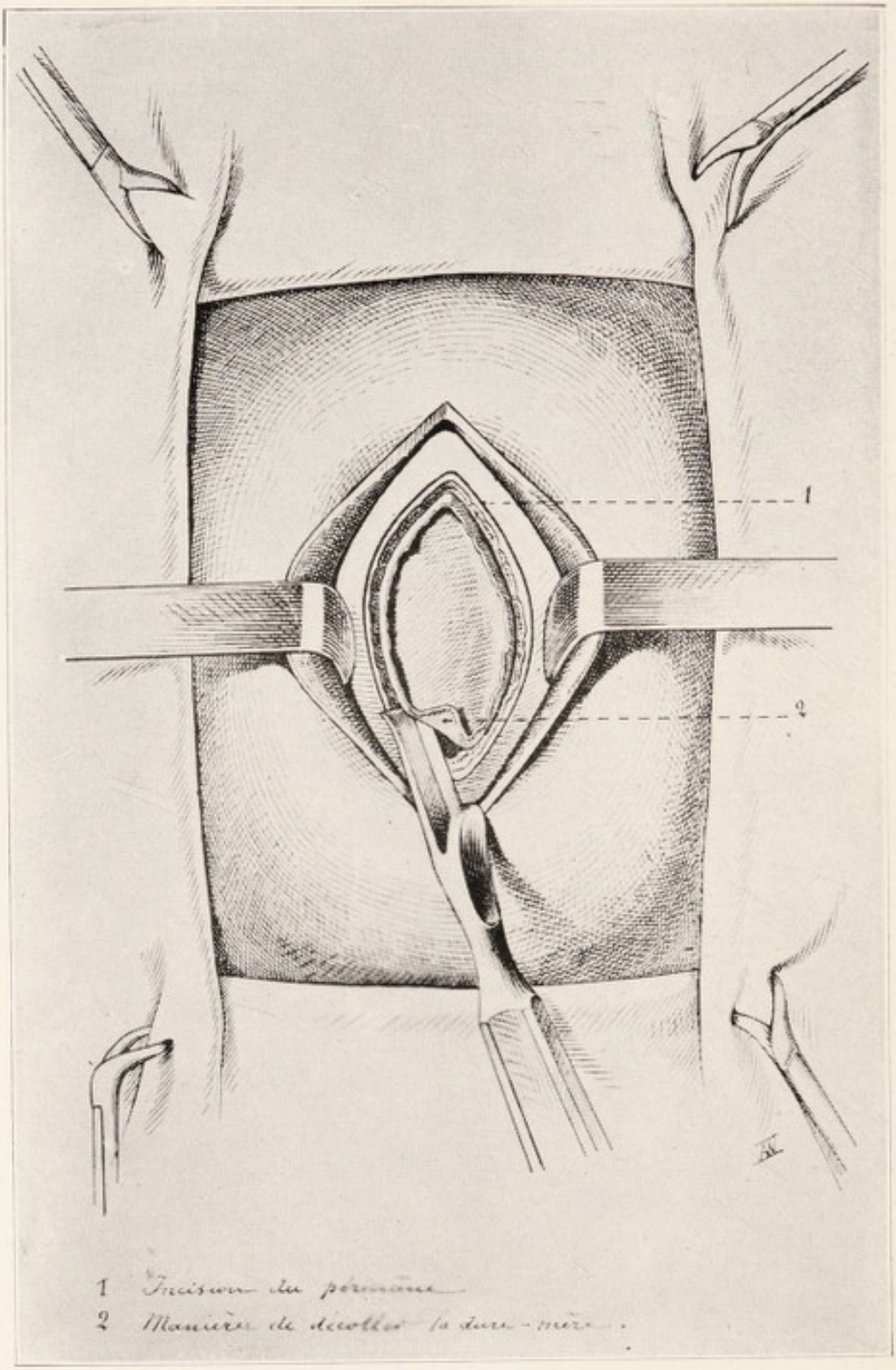


Fig. 2.—1, Incision of pericranium; 2, method of detaching the dura mater.

CARTILAGINOUS CRANIOPLASTIES.

In the course of a discussion on trephining (see p. 72 of this report), reference has been made to Dr. Chutro's promised account of his cartilaginous cranioplasties. This communication has just come into my possession and in view of the interest and far-reaching importance of this procedure in war surgery, a full version in English is presented in the following text:

CARTILAGINOUS CRANIOPLASTIES.

Indications and Technic by Dr. P. CHUTRO, Adjunct Professor of the Faculty of Buenos Aires, Chief Surgeon of the Military Hospital Buffon, Paris.

A loss of substance of the cranial bones as such produces a series of subjective and objective phenomena known under the designation of "trephinesyndrome." This syndrome is encountered pure and separately in cases of lesion of the bone, the dura mater and the superficial layers of the brain which have no differentiated function of any kind. It becomes superadded on the other hand to the clinical signs of the corresponding organic lesion, in the presence of destruction of the cerebral substance of the motor or other zones which are the centers of various functions such as speech, vision, etc.

The trephine-syndrome disappears almost entirely after a properly performed plastic operation on the skull, but the concomitant organic lesions which may be present are in no way directly benefited by the operation. A case of hemiplegia will take its usual course, the patient obtaining merely the suppression of the irritable cortical phenomena through the cranioplastic operation.

A patient with a lesion of the occipital lobe will invariably retain his ocular lesions.

Cases of Jacksonian epilepsy sometimes improve after cranioplasties, or at least, the attacks will diminish in severity, duration, and frequency, although total disappearance is uncommon.

One of our patients who suffered from monthly seizures, had his first post-operative attack 14 months after cranioplasty, and attributes it to brain fag caused by overwork as a bookkeeper in a bank.

An officer whose attacks occurred several times daily found them becoming separated by progressively lengthening intervals until they disappeared entirely. He had suffered, moreover, from monoplegia

of the left arm, which almost entirely subsided, leaving only a contraction of the muscles of the fist. This officer was enabled to resume his position as an infantry instructor.

In contradistinction from the above case, another officer with a frontal lesion, who suffered from severe and frequent attacks of general epilepsy, was in no way benefited by the operation.

As regards epileptic attacks, it must be stated that the numerous cases which have come under observation due to the war, have permitted neither the establishment of their etiology nor their pathogenesis. Some epileptic patients presented at the time of operation no compression or adhesion of the meninges; on the other hand, numerous patients with compression and extensive meningeal adhesions never presented the least sign of an epileptiform attack. Hence, a possible improvement, but no more can be promised to epileptics.

Cranioplasty must accordingly aim at two ends: (1) Suppression of the faulty (but cosmetic) cicatrix; (2) suppression of the trephine-syndrome.

After long experience with war surgery, we have reached the conclusion that all faulty cicatrices of the body should be extirpated because they impede function, create abnormal adhesions, restrict the action of the muscles and joints, and constitute a permanent risk by their marked tendency to ulcerate and maintain foci of suppuration. The extirpation of cicatrices must be obligatory in the skull. In case of a simple lesion of the scalp which has undergone suppuration, the cicatrix is very likely to have become keloid and painful. When trephining has been done, the cicatrix is always adherent to the meninges and even to the brain. These adhesions cause constant traction and thereby continuous irritation of the meninges. On the other hand, superficial cicatrices are lined with a sometimes greatly thickened or actually keloid, sclerotic layer which when it comes in contact with the brain, instead of becoming outlined has a tendency to spread in the cerebral substance, thereby giving rise to a series of invariably grave secondary phenomena. Briefly, it is desirable to remove this keloid from the brain in order to put this organ at rest so that it may heal and limit its lesion.

These irritable phenomena are part of the trephine-syndrome. The other signs which are frequently observed are as follows:

(1) A sensation of emptiness in the trephined side.

(2) A very unpleasant sensation sui-generis, felt by these patients when they are obliged to stoop or lower the head, manifesting itself in form of vertigoes and nauseas. The same phenomenon supervenes when they make some effort or on coughing.

With the patient in a sitting position, a depression is seen at the site of lost substance; when he bends over, a hernia is seen to appear

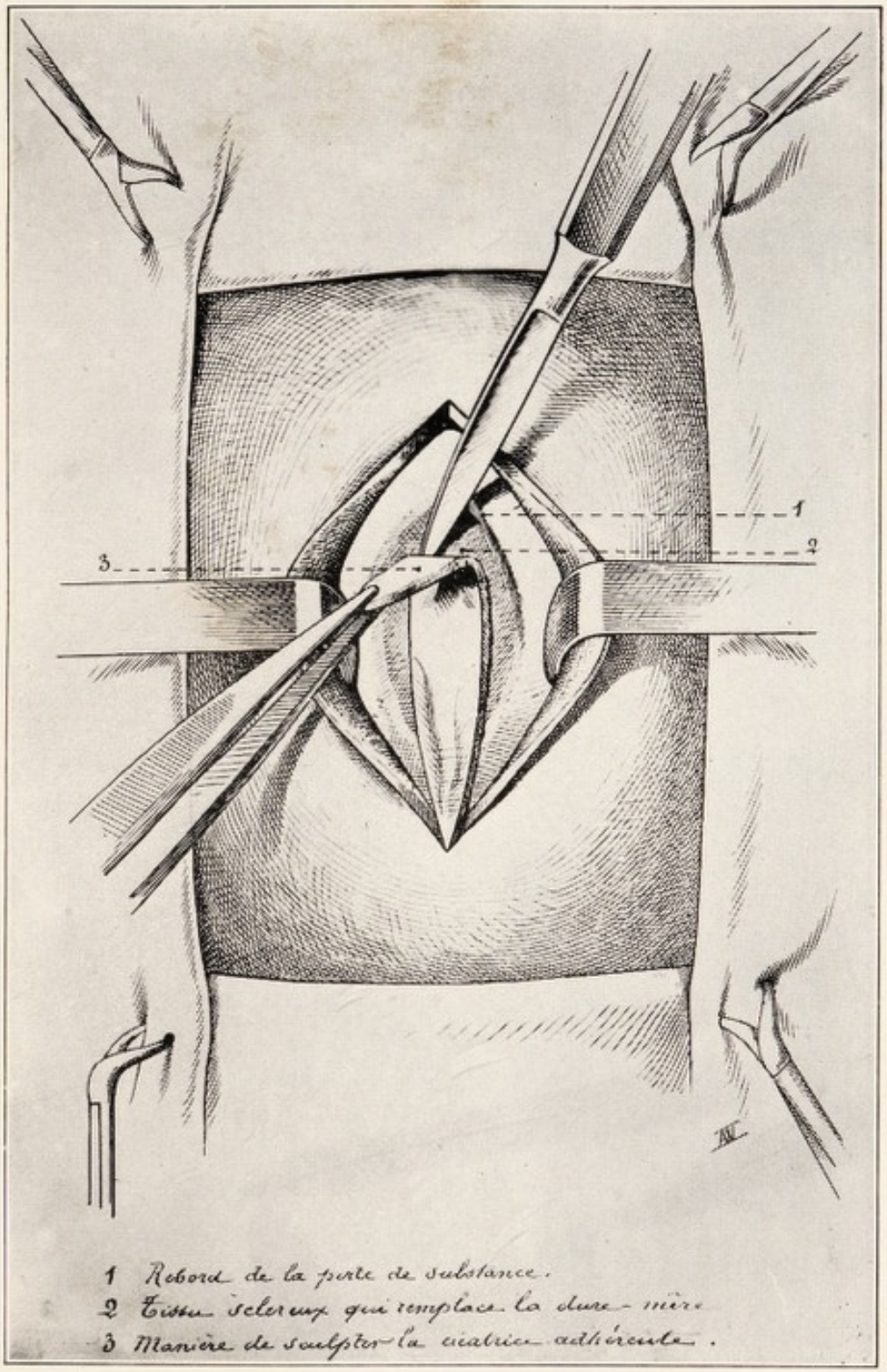


Fig. 3.—1, Border of loss of substance; 2, sclerotic tissue which replaces the dura mater; 3, method of dissecting out adherent cicatrix.

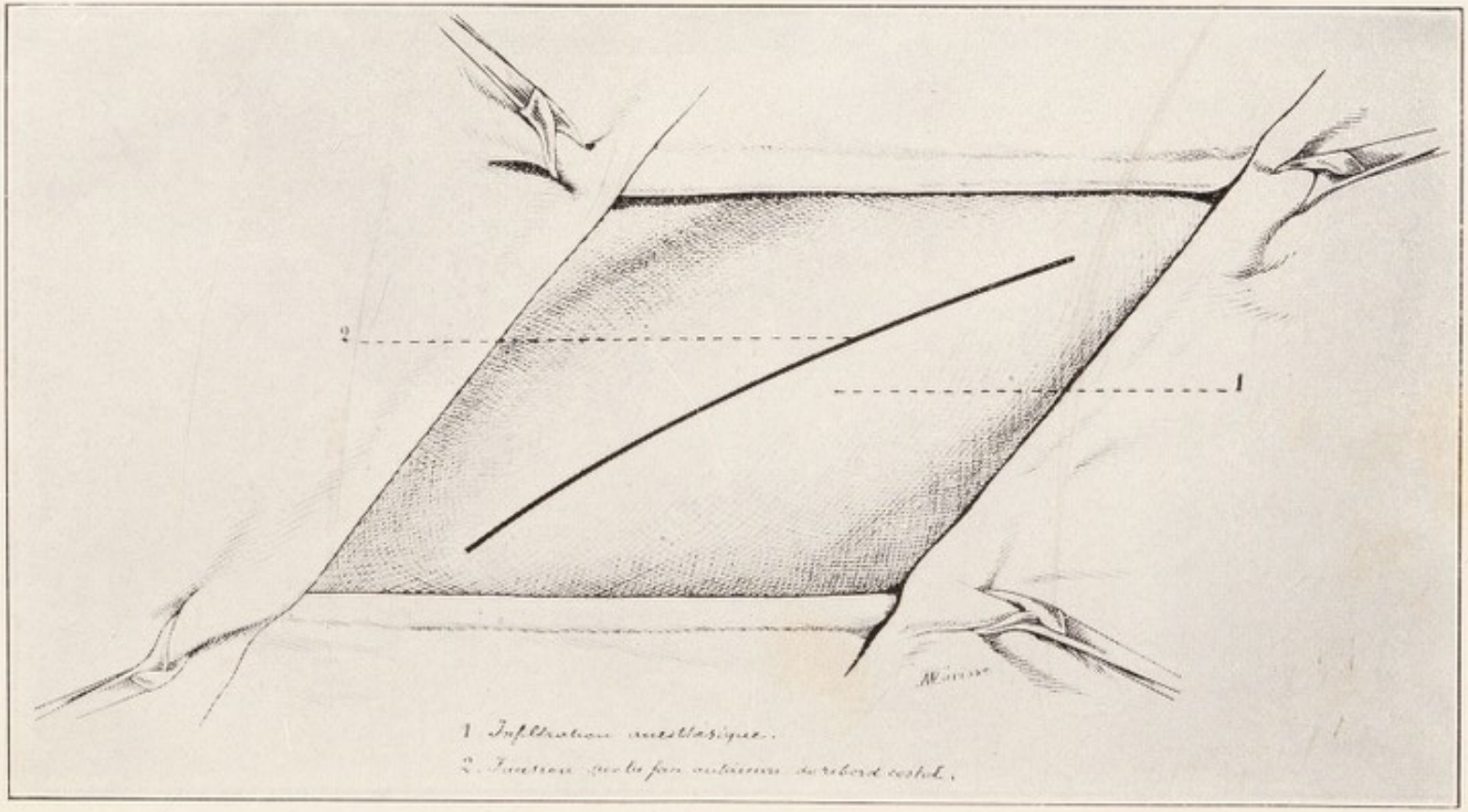


Fig. 4.—1, Infiltration with anesthetic; 2, incision on anterior aspect of costal margin.

in the same place. These continuous movements of the brain disturb the patient and when the loss of substance is considerable he is very apt to avoid all changes of position so as not to experience this highly distressing sensation.

(3) These patients can not tolerate external vibrations such as the rolling of a train, the shaking of an automobile, street cars, etc.

A patient in our service refused to submit to operation, but was so seriously inconvenienced by the vibrations of the car which brought the meals that he finally begged for an operation. As a matter of fact, the first thing noticed by him after the cranioplasty was the disappearance of the trouble caused by the same wagon.

A Chasseurs officer who resumed his service eight months after the operation, and who had previously been unable to ride in an automobile, stated that the bursting of the shells now produced no cerebral perturbation.

There are in addition a series of small variable signs, according to different individuals, largely referable to disturbances resulting from loss of equilibrium in the pressure of the intracranial fluid, caused by the solution in continuity of the skull cap; these signs subside with the performance of cranioplasty.

The advantage of restoring its uniformity of internal pressure to the brain, except in cases of over-pressure, is universally conceded.

Our own experience leads us to the conclusion that cranioplasty causes the disappearance of all the principal signs of the trephine syndrome: the last to disappear is the vertigo. The headaches and muscular weakness observed in all patients with cranial lesions subside rapidly.

The following detail illustrates the beneficial effects of cranioplasty: Trephined patients are, as a rule, unable to tolerate the "movies;" after cranioplasty they can follow the pictures on the film. The experience of two years does not yet permit the drawing of conclusions; these cases must be observed for a very long time; but meanwhile it may already be stated that a considerable number of patients are evidently benefited by the intervention. Before operating upon them the cases must be carefully studied, refraining from interference when a contraindication exists.

All losses of substance, both small and large, must be closed by a graft.

The contraindications are as follows:

(1) Infection; (2) the presence of intracerebral foreign bodies; (3) hyper-pressure, even slight, with edema of the papilla; (4) irreducible cerebral hernia; (5) cases of lesion of the occipital region with visual disturbances; (6) cases of recurrent epilepsy which do not improve on prolonged rest in bed. Beside these cases there will

always be special cases in which physician and surgeon will agree as to the nonadvisability of intervention.

Concerning the best procedure for grafting, this may be stated at some time to come on the basis of several hundreds of cases. Personally and until the contrary has been established, we accord the preference to cartilage grafts. The employment of metal, ivory, dead bone, or celluloid plates can not be generalized. Except in a few fortunate cases, these plates are cast out at the end of a certain time, or they play the part of foreign bodies.

There is no longer any doubt between *dead* and *living* grafts, the latter being preferable. It remains to determine if bone or rather cartilage should be grafted.

Bone grafts involve several disadvantages:

(1) Necessity of general anesthesia.

(2) When the pediculated flap is taken from the neighboring bone, it must be cut with the chisel and mallet, which should be avoided in cranial surgery.

(3) When the graft is taken from the tibia and the loss of cranial substance is considerable, a single graft does not suffice.

(4) Difficulty of shaping the grafts so as to follow the configuration of the skull.

(5) Sometimes the bony graft does not fuse with the margin of the loss of substance and the result is the establishment of a pseudoarthrosis, moving like the keys of a piano.

(6) After the graft has healed in, one can never tell when the growth will stop, and real proliferations may result, causing cerebral compression.

(7) The raw surface of the grafted bone remains irregular, which is disadvantageous, whether it be in contact with the dura mater or with the scalp.

In a general way bony grafts may be applied in certain small losses of substance of the frontoparietal region, when the dura mater is intact, the graft then playing the part of a lid or a cover.

Cartilaginous grafts possess all the advantages of a living graft; they heal in with remarkable facility. At the end of a certain time they acquire the consistency of bone, although without becoming ossified. The graft may be cut as thin as necessary and it is possible to shape it perfectly convex as adapted to the skull cap.

There are two methods of grafting the cartilage: Morestin's method, with a number of chips, and Gosset's procedure, with a single plate. We have nothing to say on the value of Morestin's method, as we have never used it, having utilized in all our cases the single plate, according to Gosset.

In a few instances we have found it necessary to fit two plates, on account of the great extent of the loss of substance; in other cases we have intentionally broken the plate, preserving the perichondrium intact, so as to make it less rigid.

We have performed by this method 54 cases of simple cranioplasty and 3 cases of double cranioplasty, meaning that at the same session

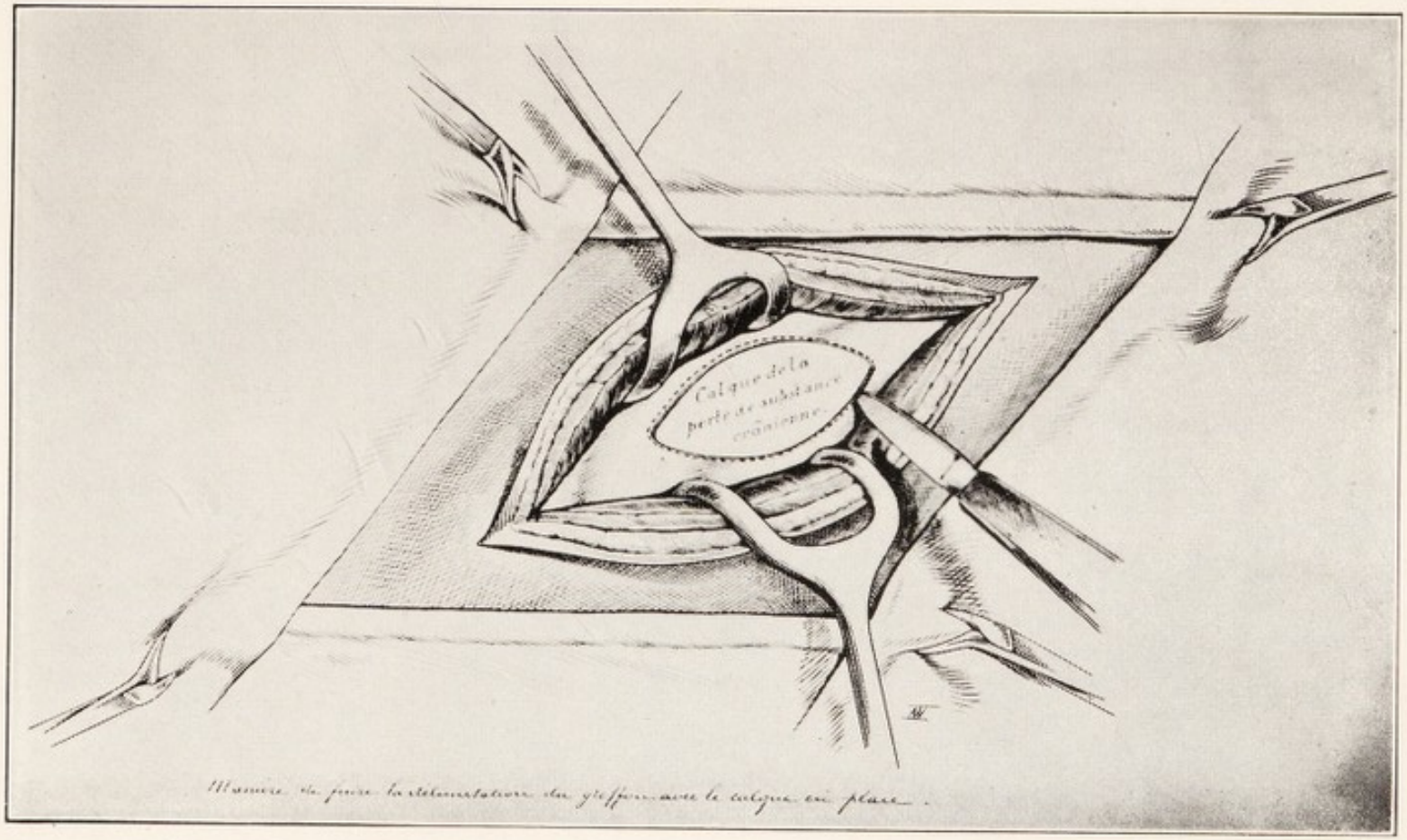


Fig. 5.—(Center). Pattern of cranial loss of substance. Outlining the graft with the pattern in position.

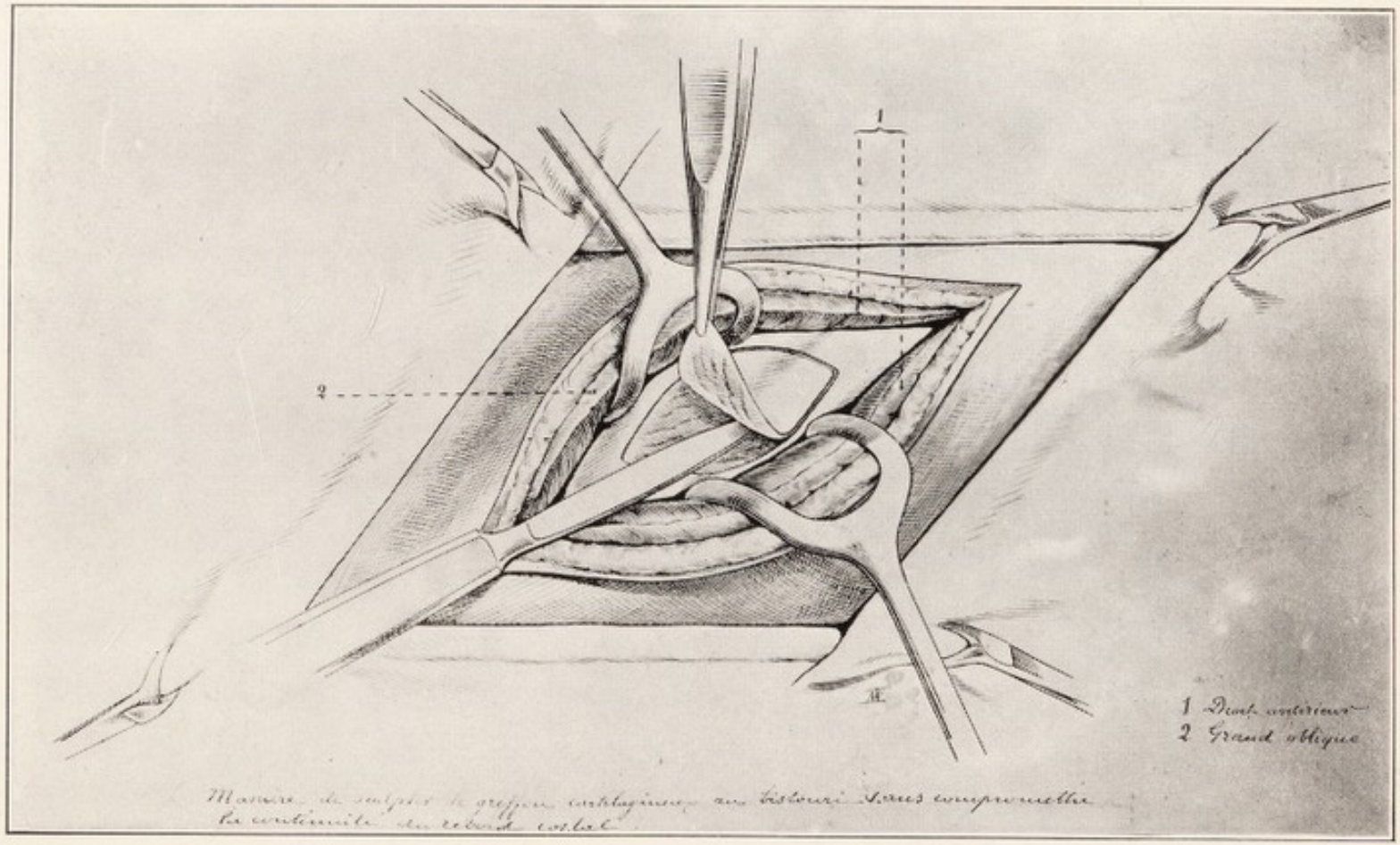


Fig. 6.—Method of carving the graft from cartilage with a bistouri without damaging the costal margin: 1, Right rectus muscle; 2, external oblique.

two cranial orifices were closed in the same patient. None of these cases were followed by disturbances referable to the intervention. All wounds healed by first intention, and there was no instance of elimination of the graft.

The results obtained in the last 50 patients are superior to the first, on account of the improved technic of the operation. We were present at the first interventions of Prof. Gosset and obtained from him the general rules governing the operation. These rules especially have contributed to the improved results:

(1) The local anesthesia; (2) the extreme thinness of the grafted plate; (3) the drainage during 48 hours, which guards against hematoma.

As to the proper time for operating upon these patients, some surgeons have tried to apply the graft immediately after trephining and extraction of foreign bodies; followed by complete closure of the wound. There is not yet a sufficient number of such cases to permit an estimate of this method.

Personally we wait for the healing of the wound and the subsidence of the tissue obstruction to apply the graft; which means that the operation is performed as soon as the condition of the tissues permits. This serves to prevent the onset of some subjective symptoms.

OPERATION.

Anesthesia.—Barring a few rare exceptions, the operation is performed under local anesthesia. A morphine injection is given one hour before the operation; in case of very excitable patients or those subject to epileptic attacks, it is advisable to give the night before and a few hours preceding the operation an enema containing 1 gram of chloral and 1 gram of bromide.

Novocain at 1 per cent with adrenalin is used. The scalp is infiltrated over a large surface, but at some distance from the region to be operated on. In case of the temporal region, superficial and deep injections are made, so as to reach all the nerves.

Anesthesia of the costal margin follows next. A long needle inserted near the cartilage of the ninth rib and pushed in horizontally between the muscles and the cartilages following the direction of the costal margin as far as the level of the fifth or sixth cartilage, and a large amount is injected in order to insure a good deep anesthesia. Without completely withdrawing the needle, it is carried across the subcutaneous tissues which are abundantly infiltrated in the customary manner.

The infiltrated costal margin forms a real "ridge," which promptly subsides because the large amount of regional connective tissue permits the absorption of the fluid.

Before beginning the operation, it is advisable to have an assistant hold the patient's head, not only to immobilize it, but especially to lend the patient a moral support and show him that he is not alone. This is a small practical detail which should not be overlooked.

Intervention.—The operation comprises two chief steps: (1) The preparation of the cranial gap; (2) the removal of the cartilaginous graft.

Extirpation of the cicatrix on the scalp.—The most common type is the crucial cicatrix; next, large irregular cicatrices are found; a horseshoe cicatrix is rare.

The rule is to make no incision which would add a new cicatrix to those already present. In the cases of horseshoe cicatrix, one cuts through the old cicatrix and mobilizes the cutaneous flap as for trephining. When the cicatrix is very irregular, it is entirely extirpated, followed by the mobilization of one or several scalp flaps, as required for the plastic work. In cases of crucial cicatrix, the operator limits himself to extirpating the larger and more adherent branch, which is cut around by an ovaloid incision.

Figure 1.—In all cases the extirpation of the cicatrix must be very cautiously done, because it is always necessary to leave a portion of the fibrous tissue which is to play the part of dura mater, and as there is no plane of cleavage, the deep aspect of the cicatrix must be carved with the bistoury. But one should not exaggerate and leave too much scar tissue. A few perforations of the dura mater or of the membrane which has replaced it permit the escape of some drops of cerebro-spinal fluid, but this has no untoward results.

Figure 2.—The cicatrix having been extirpated the lips of the wound are mobilized by some snips with the bistoury, cutting through the connective tissue which separates the scalp from the pericranium. The loss of substance appears in the wound. Detachment of the dura mater. Under the guidance of the finger an incision is applied in the pericranium at a distance of 1 or 2 millimeters from the border of the loss of bony substance. Utilizing the curved rugine of Farabeuf as a scraper the circumscribed portion of the pericranium is detached and the bone exposed.

Figure 3.—With the same rugine, which is insinuated with one of its angles between the bone and the dura mater, the detachment of the dura mater is carried out on the entire circumference (Gosset). From this time on the cerebral pulsations become stronger. By means of a piece of cloth a pattern is made of the loss of substance to serve for the removal of the graft from the costal cartilages. (Usually this pattern is cut out the evening before the operation by applying the piece of cloth or paper directly over the loss of cranial substance, the finger serving as guide and radiography as control.) Temporary

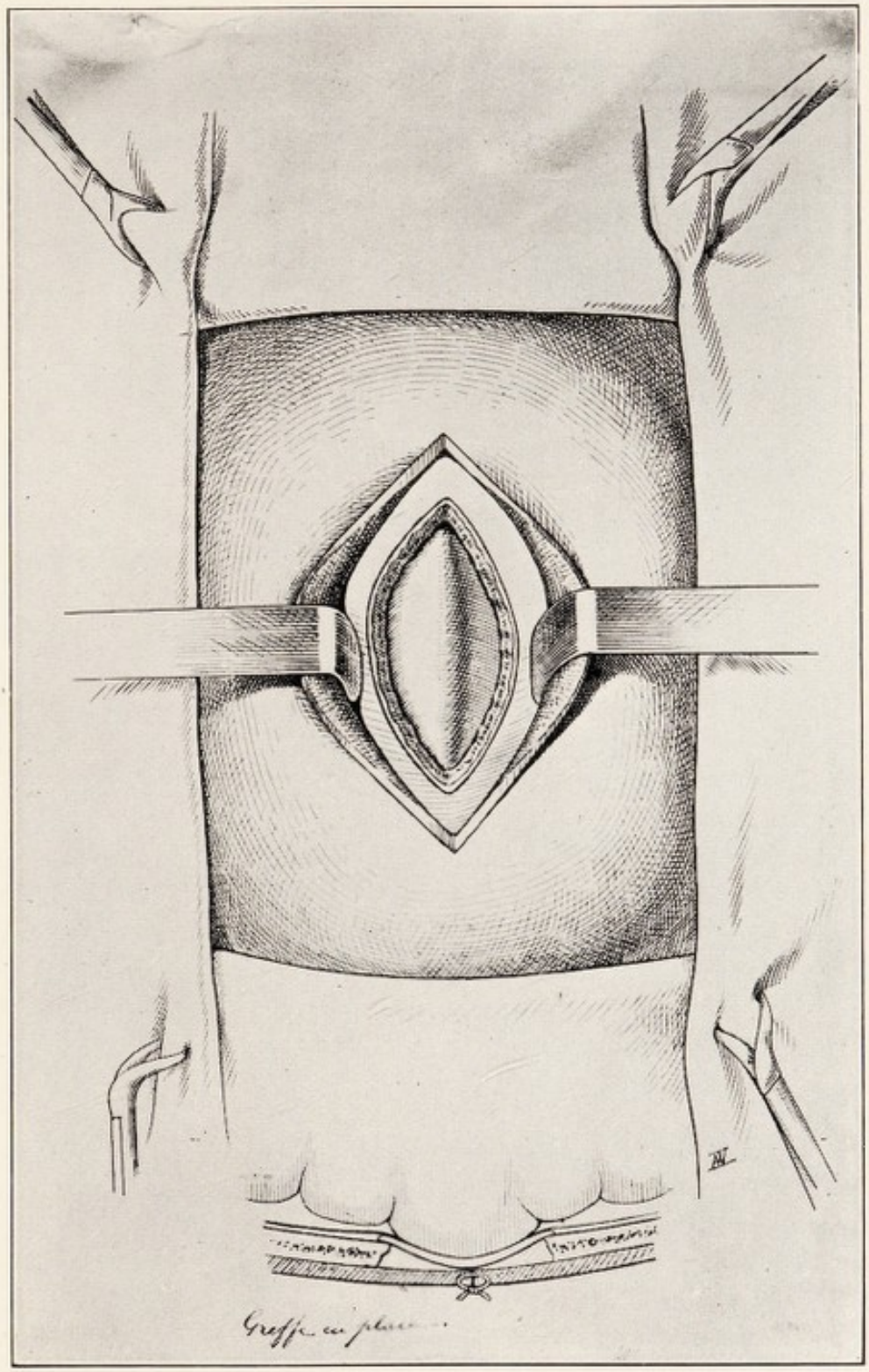


Fig. 7.—The graft installed.

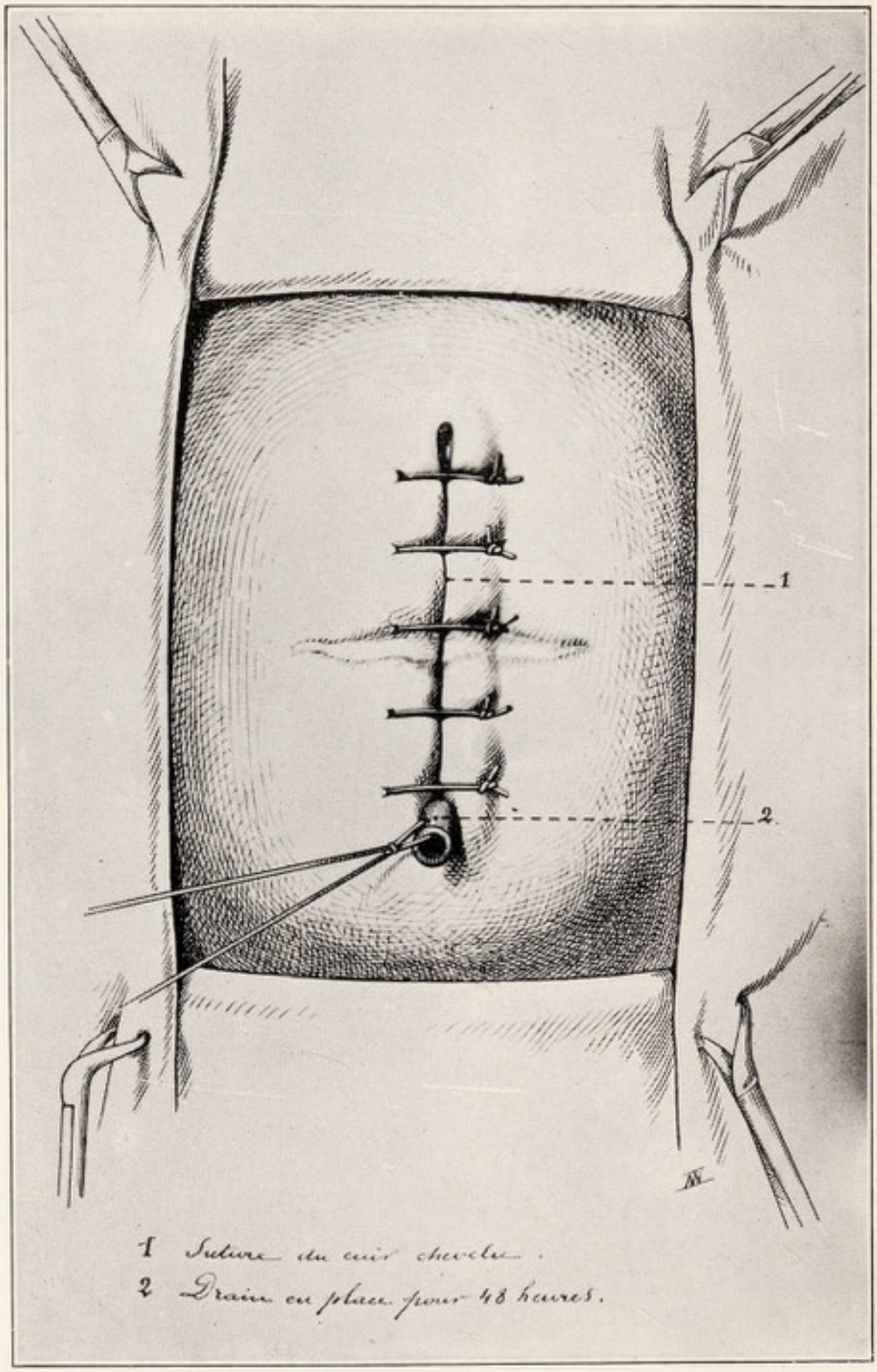


Fig. 8.—1, Suture of the hairy scalp; 2, drain left in for 48 hours

tamponing of the skull wound with compresses soaked in physiological salt solution. Next the costal margin is approached.

Removal of the cartilaginous graft.—For each of the cases we have operated upon the left costal margin has been utilized.

Incision of 8 to 12 centimeters on the anterior surface of the costal margin: Transverse division of the fibers of the anterior rectus and major oblique muscles.

Figure 4.—Two strong separators permit the exposure of the costal cartilages. Next the model of the loss of substance is applied on the cartilages; the size of the graft is outlined with the bistoury by an incision which follows the border of the pattern and takes in only the perichondrium (Gosset).

Figure 5.—The thickness of the graft must not exceed 2 millimeters. To begin with, the bistoury is placed almost flatwise grazing the ribs; the cartilage is then freely incised, cutting with to-and-fro movements.

As soon as possible the border of the graft is picked up with forceps and the incision is continued with the point of the bistoury, watching the cut surface so as to make the graft neither too thick nor too thin.

Figure 6.—The continuity of the costal margin is preserved and the loss of substance so trifling as compared to the thickness of the cartilage that two or even three layers can be removed without producing a solution of continuity of the cartilage.

Temporary tamponing of the costal wound. The graft is carried to the skull. The perichondrium must be placed in contact with the dura mater. Before putting the graft in its place it is necessary to mold it by digital pressure so as to give it the shape of a watch glass. The border of the graft is slipped between dura mater and the skull. From this instant it ceases to move (Gosset).

Figure 7.—This method of fixing the graft has been criticized and regarded as capable of producing disturbances due to compression. Untoward results were never observed in our experience. The only objection against it is that it is not cosmetic in the sense that the graft lies deeper than the bones of the skull and that consequently after healing a depression is left at the site of the operation. We employ Gosset's method only for losses of substance in the temporal bone; as the other bones are very thick, the graft is simply placed on the dura mater in contact with the bony border (diploe). Above the graft a simple suture of the scalp is performed, leaving a small drain for 48 hours.

This drainage is indispensable.—Perfect hemostasis of the operative region is almost impossible and in the absence of drainage hematomas are observed between the scalp and the graft which some-

times cause the elimination of the graft. In an autopsy case we were enabled to observe a hematoma which had detached the dura mater as far as the occipital foramen.

Headaches, aphasia, a retarded pulse, somnolence, and nausea, which some operators have noted after grafting, are very often referable to compression caused by the hematoma. None of these disturbances were observed in our patients.

The repair of the costal gap is made in three layers—muscles, aponeurosis, and skin.

The sequelae are extremely simple. For a day or two the patient complains of pain at the level of the costal margin, never in the region of the head. The drain is removed at the end of 48 hours and the threads at the end of 10 days.

In very rare cases the cicatrix was of such dimensions that the entire surface of the cartilaginous graft could not be covered with scalp tissue; the portion of graft thus left bare continued to live, was not cast off, and became covered by proliferations until healing was complete.

The patient gets up between the second and third week. The graft at this time gives the impression of being equally resistant as the skull, but repeated pressure during the examinations should be avoided. We were enabled to observe a patient 15 days after the operation, on whom a surgeon made a digital compression in order to ascertain if the graft was movable; this patient had so far had no Jacksonian attacks but had his first after this examination and several others afterwards.

As to the fate of the graft, we look back over an experience of slightly over two years. In none of these cases has it become absorbed; on the contrary, it hardens, thickens, and actually blends with the bones of the skull, but it remains transparent to the X-rays.

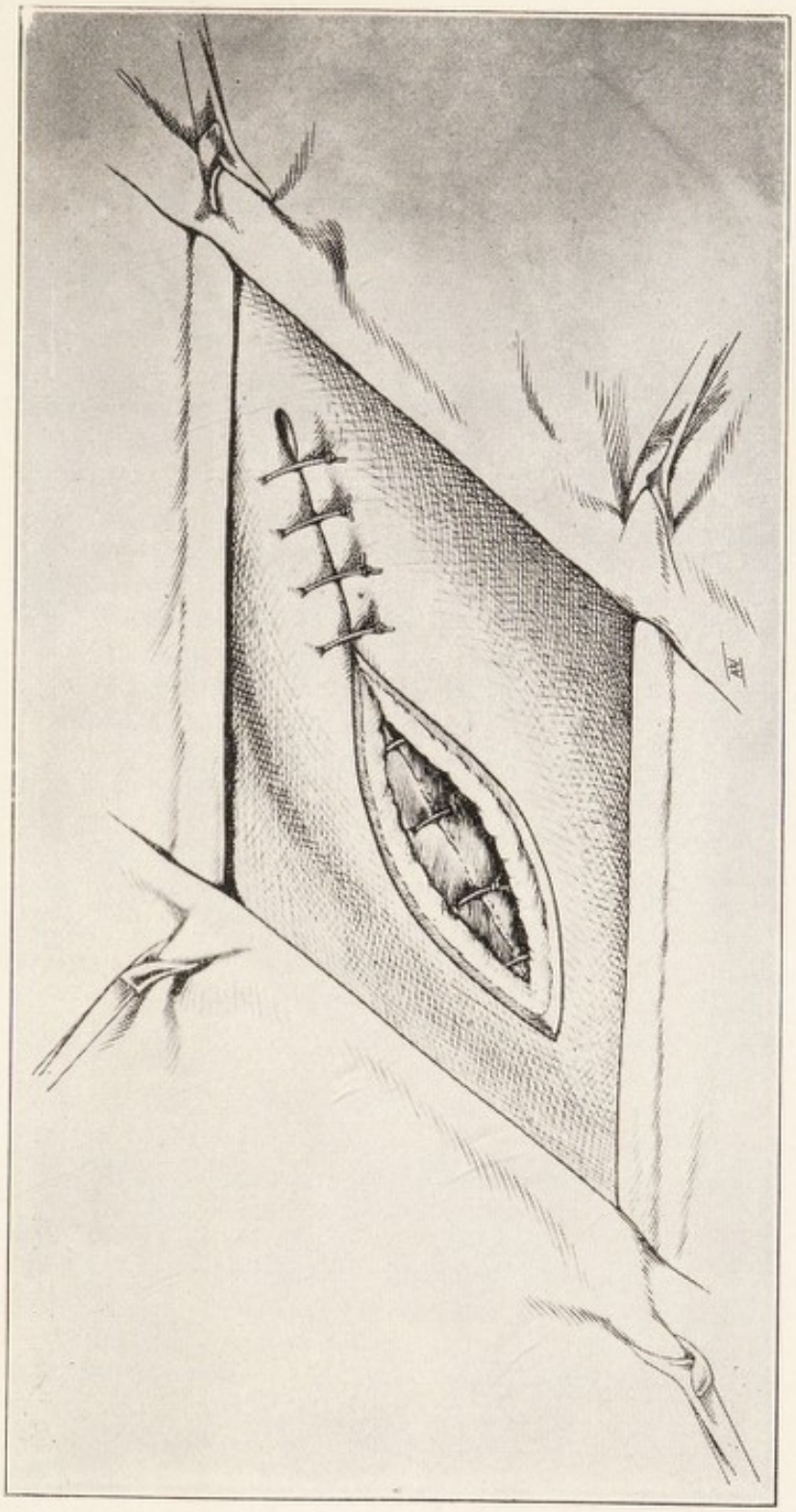


Fig. 9.

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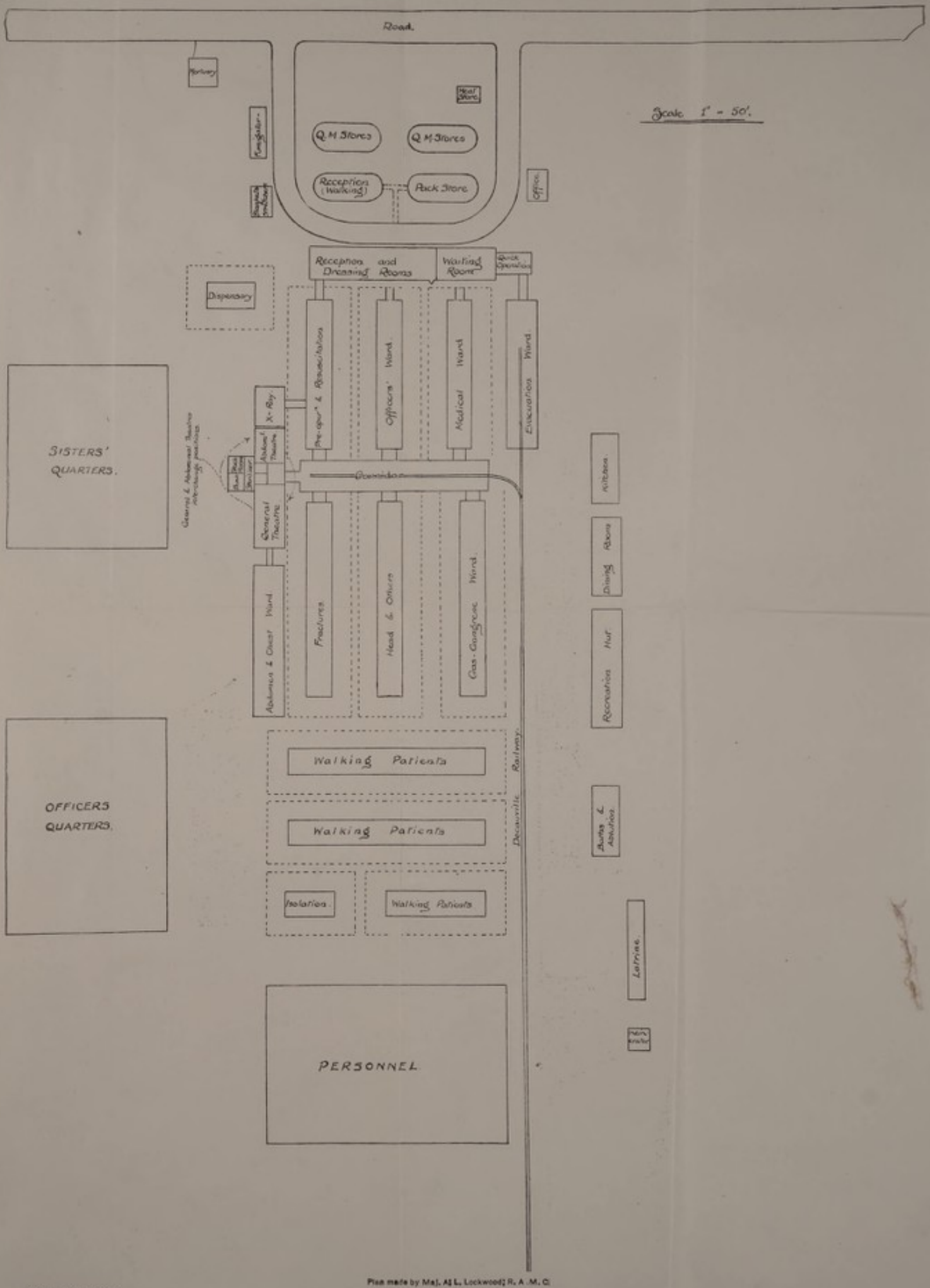
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