The surgeon's pocket-book : an essay on the best treatment of wounded in war, specially adapted for the public medical services / by J.H. Porter.

THE SURGEON'S POCKET-BOOK

BY

SURGEON-MAJOR PORTER

AND

BRIGADE-SURGEON C. H. Y. GODWIN

THE
SURGEON'S POCKET-BOOK.

FOURTH EDITION.

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Enemy
Skirmishers
Skirmishers
Supports
Supports
Supports
Supports
No 1 Batty 1st Div.
Surgeon of Battery
Main Body
I. Batty
Surgeon
Collecting Station
No 1 Bearer Co at work
Main Body
II Battalion
Surgeon
Main Body
III Battalion
Surgeon
Surgeon of Battery
No 2 Battery 1st Div in Action
Escort of Guns
A.D.C.
A.D.C.
A.D.C.
General of Division
2nd Brigade 1st Divn as 2nd Line
1000 Yards
Distance about
I Batty
Surgeon
II Batty
Surgeon
III Batty
Surgeon
A.D.C.
Surgeon of Cavalry
Divl Cavalry 1 Div.
No III Batty in Reserve
Surgeon
R.E. Co
No II Bearer Co 1st Div (in Reserve)
Dressing Station
No 1 Bearer Comp. 1st Divn
Divl Battalion 1st Divn as a Reserve
Two Miles
Distance about
No 1 Field Hospital 1st Div. (Pitched) (100 Patients)
No 2.3.&4 Field Hospitals of 1st Div. in Reserve and Awaiting Orders
E. J. H. Evatt
R. C. Foster
Des.
1886

THE

SURGEON'S POCKET-BOOK:

AN ESSAY ON THE

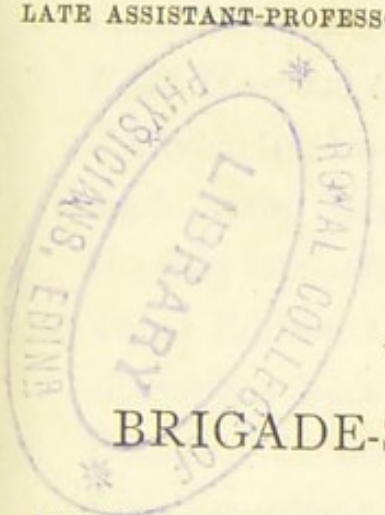
BEST TREATMENT OF WOUNDED IN WAR;

SPECIALLY ADAPTED FOR THE PUBLIC MEDICAL SERVICES.

BY

SURGEON-MAJOR J. H. PORTER,

LATE 97TH REGIMENT;
LATE ASSISTANT-PROFESSOR OF MILITARY SURGERY, ARMY MEDICAL SCHOOL, NETLEY.



Fourth Edition.

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1891.

PREFACE TO THE FOURTH EDITION.

THE Third Edition of the *Surgeon's Pocket-Book* having become exhausted, it has been necessary to prepare a new or Fourth Edition, which, it is hoped, will prove as acceptable as the last.

Great pains have been taken to bring the work up to the knowledge of the day, and amongst new matter attention has been called to the system "Bry" for fitting up railway goods' wagons as sick carriages. The Field arrangements for the Ambulance of the Army have been corrected, and plans are given for the encampment of the units, viz., a Field Hospital and a Bearer Company.

Under the heading of "Wound Treatment" a few remarks have been made upon Surgical Bacteriology, in which an attempt has been made to bring forward the chemical influence of the micro-organisms; in the Third Edition their biological existence only was considered. Several alterations have consequently had to be made in the pages on Infective Disease. In doing this, great help has been derived from Professor Senn's excellent work on Surgical Bacteriology.

Under the heading of "Gun-shot Wounds," reference has been made to the probable effects of the modern narrow bullet. The Chapter on "Abdominal Surgery" has been entirely rewritten. The Editor has to express his obligations to the excellent work "Gun-shot Wounds of the Small Intestines" by Professor C. T. Parkes, Rush Medical College, Chicago, Ill., and also to the monograph by Sir Wm. MacCormac, F.R.C.S., on "Abdominal Section for the Treatment of Intra-Peritoneal Injury."

Under the heading "Anæsthetics" the conclusions arrived at by the second Hyderabad Chloroform Commission have been given, together with some views which present a different conclusion.

The rules for the examination of sight for candidates for the Government Services have been given in full.

Lastly, as a help to Officers preparing on short notice for active service, the regulation "Kit" is detailed in Appendix V.

In conclusion, the writer begs sincerely to thank his friends and colleagues for their friendly criticisms of the Third Edition, which have been of much assistance to him in the preparation of the Fourth.

C. H. Y. GODWIN.

OAKHURST, NETLEY,
April, 1891.

PREFACE TO THE FIRST EDITION.

HAVING had some experience in the treatment of wounded soldiers during the Crimean Campaign, the Indian Mutiny, and the Franco-German War of 1870-71, I was induced to compete for a prize offered by Her Majesty the Queen of Prussia and Empress of Germany, for the best Essay on the "Practical Treatment of the Wounded in War."

The judges, Professors Billroth of Vienna, Baron von Langenbeck of Berlin, and Socin of Basle, awarded a prize to my Essay, which I now publish at the earnest request of my friends in the Medical Profession.

The great difficulty of preparing a work to meet the ever-recurring emergencies of war will, I trust, be sufficient excuse for any shortcomings which may be found in it. The army surgeon of the present day has, as a rule, to deal with the wounded under very different circumstances from his predecessors. Railways, improved transport and field appliances, as well as the privileges of the "Geneva Convention," have given to wounded soldiers better prospects of recovery in many respects; but experience has sufficiently proved that modern surgeons may still be placed, under exceptional circumstances, in no better position for the care of their wounded than were those of former days. On this account I have detailed the surgical rules of the older surgeons, as well as of those of the present day, presuming that my readers will not omit to consider the circumstances of each particular case that falls under their care, and be guided in applying the rules given in this Manual in accordance with them.

Take, for example, the circumstances of men with wounds in or near

to a Continental town, with every comfort and appliance at hand, and those of others with similar wounds on such a field as that of Alma, Magdala, or Coomassie, with the necessity for immediate long transport and exposure—how different must be the plans of treatment adopted in some of these injuries!

I have included several subjects which might at first sight be considered extraneous to the purpose of a surgical manual; such are—a scale of hospital diets, construction of cooking-places, of camp ovens, extemporary water-filters, and latrines; but, from experience in the field, I know how important for the present comfort of patients and the ultimate results of their injuries it is that the surgeon should have memoranda on these matters at hand for easy reference. Information on these points formed a portion of the contents of the original Essay, but to the present publication I have also appended the Formulary of Prescriptions which is now in general use in Military Hospitals. I have found the use of this formulary a means of facilitating work and saving time, and have therefore thought it would prove a convenient addition to the Manual.

In the preparation of this Essay I lay no claim to literary merit or originality. My object has been simply to present to the surgeon such information as I myself found the want of during my campaigns; and in doing so I have extensively made use of the labour of others, to whom I am indebted, but who, like myself, will, I am sure, be well rewarded, if their efforts tend to mitigate in the smallest degree the sufferings of the unfortunate wounded in war.

J. H. PORTER.

WOOLSTON,
May, 1875.

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SURGEON'S POCKET-BOOK.

INTRODUCTORY GENERAL REMARKS.

THE duties of the Army Surgeon, at all times responsible, are more especially so in time of war, and much of the success of armies is dependent upon the manner in which these duties are executed.

The General Officer Commanding an army in the field, owing to the pressing necessities of supreme military command, is obliged to entrust the sanitary duties to an expert officer, who should be a medical officer of high position occupying a definite recognised place upon his staff.

This medical officer ought, therefore, to exercise considerable forethought in making suitable rules for the preservation of health, and in arranging a proper organisation for the care and treatment of the sick and wounded. It is not always possible that General Officers Commanding troops in the field can comply with the strict rules of hygiene; the responsible or principal medical officer should, therefore, recognise such conditions and offer such suggestions only as are necessary, practicable, and really likely to conduce to the health and comfort of those under his medical charge. It is on these occasions when difficulties have to be overcome that the resources of the Army Surgeon are severely tested, and his genius and training prominently brought out.

To facilitate such duties and to enable the Surgeon General of an army to relieve the General Officer Commanding of any of his responsibilities, it is most necessary that he should be one of the general staff, as is the case with the Senior Officer of Royal Engineers, in order that he may be in direct communication with the General, and so learn what are likely to be the probable movements of the troops, and thus get some idea of the strategy intended. He will then be able to sketch out suitable plans for the field ambulance; in some cases, possibly, preventing it from blocking up and obstructing important roads, and, in others, by arranging for an early and rapid transfer of wounded men to the base, thus freeing the army from such encumbrances, and so enabling the General to make a forward movement earlier than he could otherwise have done. To quote the language of a distinguished officer *—"The General

*Camperdown Commission Question, 1558-1890.

Officer should have his head full of the forward movement, and the Medical Officer should have his head full of the backward movement." It will be quite obvious to those who know anything about armies that the only way in which a Surgeon-General could render this assistance to a General Officer is by being in constant touch and communication with him as one of the staff, but if the Surgeon-General of an Army is to be relegated to the lines of communication or base,* he ceases to have any powers, and the authority that he should legitimately exercise will have to be usurped by a junior, as it is utterly impossible that any military officer could exercise supreme command over an army in the field for any length of time without requiring constant reference to his principal medical officer upon a number of points of pressing or even vital importance, and as the professional advice tendered might or might not affect his plans, it can only be right that the medical officer so consulted should be the one to whom the country has entrusted the medical charge of the army. If, however, the present regulations are to continue in force the Surgeon-General selected by the Secretary of State for War for the medical charge of the army will be miles away from the General Officer Commanding whose medical adviser must then be some junior medical officer, who will naturally give his best opinion under the circumstance but without any of the sense of responsibility that would weigh with the Surgeon-General of the Force.

Organisation of Transport.—Rules and regulations exist in all civilised countries for the organisation of transport, supply of stores, comforts, medicines and surgical instruments under their respective departments; but it is becoming now the recognised province of the medical staff in all European armies to take possession of the sick or wounded soldier from the time that he "falls out" at the front until he reaches the base hospitals however long the line of communication may be. It is, therefore, the nature of these executive duties that has led the medical officers in the various armies to seek to have their position and status better defined. In the field the military power is paramount and everything is subordinated to it, consequently only those persons possessing army rank have authority. Medical officers of the army feel that if they are to accept the new responsibilities which the demands of modern warfare have of necessity thrown upon them, their position as officers in the matter of rank must be unequivocal. In the field there is too much seriousness of purpose present with every one to admit of any self-assertion, nor in the nature of things is this desirable at any time; therefore army surgeons seek for such recognition as will render them efficient in the discharge of their proper and legitimate duties without their having the least desire to trench upon the duties of their combatant brethren. It would seem only logical that the more the army medical officer is identified with and forms part of the military machine, the more efficient he will be, and consequently the greater advantage will result to the army at large.

The Army Surgeon ought to take considerable pains to make himself

* *Regulations for Medical Services.* Part I., paras. 107, 108. 1890.

acquainted with the construction of all transport conveyances for the sick and wounded, and with the regulated plans of encampments for bearer-companies and field hospitals, together with all the minutiæ of their respective equipments. This knowledge can only be acquired by his having sufficient opportunities in peace time for constant practice with the units—viz., a field hospital and a bearer-company—the equipments for which are needed for this purpose in all large military centres. It is too late to attempt to learn the A B C of such things on service when every man is pressed for time and calls for help are being made on all sides. The time to learn about field hospitals and their equipment, where to find the different medicines, surgical appliances, as well as the cooking and feeding arrangements; how to pitch and strike a camp; how to readily divide a field hospital into its halves, each with its proper complement of stores of all kinds, can only be learned in the leisure time of peace, while upon a proper knowledge of such things on the part of the Medical Staff Corps will depend the welfare and lives of sick and wounded officers and men.

Surgical Instruments should be special objects for care. The French and German Armies have adopted the plan of having all their surgical knives made in piece with the handles, so that there are no scored wooden handles to hold and retain dirt. The cases in which they are packed are made of metal, and serve the double purpose of cases and of troughs for soaking the instruments before using them. When required for operation the contents are taken out and the empty metal case is filled with an antiseptic lotion in which the knives are soaked; when no longer required for this use they are emptied and dried and the knives are carefully packed away in them by means of absorbent cotton wool.

The Art of Extemporising Appliances.—The extemporaneous construction of splints, pads, cushions, field kitchens, hospital huts, latrines, bedcots, litters, carts, &c., should engage the earnest attention of the army surgeon as he may be placed in positions when regular artificers are not available; with knowledge on these matters, and the aid of a few orderlies, he may be able to secure shelter, properly cooked food, and comfort in a short time. On service he will find that, unless he is capable of supervising and directing such things, much will be left undone and those under his care must consequently suffer; and even if the usual resources fail, or are not at hand, he should be able by extemporaneous expedients to succour the wounded and relieve the sick. An acquaintance with the dress of the soldier may assist in discovering some cause for inability to march or keep up with the others, such as tight collars, or badly-fitting boots, or wrinkles in trousers, &c.

The Carriage of the Sick and Wounded on stretchers is highly important, and the surgeon should be in a position to instruct those about him in the event of regularly trained men not being available.

A stretcher section consists of four detachments, and each detachment of four men, two of whom carry the stretcher, while two act as a relief during the transport, and assist in placing upon the stretchers men who have met with serious fractures or other injuries.

Before attempting to remove a badly-wounded man from the spot where he has fallen the stretcher should be brought close up to him. The wounded man should not be carried by hand further than can be avoided. In placing the stretcher for this purpose, it should be laid by the side of the patient according to present regulations, but in some systems it is directed to be placed at the head of the patient in a line with his body.

The following instructions have been laid down by Sir Thos. Longmore for the proper carriage of stretchers :—

The front and rear bearers of the conveyance must start with opposite feet. They must not move "in step," but, on the contrary, must march out of step, or, as the ordinary expression is, must "break step." If the man in the front steps off left foot forward, the man in the rear must step off at the same moment right foot forward, or *vice versâ*, and this broken step must be maintained throughout the whole distance of the transport.

The bearers must march with a steady but easy step, particularly avoiding that elevation of their bodies which is caused by springing from the fore part of the feet. The foot should be planted without any wavering on the ground at each step, and in moving forward it should only be raised sufficiently to clear the ordinary impediments on its surface. Some bearers, unless this rule is enforced, will make a slight spring in their movements, which spring is of course communicated to the more or less pliable conveyance they are carrying. They do so in the belief that the weight is sustained more easily in consequence of the elastic movement which is thus obtained, but they take no note of its ill effect on the person conveyed. Whether even or uneven as regards measure of time, great care must be taken that the steps of the front and rear bearers are invariably even and alike in distance. If the steps do not well and accurately agree in length, there will constantly be a hasty "catching up" of one or other by his fellow-bearer, and the stretcher and patient will be jolted on every occasion when an effort is thus made to re-adjust the distance. If the bearers march with an exactly corresponding step as regards length, this source of disturbance will be avoided.

When forming a stretcher detachment, as far as circumstances permit, men of nearly the same height and strength should be selected for acting together. When a stretcher is supported by men of equal height and proportion, if the ground be level, the stretcher will necessarily assume a horizontal position also, and men possessed of like degrees of strength will carry the weight and move together more evenly. If the ground be uneven, the bearers will have to mutually adapt the height of their respective ends of the conveyance to the irregularities in order to preserve its level condition.

When slings or shoulder-straps are used to assist the bearers in carrying stretchers, care should be taken at starting that they are buckled so that the parts supporting the poles are at equal distances from the surface of the ground.

As most ground over which the wounded men have to be carried is likely

to present irregularities of surface, it becomes an important matter for bearers to practise the carriage of the stretchers so as to acquire a facility of keeping the stretcher level, notwithstanding that the ground is uneven.

If the ground over which the conveyance has to pass presents a general ascent, and the bearers are of different heights, then the rear or No. 3 bearer should be the taller and stronger man, for his greater height and the greater strength of his arm will be useful in supporting and raising the stretcher up to the level of the end carried by the foremost man. The weight of the stretcher will naturally be thrown in the direction of the man on the lower level.

If the ground presents a general descent the front or No. 1 bearer should be the taller and stronger, for the same reasons as those just given as regards the No. 3 bearer under the opposite circumstances.

A sick or wounded person on a stretcher should be carried, if the ground be tolerably level, with his face looking toward the direction in which the bearers walk. The front or No. 1 bearer then supports the end of the stretcher at which the patient's feet are placed; the bearer near the patient's head is the rear bearer or No. 3.

If the bearers have to carry the stretcher up hill, the front bearer should support the end of the stretcher on which the patient's head is placed, excepting under the following circumstances :—

If the bearers have to carry the stretcher down hill, the rear bearer, or No. 3, should support the end on which the patient's head is placed.

The reverse of these positions should be assumed by the bearers, both as regards going up hill and going down hill, when the patient being carried is suffering from a recent fracture of the thigh or leg. The patient's comfort and welfare will be best consulted as a general principle by the arrangements suggested in the previous paragraphs. Although under all circumstances the level position should be sought for as much as possible, still, if the slope of the ground be such that it cannot be attained, it appears desirable that the inclination downwards should be towards the feet rather than towards the head of the patient. But with regard to the exceptions just named, a reverse position of the patient is directed in order to prevent the weight of his body pushing the upper end of the broken bone down upon the helpless and motionless portion of the limb below the seat of the fracture.

No attempt must be made to carry a helpless patient over a high fence or wall, if it can possibly be avoided; it is always a dangerous proceeding. The danger is of course increased in proportion to the height of the wall or fence. If the fence or wall be high, either a portion of the wall should be thrown down, or a breach in the fence made, so that the patient may be carried through on a stretcher; or the patient should be carried to a place where a gate or opening does already exist.

In crossing a ditch, dyke, or hollow, the stretcher should be first laid on the ground near its edge, the first bearer then descends, the stretcher with the patient upon it is afterwards advanced, the first bearer in the ditch supporting the front of the stretcher, while its other end rests on the edge of the ground above. While thus supported, the

second bearer descends, the two bearers now lift the stretcher to the opposite side, and the fore part being now made to rest on the edge of the ground while the rear part is supported by the second bearer in the ditch, the first bearer is left free to climb up. The stretcher is now pushed or lifted forward on the ground above, and rests there while the second bearer climbs up, the two bearers then carry the stretcher on.

On no account should a stretcher be permitted to be carried on the shoulders of two or four bearers. The evil of such a proceeding is not only that it is difficult to find several bearers of precisely the same height so that a level position may be secured, but also that the wounded or sick person, if he should happen to fall from such a height owing to the helpless condition in which such a patient usually is, will not be unlikely to sustain a serious aggravation of the injuries he may already be suffering from. Moreover, one of the bearers of the stretcher ought always to have his patient in view so as to be aware of hæmorrhage, fainting, or other changes requiring attention taking place, and this cannot be done when the patient is carried on the shoulders.

Surgeon-Major Will, in his report upon the Nile Expedition, 1884, writes—"I substituted ropes for the leather shoulder straps, grummets were made similar to those on board ship through which the ropes were passed, two bamboo poles eight feet long were run through the grummets and the stretcher was then carried by means of the pole upon the shoulders of four men. This method proved suitable and comfortable to both patients and bearers."

Means of Extemporaneous Transport.—There are occasions when a sufficient number of stretchers may not be at hand; it will then be

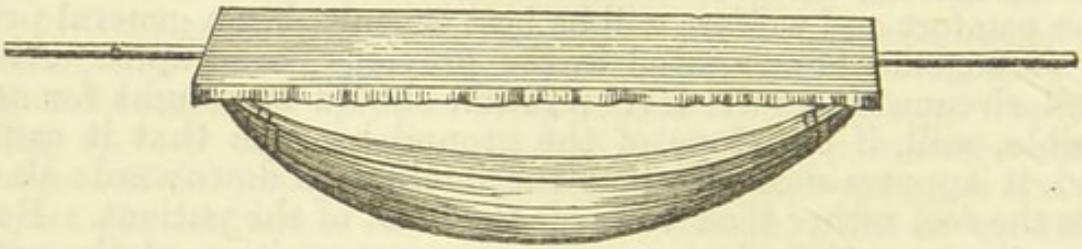


Fig. 1.

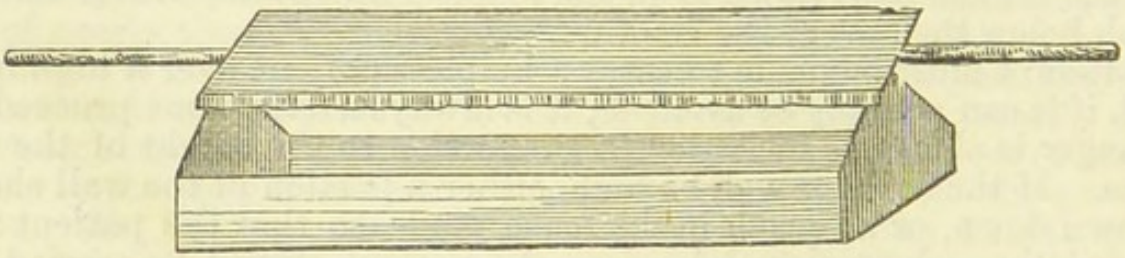


Fig. 2.

Hammocks and Cots used during the Ashantee War, 1873-74, arranged with shades for protection from the sun. (From drawings by Surgeon J. Fleming.)

necessary to adapt oneself to circumstances, and take advantage of such means as may be present. If near shipping, hammocks and cots may be

converted into stretchers by being suspended from single poles, as in figs. 1 and 2, or by a little management they can be arranged to be carried between two poles. The former plan was adopted during the late expedition of British troops in Western Africa, and Staff Surgeon H. Fegan, R.N., mentions that each hammock was fitted with a pillow made of another spare hammock, which, in the event of any emergency, could be easily slung from tree to tree, and thus often proved very useful.

The following stretchers may be constructed on the spot from materials generally available :—

"Blankets, by having a loop sewn at each corner, can with two poles or two rifles make temporary conveyances. A loop should be sewn at

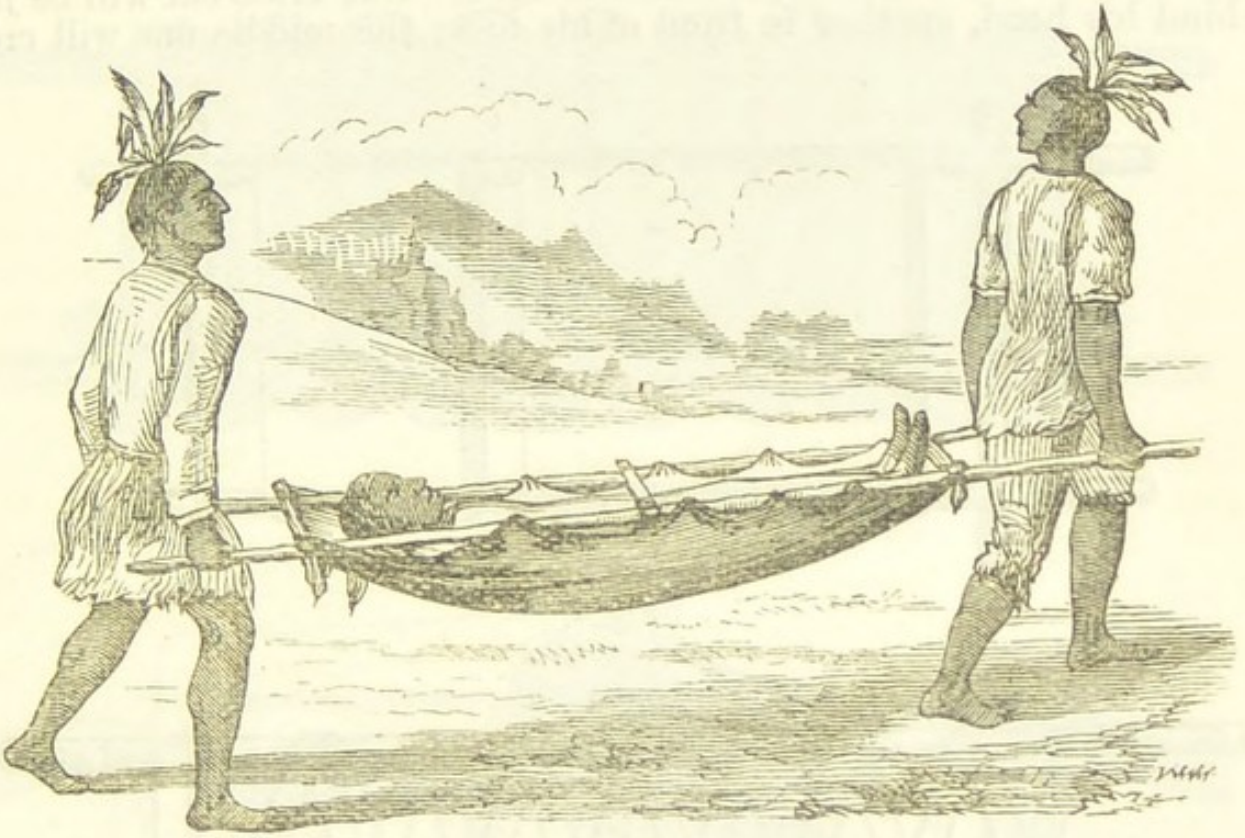


Fig. 3.

each corner, and the blanket be then doubled over so that the two loops at each end are brought together ; a pole or rifle can be passed through the four loops on one side, and another passed within the doubling of the blanket on the other side.

"In urgent cases a blanket may be used as a means of carriage by four men, one taking hold of each corner. It must first be spread out upon the ground, and the patient laid gently on it in a suitable direction."

Mr. Hamilton of the U.S.A., in writing of blanket litters, recommends "cedar as the best for carrying-poles, being light, elastic, and strong, next to these, pine or ash. Two cross-bars are sufficient. The blanket may be rolled in before the cross-bars are made fast, or, the cross-bars being first secured, the blanket may be 'knotted up' by strings, and if

strings cannot otherwise be procured, they may be made by tearing strips from the margin of the blanket."

Dr. G. Suckley, U.S.V., says "that he has occasionally in frontier service constructed a temporary litter of two poles cut from the forest, these being laid upon the edges of a blanket, rolled in, and finally made fast with strong twine, by puncturing the blanket at intervals of a foot along the sides of the poles, and tying the twine strongly on the outside."

Galton recommends a temporary stretcher to be constructed in the following manner:—"Cut two stout poles, each 8 feet long, to make its two sides, and three other cross-bars of 2½ feet each, to be lashed to them. Then, supporting this ladder-shaped framework over the sick man as he lies in his blanket, knot the blanket well to it, and so carry him off palanquin-fashion, as represented in fig. 3. One cross-bar will be just behind his head, another in front of his feet; the middle one will cross

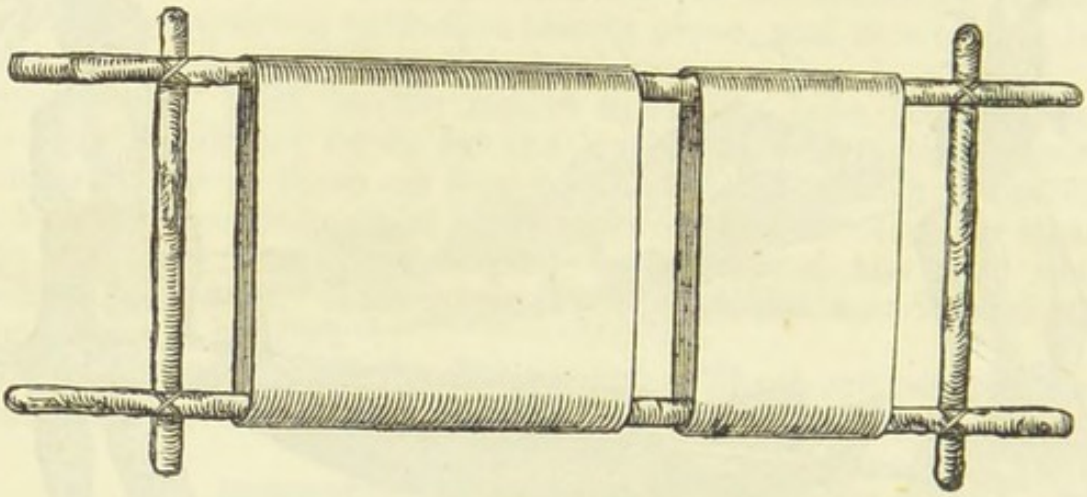


Fig. 4.

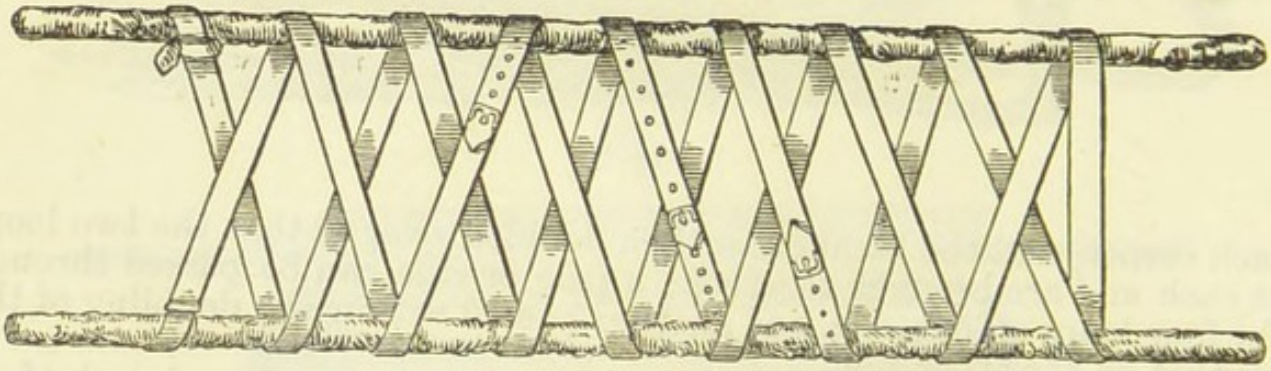


Fig. 5.

his stomach and keep him from falling out, and there will remain two stout handles for the carriers to lay hold of. A kind of wagon-top can easily be made to it with bent boughs and one spare blanket."

"Oat or corn sacks will serve as a canvas bottom to a temporary litter, or in an emergency, any old pieces of cloth—the fragment of a tent, an overcoat, or even a pair of pantaloons; some of which things can almost

always be found on a battlefield. Litters thus constructed also make excellent beds in a hospital tent, when placed upon four crotchet sticks driven into the ground."

General Jackson recommended and adopted occasionally a very simple method of conveying the sick in his expedition against the Indians—viz., to suspend a bull's hide between two muskets, upon which the patient was carried by two or four men, as the case might require.

Fig. 4 represents a very simple stretcher made with two long poles and two shorter ones laid cross-wise and nailed (or secured by tying), strong cloth, linen, or any other material being stretched across. Boards may be substituted for the cloth, in which case a sack filled with straw, hay, or other soft material must be laid above them. Fig. 5 represents a

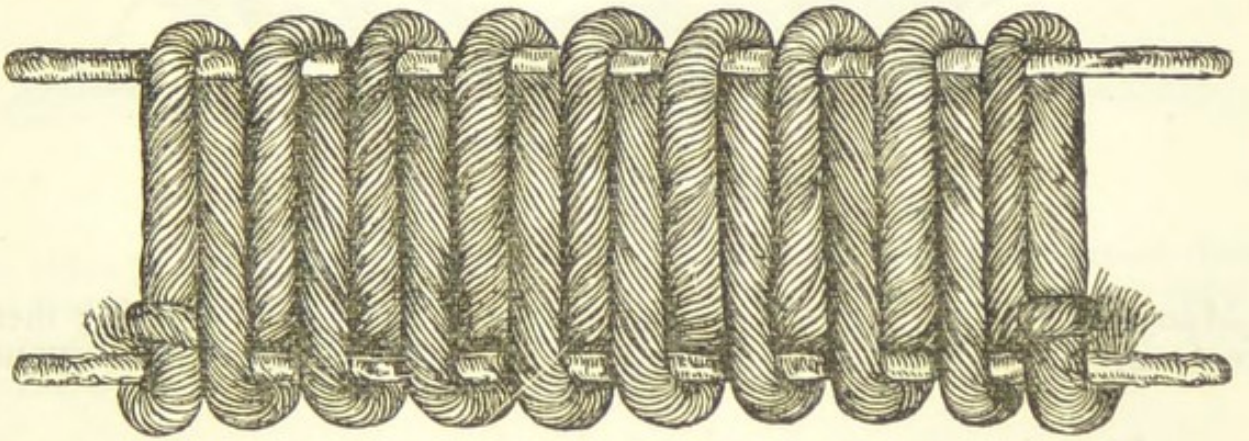


Fig. 6.

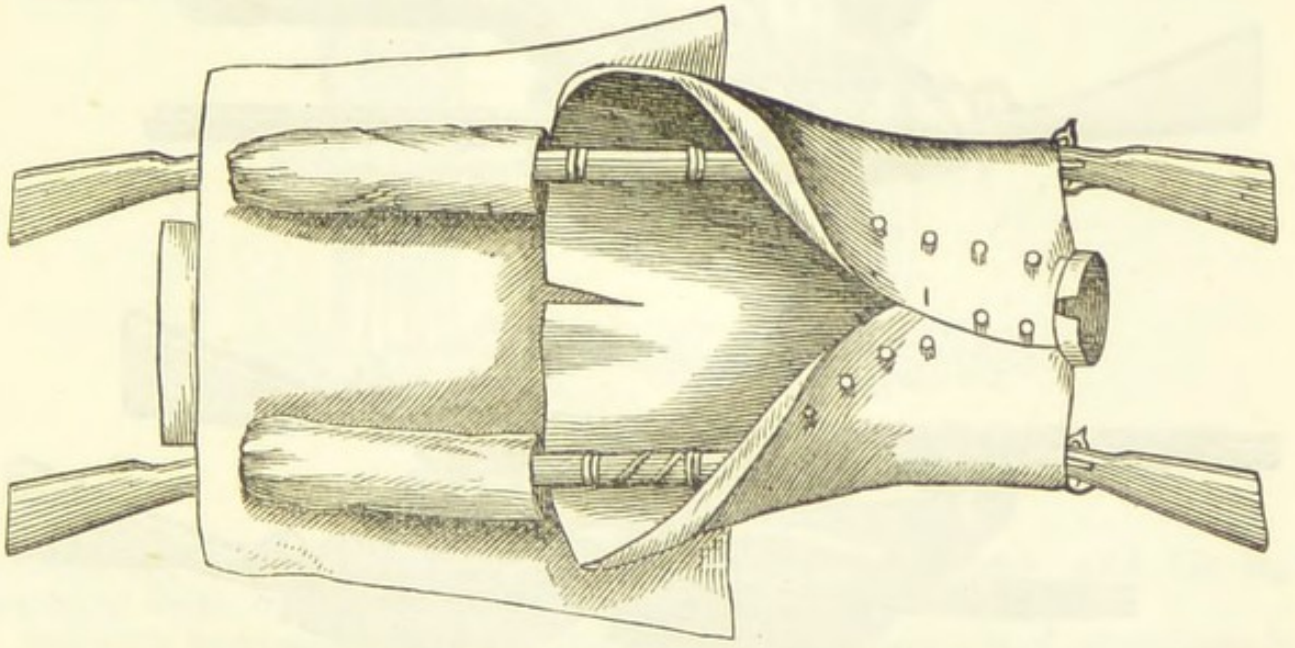


Fig. 7.

stretcher composed of two long poles of equal length with two or three of the men's belts interlaced. Two cross poles would, of course, keep the long ones apart and make the contrivance more comfortable, but heavy,

Fig. 6 represents a stretcher constructed with a hay or straw rope, which (though troublesome to construct, and requiring experts in the manufacture of the rope) might be found convenient if circumstances admitted of its being made.

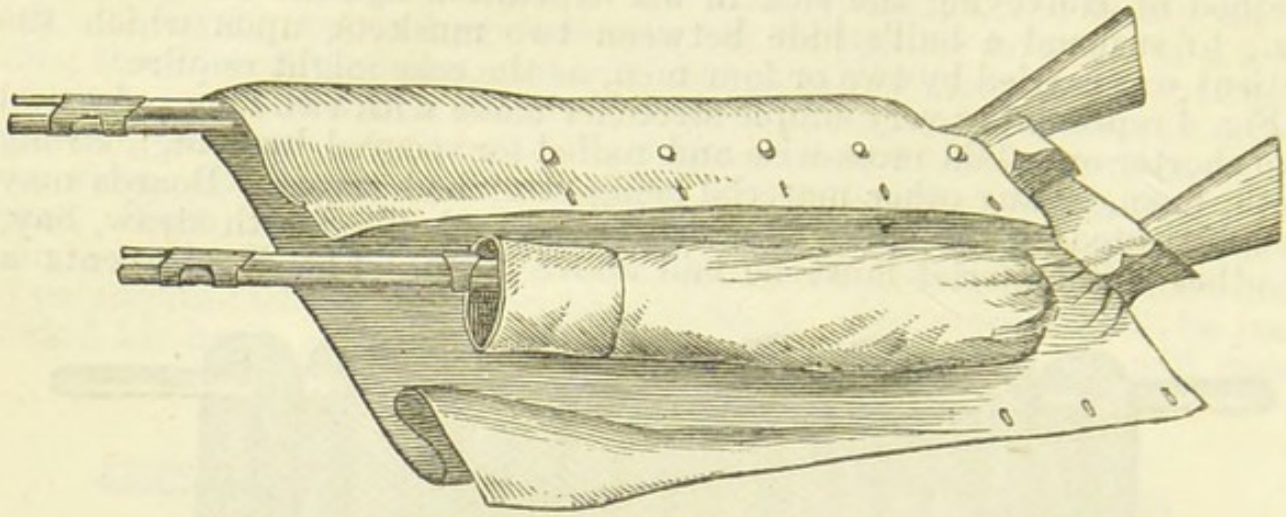


Fig. 8.

Many plans have been devised from time to time for converting men's greatcoats or tunics, and rifles, into temporary means of conveyance,

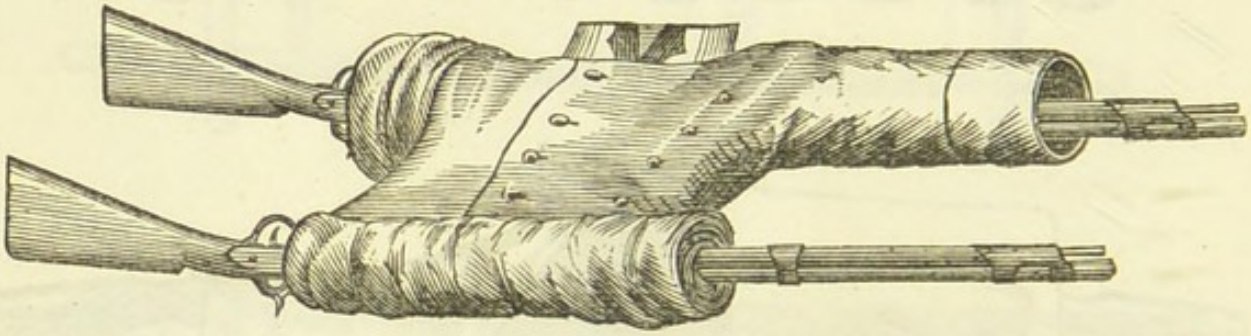


Fig. 9.

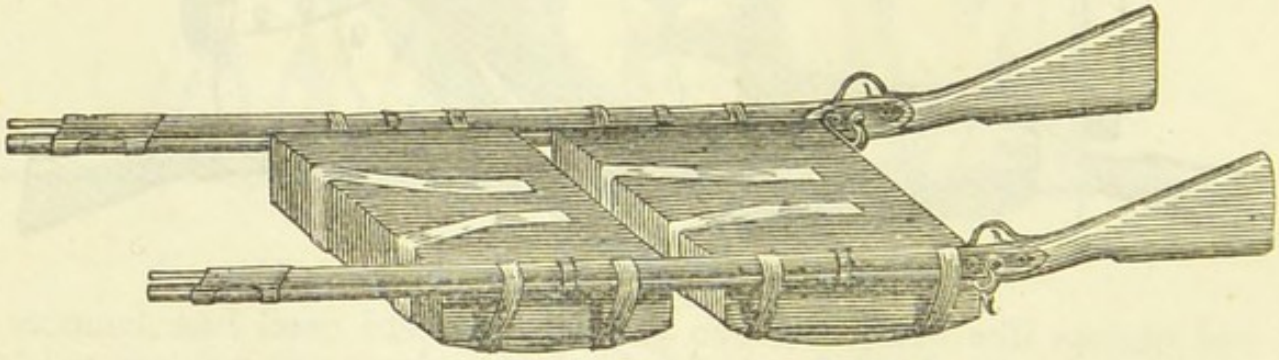


Fig. 10.

sufficient in an emergency to carry a wounded soldier from an advanced post to the first line of surgical assistance. Fig. 7 represents a stretcher

constructed with four rifles and two greatcoats. Two rifles are firmly lashed together by their barrels, so as to take the place of poles. The sleeves of the coats are then turned into the inside of the garments, and

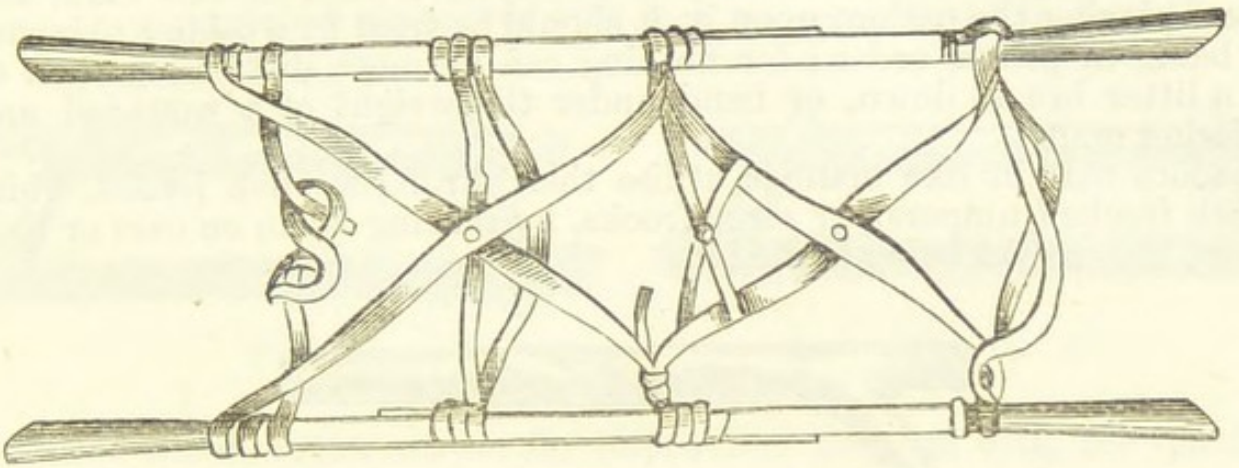


Fig. 11.

the rifles passed through them, after which each coat is buttoned down the front in the usual way. With one tunic or coat and two rifles a short stretcher may be constructed, as shown in figs. 8 and 9, which would answer for a wounded soldier unable to walk, but capable of

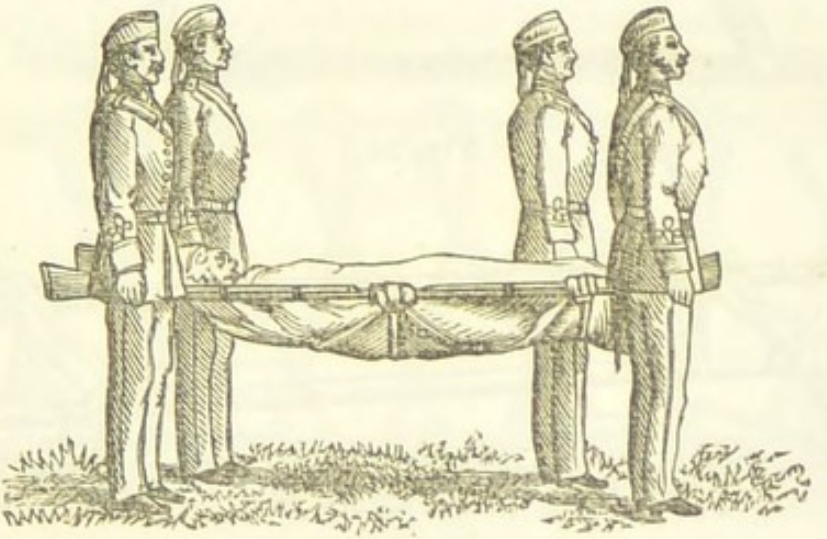


Fig. 12.

sitting up, his back being placed against front bearer and his legs hanging down in front of rear bearer.

Soldiers' knapsacks may be utilised in the formation of stretchers by being fastened with their straps between poles or rifles, as represented in fig. 10.

Figs. 11 and 12 represent an arrangement of four muskets with valise equipment and straps, devised by Surgeon-Major Sanderson, 30th Regiment.

Dr. Appia suggests that an extempore litter may be made by shirts found in the knapsacks. The poles are to be inserted into the shirt, a number of shirts being placed one above the other. There may be some doubt, he says, as to the solidity or frailty of a litter of this kind, and before placing the patient upon it, it should be tried by a soldier to insure all being in proper order; for nothing can be more distressing than to see a litter break down, or bend under the weight of a wounded and suffering man.

Sailors may in like manner utilise their strong woollen jersies, white smock frocks (jumpers), or serge frocks, by placing them on oars or boat hooks, the sleeves being turned in.

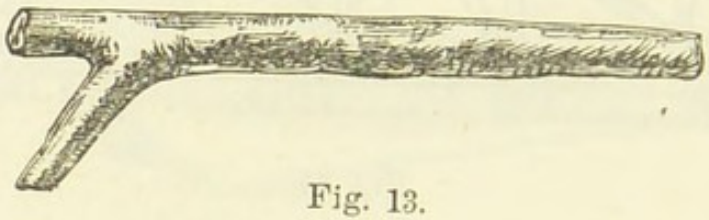


Fig. 13.

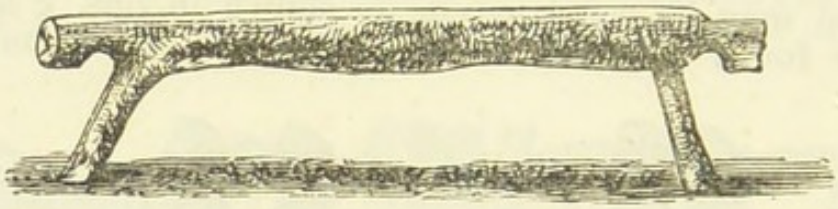


Fig. 14.

Fig. 15.

Should materials exist for constructing fascines and gabions, excellent litters may be made in the same manner.

Surgeon-Major C. Smith of the Norwegian Army has designed from strong boughs of trees several most ingenious stretchers, which have the great advantage of being supported by legs—a most important item in the construction of all stretchers. Fig. 13 represents a portion of a bough, having at its side a branch strong enough to serve as a leg; it requires four such pieces to make a stretcher, each being levelled at one

end with a hatchet or strong knife, and two of them joined together, as shown in fig. 14. These are then attached to side poles by cords, osiers, or other materials, when the framework of a firm stretcher is constructed (fig. 15), on which is to be placed for its bottom a piece of canvas. He has also constructed stretchers with legs, as represented in figs. 16 and

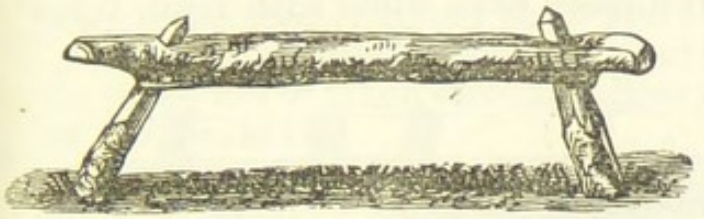


Fig. 16.

Fig. 17.

17, all of which might answer for improvised hospital cots, the handles being shortened or removed.

Cavalry lances have been recommended for forming the side poles of extemporary stretchers; but they will scarcely bear a weight of 10 stones, are too elastic, and therefore unsafe.

Country Carts.—When sufficient wheeled carriage or transport suited for the wounded is not available, country carts may be adapted for the purpose by a few simple arrangements.

If materials are procurable, a stretcher may be constructed with ropes (fig. 18) of straw, hay, telegraph wire, or leather belts, and slung within

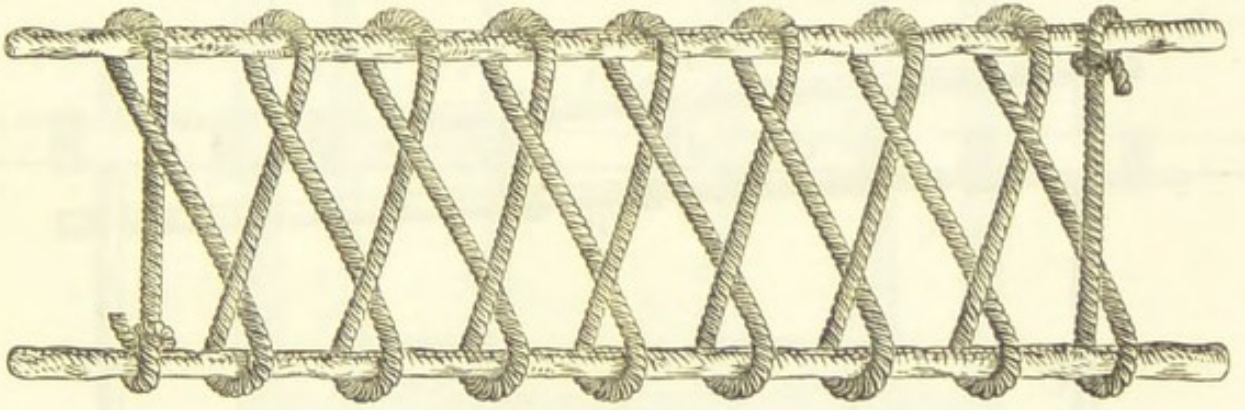


Fig. 18.

from the sides of the cart, care being taken that the lashings are well secured but not too tight or too loose; in the former case, the stretcher would receive the impulse from the body of the cart, and in the latter it would knock against its sides.

Should means for constructing a stretcher not be at hand, the cart may be filled with small branches of trees evenly placed, and over them a thick layer of straw, hay, rushes, ferns, dried leaves, or any soft material on which the sufferer may be laid.

A large quantity of fresh straw evenly laid in a cart will form a moderately comfortable conveyance, on which wounded men may be

carried for a considerable distance without any ill effects. In India it is not uncommon to place a dooly on a country cart filled with straw or dried leaves when bearers are not procurable.

Surgeon-Major Manly, V.C., has described an extemporised arrangement for adding to the comfort of the sick when transporting them, which he used in New Zealand. Each drag (a two-wheeled cart) took two wounded. Two hospital bed-cases were filled with fresh ferns

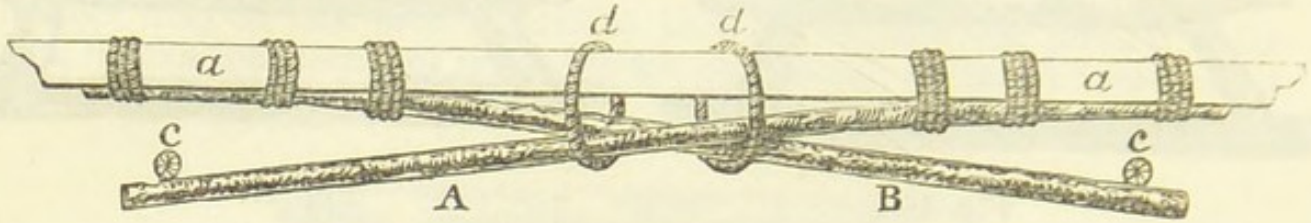


Fig. 19.

and placed in the drag and two wounded men placed on them. If the wound was of the upper extremity, or through the chest, more ferns were placed under the bed-case so as to raise the front half of it, by which means the man could sit in the recumbent position; if of the lower extremities, the other half of the bed was also raised, so as to elevate the legs and thighs above the body. By these arrangements and proper distribution of sick (that is, when a slightly-wounded man is placed alongside one badly wounded), marches of 20 and 25 miles were made with comparative comfort.

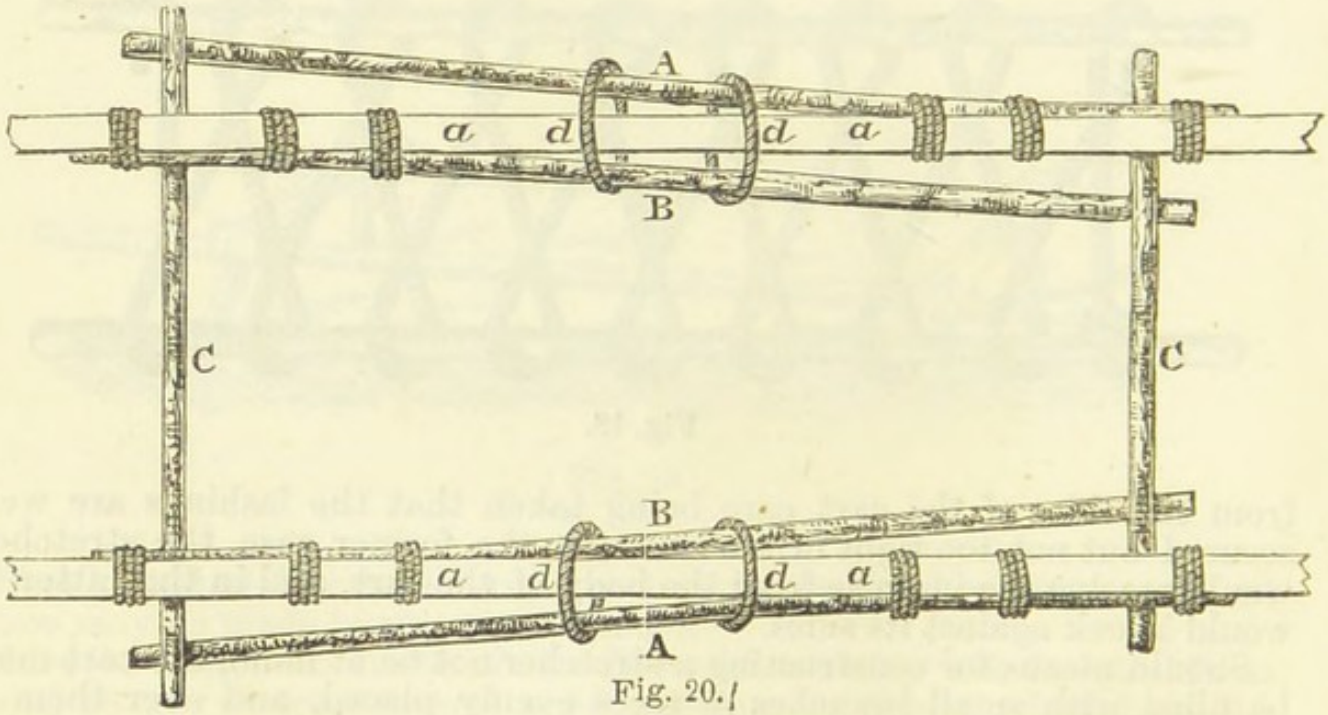


Fig. 20.

Surgeon-Major C. Smith has also designed a method for carrying two badly wounded on stretchers in a country hay-wagon. The arrangement is as follows: One end of a rough pole (A, figs. 19 and 20) is lashed

to the top side rail (*aa*) of the wagon outside the side bars, to the front, as in fig. 20; another (B) is similarly lashed to the rear; this being done at both sides, cross poles (*cc*) are lashed to the free end of these poles; these cross poles support the stretchers which are lashed to them. In this manner the wounded in travelling have the advantage of the spring of the longitudinal poles; to keep this within limits, bands of osier (*dd*) are placed loosely round them and the top side rail of the wagon.

Railway Hospital Trains.—Railway carriages, vans, or trucks should be made use of when circumstances admit for the more rapid dispersion of the disabled.

Regular railway transport not being available, it may he necessary to convert baggage and store wagons into suitable transport. Mattresses and bed-sacks filled with straw have been laid on the floor of the wagons, but in consequence of the jarring caused by the vibration of the conveyance they are not considered comfortable. Loose straw has also been tried but found defective in elasticity, as it becomes rapidly displaced from under the bodies of the patients, accumulating in heaps, and is easily broken up and matted, when used the supply should be liberal.

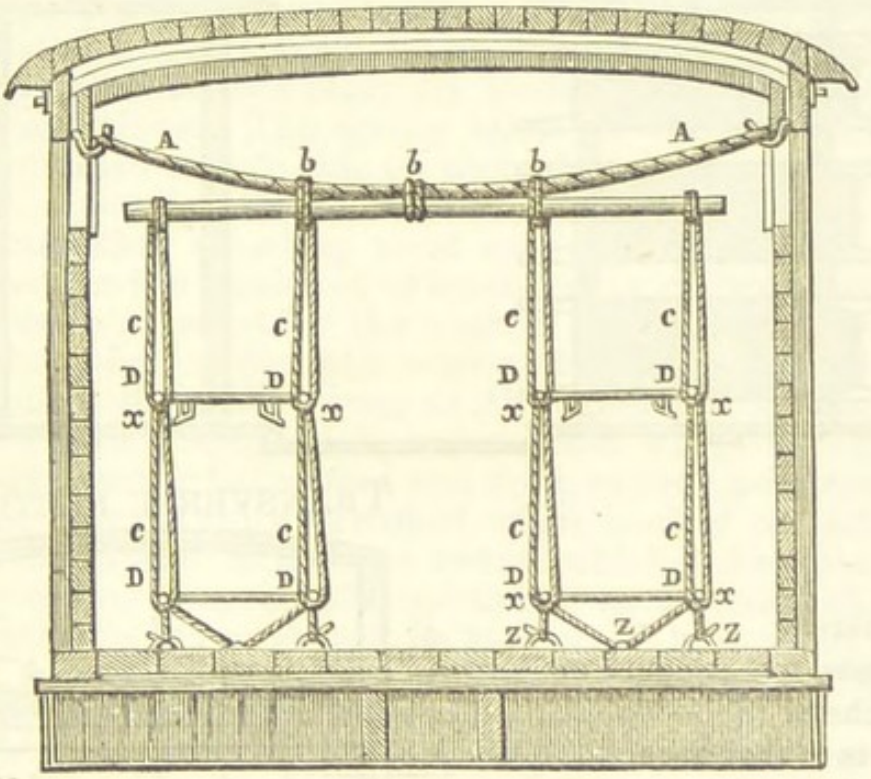
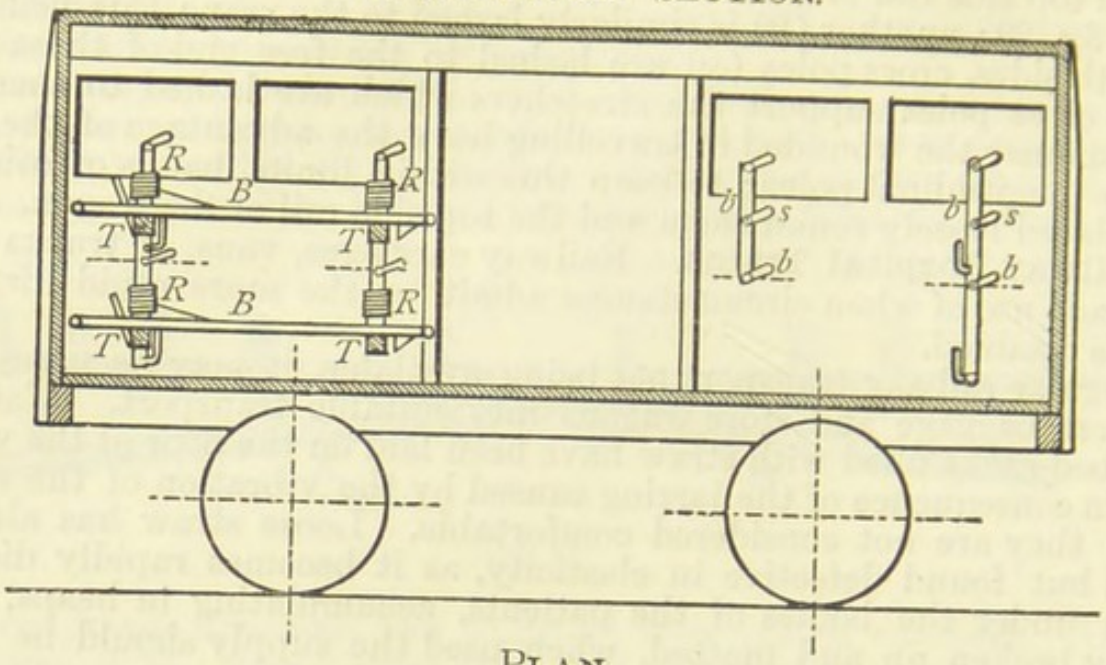


Fig. 21.

Major-General Zavodovsky, of St. Petersburg, has adopted the following plan for preventing all shocks from the motion of trains:—Two cables (AA, fig. 21), an inch in thickness, are suspended across the top of the car, and secured to iron hooks that fasten to iron rings, $2\frac{1}{2}$ inches below the roof of the car. If hooks and rings are not available, the ropes may be passed through four holes bored in the side of the car. To each of the two ropes is attached at three points (*bbb*) a pole of oak, birch, elm, ash,

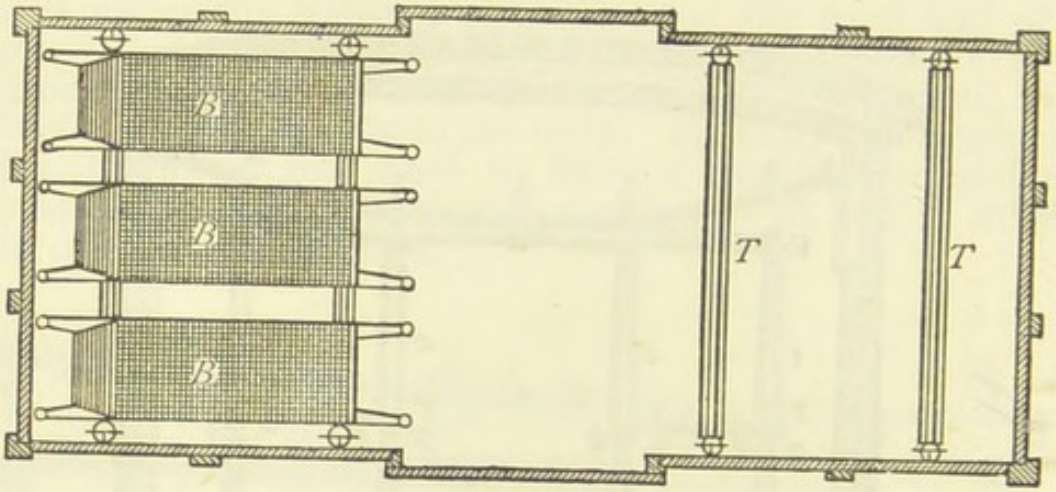
LONGITUDINAL SECTION.

Fig. 22.



PLAN.

Fig. 23.



TRANSVERSE SECTION.

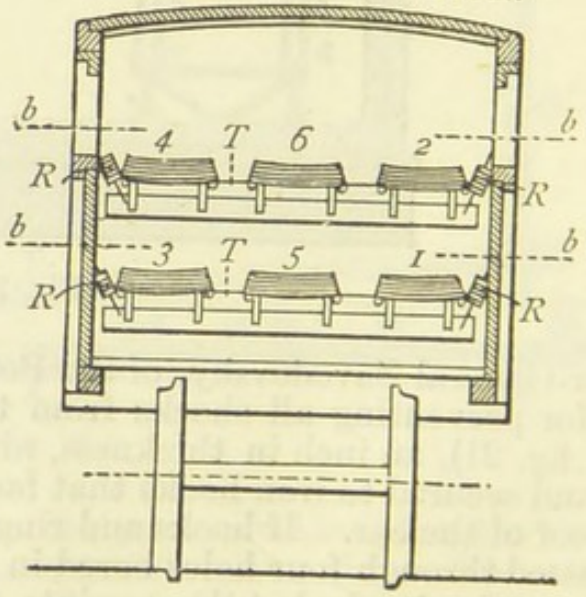


Fig. 24.

B, Stretchers.
T, Traverses for support of stretchers.
S, Supports of traverses.
b, Bolts for fixing them to the sides of the wagon.
R, Steel spiral springs.

or other springy wood adapted to the width of the car, but at least 8 feet long and $2\frac{1}{2}$ inches thick in the middle, and $1\frac{3}{4}$ inch at the ends. To the poles thus placed horizontally, there are attached on either side four cords (*cccc*) with knots (*xxxx*), so arranged that they may support on a level the stretchers (DD) on which the wounded men are supposed to be reclining. In order that, when the car is in motion, the stretchers with the patients may not sway backward and forward and strike against the sides of the car, the lower stretchers are fastened by $1\frac{1}{2}$ inch ropes to three small iron hooks (*zzz*) screwed into the floor of the conveyance.*

The "Bry" System.—Another mode and one largely adapted by the French is called the "Bry" system (after Colonel Bry, of the Engineers, who devised it). By this method each covered goods wagon is adapted to carry twelve wounded men on stretchers in a very comfortable and easy manner. Two pairs of stout wooden traverses, *T T*, are placed at either end of the wagon on each side of the door, one above the other, and each is suspended at either extremity to the side of the wagon by a stout *steel spiral spring*, *R R*. Each pair of traverses is intended to receive and support three stretchers, *B B*, which are held in position by some leather straps which confine the legs of the stretcher and thus prevent them from slipping. The steel spiral spring is short and very strong, and it is fastened to the side of the wagon by an iron plate which is firmly bolted to it. Each wagon can thus carry six loaded stretchers at either end in tiers of three and three. The spring takes all the jolts and jars, and so enables the wounded men to ride on their stretchers comfortably to their journey's end. (See figs. 22, 23, 24.)

Ship's Hammocks, affording most easy and convenient conveyance, may be utilised for the transport of wounded in railway vans or wagons. The method recommended by the author (S. M. Porter) is to erect uprights at either end inside each wagon (the walls of railway wagons are usually not sufficiently strong or thick enough to bear the weight of one or more men suspended in hammocks), which should be secured in a temporary manner to the roof and floor, at such a distance apart that the hammock may be fully stretched when hooked or lashed to them. To prevent the lateral motion or swing which takes place when the wagon is proceeding at speed, that portion of each hammock immediately under the patient's knees should be supported by a stout stick placed horizontally, suspended at either end by cords attached to the roof and again to rings or hooks in the floor.

It might be possible to make use of ship's hammocks for this purpose in the event of transporting sick or wounded from inland to a port of embarkation, where, no doubt, they could be obtained from the shipping. *Horse litters* were used during the American War in 1862, and are well adapted for frontier service, they may be constructed for one or two horses. For the former, one end is supported by a horse or mule, while the other end rests on the ground; with the "two-horse litter" both ends are supported, but as the horses or mules carrying such a contrivance should be well trained, the "one-horse litter" is preferable and is easily made.

* *Report on a Plan for Transporting Wounded Soldiers by Railway.* G. A. Otis, 1875.

Transport in Mountainous Districts.—In India there are several means for conveying sick or wounded men on field service in the hills, such as *dandies* and *jhampans*, but these do not admit of the patient being placed in the recumbent position. The author (S. M. Porter) some years ago designed a conveyance for badly-wounded men, which consists of a cot adapted with a hood and cover, and carried with a jhampan frame as shown in illustration (fig. 25).

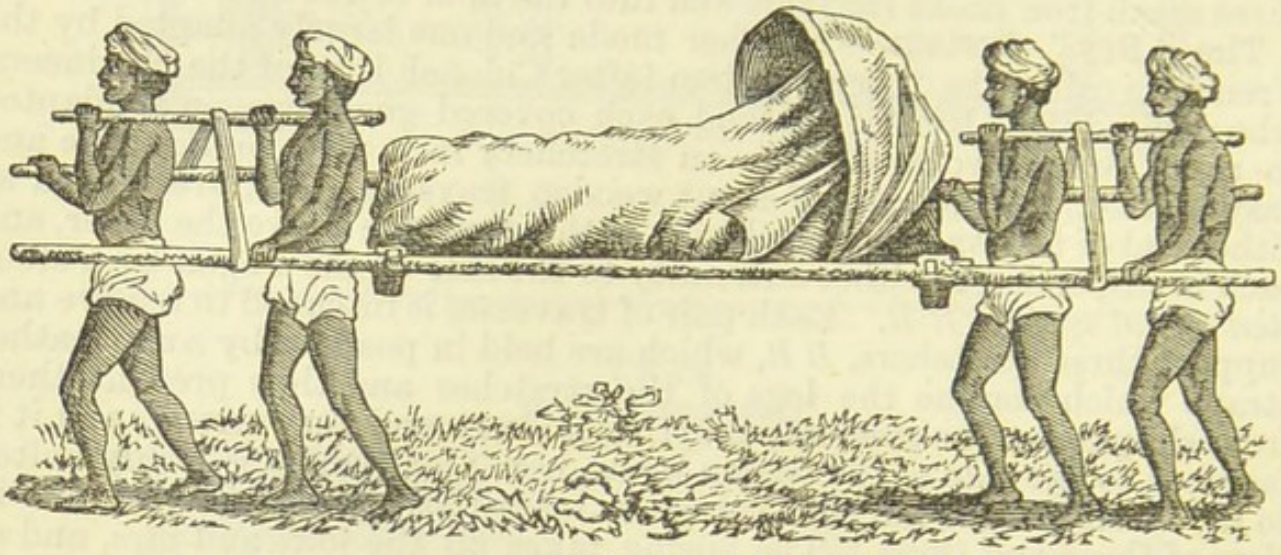


Fig. 25.

This conveyance could be easily improvised from an ordinary bed cot (*charpoy*) and bamboo poles. It has the following advantages, that the recumbent position can be maintained throughout the march; that on the line of march a patient need never be shifted; that the cot answers the purpose of a bed at night; and that a less number of natives is required for its carriage than for any other form of conveyance admitting of a recumbent position. It thus affords all the advantages of a *dooly*.

Cacolets.—Dr. Appia, who has had great experience with this mode of conveyance, remarks with reference to the cacolet *with rests*, that it is very rarely of use even in wounds of the trunk, of an arm, or almost of the foot; but that it is impracticable in wounds of the abdomen, in fractures of the thigh, wounds of the knee, and compound fractures of the leg. In cases such as these, the cacolet *bed* or *litter* has rendered excellent service. In order to prevent the shaking as much as possible, it is desirable to make the patient sit or lie upon very pliant cushions, and for this purpose he recommends those made of india-rubber, which he has frequently made use of.

Dy. Surgeon-General Lithgow writes in his report upon the Nile expedition, 1884, that nothing but dire necessity should sanction the use of litters with camels, but cacolets proved most useful and comfortable.

For the embarking or disembarking of sick and wounded, where stretcher conveyance is not available or cannot be used, Dr. J. D. Macdonald, F.R.S., R.N., has designed an "ambulance lift for ship or

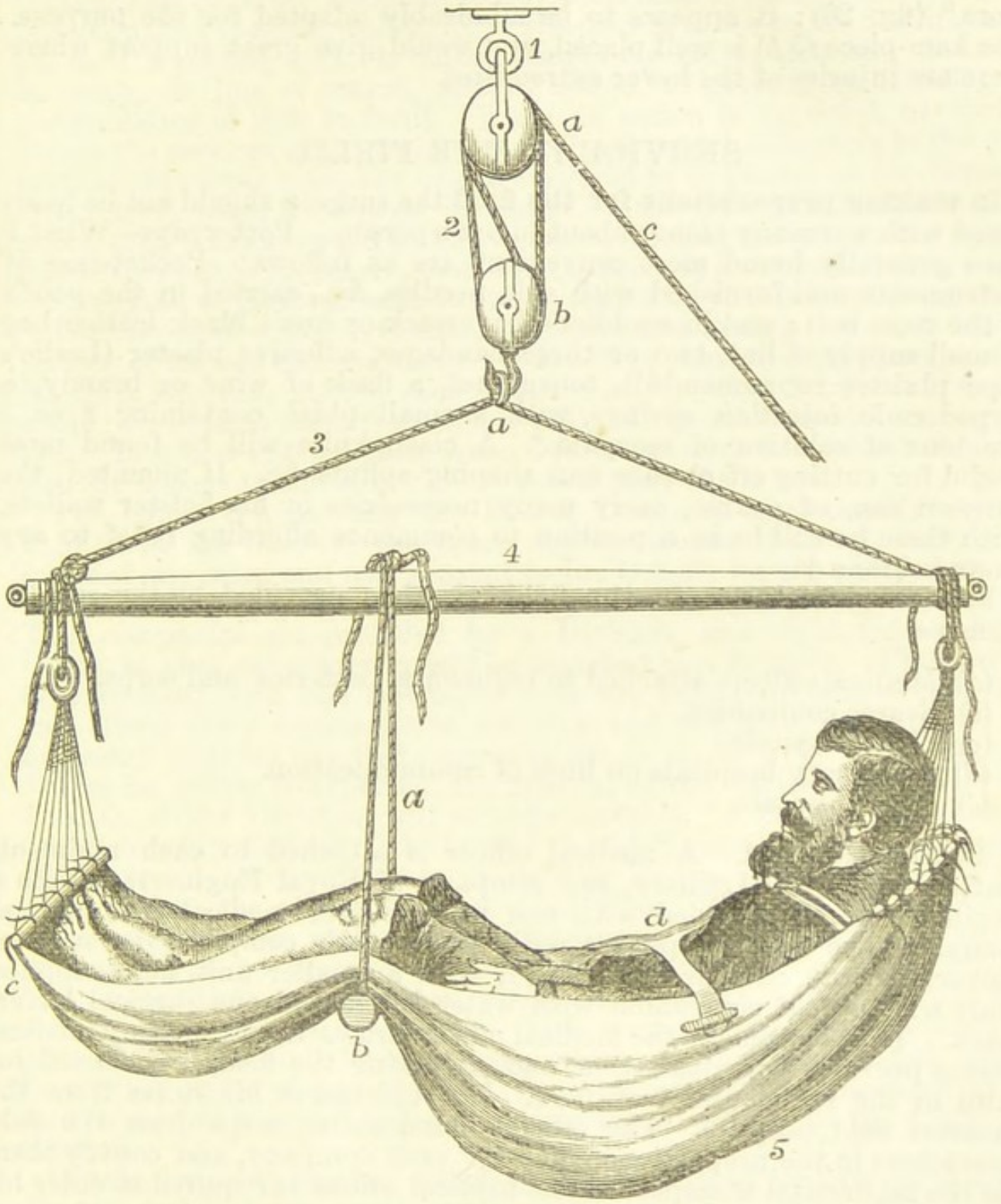


Fig. 26.

AMBULANCE LIFT FOR SHIP OR SHORE.

References to the Figure.

1. Hook or eye-bolt fixed to the beam over the hatchway.
2. A "double whip," or a purchase with a double block above and a single one below, *a* and *b*; *c*, the hauling part.
3. A "span" with an eye in the middle for the lower hook of the purchase.
4. A pole 4½ feet long with which the span is connected.
5. An ordinary hammock attached by the head and foot clews to the extremities of the pole, and further sustained by lanyards, *a*, fixed to a ham-piece, *b*, besides

shore" (fig. 26); it appears to be admirably adapted for the purpose. The ham-piece (5 *b*) is well placed, and would give great support where there are injuries of the lower extremities.

SERVICE IN THE FIELD.

In making preparations for the field the surgeon should not be hampered with too many things about his own person. Porter says—What I have generally found most convenient are as follows:—Pocket-case of instruments well furnished with silk, needles, &c., carried in the pouch of the cross belt; and in a soldier's haversack or small black leather bag a small supply of lint, two or three bandages, adhesive plaster (Leslie's tape plaister recommended), tourniquet, a flask of wine or brandy, a hypodermic injection syringe, with a small phial containing 2 or 3 drachms of solution of morphia.* A clasp knife will be found most useful for cutting off clothes and shaping splints, &c. If mounted, the surgeon can, of course, carry many necessaries in his holster wallets, with these he will be in a position to commence affording relief to any wounded man.†

Medical assistance in the field‡ is thus provided by the regulations:—

(*a*) Medical officers attached to regiments, batteries, and corps.
(*b*) Bearer companies.
(*c*) Field hospitals.
(*d*) Stationary hospitals on lines of communication.
(*e*) Base hospitals.

Regimental Aid.—A medical officer is attached to each regiment, battery of Royal Artillery, and company of Royal Engineers. With a regiment he is provided with one pair of field medical and surgical panniers, one field companion with water bottle complete, one surgical haversack, one circular tent; but, if with a smaller unit, he is supplied only with a field companion with water bottle and one surgical haversack. This equipment the medical officer draws from the army medical stores previous to embarkation, and on taking the field, it is carried for him in the regimental transport. He replenishes his stores from the nearest field hospital. The officers commanding corps draw the field stretchers in the proportion of one for each company, and convey them in the regimental transport. The medical officer is required to enter his

which a strengthening footpiece, *c*, is retained in its place by the foot clews of the hammock, and greater security is given to the patient by the strap and toggle, *d*, holding the sides of the hammock together. The ham-piece, 5 *b*, is tightly secured to the hammock to prevent displacement.

* Morphia in solution is liable to spontaneous change, and is uncertain in its strength if laid up for any time. To obviate this, M. Vidal adds to the solution a quantity of choral equivalent to twice the weight of the morphia it contains.—"New Remedies," Jan. 1870.

† *Vide* Appendix V. for personal equipment.

‡ Abbreviations used in the text—P.M.O., Principal Medical Officer; O.S.D., Ordnance Store Department.

transactions in Army Book, 39, and beyond this, to furnish no returns or reports unless specially called for. His duty is to see in the first instance all men reporting sick, to afford temporary aid to sick and wounded in camp, on line of march, and in action, to prevent malingering or accumulation of sick in front. When an action is expected, he should obtain the services of the trained regimental stretcher-bearers in the proportion of two per company who are ordered to be placed at his disposal, Q.R., 1889, place a corporal in charge of the field panniers, and then afford such temporary aid to the wounded as may be within his power, but neither he nor his bearers should on any account lose touch of their corps.

First line of medical assistance is formed by the Bearer Companies.

The carriages of the regimental transport of a Bearer Company form a portion of its war establishment. The officer commanding is responsible for their efficiency in the same manner as for other details of his command; he obtains them from the O.S.D. Woolwich Arsenal on requisition. It is now ordered that, when a force proceeds to its destination by sea, the transport and stores are to accompany the troops.

The officer commanding the Bearer Company is responsible to the P.M.O. at the base for the arms, accoutrements, clothing, and necessaries of the men, and will account to the O.S.D. for the equipment and stores of the company in Field Equipment Ledger Army Book, 248. Two companies are provided for a Division, and eight for an Army Corps, so that one company will be attached to a Brigade. They are to be associated with and encamped near the field hospitals, so that they can afford every assistance to the sick and wounded, and furnish the necessary guards, but their organisation is to be kept quite distinct. When an action is expected, the medical officer, under direction of the P.M.O. of the Division, will arrange suitable "collecting rendezvous" and "dressing stations;" the former should, if possible, be under shelter but as close as is convenient to the fighting line, and the latter out of fire.

In action the company is divided thus: Two stretcher sections under one surgeon, each section consisting of one sergeant and sixteen privates, will be sent to succour and collect the wounded bringing them to the Collecting Station, where one sergeant will be posted with a field companion in his charge. Five corporals and five privates are attached to the ambulance wagons, which, as they are loaded, should be sent off under charge of a N.C.O. or private to the Dressing Station, and as soon as they are unladened they should return to the Collecting Station.

At the Dressing Station, which should be marked by two red flags, or by two red lanterns at night, the senior medical officer with another surgeon, the sergeant-major, compounder, one sergeant, one bugler, one corporal, and four privates (one cook), will be assembled with the surgical equipment, stores, and water carts. If any building is available, full use should be made of it; if not, the tent must be pitched; beef tea, &c., should be got ready and everything put in readiness that can afford aid to the wounded coming in, and help during the pressure of work. Medical officers should be borrowed from the nearest field hospital. After the wounded are dressed, and a tally ticket attached to each man's

War Establishment of a Bearer Company.

A BEARER COMPANY.

Ranks.	Personnel.							Horses.		
	Officers.	Warrant Officers.	Staff-Sergeants and Sergeants.	Artificers.	Buglers.	Rank and File.	Total.	Private, or Provided under Allowance Regulations.	Public. Riding.	Public. Draught.
Medical Staff.										
Surgeon-Major, ...	1	...	...	...	...	...	3	1	...	...
Surgeons, ...	2	...	...	...	...	...		2	...	...
Medical Staff Corps.										
Warrant Officer, ...	...	1	...	...	...	...	1	...	1	...
Staff-Sergeants and Sergeants.										
Quarter-master Sergeant, ...	...	...	1	...	...	...	6	...	...	...
Compounder, ...	...	...	1	...	...	...				
Sergeants, ...	...	...	4	...	...	...				
Bugler, ...	...	...	...	...	1	...	1	...	...	...
Rank and File.										
Corporals, ...	...	...	...	...	...	6	53	...	...	...
Privates, ...	...	...	...	...	...	8		...	...	...
,, as Cooks, ...	...	...	...	...	...	3		...	...	...
,, Bearers, ...	..	...	...	...	...	32		...	...	...
,, Servants, ...	...	...	...	...	...	3		...	...	...
,, Supernumerary,	...	...	...	...	...	1		...	...	...
Total, ...	3	1	6	...	1	53	64	3	1	...
	64							4		
Transport Attached from Commissariat and Transport Corps.										
Officers.										
Subaltern, ...	*1*	...	...	...	...	...	*1*	...	*1*	...
Sergeants, ...	...	...	*1*	...	...	...	*1*	...	*1*	...
Artificers.										
Collar-maker, ...	...	...	...	*1*	...	...	*2*	...	...	...
Farrier, ...	...	...	...	*1*	...	...		...	*1*	...
Bugler, ...	...	...	...	...	*1*	...	*1*	...	*1*	...
Rank and File.										
Corporal, ...	...	...	...	...	...	*1*	*36*	...	*1*	...
2nd Corporal, ...	...	...	...	...	...	*1*		...	...	...
Privates, as Drivers, ...	...	...	...	...	...	*29*		...	...	*58*
,, Bâtman, ...	...	...	...	...	...	*1*		...	...	...
,, Cook, ...	...	...	...	...	...	*1*		...	...	...
,, Supernumeraries,	...	...	...	...	...	*3*		...	...	...
	1	...	*1*	*2*	*1*	*36*	*41*	...	*5*	*58*
	41							*63*		

* Details in *italics* are provided by Commissariat and Transport Corps.

Summary to show a comparison between Wheel and Pack Transport for a Bearer Company in the Field :—

Description of Stores.	Wheel Transport.				Pack Transport.		
	Wagons.	Carts.	Drivers.	Horses.	Drivers.	Mules.	Remarks.
Medical and surgical stores,	1	2	*2*	*4*	*4*	*11*	At 1 driver to 3 mules.
Baggage and reserve rations,	1	2	*2*	*4*	*4*	*12*	" "
Supplies, ...	...	1*	*1*	*2*	*1*	*2*	At 1 driver to 2 mules.
Tents, ...	...	1*	*1*	*2*	*1*	*4*	At 1 driver to 3 mules.
Ambulance, ...	10	10*a*	*20*	*40*	*b*	*b*	*a* Ambulance carts have only 1 driver and 2 horses each.
Water, ...	...	1*	*1*	*2*	*1*	*3*	*b* Depends on the number of additional stretchers ordered.
Spare, ...	...	...	...	...	*1*	*3*	N.B.—Details in *italics* are furnished by C. and T. Corps.
Total, ...	12	17	*27*	*54*	*12*	*35*	

* One supply cart, one tent cart, and one water cart are supplied with the 12 wagons to complete the equipment when wagons are used.

For plan of encampment see fig. 27.

clothes specifying the regiment, number, rank, and name, with the nature of the injury, the treatment, &c., they will be placed in the ambulance wagons of the second line and taken to the field hospitals. The amount of attention that should be paid to the wounded at the dressing station would differ very materially according to the distance of the field hospitals; if the latter were close at hand, little or no interference would be required, but if a considerable distance has to be traversed, and many hours have to elapse before the field hospital could be reached, surgical operations of all kinds might have to be performed to bring them within the range of primary operations, that is within the first thirty hours, after that the operations would have to be classed as intermediate, and this is the period no surgeon would willingly choose. The quarter-master sergeant with two cooks, bâtmen, and baggage should be placed a little in rear of the dressing station, and arrange so as to have a meal ready for the men of the company after the action is over. After the engagement a close search should be made for any wounded men, or men apparently dead, and lanterns for searching in the dark form part of the equipment.

The arms, ammunition, and accoutrements of a wounded man are always to be picked up and carried with him to the dressing station and field hospital, but great care should be taken to see that the rifle is not loaded before it is carried away.

The Second Line of Medical Assistance consists of the Field Hospitals.

War Establishment of a Field Hospital.

Field Hospital of 100 beds.

Ranks.	Personnel.						Horses.		
	Officers.	Warrant Officers.	Staff-Sergeants and Sergeants.	Artificers.	Rank and File.	Total.	Private, or Provided under Allowance Regulations.	Public. Riding.	Public. Draught.
Medical Staff.									
Surgeons-Major,	2	...	...	...	...	5	2	...	...
Surgeons,	2	...	...	...	...		2	...	...
Quartermaster,	1	...	...	...	...		1	...	...
Medical Staff Corps.									
Warrant Officer,	...	1	...	...	...	1	...	1	...
Staff-Sergeants and Sergeants.									
Ward Master,	...	...	1	...	...	7	...	...	...
Steward,	...	...	1	...	...		...	...	...
Compounders,	...	...	2	...	...		...	...	...
Cook,	...	...	1	...	...		...	...	...
Pack Storekeeper,	...	...	1	...	...		...	...	...
Supernumerary,	...	...	1	...	...		...	...	...
Rank and File.									
Corporal as Steward,	...	...	...	...	1	32	...	...	...
,, Cook,	...	...	...	...	1		...	...	...
,, Clerk,	...	...	...	...	1		...	...	...
,, Supernumerary,	...	...	...	...	1		...	...	...
Privates as Ward Orderlies,	...	...	...	...	14		...	...	...
,, Cook,	...	...	...	...	1		...	...	...
,, Pack Storekeeper,	...	...	...	...	1		...	...	...
,, Messenger (*a*),	...	...	...	...	1		...	...	...
,, Washermen (*a*),	...	...	...	...	2		...	...	...
,, Servants,	...	...	...	...	5		...	...	...
,, Supernumeraries,	...	...	...	...	4		...	...	...
Total,	5	1	7	...	32	45	5	1	...
	45						6		
Transport attached from Commissariat and Transport Corps.									
Warrant Officer,	...	*1*	...	...	...	*1*	...	*1*	...
Sergeant,	...	...	*1*	...	...	*25*	...	*1*	...
Corporal,	...	...	...	...	*1*		...	*1*	...
2nd Corporal,	...	...	...	...	*1*		...	...	...
Artificer (Farrier),	...	...	...	*1*	...		...	...	...
Privates, as Drivers,	...	...	...	...	*18*		...	...	*36*
,, Cook,	...	...	...	...	*1*		...	...	...
,, Supernumeraries,	...	...	...	...	*2*		...	...	...
	...	*1*	*1*	*1*	*23*	*26*	...	*3*	*36*
	26						*39*		

Details in *italics* are provided by Commissariat and Transport Corps.
(*a*). These are supplied from the reserve of the M.S.C. or from the Militia reserve.

Summary to show a comparison between Wheel and Pack Transport for a Field Hospital in the Field :—

Description of Stores.	Wheel Transport.				Pack Transport.		
	Wagons.	Carts.	Drivers.	Horses.	Drivers.	Mules.	Remarks.
Medical and surgical stores,	4	8	*8*	*16*	*9*	*27*	At 1 driver to 3 mules.
Baggage and reserve rations,	2	4	*4*	*8*	*7*	*20*	" "
Supplies, ...	...	1*	*1*	*2*	*1*	*2*	At 1 driver to 2 mules.
Tents (for personnel), ...	...	1*	*1*	*2*	*6*	*18a*	At 1 driver to 3 mules.
Water, ...	...	2*	*2*	*4*	5	*8*	" "
Spare,...	...	...	...	...		*8*	*a* Including tents for sick. N.B.—The details shown in *italics* are furnished by the Commissariat and Transport Corps.
Total, ...	6	16	*16*	*32*	*28*	*83*	

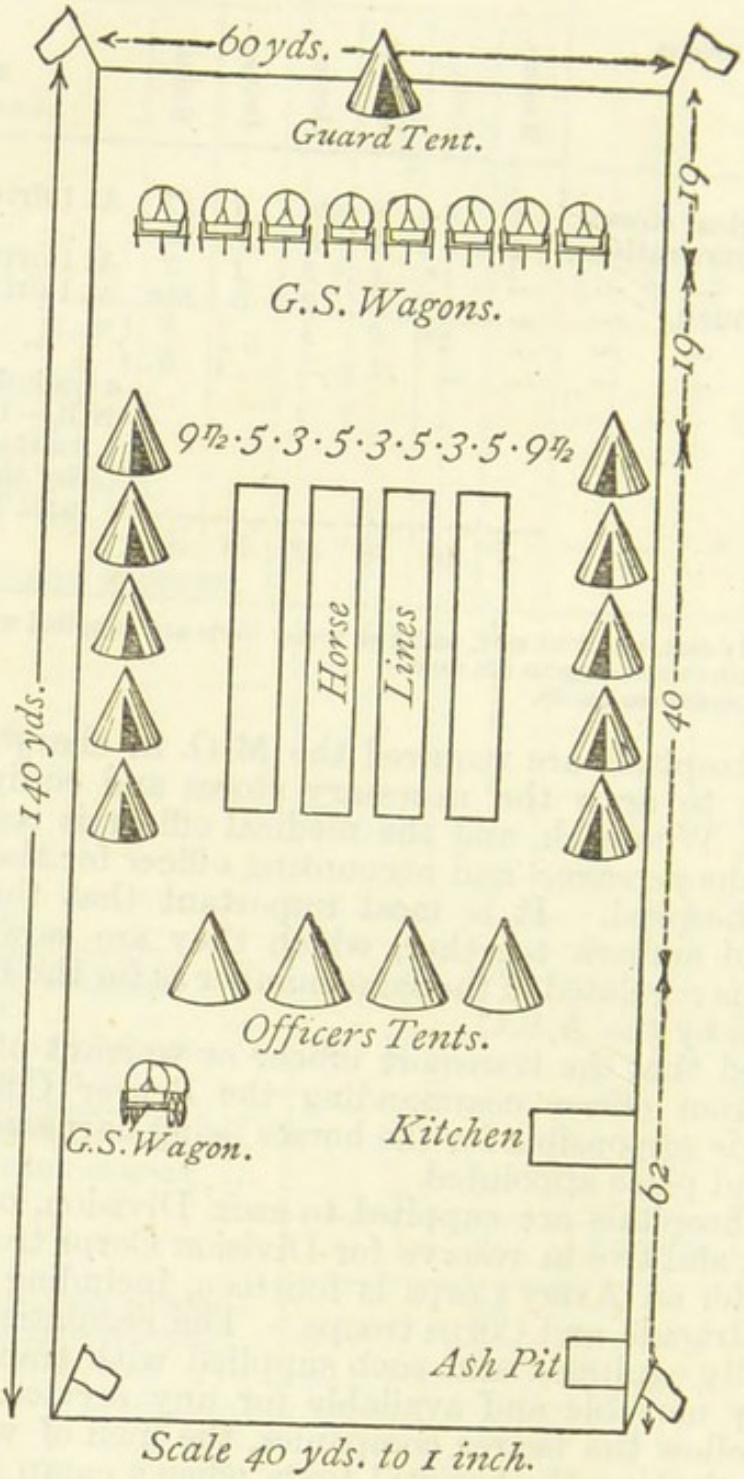
* Note.—One supply cart, one tent cart, and two water carts are supplied with the six wagons to complete the equipment when wagons are used.
For plan of encampment see fig. 28.

When field hospitals are required the M.O. in charge will direct the quarter-master to draw the necessary stores and equipment from the Royal Arsenal, Woolwich, and the medical officer is responsible for the equipment of the *personnel* and accounting officer for the equipment and stores of the hospital. It is most important that the *personnel* and *matériel* should embark together, which they are now ordered to do. The transport is regulated in the same manner as for the Bearer Company, and is supplied by the A.S.C.

It is directed that the transport officer or warrant officer A.S.C. will take orders from officer commanding the Bearer Company or Field Hospital, and is responsible for the horses being harnessed and hooked in at the time and place appointed.

Four field hospitals are supplied to each Division, one is attached to each Brigade, and two in reserve for Division Corps troops if necessary. The number for an Army Corps is fourteen, including two attached to the Cavalry Brigade and Corps troops. The regulations lay down that all will be fully equipped and each supplied with transport, so as to be independently movable and available for any service. On the line of march they follow the bearer companies, the men of which, on request, will assist in pitching the hospital tents when a camp is formed. Each hospital is so arranged as to be capable of dividing into half hospitals for 50 patients. They are non-dieted, and all patients bring with them their kits, arms, and accoutrements, which have to be entered in detail in the Pack-store Book, A.F., 182. It is most important that every man's name should be *at once* entered in the Admission and Discharge

CAMP FOR BEARER COMPANY. M.S.C.



The depth of this Camp can be reduced to 100 yards.

Fig 27.

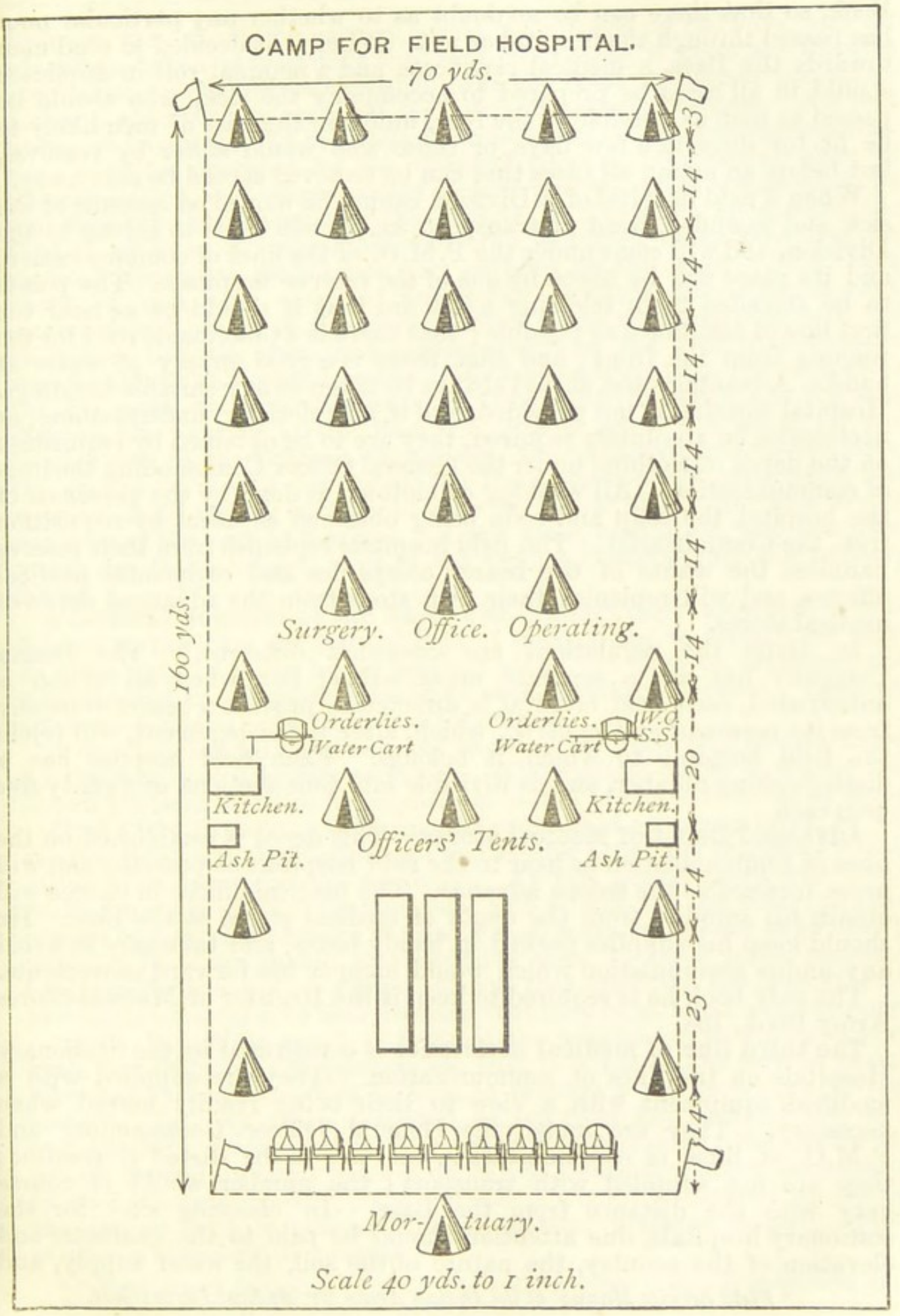

CAMP FOR FIELD HOSPITAL.
70 yds.
160 yds.
3
14
14
14
14
14
14
14
20
25
14
Surgery.
Office.
Operating.
Orderlies.
Water Cart
Orderlies.
Water Cart
W.C.
S.S.
Kitchen.
Kitchen.
Officers' Tents.
Ash Pit.
Ash Pit.
Mor-
tuary.
Scale 40 yds. to 1 inch.

Fig. 28.

Book, so that there can be no doubt as to whether any particular man has passed through the hospital or not. When it is decided to send men towards the Base, a medical certificate and a nominal roll in duplicate should in all cases be prepared to accompany the sick, who should be passed as soon as possible to the rear, unless in the case of men likely to be fit for duty in a few days, or those who would suffer by removal, but before an action all cases that can be removed should be sent away.

When a field hospital of a Division cannot be moved on account of the sick and wounded, want of transport, &c., it will cease to belong to the Division, and will come under the P.M.O. of the lines of communication, and its place will be taken by one of the reserve hospitals. The points to be attended to in selecting a site are that it should be as near the first line of assistance as possible; that there is a practicable road for the wagons from the front; and that there is a good supply of water at hand. Advantage, too, should always be taken of any suitable buildings. Hospital clothing is not provided, and if any clothing, underclothing, or necessaries be absolutely required, they are to be obtained by requisition on the depôt of clothing under the General Officer Commanding the lines of communication. All washing of clothing is done by the *personnel* of the hospital, the soap and soda being obtained as usual by requisition from the Commissariat. The field hospitals replenish from their reserve panniers the wants of the bearer companies and regimental medical officers, and will replenish their own stock from the advanced depôt of medical stores.

In India the regulations are somewhat different.* The Bearer Company has not a separate organisation; but when an action is anticipated, each field hospital is directed to provide a bearer company from its *personnel* and *matériel*, which, after the engagement, will rejoin the field hospital to which it belongs. Each field hospital has a distinguishing number, and is divisible into four sections of twenty-five beds each.

Advanced Depôt of Medical Stores.—This depôt is established on the lines of communication as near to the field hospitals as possible, and will move forward as the troops advance. The medical officer in charge will obtain his supplies from the depôt of medical stores at the Base. He should keep his supplies packed in handy boxes, and take care to avoid any undue accumulation which would hamper his forward movements.

The only book he is required to keep is the Register of Medical Stores Army Book, 168.

The third line of medical assistance is constituted by the Stationary Hospitals on the lines of communication. They are supplied with a modified equipment with a view to their being readily moved when necessary. They are under the General Officer Commanding and P.M.O. of lines of communication, and are to be dieted if possible; they are not supplied with transport; the number would of course vary with the distance from the Base. In choosing sites for the stationary hospitals, due attention should be paid to the character and elevation of the country, the nature of the soil, the water supply, and

* *Field Service Manual of the Indian Army for Medical Department.*

drainage, they should be easy of access, near roads or railways, and all advantage taken of buildings that may be suitable, if none are suitable hospital marquees will be furnished from the Base. Separate accommodation is always to be provided for sick and wounded officers. All sick transport from the field hospitals in front along the lines of communication is to be provided by the General Officer Commanding lines of communication, and when parties of sick and wounded are about to be sent from the field hospitals, the P.M.O. of Divisions must warn the P.M.O. of lines of communication, who will then make provision for medical inspection, attendance, and supplies on the road. With each party of sick and wounded proceeding towards the Base, a non-commissioned officer of the Medical Staff Corps will take charge of the pack-store list, kit, arms, and accoutrements of the men, and should a man be left in an hospital on the line of communication, his pack-store list, kit, arms, and accoutrements are to be left with him. But if a man dies on his journey to the Base, his effects are to be taken on and handed over to the Officer Commanding the military depôt at the Base. On arrival of a sick convoy at the Base, the medical certificates and nominal rolls are to be handed over to the P.M.O., the kits are to accompany the men to hospital, but the arms, amunition, and accoutrements are to be handed over to the Officer Commanding the military depôt.

A General Hospital at the Base, with military depôt attached, is to be formed at the base for 500 patients, if inexpedient to form it on shore its place may be taken by an hospital ship. It is to be organised and administered in a similar manner to such hospitals in peace. Separate accommodation is to be furnished for officers.

A depôt of military and surgical stores at the Base will be established for the supply of hospitals and ships. The medical officer in charge will obtain his fresh supplies by requisition on the Director-General at home.

First Field Dressings.—During the progress of an engagement, as well as after it is over, the Regimental and Bearer Company Surgeons will be called upon to attend the wounded. At this period there will not be much time for careful examination, and it will tax all their physical powers to meet the pressing claims of each wounded soldier as he may be found. It is to enable the wounded man to have some means of temporarily dressing his wound at once, that attention has been given to providing some form of first dressing that may be at hand when required.

Sir T. Longmore says*—"Some of the reasons for providing soldiers with first field dressing packets are, that it is natural to seek to cover a wounded surface; hence it is wise to provide a soldier with a suitable material; he may, when wounded, be far from any medical aid, as on outpost duty, reconnoissances, or other mounted duty; the course of a wound depends in many cases upon its first treatment, hence the necessity of an antiseptic dressing; the quicker a wound is covered up the less the danger from infectious outside matter, pressure quickly applied is often a sufficient hæmostatic."

* "First Field Dressing," by Sir Thos. Longmore, C.B. *Transactions of the International Medical Congress*, Washington., U.S., vol. ii.

The first field dressing lately provided in the medical equipment of our army, but which was not recognised in any military regulation, consisted of two pads of carbolised tow, a carbolised gauze bandage, a triangular bandage of singularly coarse and heavy material, all of which were wrapped up in a tinfoil wrapper under a parchment cover. This form, however serviceable it may have been at the time of its introduction, has now become quite obsolete, and it is to be hoped that it may be speedily changed for one containing a more stable antiseptic. Surgeon-Major Bourke* has proposed one containing alembroth absorbent cotton-wool, bandage, and levigated iodoform; it is a very excellent one. All European armies have adopted a form of first dressing packet. In the French and German army the antiseptic used is sublimate of mercury. The French pattern is singularly neat and portable, as the materials used are of the finest texture and firmly compressed by means of hydraulic pressure.†

The Germans have discarded the triangular bandage (*vide* fig. 29) and substituted some four yards of a roller bandage in its place. It is a question whether this is an advisable change to have made in a first dressing packet. The triangular bandage is so convenient a form and

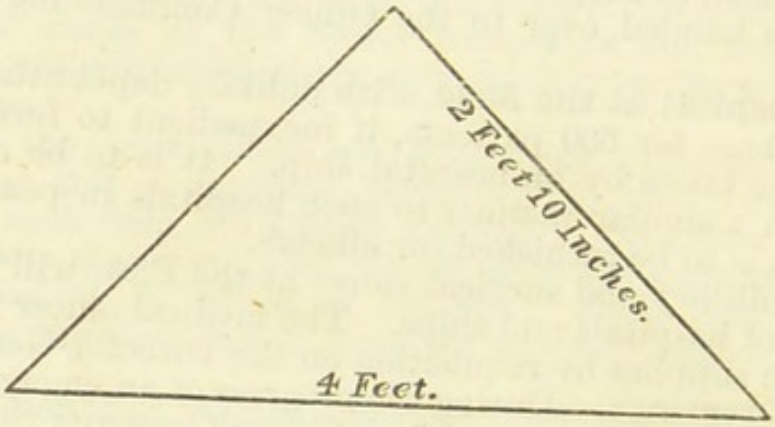


Fig. 29.

one that is easily adapted to so very many purposes which a roller bandage is quite incapable of fulfilling, it seems that its absence would be a distinct loss to any army operating out of the confines of a civilised country, where the supplies for the wounded have all to be carried, and where no help is possible from the neighbouring inhabitants. This very useful triangular bandage, if only made from fine material, occupies no more appreciable room than yards of roller bandage would necessarily take up while it is capable of a far wider application.

These portable light dressings are assuming a great importance in civil practice in the case of country and colonial surgeons. They are so easily carried that the country practitioner can put several in his pocket, and when called suddenly to a case of wounding he has at once a good reliable dressing at hand to apply as a temporary measure until

* Manufactured by John Milne, of Ladywell.

† A new first field dressing is under consideration for which the French pattern has been taken as a model, it will not contain a triangular bandage.

he has time and opportunity to bring more elaborate materials to the case.

Wounded to be first relieved.—At the Collecting and Dressing Stations the Surgeon will have to afford assistance to the wounded as they are brought to him, but should he be in a position to make a selection those suffering from hæmorrhage should receive his first consideration, while those otherwise wounded should have warm drinks or stimulants administered, and with consolation and a few kind words they will be in a more comfortable position and better able to bear the pain of having their wounds dressed when their turn comes.

Hæmorrhage.—The expedients for arresting hæmorrhage are considered under the subject heading "Hæmorrhage."

Shock.—The constitutional disturbance which takes place on a man being wounded is described as shock. This differs in severity in different subjects being influenced by moral character, intelligence, state of health, and nature of wound. It has also been stated that conical bullets from a rifle cause greater shock than round. As a rule, the greater the injury the more intensified the shock. At the same time there are examples of very severe wounds and but little shock, and *vice versâ*. Mr. Guthrie mentions a case of a soldier at Talavera, who was struck on the head by a 12-pound shot, which drove some bone into and some brain out of his head. He was walking about complaining but little immediately after the accident, although he died subsequently.

Porter says—"My experience is that all wounded persons suffer to a greater or lesser extent from shock, which manifests itself in feebleness of pulse, cold perspiration, change of colour, and disquietude of mind; the more aggravated form, where large joints are injured, long bones fractured or cavities opened, being fainting, mental agony, loss of reason, convulsions, hiccup, vomiting, irregular chills, sense of weight, collapse, all of which are most unfavourable symptoms, and their continuance sufficient to cause great alarm."

Fig. 30.

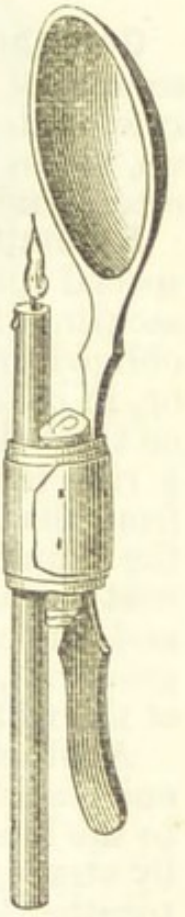


Fig. 31.

The treatment will consist in considering whether any surgical proceeding is necessary with a view of checking any internal hæmorrhage; but if no such step is demanded, nor appears practicable, we can only administer consolation or encouragement, with cordials, beef tea, wine, or brandy. In severe cases the patient should be placed in the recumbent position, with warm bottles or bricks to the feet; friction should be applied to the

surface of the skin; a turpentine enema may be administered together with the subcutaneous injection of ether in 10 minim doses; and opium should be given internally.

The Pain of a Gun-shot Wound is sometimes excruciating especially when a large nerve has been wounded, or the weather is very cold. The use of morphia in solution, given in the form of a hypodermic injection, has been found to afford such speedy relief, to be so convenient of administration, and so portable, that it is now generally used in warfare.

Lights.—It frequently happens in service that the surgeon may not be provided at night with lamps or candles for dressing wounds. Surgeon-Major Porter improvised a lamp from the soldier's oil-bottle by simply placing a piece of lint in it and a pin crosswise, so as to prevent the lint from slipping in. By means of this lamp (fig. 30) he has, in a darkened room, been able to ligature a carotid or femoral artery. For improvising a lamp and reflectors, an apparatus with a candle and spoon, as shown in fig. 31, might be constructed.

GUN-SHOT FRACTURES.

Gun-shot Fractures especially of the lower extremities are always sources of great anxiety on the field of battle, as the sufferer must, as a rule, undergo transport, and unless the limb or limbs are securely "put up," even in a temporary manner, the consequences will be most serious, often rendering slight injuries severe and complicated.

Extemporary Appliances.—It is not always possible to have at hand special splints, plaster of Paris, or any of the numerous contrivances for securing fractures; the surgeon will, in consequence, frequently be obliged to make use of such expedients as circumstances will admit of, or, in other words, improvise splints from materials generally available on the field of battle. For this purpose, in a case of fracture of the thigh, a rifle may be placed along the outside of the limb (fig. 32), extending from the axilla to the foot. It should be secured by a bandage round the trunk and by another round the foot and ankle; a soldier's great-coat or cape should then be folded so as to partially surround the limb and the rifle, the whole being secured by means of the straps of the greatcoat, bandages, or anything suited for the purpose. The butt end of the rifle should be placed in the axilla.

Another plan for putting up a fractured thigh is with two long splints, one reaching from the hip to the heel, and the other from the perineum to the heel, a third short one being placed in front, and the whole secured by straps, handkerchiefs, or bandages (fig. 33). Both feet should be tied together.

Esmarch, in putting up fractures of the thigh on the field, makes use of the soldier's long boot (all the troops in the German army wear the Wellington boot), to which he attaches his means of extension and gives support to the leg. He cuts the boot down the front as far as the instep, the sole of the boot is then perforated in two places in front of the heel, through which the extension cord or bandage is passed, the soft *upper* is

then rolled backwards on a stick or short sword (fig. 34) and secured, the foot is then placed in the boot and secured with an ordinary bandage.

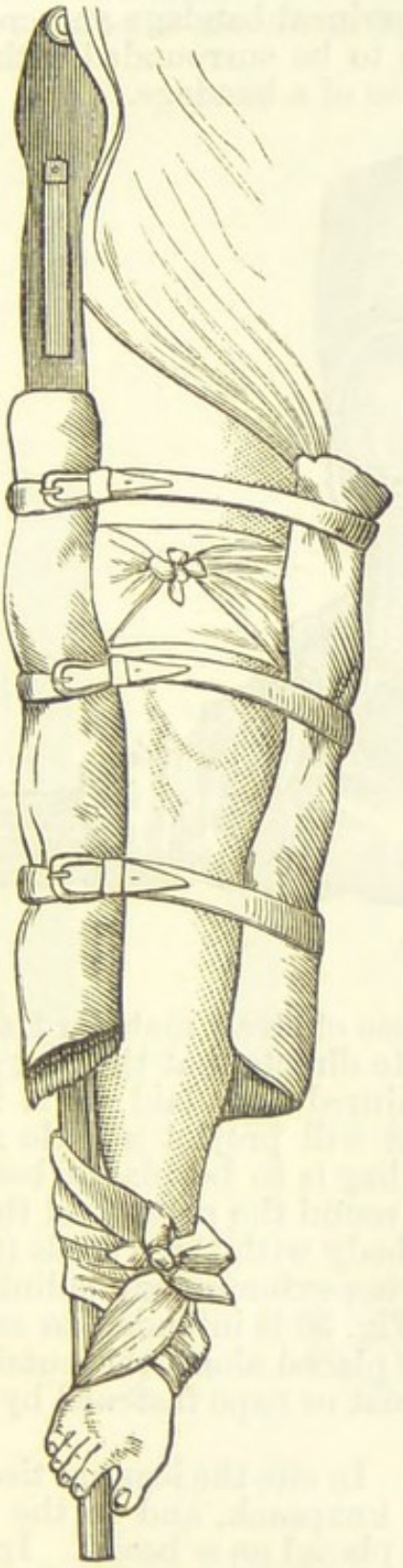


Fig. 32.

Fig. 33.

This having been done, and extension made to the end of the stretcher, it will be found that the sword or stick on which the *upper* is rolled will

rest on the side poles of the stretcher and give great support to the leg. Counter-extension is made by means of a perineal bandage (piece of cloth or waist-belt) secured to the upper cross-bar of stretcher, a strong elastic ring intervening between the knot and perineal bandage and cross-bar of stretcher. The fractured thigh bone is to be surrounded with a scored splint and secured with two or three turns of a bandage.

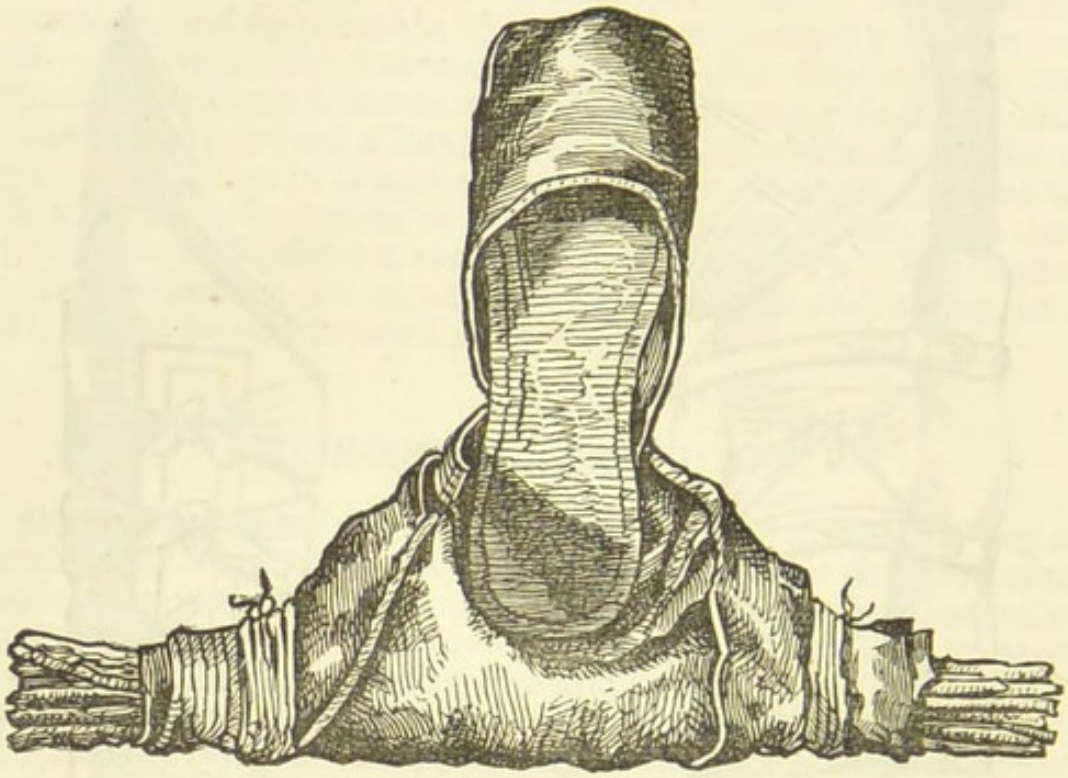


Fig. 34.

Straw Mats.—Dr. Port suggests the use of straw mats for transporting patients with fracture of the thigh. He directs that the mat should be spread out on the ground, and the injured man laid on it in such a manner that the upper edge of the mat will project a little above the crests of the hip bones; a chaff or sand bag is to be placed between the thighs, the sides of the mat wrapped round the pelvis and thighs, and the whole secured to the injured man's body with three cords (fig. 35).

For fractures of the leg, the following extemporary splints may be constructed with very little trouble :—Fig. 36 is intended to represent a fracture of the leg secured with a splint placed along the outside of the limb, and the whole rolled in a greatcoat or cape fastened by straps or pieces of bandage.

Figs. 37 and 38 speak for themselves. In one the legs are tied together at the ankles and placed on a soldier's knapsack, and in the other the legs are also tied together, but they are placed on a board. In securing limbs in such positions, some soft material should be placed underneath them and in between, so as to fill up spaces and make the parts comfortable ; if nothing better can be found, hay or straw will answer.

A fractured leg may be easily put up with the scabbard of a sword

and a board, as represented in fig. 39, or with two bayonets, as in figs. 40 and 41.

A roll of straw makes a capital temporary splint placed along the outside of the limbs, as shown in fig. 42.

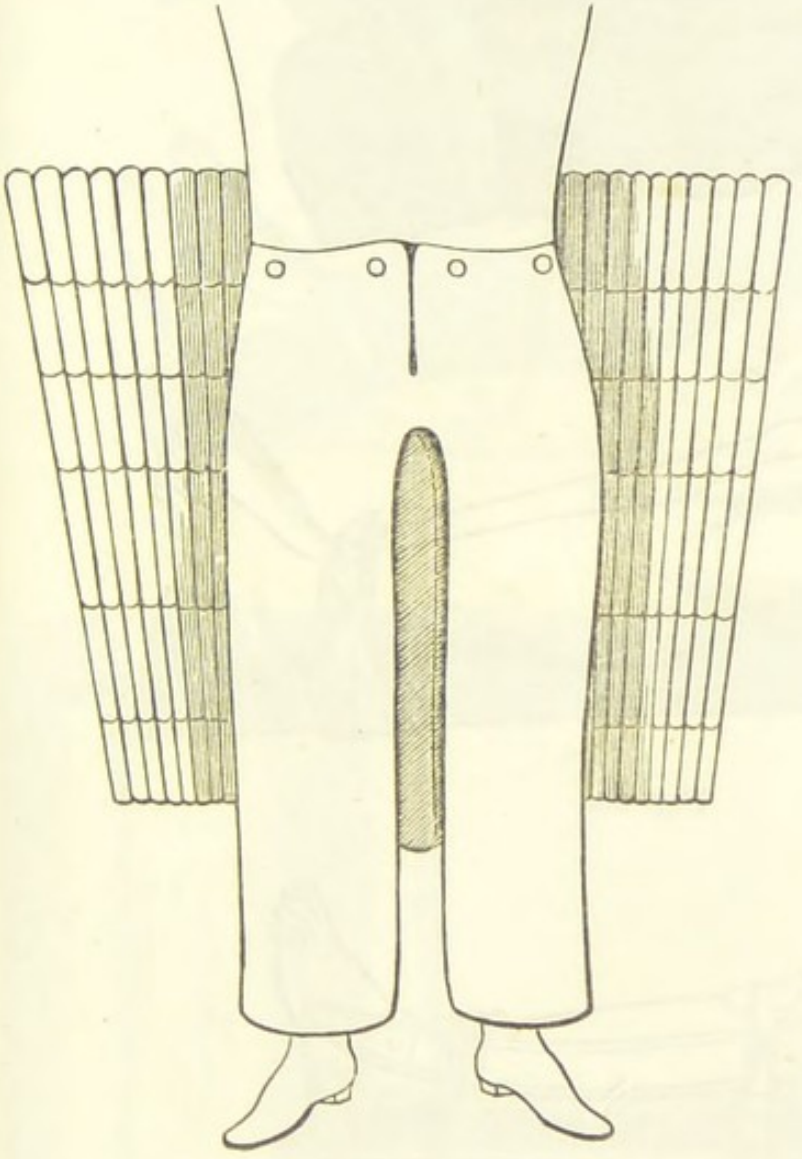


Fig. 35.

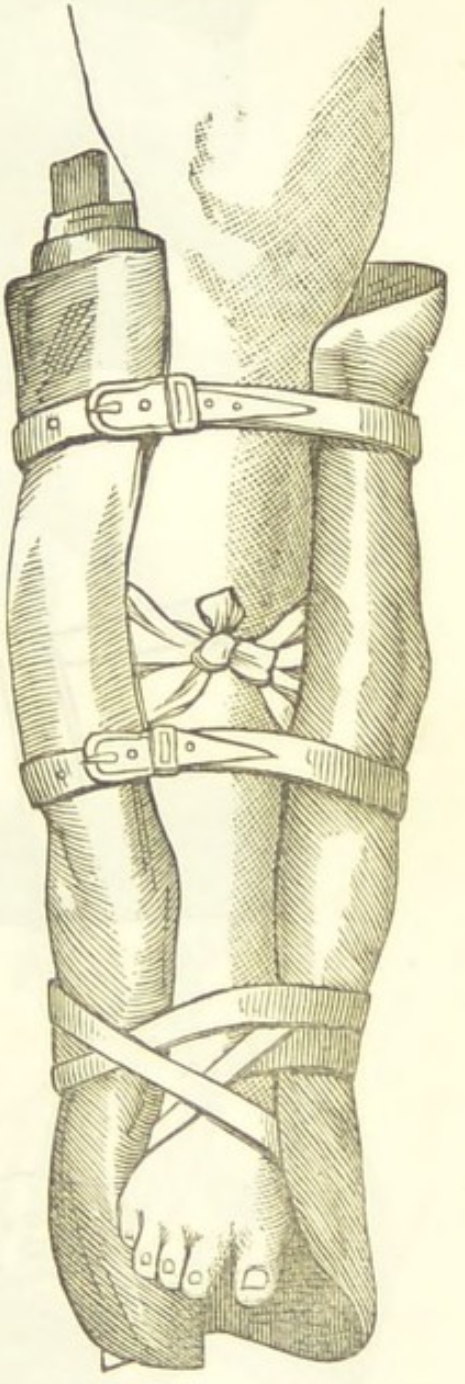


Fig. 36.

When a piece of cloth and two rolls of straw are available, a most comfortable splint may be constructed by placing the limb in the centre of the cloth, and rolling the bundles of straw in the cloth on either side until they come in contact with the fractured member (fig 43).

Fractures of the arm may be "put up" with very thin bundles of

straw lined with cotton wool or wadding, or they may be enveloped in straw, in which case it is of course necessary to have a soft lining.

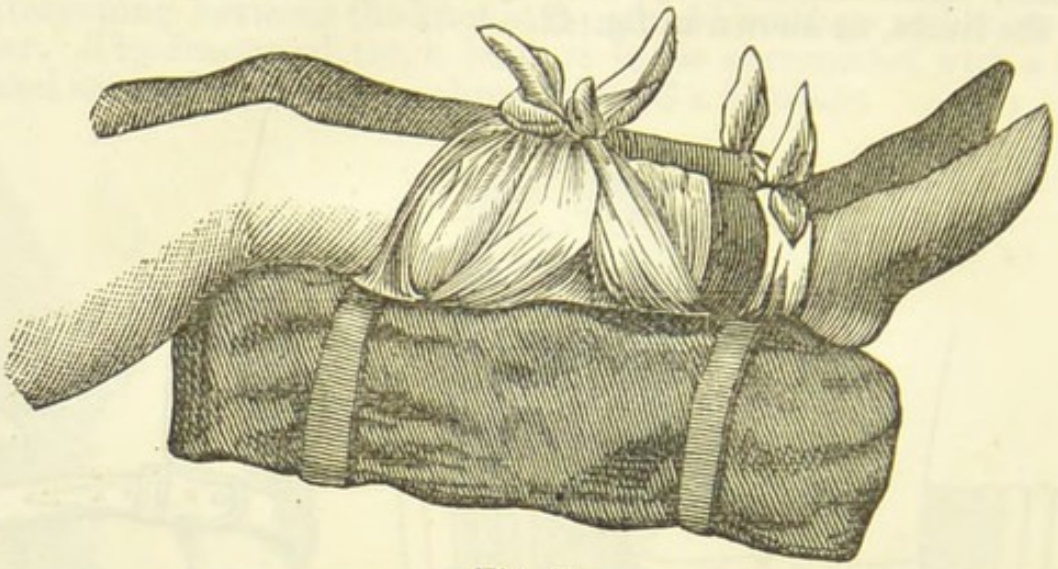


Fig. 37.

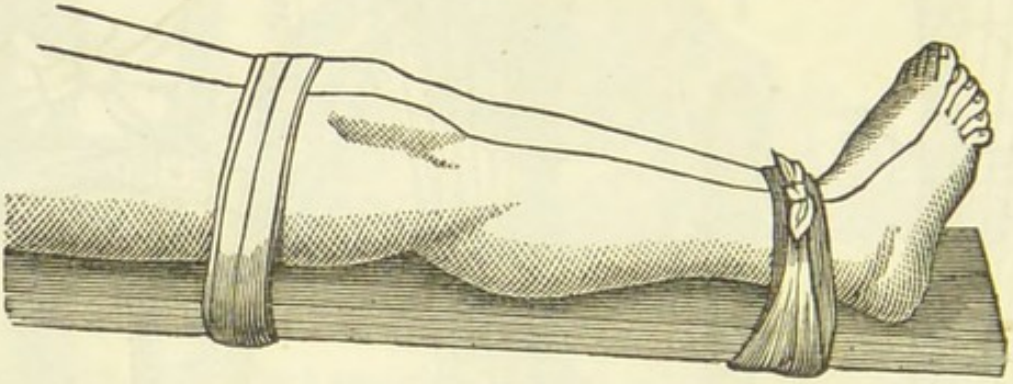


Fig. 38.

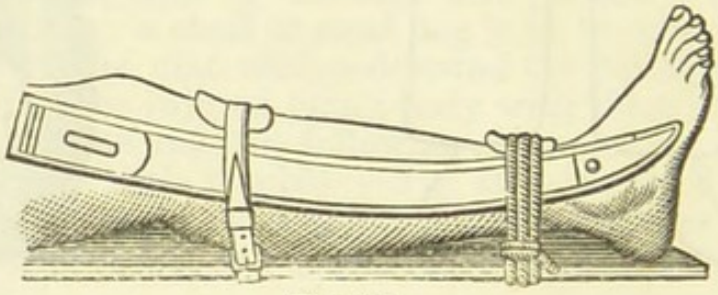


Fig. 39.

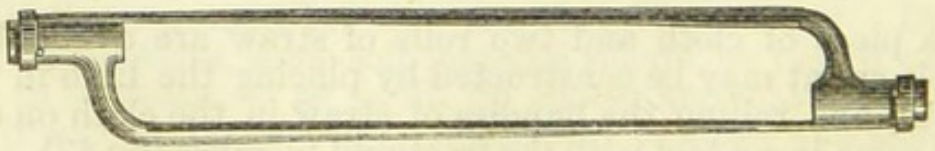


Fig. 40.

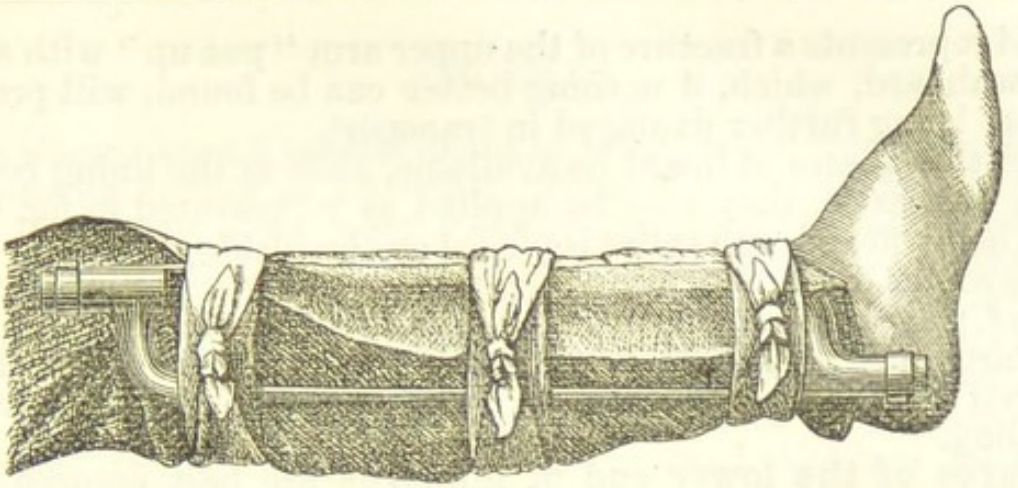


Fig. 41.

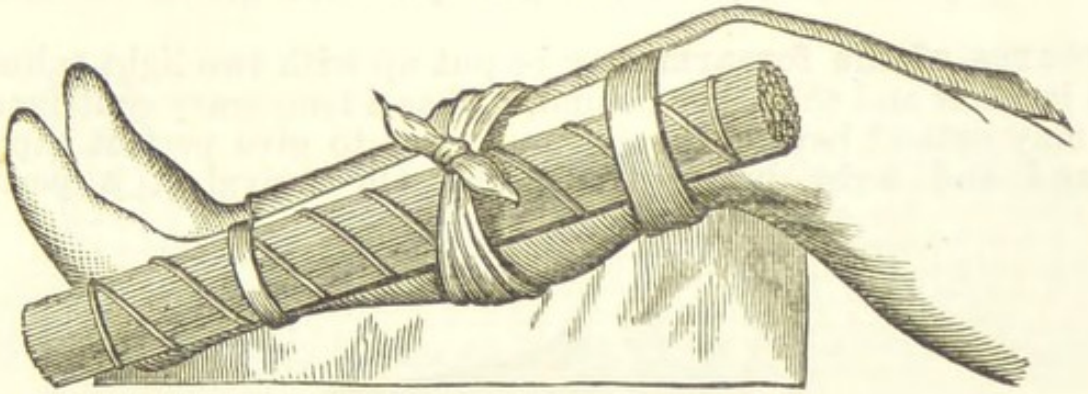


Fig. 42.

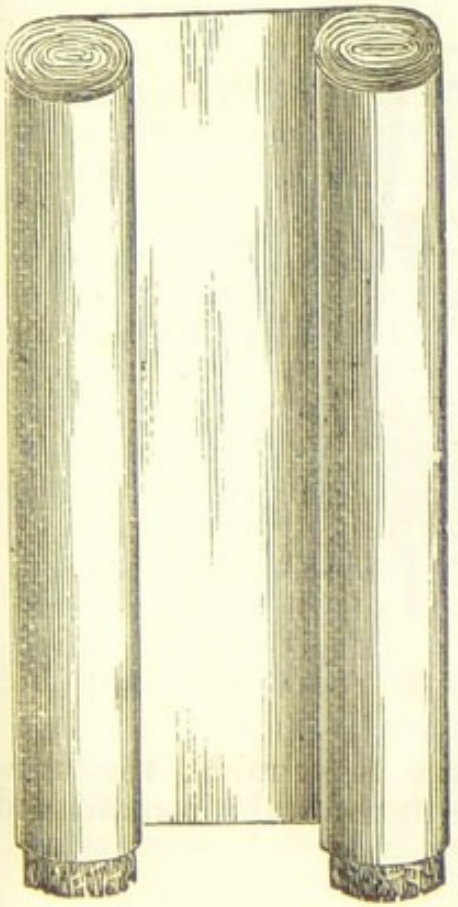


Fig. 43.

Fig. 44.

Fig. 44 represents a fracture of the upper arm "put up" with a bayonet and its scabbard, which, if nothing better can be found, will prevent the limb from being further damaged in transport.

Should thin pieces of board be available, such as the lining boards of a soldier's knapsack, they may be applied as represented in fig. 45. The forearm being flexed, one splint is placed on the inside of the arm reaching from the axilla to the inner condyle, a second long splint is placed on the outside of the arm reaching from the acromion to the external condyle, and a third may be placed on the front and a fourth behind, these may be secured by straps or bandages. The forearm should be supported with a sling.

Fractures of the lower end of humerus are best secured with an inside rectangular splint, the straight splint not giving sufficient support.

Fractures of the forearm may be put up with two light splints, one placed in front and the other behind, and as a temporary contrivance the splint may extend beyond the fingers, so as to give perfect support to the hand and wrist during transport. On arrival at a permanent

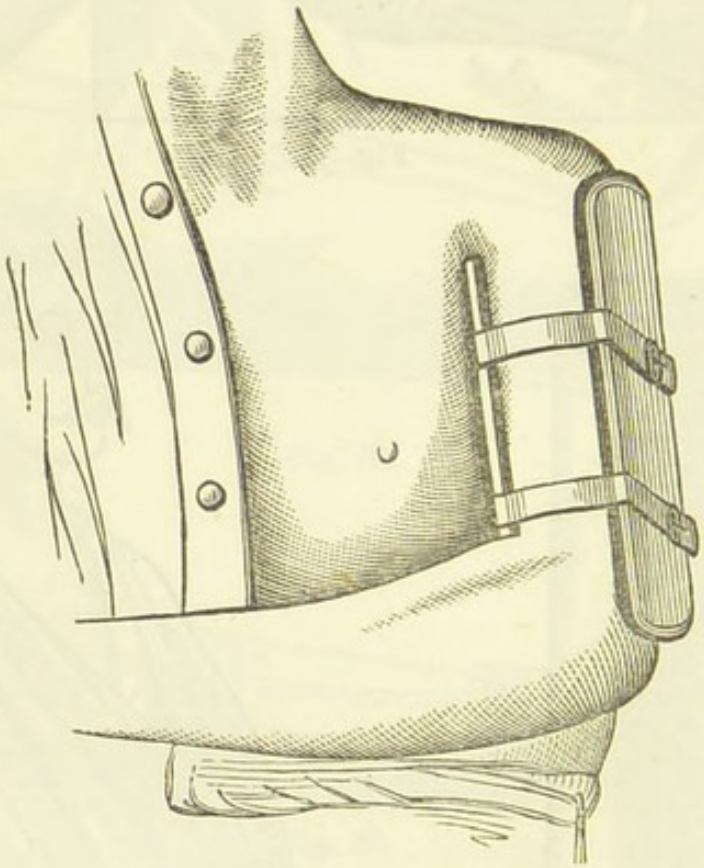


Fig. 45.

hospital, or any place where proper splints are procurable, the temporary ones should be replaced by such as are in use and recommended for particulars fractures.

SPLINTS.

It has always been a special point in preparing surgical appliances for war to provide splints of materials which will be sufficiently strong to support the largest bones when fractured or shattered, and at the same time be light, easily carried, and capable of being applied with facility.

The old-fashioned *wooden scored splints* were at one time much used, but they were liable to be rendered unserviceable by exposure to wet or from the moisture of wounds, and have consequently fallen into disfavour; they were, however, in the opinion of S. M. Porter, the most valuable and useful splints which a surgeon could take into the field with him, being light and easily adapted to all regions.

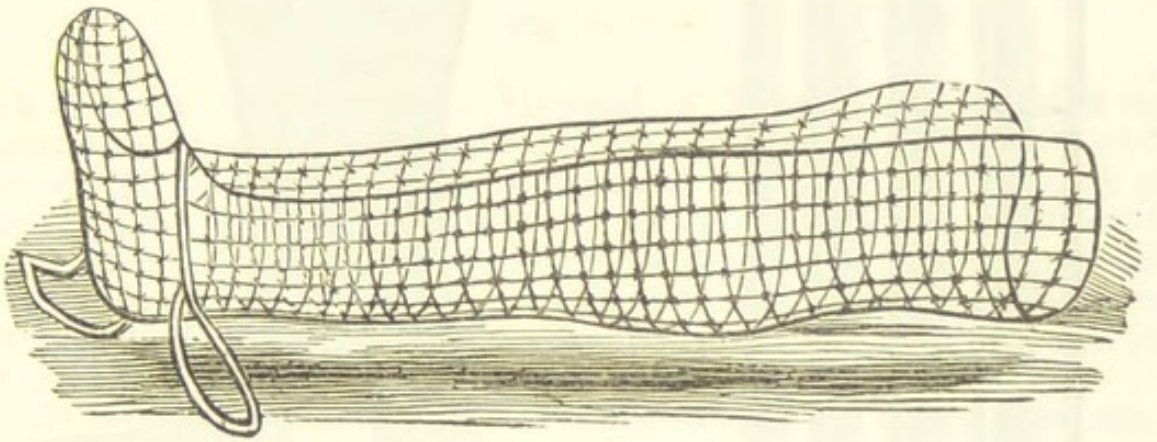


Fig. 46.

Wire or Trough Splints.—The French have introduced splints made of wire, which are very strong but somewhat cumbersome; they are formed to the shape of the limbs for which they are intended, those for large limbs being composed of a stronger description of wire than those for smaller, and having the general appearance of splint represented in fig. 46, which is intended for the leg.

Duncan Splint.—Duncan has designed a splint known as the "*rattan splint:*" it is composed of cane or small ratan, strung as it were together and cut to certain lengths; each end is covered with a cap of cloth to prevent splitting or the rough ends irritating. They are very light, but rather bulky, presenting the appearance, without caps, as shown in fig. 47.

A modification of this splint has been made by covering the cane with canvas and attaching three straps and buckles, or as many as may be considered necessary for the size of the splint; this makes the splint more bulky than Duncan's.

Iron-wire Gauze Splints (fig. 48), familiar to all surgeons form most convenient appliances, but they are heavy, and apt to rust when exposed to moisture.

Thin sheets of perforated zinc or tin, guttapercha, leather, cane, whalebone, felt, and various other materials, have been proposed, so

important and necessary is it that some kind of splint should reach the field of battle and be ready for immediate application.

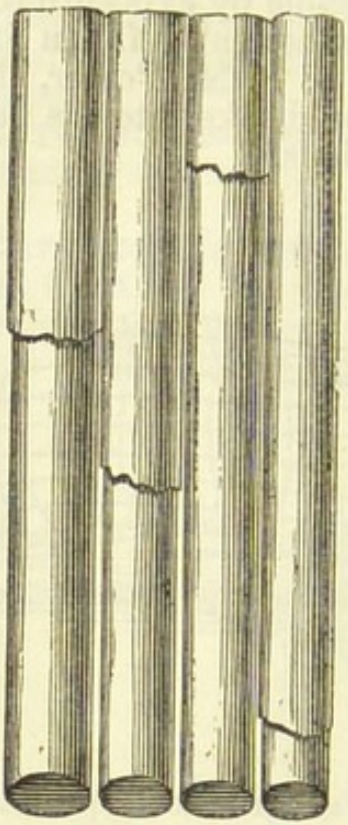


Fig. 47.

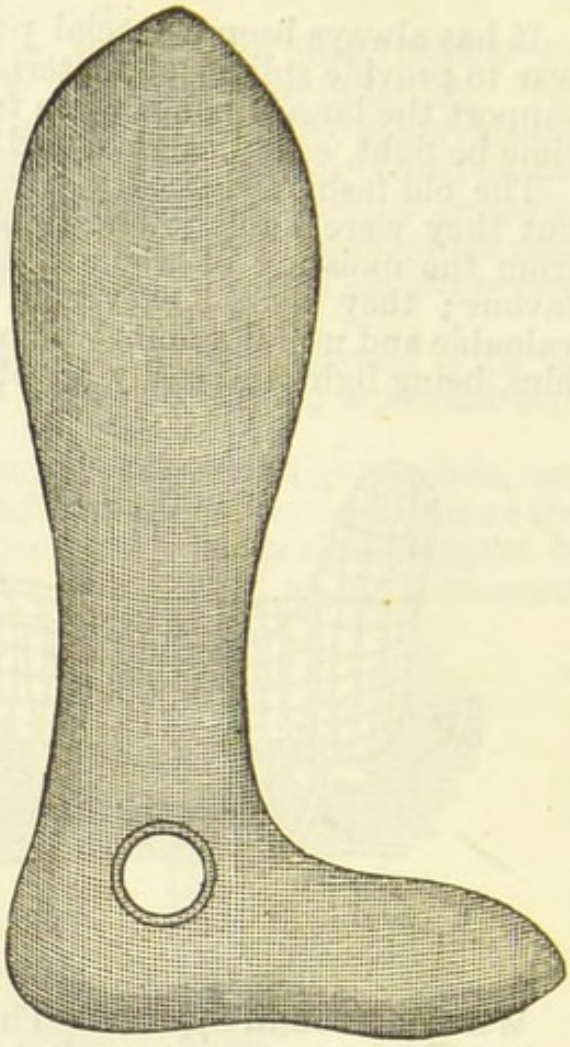


Fig. 48.

Extemporised Splints.—Besides the extemporised splints already mentioned the following articles may be utilised—lathes, switches, rushes,

Fig. 49.

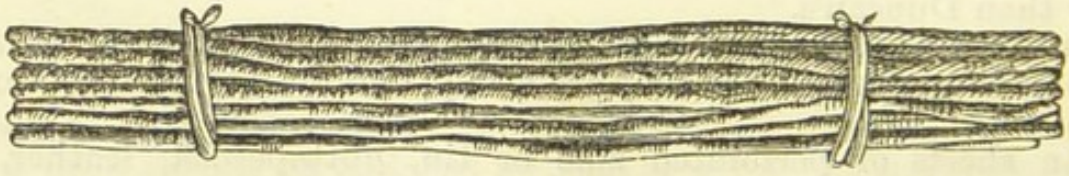


Fig. 50.

reeds, straw, brushwood, twigs (arranged as in figs. 49, 50, and 51), heather, leather straps, such as a trace or stirrup leather, or strips of tin. There is very little difficulty in converting the many articles found about a house, farm-yard, or in fields, into temporary splints, but even with the best and most perfect, which will answer for use in permanent hospitals, there are some fractures in which it is almost impossible to keep the broken ends of the bones in position during transport.

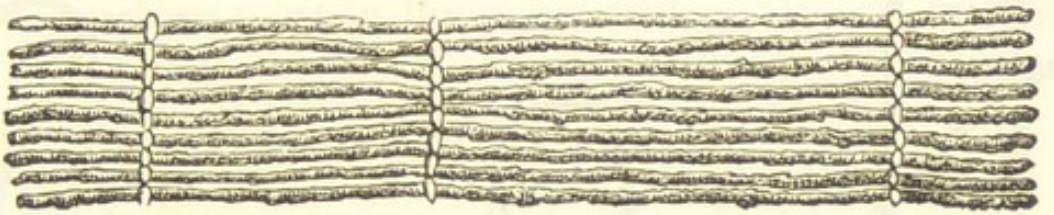


Fig. 51.

Bark of trees Mr. Benjamin Howard of New York has made use of with great advantage. Telegraph wire has been suggested by the author, the great difficulty with it being a means of cutting it at the exact point required. This has been obviated by constructing a file on the outside of one of the blades of the straight scissors (fig. 52) in an ordinary pocket-case ; this is capable of cutting a notch in the wire, and so weakening it that it may be broken with ease. Fig. 53 represents a splint for a leg or forearm ; the latter being considerably shorter and narrower.

Fig. 54 represents a splint for the outer side of the upper arm, one end being bent over the acromion, and the other under the olecranon, as might be done with a piece of leather strap. Fig. 55 is an inner or back splint for the upper arm. Fig. 56 represents an angular splint for

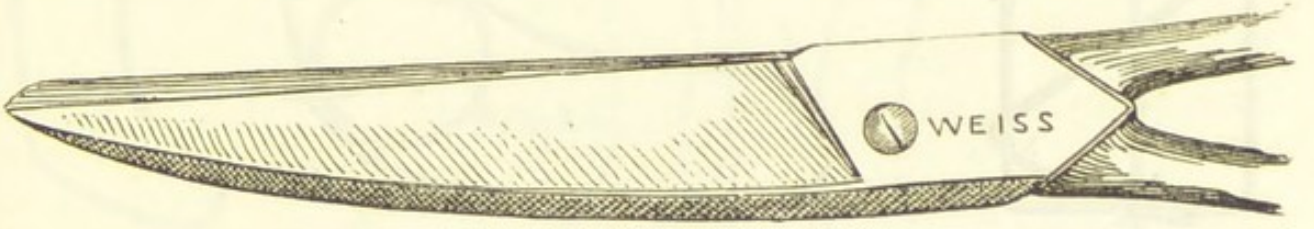


Fig. 52.

fractures of the lower end of the humerus, or injury of the elbow. These splints may be made more splint-like by having strips of the soldier's clothing, bandage, or other soft material rolled round them, when they will be found capable of supporting any fractures. For fractures of the thigh it is only necessary to select a larger wire and prolong the splint (fig. 55).

Extemporary Pads and Cushions.—The army surgeon may at times be under difficulties as regards the construction of pads or cushions ; they may, however, be made with cotton-wool, tow, oakum, chaff, shavings of cork or horn, cut straw, hair, cut paper, feathers, dried sea-weed, bran, dried leaves, felt, saddle cloth, articles of clothing, saw-dust which,

if taken from any of the pine species, will be found to contain some antiseptic qualities.

But it must be remembered that, however suitable many of these various things may be for purposes of padding, yet it would be highly dangerous to use some of them if there were a flesh wound, on account of their possible septic qualities.

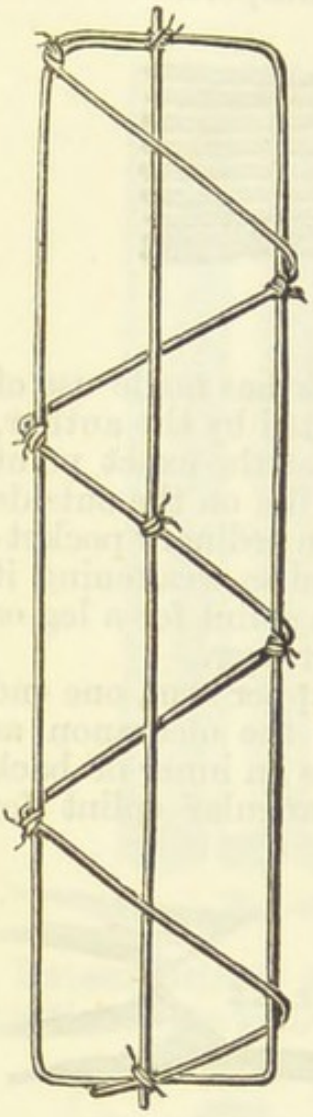


Fig. 53.

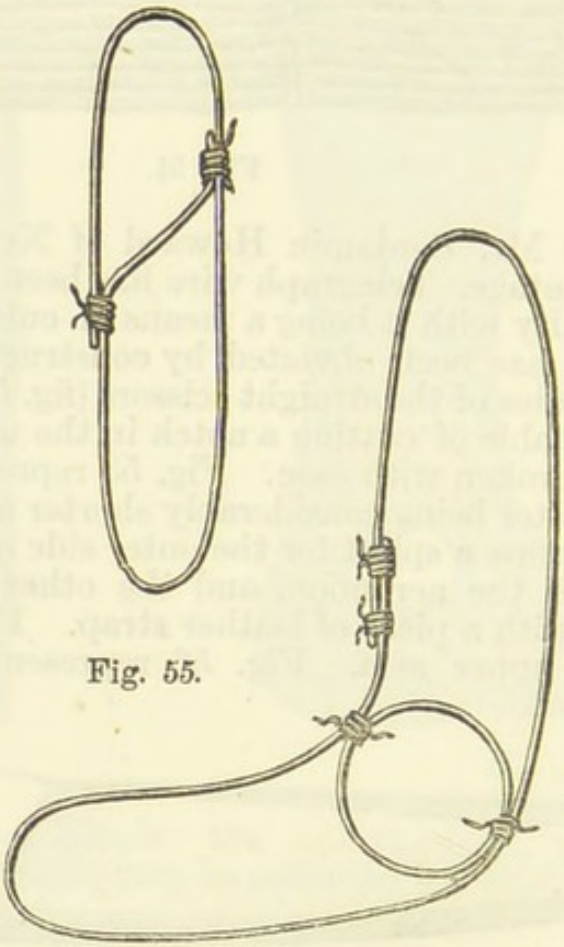


Fig. 55.

Fig. 56.

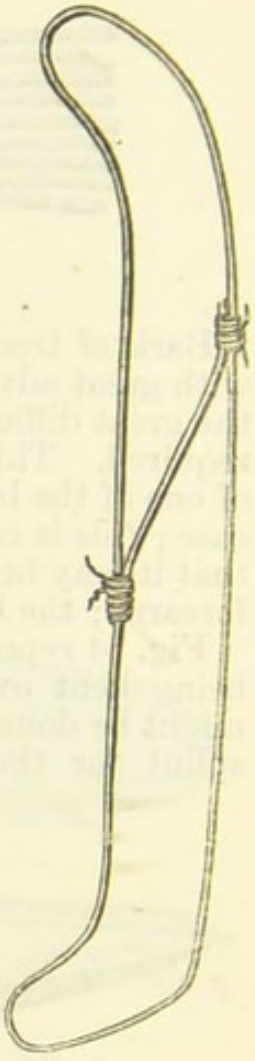


Fig. 54.

Plaster of Paris has been much used of late years for securing fractures on the field, and though its preparation causes great delay, still the results have been highly satisfactory. During the operations before Plevna, August, 1877, and at Shipka (Russo-Turkish War, 1877, 1878), 950 gypsum bandages were applied in the course of a few days, and it is confidently asserted that in the campaign, thanks to gypsum, the treatment of gun-shot wounds traversing the limbs has been most successful.*

Many plans have been proposed for its application, but the surgeon

*Russian Medical Journal, "Sooraymenaya Meditsina."

should make himself familiar with its nature and its preparation before attempting to apply it on the battlefield.

Plaster of Paris is excessively prone to deteriorate and is therefore difficult to keep, it is heavy and bulky. The so-called water-glass, which is a solution of silicate of potash, makes admirable light appliances, but it requires some time to dry before it becomes stiff and hard.

Billroth remarks on this subject: "I consider the treatment of gun-shot fractures by fenestrated plaster-bandages as the only proper method (excepting perhaps those in the upper part of the arm or thigh); the

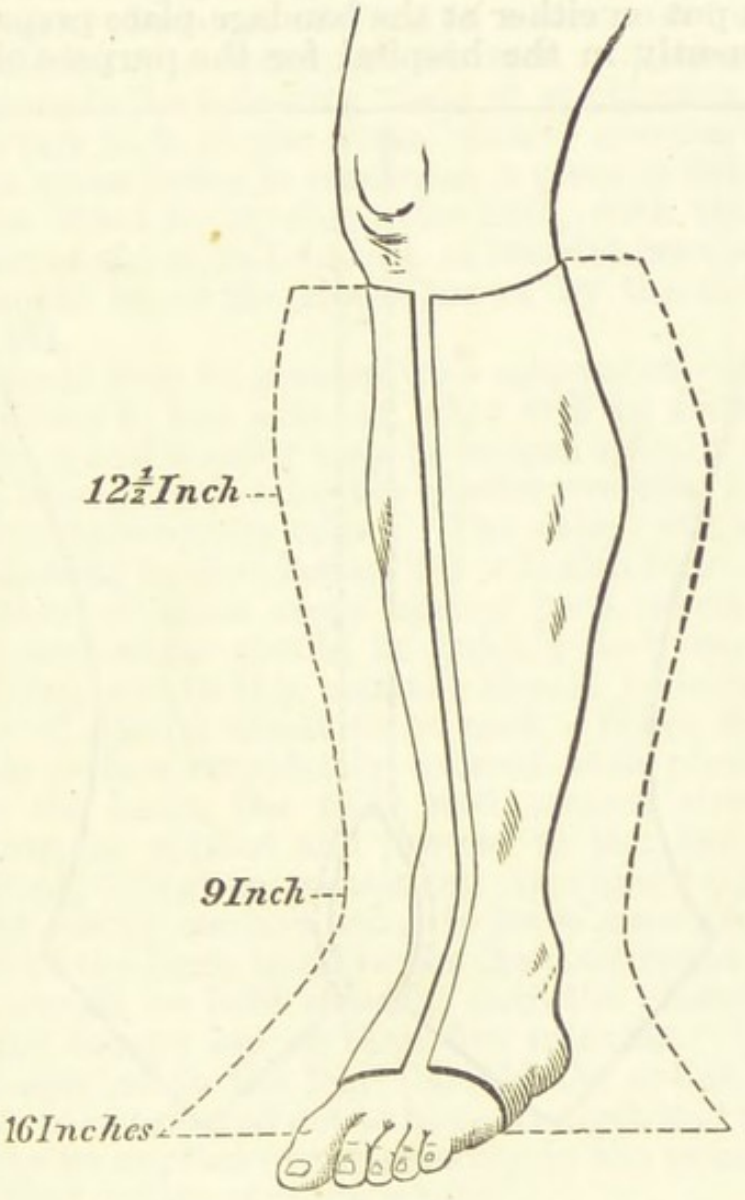


Fig. 57.

only thing against it is that surgeons who have not already treated open fractures with plaster dressings, and are not adepts in the application, should not make their first experiments on gun-shot fractures, but should only apply dressings with which they are familiar."

Pirogoff, who claims priority of the invention, gives the following account of the process for its application: "A drainage tube is drawn

through the wound, which is either covered with charpie or united by sutures, a roller of flannel, cotton, or other rough texture is applied over the entire limb, and on this the plaster of Paris is smeared ; a large piece of wire gauze is then taken, an aperture corresponding to the size and position of the wound cut out, and with the remainder the limb is closely enveloped. Plaster of Paris paste is again laid on, and finally the whole is fixed by one or more layers of paste bandage, additional turns being given in the vicinity of the fenestra if extra strength is required. When the material has fully hardened, the fenestra is opened through the parted bandage by means of a strong scalpel. The plaster of Paris bandage may be put on either at the bandage-place preparatory to transport, or subsequently in the hospital for the purpose of treatment ; in

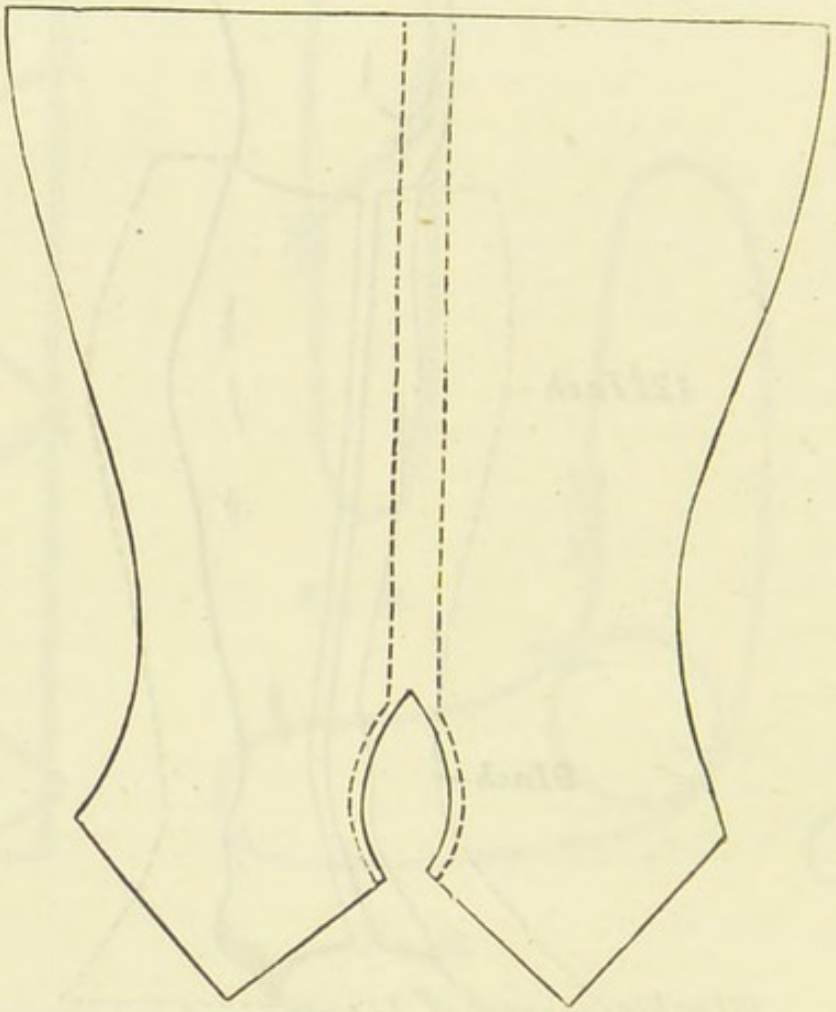


Fig. 58.

the former case without fenestra, providing the distance to be accomplished is not too great, and that the appliance can be removed on arrival. Pirogoff does not delay its application on account of inflammatory swelling, but he slits the bandage up the whole length, and so converts it into a case out of which the limb can be taken and cleaned when required. When the swelling subsides the ordinary plaster of Paris bandage must be substituted. He lays down the fundamental advantages of the appliance as follows :—

"It exercises a uniform circular pressure throughout the entire length of the limb, thereby paralysing the attacked muscles; it secures immobility to the broken fragments; and it keeps up continuous extension to a certain extent when put on and allowed to harden while the limb is extended. The firm unyielding capsule formed by this bandage when it embraces the joints above and below the wound prevents the further approximation or riding of the broken ends, and keeps the limb on the constant stretch. Finally the fenestra in the bandage must be so arranged that the fixity of the bandage must not be lessened."*

Surgeon-Major Moffitt, who has made several experiments in connection with the employment of plaster of Paris as a means of forming splints or supports to facilitate the transport of men suffering from gun-shot fractures, recommends the following mode of application :—

"Plaster of Paris in a proper state, water, spermaceti ointment, a small basin and a spoon being in readiness, a piece of flannel is to be cut, of shape and size fitted to envelope the limb, with the exception of a longitudinal space of about half-an-inch in breadth between its edges. If for the leg, it should be of the shape shown by the dotted line in the illustration (fig. 58).

"The limb should then be greased with spermaceti ointment, and the hairs smoothed down to the skin, or what will be found to answer as well, if not better, a calico roller may be wound spirally round the limb, and divided at a later period, after the plaster covering is applied, along the vacant interval between its edges. The calico will not only prevent the hairs from sticking to the plaster, but will also form a neat lining for the splints. Either of these steps having been taken, equal parts of plaster of Paris and water should be quickly and thoroughly blended together by stirring, and in this mixture should be immersed, with the hands, the piece of flannel about to be used. When the flannel is well saturated, and its surface completely covered with plaster, it should be withdrawn from the basin, the folds and creases stretched out of it, and it should then be applied and pressed to the limb so as to fit it accurately, without, however, permitting its edges to join each other; the object of this last precaution being to leave a narrow open space up the whole length of the limb, to allow for the occurrence of swelling. In this position it should be held steadily until the plaster has set, which will generally not occupy longer than five minutes. The illustration shows the splint applied to the leg. Should the splint, however, after the plaster is set, be considered not to have strength and firmness enough, another layer may be applied over it exactly in the same way. A roller may now be applied lightly over the whole.

"The quantity of plaster requisite for a leg is about eight ounces; for the thigh and arm in proportion.

"Should it be desired, however, to make the plaster more secure, or to continue its application as a permanent splint, this may be done with great facility by the addition of a little dextrine. This will be best accomplished by taking a piece of flannel of the dimensions similar to that used for the plaster of Paris, coating one side of it over with a thick

* *Medical Times and Gazette*, August, 1873.

solution or paste made with the ordinary dextrine, and applying it over the plaster of Paris splint already in use."

At the Congress of Military Surgeons held in Paris, 1878, *Neudörfer* exhibited another method. He encloses dry plaster between folds of cotton or linen cloth, this he thoroughly saturates with water, which he presses out by passing a piece of stick rapidly and evenly over the surface of the cloth. This description of bandage dries quickly.

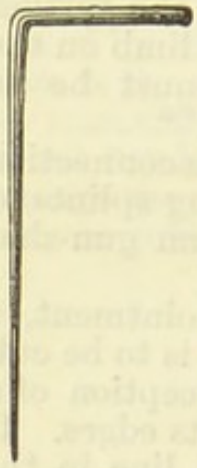


Fig. 59.

The mode of applying the plaster apparatus, as practised in the *Bavarian Army* during the late Franco-German war, is as follows:—"Two pieces of flannel, 20 inches broad, are stretched together for the leg, as represented in fig. 58, and stitched down the middle; and beyond this both are cut through in the same line for the length of the foot. The flannel is placed under the limb, so that the seam reaches from the ham to the heel. The sides of the inner piece are brought together over the leg, and fixed in front and along the sole by pins (bent at right angles (fig. 59), so that they may be easily extracted afterwards), and thus a closely-fitting stocking is formed. The sides of the outer piece are then brought forward and cut, so that each may overlap the middle line of the leg and sole by three-quarters of an inch. The limb is then laid on one side, and, while this outer piece of flannel is held back, a layer of plaster of Paris of the consistence of thick cream is spread evenly to the thickness of half an inch over the inner piece, and made to pass quite to the seam behind and the line of juncture of the sides of the inner piece in front. The outer piece is pressed over this before it sets, and should just reach the middle line in front and along the sole. When this has set, the limb is turned over, and the process is repeated on the other side (fig. 60). The pins may now be removed. The seam serves as a hinge,

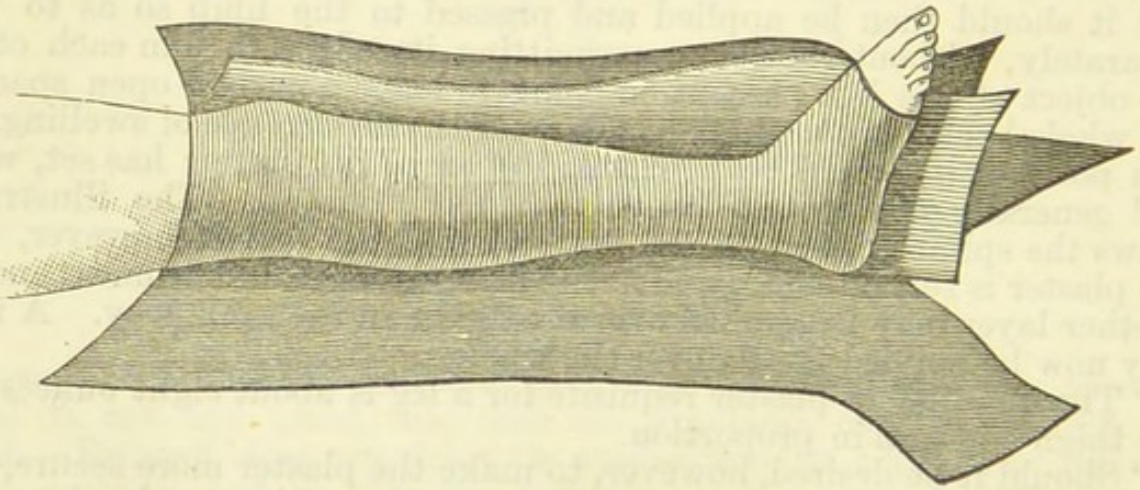


Fig. 60.

and when the whole has set the splint may be taken off, the edges of the plaster trimmed, and those of the inner piece of flannel cut so as to leave sufficient to turn over and stitch down on the outer piece. The splint is

then readjusted and fixed by a bandage. The setting of the plaster may be retarded by the addition to it of a solution of borax. Thus, a solution of one part to twelve of the water used will retard the setting fifteen minutes.

From experiments made at Netley, the following are the quantities of plaster of Paris required for each of the different bandages by the Bavarian method :—Leg, 24 oz. ; thigh, 28 oz. ; elbow and forearm, 16 oz.

Volcer has devised a plan for applying a plaster of Paris bandage to a

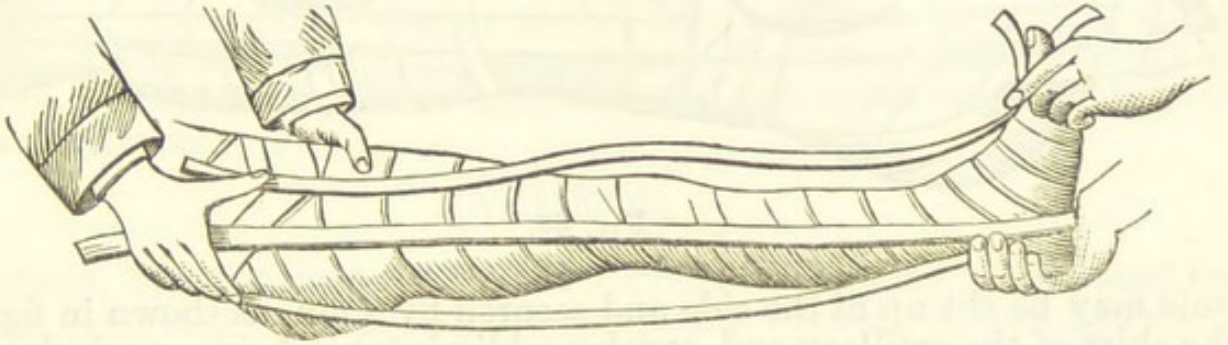


Fig. 61.

fractured thigh, which is as follows :—If time admits, give chloroform, and keep the patient under its influence till the plaster hardens. The patient should be kept perfectly steady. The extremities, from the toes to the haunch, must be enveloped in wadding, which is to be cut into strips 4 inches in width ; this wadding is then to be covered with moist gauze, which keeps it in position ; over this narrow strips of thin wood (fig. 61), so flexible that they can be rolled like a bandage, are to be placed on four sides of the entire length of the limb. Two attendants fix with their hands these long splints until an ordinary plaster bandage,

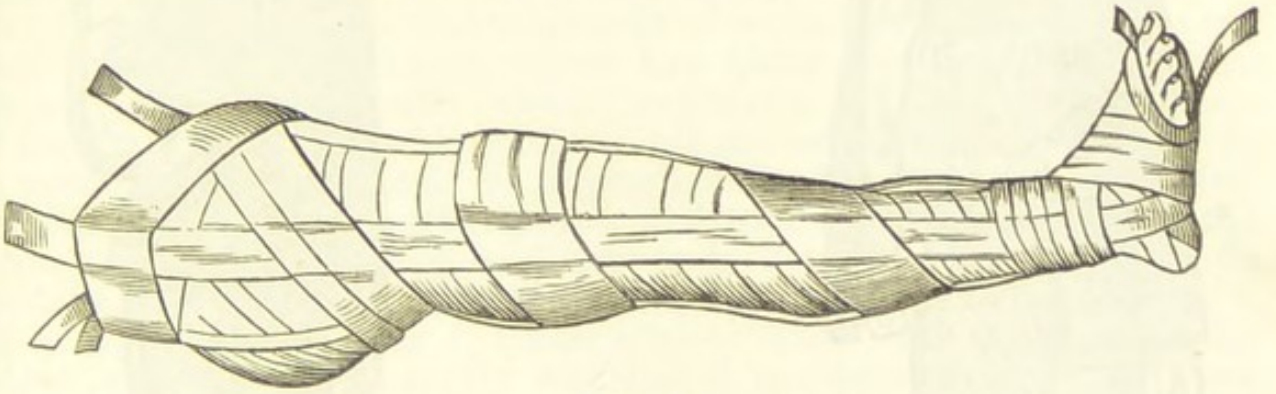


Fig. 62.

which has been dipped in water, has been placed round the limb, by means of which the splints are firmly fixed (fig. 62). Then five or six plaster bandages are used from the toes to the haunches, carrying the bandage well round the hips. Care should be taken that the plaster bandage does not extend over the wadding at the hips and abdomen, and that an orifice (fig. 63) is left for discharges and application of dressings in the event of there being a wound.

Arm Slings.—The most convenient form of sling for supporting an injured arm is the triangular bandage already referred to (fig. 29) ; but, in the event of one not being available, the skirt of an infantry soldier's

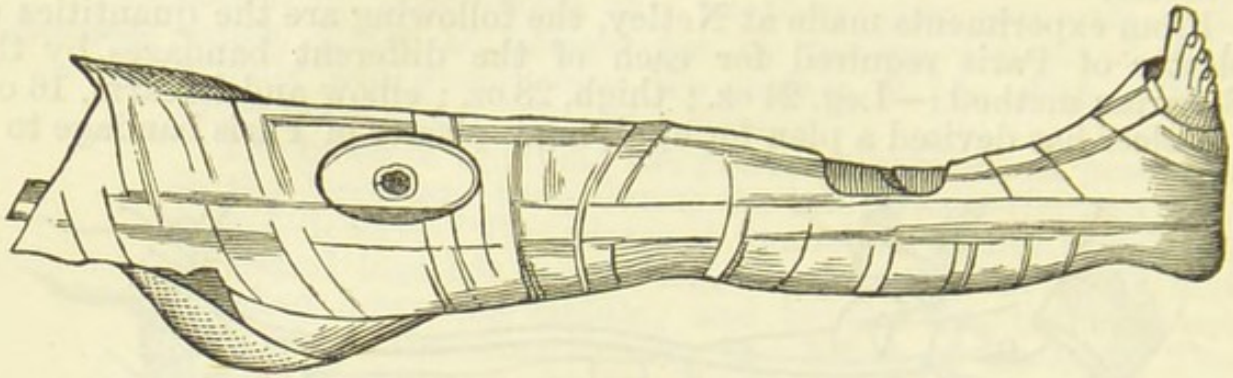


Fig. 63.

tunic may be slit up at the side and secured by a pin, as shown in fig. 64. The skirt of the artillery and cavalry soldier's tunic being much shorter, the sleeve of the injured side may be utilised by being slit up and secured, as represented in fig. 65.

Fig. 64.

Fig. 65.

FAT-EMBOLISM.

Fat-embolism, as a sequence of fractures, consists in the passage into the veins of liquefied fat which is carried into the lung, brain, and spinal cord, blocking up the capillaries of these organs. A condition liable to

bring about fat-embolism is a crushing violence to the bones, so that the cancellous texture is much broken up, and the medullary fat thus set free. The symptoms are apt to be taken as those of shock, occurring as they do in the first two or three days after the injury. Its onset is marked by transient attacks of dyspnœa, with irregular action of the heart, slight hæmoptysis, and at first shallow breathing, at times interrupted by deep sighing inspirations, subsequently the peculiar form of breathing known as "Cheyne-Stokes" manifests itself. Collapse with marked pallor of skin and mucous membrane soon ensues; fat has been detected in the urine. Czerny thinks this condition in a very slight degree is a constant attendant upon cases of fracture.—*Encyclopædia of Surgery by Ashhurst.* It has been observed as a result of other injuries besides fractures.

WOUNDS.

Wounds, how inflicted.—Wounds inflicted in war may be produced by missiles projected by some explosive material, such as bullets, gun shot, shrapnel, shells, grape and cannister shot, and slugs, which come under the head of gun-shot wounds. There are other wounds produced by sabre, bayonet, or lance, and indirectly by fragments of substances struck by bullets, shot, or shell, such as stones, wood, metal, and even by fragments of the bones of comrades, or by explosion of the engines of war above and below water. Arrow wounds are occasionally met with.

Nature of Wounds.—From the depth to which wounds extend they are denominated *superficial*, *muscular*, and *penetrating*: and from the nature of the weapon with which they have been inflicted they are characterised as *incised*, *punctured*, *lacerated*, and *contused*. They may also be classified according to the region of the body, as, for instance, wounds of the head, face, thorax, abdomen, and extremities.

Before describing the actual treatment of wounds it is necessary to say something about bacteriology which has quite revolutionised surgical pathology, and consequently wound-treatment. Unless, indeed, these new facts are grasped by the surgeon, all modern treatment will be to him meaningless, and it will be impossible for him to take the pains, care, and time requisite for the proper and intelligent application of the dressings, consequently they are likely to be delegated to some nurse or attendant, and then astonishment may be expressed at the bad results.

In a recent address* Sir J. Lister says—"The germ theory of septic diseases is indeed now happily established incontrovertibly. All now admit that septic mischief in our wounds depends upon the development of micro-organisms in them derived from without." Again, "For the successful antiseptic treatment of wounds two essential points are, of course, necessary. In the first place, we should proceed so as to leave nothing septic in the wound before we apply the dressing; and in the second place, we should put on such a dressing as we can thoroughly trust to keep out septic mischief until that dressing shall be changed;

* "An Address on a new Antiseptic Dressing," by Sir Jos. Lister. *Lancet*, 9th Nov., 1899.

and," he contiuues, "the number of surgeons is constantly increasing who, when they have operated on an unbroken skin with a fair field around for the application of their dressings, if they see septic inflammation occurring in the wound with its attendant dangers, know that it is their fault, or the fault of the antiseptic appliances at their disposal."

Professor Senn* "divides inflammation into two classes—1, simple or plastic inflammation; 2, infective or destructive inflammation. Simple or plastic inflammation is a regenerative process, in which the tissues are in an aseptic condition and the products of tissue proliferation are transformed into normal permanent tissue, and as no toxic ptomaines are found in simple inflammation owing to the absence of micro-organisms, septic and febrile disturbances are entirely absent. It is not a disease, but a physiological process for the repair of a wound or the regeneration of a part.

"Septic or infective inflammation is caused by the presence of specific microbes, and the products of the inflammatory process do not undergo transformation into tissue of a higher type. The intensity of the inflammation depends as well upon the nature of the microbes as their quantity."

At the present time the question has arisen—Are all the ills attributable to microbes due merely to their presence and growth, or are they due to the action of definite chemical compounds formed during the life and growth of these organisms? Lauder Brunton† observes, "We are now beginning to look upon many of the symptoms which occur in consequence of the action of microbes as being due not to their direct action upon the tissues, but to their indirect action in forming poisons;" he asks, "do the microbes break up the albuminous substances or hydrocarbons which they attack in the fermentative and putrefactive processes by means of their actual protoplasmic structure, or do they, like the higher animals, secrete organic ferments or 'enzymes,' by means of which the disintegration is actually carried on?" Again, Cheyne remarks, "Except in the case of wounds the chemical substances which aid in enabling the bacteria to gain a foothold are the products of the organisms themselves. That various bacterial products are highly poisonous is now well known, and in the case of putrefactive and pyogenic organisms, these products are able not only to cause local trouble as wound inflammation, suppuration, and tissue-necrosis (gangrene), but also to set up fever, to depress the vitality of the patient, or, it may be, even to cause death. With regard to these general effects of bacteria, we find in books of surgery, in addition to septicæmia and pyæmia, a third group of general septic diseases due to the action of these products described under the title of septic intoxication or sapræmia."

It has long been known that the healthy tissues were unsuitable ground for the development of micro-organisms, and that, while dead matter in a wound (as blood-serum, &c.) offered a most suitable pabulum for their growth and development, yet the living tissues in the wound had a power of protecting themselves against their attack and of check-

* *Surgical Bacteriology*, by Professor Senn, Chicago.

† *The Croonian Lectures*, 1889, by T. Lauder Brunton, M.D., F.R.S.

ing their development. Metschnikoff has heen carrying on some researches into this circumstance, and he describes the leucocytes of the tissues as feeding on bacteria, taking them into their protoplasmic substance and digesting them, thus preventing their indefinite propagation among the tissues. The cells which exercise this devouring function he termed "phagocytes," and the whole process "phagocytosis." Lister, in his Berlin address, says that various objections have been urged against these views, but he thinks that Metschnikoff has met them effectively. He also adds that this theory explains much that has been mysterious in the relations of micro-organisms to wounds. Koch, however, is disposed to think that this explanation of Metschnikoff's, that a kind of struggle occurs between the invading parasites and the phagocytes (which are supposed to act as defenders of the body), is losing ground, and that the probability is that in this question the principal part is played by chemical processes rather than that it is due to purely cellular processes alone.

Suppuration is now believed to be entirely due to the presence of pathogenic microbes, or rather to their ptomaines or ferments, which, however, can only cause it in the tissues immediately in contact with them. Its progressive character is due to the spread of the micro-organisms within the body, and the production of ptomaines proportionate in amount to the number of microbes present. In one case the suppuration remains circumscribed as in a furuncle; in others the regional infection is more extensive, and a diffuse phlegmonous inflammation is the result; while in a third the local infection leads to a general invasion, and the patient dies of sepsis or pyæmia. Several observers positively deny that any mechanical, chemical, or thermal influences can produce suppuration if microbes are excluded. Cheyne asserts that for the formation of a true abscess we require the peptonising ferment produced by microbes. He describes a minute abscess as containing a colony of microbes, which, when fixed in the tissues, cause a limited coagulation-necrosis of the tissues in immediate contact with the microbes by the action of the ptomaines. A few hours later, a zone of leucocytes aggregate around the dead tissue. The products of inflammation also remain fluid, probably from the peptonising effect of the microbes, and thus an abscess is formed.*

To sum up, micro-organisms are then the immediate cause of all forms of acute suppuration and of traumatic infective disease, under which is included pyæmia, septicæmia, erysipelas, hospital gangrene, phagedæna, osteo-myelitis, and tetanus. The so-called burrowing of pus in unhealthy wounds is due to their spreading in the tissues. Also the secondary hæmorrhage occurring in suppurating wounds in the second or third week is mainly due to a softened and diseased condition of the walls of the artery, brought about by the peptonising action of the ferments found during the growth of these organisms in its neighbourhood.

The causes of putrefaction and wound-infection being thus shown to be due to the entrance of germs into the wound, it will be evident that to prevent putrefaction of the discharges, the wound must be protected

* *Surgical Bacteriology*, Professor Senn, Chicago.

from all chance of invasion of the organisms, or, if this cannot be done, as in the case of accidental injuries, the wound must be so treated by antiseptics as will interfere with and prevent their power of development. Lister, in his Berlin address (1890), says that his practice for some time past has been to wash his operation wounds with a strong solution of corrosive sublimate, and at the same time he has doubts whether either washing or irrigation was really necessary; but since he discontinued the spray he has been careful to compensate for its absence, not only by antiseptic washing and irrigation, but by surrounding the seat of operation with widespread towels wrung out of an antiseptic solution. He says also that the use of carbolic acid solutions, as well as the use of strong corrosive sublimate solutions (1-500), produce inconvenient irritation, and, therefore, when opening an articulation, as for suturing a transverse fracture of the patella, he abstains from washing, and, as a substitute, irrigates with a weak solution of corrosive sublimate (1-4000). Lister found that carbolic acid, when used as an antiseptic agent, induced by its irritation such a copious effusion of bloody serum as to necessitate an opening for its exit; hence came the drainage of wounds; but, he continues, "if we can discard the application of an antiseptic to the cut surfaces, using sponges wrung out of a liquid that is aseptic but unirritating, such as the 1-10,000 solution of corrosive sublimate, we may fairly hope that the use of drainage tubes may be dispensed with. Cotton wool sterilised by heat can only exclude septic germs when it is in a dry state. When it is soaked to its external surface with a copious discharge, it must be liable to become septic *en masse;* if, therefore, the discharge is considerable, it is essential that the dressing be of a kind which will not permit the development of septic organisms in it, although it be saturated throughout; and this can, I believe, only be attained by the use of chemical substances."

Lister continues:—"Our wounds being no longer subject to the constant irrigation of the spray, and carbolic acid having given place to the less irritating, though more efficient, solution of corrosive sublimate, serous discharge is much less than formerly, and less drainage is required. In many small wounds where we used to find drainage imperative we omit it altogether, and in those of larger extent we have greatly reduced it, and it would be a great thing if we could dispense with drainage altogether."

The best drains are those made of red india-rubber—the tube must not project beyond the surface, and a loop of silk should always be fastened into it at its orifice. It is better to use two or more smallish tubes than one large one, because on the day after the operation one of these may be removed altogether. "No tube," says Cheyne, "which one wishes to put back again, should be removed until the third day, on account of the difficulty in returning it. Generally on the third day half the tube is cut off, and it is reduced in length at subsequent dressings till it becomes no longer necessary." Sinus forceps are of the greatest use in inserting drainage tubes, and every pocket-case ought to contain a pair.

There is a certain amount of reaction about the use of drainage tubes in the minds of surgeons. They are now used more sparingly than

formerly, and their use is dispensed with at the earliest date possible. If not positively necessary, they no doubt keep up irritation and prevent healing.

"Sponges should be well washed after an operation, and then kept in a jar containing 1-20 carbolic solution; during an operation they are washed in a 1-40 solution. Sponges after use often become filled with fibrin, and thus rendered useless. Lister, therefore, after an operation places the sponges in a tank containing water, putrefaction of the fibrin occurs, and after some days the sponges can be easily cleaned. They are then placed in a 1-20 carbolic solution."—*Cheyne.*

In stitching up the wound, the edges of the wound should be brought closely and accurately together by silver wire or gut sutures rather deeply placed at regular intervals, and between these the edges of the skin should be correctly approximated by wire or catgut sutures.

In the case of large or deep wounds made accidentally, or by gun-shot, where, perhaps, some hours have elapsed before the case comes under the surgeon's attention, the practice is somewhat different. Here septic germs may have gained access to the wound; it is, therefore, most important to try and destroy them, and prevent others from gaining entrance. This would be best accomplished by thoroughly washing out the wound or joint with a 1-20 carbolic solution, or 1-500 * mercurial solution, by means of a syringe and catheter, taking care that the solution is brought in contact with every part, this will cause the wound to discharge freely for a while; a drainage tube should, therefore, be inserted, and the edges of the wound brought together by sutures, and the wound dressed with an antiseptic dressing so arranged as to be kept close to the surrounding skin, and thus prevent the direct access of the air.

The antiseptics chiefly in use are :—

Carbolic acid, which is used in a 1-40 and 1-20 solution in water, in a 1-5 solution with rectified spirit, also with oil or glycerine as 1-10 and 1-20; we also have carbolised cotton wool and tow. It is a powerful germicide, but it is extremely irritating, and interferes with healing by destroying granulation tissue. Healthy granulations are non-absorbent; if, however, the superficial layer of granulation tissue is destroyed, a weak spot is produced in which pyogenic cocci can develop, and through which they may enter the body; hence Cheyne doubts if it is well to wash out septic wounds so often as is done at present, though of course it is right to remove decomposing discharge. Therefore, except in the first instance, to purify a wound, carbolic acid, if used at all, should never be allowed to come in contact with the wound surface. It is poisonous and very volatile.

Corrosive sublimate, or mercurial chloride, is a most powerful germicide. It is used in solution, and in specially prepared dry absorbent dressings. The solution 1-500 may be used for all purposes that the 1-5 spirit solution of carbolic acid, or the 1-20 watery solution, would be applicable—*i.e.*, for the thorough purification of accidental wounds or gun-shot injuries when first brought before the surgeon; but after the

* *Vide* formulæ at the end of the book.

first purification, 1-4,000 is the strength best suited for ward use. 1-5,000 may be used for irrigation during an operation, and 1-10,000 for washing out the abdominal and pleuritic cavities. In dressing wounds it may be applied in lint which has been soaked in the 1-4,000 solution. It is apt, however, to produce a troublesome eczema on some skins, and it will blister if applied in a too concentrated solution. Another disadvantage is that albumen interferes with its antiseptic action very considerably. Woodwool owes its antiseptic properties to this drug; it is said to contain ½ per cent. of sublimate and 5 per cent. of glycerine, but it is not a very absorbent dressing.

Sal alembroth is a double chloride of mercury and ammonium; the chloride of ammonium in combination protects the chloride of mercury from the interfering influence of albumen; at the same time this double salt is much less irritating and more efficacious, antiseptically, than the chloride of mercury alone. The dressings prepared with it chiefly in use are the absorbent cotton and the so-called gangee tissue, both of which are also coloured blue by means of an aniline dye, which is so incorporated with the salt that, as the salt is washed out by the discharge, the blue colour disappears with it, the wool remaining white, and thus showing that all its antiseptic qualities have been removed.

Quite recently Sir Jos. Lister* has brought forward a new preparation, which is a double salt of cyanide of mercury and zinc; this is an amorphous powder insoluble in water. It is highly irritating to the nostrils, and while trustworthy as an antiseptic, it is completely unirritating to the skin. A prepared gauze is sold. Sir Jos. Lister says: "In actual practice, a few layers of gauze placed next the wound are washed in a solution of carbolic acid (1-20). The carbolic acid soon flies off, and there is left in the application next the wound merely the unirritating double cyanide; and under this we find that not only do wounds, the edges of which are brought accurately together, unite beautifully by first intention, but even granulating sores heal by the gradual process of cicatrisation from the edges in a way that we have never seen so satisfactorily under any other dressing. To make a quick dressing with it, take some of the cyanide powder, and stir it up with 1-4,000 sublimate solution, so as to produce an opaque liquid, and put linen rags into it, and then place them in a folded towel to take out the excess of liquid; you have your dressing ready, prepared then and there."

Boracic acid has weak germicide action. It is used in solution on prepared lints and cotton wool, and as an ointment. The ointment consists of two strengths. The strong (1-5) is adapted for dressing deep wounds, &c., and the weak is one of the best applications for all superficial and granulating sores. It is antiseptic and quite unirritating. Several folds of lint soaked in warm boracic lotion, and applied to a part when covered with oil-silk or guttapercha, forms the antiseptic poultice. A cold saturated solution contains 4 per cent. of boracic acid.

Salicylic acid has a stronger germicide action than boracic acid. It is used in the same way. Cheyne says that Thiersch uses jute instead of cotton to impregnate with this acid. This jute is made from the bark of

* Medical Society, London. *Lancet*, Nov. 9, 1889.

various species of corchorus grown in Bengal, and is cheaper than cotton wool, and, at the same time, more absorbent.

Iodine has a great antiseptic power, and is a good application to wounds to check any putrefactive action ; it is best used in solution of ʒij to one pint of water. To obtain perfect hæmostasis after operations, Mr. Bryant recommends the application of a sponge wrung out of iodine water at 130°F.

Iodoform acts well, owing to its readily parting with iodine. It is used dry in the precipitated and crystalline forms, and in preparations as iodoform wool, gauze, and ointment. Dr. Oppler mixes iodoform with finely powdered coffee, and maintains that its peculiar odour is thereby lost. It produces in some cases poisonous effects, the chief symptoms of which are a "high temperature (104°F.), loss of appetite, emaciation, patient complains that everything smells and tastes of iodoform, there is a quick pulse, violent delirium in some cases, drowsiness in others."—*Erichsen.*

Salol, salicylate of phenol, is without taste, and insoluble in water. It is said to be as active as iodoform, as well as cheaper, non-poisonous, and without smell.

Sulpho-carbolate of zinc is highly recommended as an antiseptic by Dr. Bottini, of Pavia. It is readily applied in solution, and is a good injection in gonorrhœa.

Chloride of zinc is a reliable antiseptic for the common bacterium of putrefaction, though it does not destroy anthrax spores. It is used in solution of 40 grs. to the ounce of water, and is said to have the property of preventing putrefaction in a wound for some time after its application, and is especially useful in all wounds communicating with the mouth, rectum, or bladder. It is most useful for all wounds when there has been any foul condition of the surface, or in sinuses. Sir Wm. Burnett's solution contains 300 grs. to the ounce—so 1 ounce diluted with 6½ ozs. of water will make a solution which would contain 40 grs. in the ounce.

Eucalyptus oil is a very powerful germicide. It is used in solution in olive oil (1-10), also in gauze, and as an ointment. It is most useful in all foul wounds near the anus, perineum, scrotum, &c.

Burnt Alum and *Bismuth* have both been recommended as good hæmostatics and as applications to wounds.

Alcohol is a good antiseptic. It has been much recommended by Mr. Jonathan Hutchinson, who uses as a dressing to his operation wounds a lotion composed of 6 parts of absolute alcohol, a half part of Liquor Plumbi, and 16 parts of distilled water—compresses of lint are soaked in this and kept damp with it during the day.

Condy's Fluid has active powers as a germicide, and is a good wash when diluted for foul sores.

Chlorinated Soda solution, ʒss to the ounce of water, is said by Dr. Cabot to stand next to the 1-20 carbolic solution in rapidity of action on bacteria. It is a good application to wounds when there is much fœtor. The balsams, as Tinc. Benzoin Co., &c., are most useful applications to old, indolent, and septic wounds.

Cotton wool is a good covering for wounds ; it acts by filtering the air,

and thus allowing no dust or germ to reach the wound. Absorbent cotton is a better preparation, as it quickly soaks up any discharge, and thus tends to promote drainage and to keep the wound's edges dry; but if it becomes soaked to its external surface by a copious discharge, it must be liable to become septic *en masse*.

Tenax or marine lint is harsh, and should therefore not be placed next to the wounded surface, but it forms a most useful outer covering.

Suppurating Wounds.—If, when a wound comes under notice, it is already foul and suppurating, we must endeavour to destroy the causes of putrefaction which have gained admission, and to hinder the development of fresh organisms in it. This is to be accomplished by the use of one of the antiseptics, scraping away old granulation tissue by means of a Volkmann's spoon, free drainage, and in a large wound with cavities by irrigation with some antiseptic solution. Dry dressings have much to recommend them; the surrounding skin is kept healthier and in better tone than by constant wet applications; the less watery the discharge the less danger of its putrefying. Then, again, a dressing should not be changed oftener than is absolutely necessary. If a wound has been purified by the chloride of zinc or other solution, and is rendered quite aseptic, there can be no object in changing a dressing unless discharge should have come through; but, on the other hand, if the discharge is decomposing it cannot be removed too quickly.

When the wound is granulating the weak boracic acid ointment is one of the best dressings; it need not be changed oftener than every two or three days. An elevated position of the part with good equable bandaging helps the healing process very considerably by favouring the weakened circulation. Poultices and water dressing favour in the highest degree the development of bacteria and consequently suppuration—they should never be used. Water, being the especial habitat of bacteria, should not be used at any time for washing wounds.

No probe, director, or, indeed, any instrument, should ever be introduced into any wound or sinus without first having been dipped in a solution of carbolic acid (1-20). It is a good plan to have a wide-mouthed bottle in the dressing-tray filled with this solution for this especial purpose. It is then always at hand, the use becomes a habit, and there is no unnecessary waste.

Incised wounds should be thoroughly purified by the carbolic or mercuric solution; the parts should then be brought together and maintained so by suture. If, however, the wound is very deep or extensive a drainage tube will probably be required; the wound should then be covered with a dry absorbent antiseptic dressing, the part elevated, and a good equable bandage applied.

Punctured wounds (such as may be produced by a bayonet) of the soft parts are peculiarly liable to be the cause of septic inflammation in the neighbouring textures, followed by the formation and confinement of matter under the fascia, or to be the cause of injury to deep-seated vessels, and of subsequent hæmorrhage. Should a foreign body be suspected, it should be searched for and removed, the wound should be well washed out with an antiseptic solution, a drainage tube in-

serted, and the wound dressed with some dry absorbent application. Should no foreign body be suspected, and the lips of the wound fall together, no examination should be made, but the wound should be covered with a dry dressing and the parts gently but evenly supported by a bandage. In the event of the wound becoming inflamed the greatest attention must be paid to prevent the retention of discharge, free drainage should be established, and the wound surface dressed with wet boric lint under an oil-silk or guttapercha covering.

Lacerated wounds are such as are inflicted by blunt obtuse bodies destroying to a certain extent the vitality and organisation of the textures. There is usually little hæmorrhage, but the pain may be very severe. If the wound has been made by a canon shot, the parts will present a very ragged surface, the skin being stripped away, the tendons in all probability hanging out, bellies of torn muscles protruding, and the vessels exposed, but no hæmorrhage. These wounds are very slow in healing, in consequence of the superficial parts being so disorganised.

In no class of wounds is the effect of antiseptic treatment more marked than in these injuries. In the experience of the writer, sloughing and suppuration is greatly lessened, and tissues that appear quite destroyed recover themselves in a wonderful manner. The injured part should be thoroughly cleansed and purified by one of the stronger solutions, as the chloride of zinc 40 grs. to 1 oz. of water, or the 1-20 carbolic solution, or 1-500 mercuric chloride. The torn tissues should then be replaced in their proper positions, tendons and nerves, if divided, should be united by suture (chromic gut), and the whole covered with folds of the sal alembroth or other antiseptic wool. These dressings should not be removed unless discharge comes through, or some signs of putrefaction show themselves. The writer always inclines to dry absorbent dressings instead of wet if possible.

Wind Balls.—Extensive injuries to internal viscera have been inflicted without any sign of an external lesion ; bones have been broken, and yet no sign on the external skin of contact with any missile. These injuries are produced by what are known as wind balls, which many authorities on gun-shot wounds have endeavoured to explain.

Sir T. Longmore considers that "the true explanation of the appearance presented in those cases which were formerly called wind contusions, appears to rest in the peculiar direction, the degree of obliquity with which the missile has happened to impinge against the elastic skin together with the relative situation of the internal organ injured to the missile, and to other hard substances in the neighbourhood. The surface itself is not directly torn or cut into, because the impact of the projectile has not been sufficiently direct to effect an opening ; but the parts beneath are crushed by the pressure to which they have been subjected between the combined influence of the weight and the momentum of the ball or shot on one side, and of some hard resisting substance on the other. Thus on a cannon ball passing across the abdomen, the elasticity and ready mobility of the skin may enable that structure to yield to the strain to which it is exposed, while viscera are ruptured by the projectile forcing them against the vertebral column. So the weight of a ball passing

obliquely over the forearm, may possibly crush the bone between itself and some hard substance against which the arm may be accidentally resting, without lesion of the interposed skin."

Wounds, whether received directly or indirectly, may be complicated by the entrance of extraneous bodies, such as portions of clothing worn by the wounded, or various articles which may have been about his person.

GUN-SHOT WOUNDS.

How Gun-shot Wounds are Influenced.—Gun-shot wounds may be influenced by the shape and weight of the missile, its velocity, and the structure injured. For instance, a conical bullet will do more injury to a bone and soft parts than a round one of the same weight and fired at the same proportionate distance ; and a hollow conical bullet will cause more damage to the soft parts, periosteum, and bone than a solid one, both being fired under the same circumstances. The position a limb may be in at the time of being struck will influence the direction of the wound ; also a very slight obstacle, such as a button or a coin, and even a tendon in a state of tension has been known to turn the course of a *round* bullet.

The modern bullet is elongated in form and small in diameter, ·303 in., and is fired with a high charge ; it is made up of a casing or envelope containing a core of lead. Some recent experiments have shown that this kind of bullet is apt to break up when it meets with much resistence, such as a bone, for example, would offer. When this occurs, the resulting wound is most serious owing to the great destruction of soft parts beneath the skin, and even the bone itself may be pulverised. On the other hand, if these long narrow bullets when travelling at a high velocity strike a part of the body, they may just pierce the part and pass straight through a bone without causing any splintering, though if the force be at all spent they would then be apt to splinter it badly.

M. Delorme, * Professor at the Val de Gräce, carried out some experiments which yielded very much the same results as those above mentioned. He wished to ascertain whether, as had been alleged by some, that small calibre bullets produced small and trifling wounds as compared with those of larger bullets, or, as stated by others, that they produced much more terrible wounds. He came to the conclusion that the size of the bullet makes but little difference, provided that the velocity with which it is driven is the same. The amount of destruction depends upon the velocity and not upon the size of the bullet. The size of the wound of entrance diminishes as the velocity falls, and increases as the velocity rises, as in short ranges. At 600 yards with the service charge the size of the wound of entrance is in diameter half that of the bullet, the wound of exit is usually a little larger than the wound of entrance. At short ranges, such as 200 or 300 yards, he found what are termed explosive effects, the skin and muscular wounds were very large and the tissues quite disorganised.

* "Communication à l' Académie de Médicine," seance du 29th Mai, 1889.—*Archives de Médicine*, vol. xii.

If the wound of exit was as large as the tip of the little or index finger, it indicated that there was much comminution of bone with loose splinters.

Again, with reference to the bullets made of hardened lead enclosed in a metal covering, M. Delorme found that they could in some instances pierce a limb and shaft of a bone without undergoing any alteration of shape or breaking up, but if the leaden point of the bullet underwent any alteration of shape, from any cause, as striking a bone, &c., its casing at once stripped off, the leaden core breaking up into a number of minute pieces which were widely scattered in the disorganised and broken-up tissues.

Examination of Wounds.—It is of the greatest importance that, on all occasions, strict cleanliness should be observed in the examination of wounds, especially on the battlefield, when the surgeon may inadvertently poison wounds by conveying dirt and blood and other septic matters on his hands. Wounds, therefore, should not be examined or fingered on the field of battle, but only interfered with in cases of hæmorrhage or from some other urgent necessity. The surgeons of the first line of assistance should content themselves with applying some antiseptic covering to the wound to protect it until the patient can reach the dressing station or field hospital, where alone a thorough examination should be made. It must be obvious, upon the least reflection, that any interference with wounds on the field will be liable to render them septic.

Dr. Carl Reyher, in the late Russo-Turkish campaign, insisted "that wounds were never to be examined at the front either with fingers or instruments, nor was any attempt to be made to extract the ball. The only exceptions were in the case of hæmorrhage, and in cases where the projectile had passed through one of the large cavities of the body, and, without wounding the contents, had remained in the wall of the cavity. Here he advised the removal of the ball at once for fear that it might, if left, fall back into the cavity implicated." "For surgeons at the front," he says, "there is only one line of treatment—to occlude the wound provisionally, to lay the wounded part in a suitable position on the litter, and to render it provisionally immovable. As a provisional dressing the salicylic balls recommended by Esmarch are the best." *

On arrival of the patient at the field hospital, a thorough examination must be made. Here the surgeon will have all the needful appliances. If it is a case where a rifle ball has passed through the soft parts without injuring the bone, and there is no reason to suspect that clothing or other foreign matter has been carried in; if the edges of the wound fall fairly together, and if there has been no *previous* examination by fingers or probes, it would be right to abstain from any interference with the bullet track, and to be content with simply purifying the surrounding skin with a carbolic lotion, and then applying a dry antiseptic lint or pad to the wound of entrance and exit, and maintain the same by a good even bandage; accepting here Esmarch's opinion "that rifle bullets passing quickly through the clothes may not carry into the wound any

* *Antiseptic Surgery*, by W. W. Cheyne, F.R.C.S.

causes of putrefaction." Esmarch * also writes, after reading the reports of Reyher and Bergmann in the last Russo-Turkish War, "It is evident, beyond doubt, that a much larger number of the most severe injuries of bones and joints can be aseptically healed under the dry scab than we have ever dared to hope. Even the presence of dirty pieces of clothing in the depth of the wound appears not so very rarely to allow the aseptic process, when the air has been immediately excluded."

Acting upon this experience, supposing a bullet wound to have been treated on the field as above described, and, on arrival of the patient at the field hospital, the dry dressing is found to have become agglutinated to the wound by blood, &c. Should there be no fever, pain, or other pressing symptom, this dressing should be left untouched, even supposing it to be a joint implicated, in the hope that it will heal asceptically under this scab; but measures should be taken to ensure rest and immobilisation, and the attention of the surgeon can then be given to some other wound that will obviously require examination.

Reyher is so impressed with the importance of not "fingering" a wound that he says, "even if there is known to be cloth in it, it should not be examined, but that it should be washed out and attempts made to heal it; if, subsequently, the foreign body does give rise to irritation, it is a far simpler thing to cut down and remove it in the convenience and leisure of a stationary hospital, than to run any risk of contaminating a wound in a field hospital, as all interference in the latter is apt to do."

If, however, the wound is of such a nature as to imperatively demand a digital examination, with a view to deciding upon the proper course of treatment, the sooner this operation can be performed the better.

Before the finger is introduced, it is, of course, to be well washed in the carbolic or other solution. Here it may be remarked that carbolic acid in solution in no way loses its powers, though it may look dirty from repeated use, even though blood be mixed with it. It is by no means necessary that fresh solution should be poured out for each hand-washing, it would be sheer waste to do so, and no field hospital supplies would stand it.

If the wound is too small to readily admit the finger, it should be enlarged, as the size of the external injury will not be any gauge as to the extent of injury inflicted upon the bone or bones.

Sir T. Longmore recommends the following course to be adopted when exploring with the finger:—

"The finger should be inserted slowly and steadily towards the deepest part of the wound. During its passage the surgeon should carefully observe whether any foreign body appears to be pushed before it, or to be lying by the side of the track of the bullet, and should note any other peculiarities of the wound. He should also ascertain whether the end of the track is reached, and if this is found to be arrived at, a careful circular sweep of the finger-end will then usually settle if any, and what, foreign bodies are lodged. The surgeon should not withdraw his finger until the course the projectile has taken, the injury it has done, the complications of the wound, such as the presence of foreign bodies, and,

* *Langenbach's Archiv*, xxiv. April, 1879.

in such a case, their kind and situation, have been decided by him; the exploration will then be completed by one operation, and a second insertion of the finger for the purpose, which is always irritating to the patient, avoided. If the finger be not sufficiently long to reach the bottom of the wound, even when the soft parts have been approximated by pressure from an opposite direction; and when the lodgment of a projectile is still suspected, or some other point of doubt remains to be solved, such as the direction the projectile has taken in the latter part of its course, we are compelled to make a further exploration by other means. Generally, a long silver probe, that can be bent if required, and that can be guided into a definite direction at the will of the surgeon, will be found to be the best substitute for the finger. The probe should be used with great discretion, for, without care, it may readily be made to inflict injury on vessels and other structures which have escaped from direct contact with the ball, but have returned by their elasticity to the situation from which they had been pushed or drawn aside during its passage.

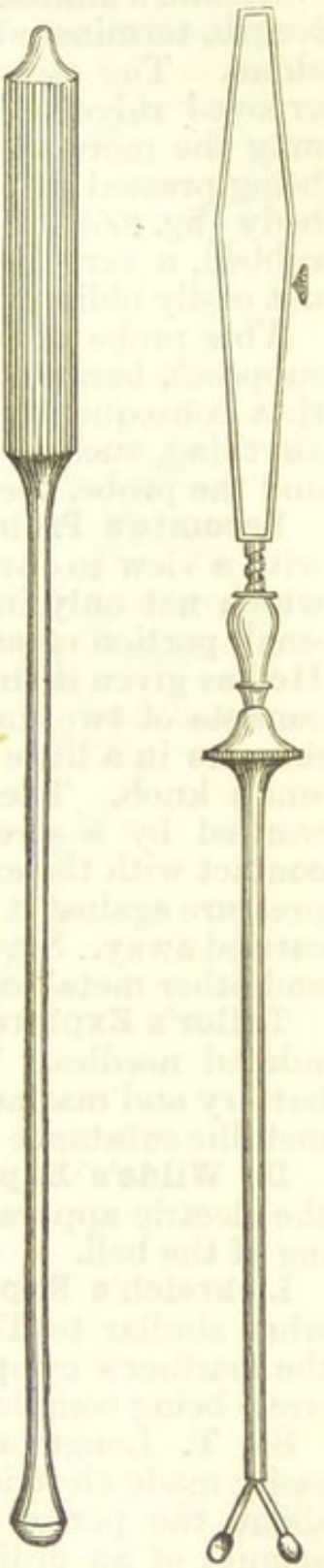


Fig. 66. Fig. 67.

"Sometimes, when the finger in the wound fails to find a lodged projectile, the particular spot in which it is lying may be detected simply by relaxing the muscular tissues, so as to give a loose and pendulous condition to the parts concerned, and then lightly tossing up the flesh at different points from below with the tips of the fingers. A bullet lodged among the soft parts will occasionally make its presence known under such an action by the impulse which its weight communicates to the top of one of the fingers when the parts, having been shaken upwards, return to their previous position. Sometimes a gentle kneading pressure in the neighbourhood of the injury, assisted by information derived from the sensation of the patient, will lead to the detection of such a foreign body; or it may be discovered by passing the palm of the hand down a limb.

"Cases in which the exploration by the surgeon's finger is altogether impracticable, and in which the use of the probe is attended with so many sources of doubt as to prevent any satisfactory conclusion in respect to the lodgment or absence of foreign bodies from being arrived at, occasionally occur." Much trouble and inconvenience will then be experienced unless the surgeon is in possession of some of the contrivances for clearing up these doubts.

Nélaton's Probe.—M. Nélaton designed a probe for ascertaining the nature of the foreign body impacted in the bone of one of General Garibaldi's ankles. It consists of a slender rod of metal 5 or 6 inches in length, terminated at one end by a small knob of white, unglazed biscuit china. The other end of the probe is furnished with a small handle, grooved ridge-and-furrow fashion, in order that the finger and thumb may the more easily roll it between them, while the porcelain knob is being pressed at the bottom of the wound against the suspected foreign body (fig. 66). If it be a leaden bullet against which the porcelain is rubbed, a very distinct mark of lead is impressed on the latter, which is not easily obliterated.

This probe of M. Nélaton's may possibly deceive the surgeon, if he supposes, because no dark mark has been produced on the biscuit china, that consequently there is no bullet, as in the event of there being anything, such as pieces of cloth, paper, linen, or membrane, between it and the probe, there will be no leaden mark.

Lecomte's Probe.—Dr. Lecomte has designed an instrument (fig. 67) with a view to obviate the difficulties experienced with Nélaton's probe, which not only indicates the presence of lead, but by bringing away a small portion of anything capable of being cut into, declares what it is. He has given it the name of the "Probe Nippers" ("Stylet Pince"). It consists of two fine steel blades enclosed in a canula; each blade terminates in a little cup, and when both are brought together they form a small knob. These blades are in connection with a rod and handle worked by a screw. When the knob of the probe is brought into contact with the extraneous substance, it is caused to open, and then, by pressure against it and causing the little blades to close, a small portion is carried away. Several instruments have been designed for detecting lead and other metallic substances by means of electricity.

Tailor's Explorer.—Mr. Tailor's electric explorer consists of two insulated needles. They are connected by wires with a small galvanic battery and mariner's compass. When the points of the needles touch the metallic substance the needle of the compass is deflected.

De Wilde's Explorer.—Mr. De Wilde has adapted a telegraph bell to the electric apparatus, which denotes the presence of metal by the sounding of the bell.

Liebreich's Explorer.—Liebreich has designed an instrument somewhat similar to Tailor's, except that a galvanometer is substituted for the mariner's compass, the needle of which is deflected on the electric circle being completed.

Sir T. Longmore exhibits to his class (R. V. Hospital, Netley) an easily made electric instrument (fig. 68), so portable that it can be carried about the person of the surgeon. He describes it as follows:—The magnet of an ordinary pocket compass, which has had some turns of wire covered with thread wound round it as an induction coil, is employed for the electric indicator, while a piece of zinc sheeting bent round a small plate of copper, but separated from it by flannel padding saturated with the usual diluted acids, forms the voltaic pile. The exploring nstrument is formed by two insulated wires bound together,

but the points left free. These parts being connected, when the circuit is completed by contact with metal, the indication is given by movement of the magnet of the compass.

Extraction of Bullets and other Missiles.—For the extraction of

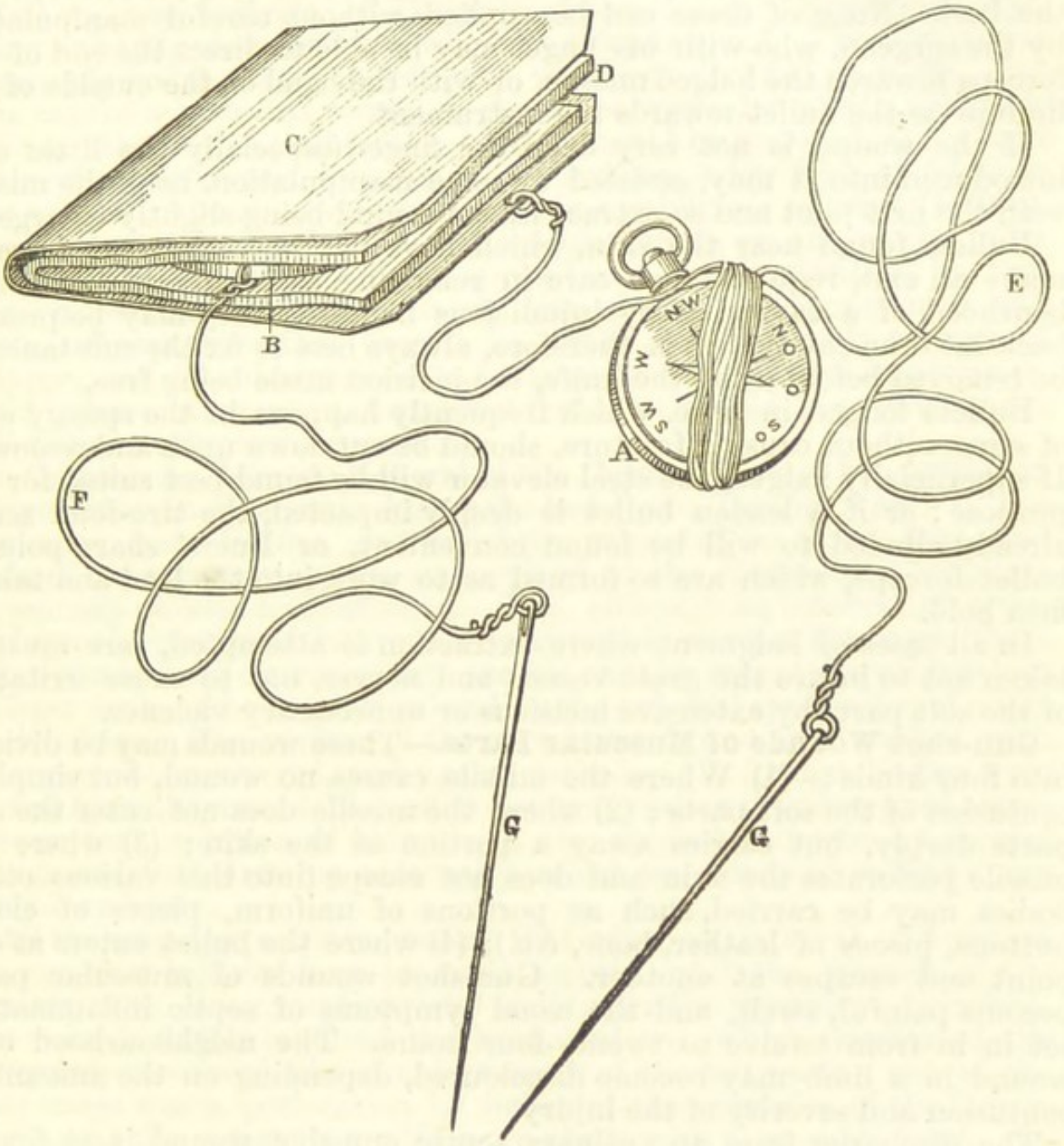


Fig. 68.

A, Pocket compass; B, Copper sheeting (a penny piece will answer); C, Plate of zinc; D, Flannel saturated with dilute acid; E and F, Insulated wires; G, Exploring needles.

bullets, fragments of shells, or other extraneous matters, various instruments have been devised. Coxetor's extractor has been found most useful for this purpose. Also a long and strong forceps with spoon-like blades, into which a bullet is supposed to slip. There is also the "tire-

fond screw," and Luers' sharp-pointed forceps; and innumerable forceps designed to suit the fancies of military surgeons. Billroth speaks in favour of the American bullet forceps, its peculiarity being that it can be well opened even in the narrowest canals, and that it catches securely; he finds that long strong ear or nose-forceps and polypus forceps are the best. None of these can be applied without careful manipulation by the surgeon, who with his finger may be able to direct the end of the forceps towards the lodged missile, or with the hand on the outside of the limb press the bullet towards the instrument.

If the wound is not very deep, the finger (especially the little one) introduced into it may, assisted by some manipulation, hook the missile with the first joint and so extract it, the wound being slightly enlarged.

Bullets found near the skin, which have not had sufficient force to make an exit, require much care in removing, especially in the neighbourhood of a cavity, as by injudicious handling they may be pressed back into the cavity. It is, therefore, always best to fix the substance to be removed before using the knife, the incision made being free.

Bullets lodged in bone, which frequently happens in the spongy ends of some without causing fracture, should be cut down upon and removed. If superficially lodged, the steel elevator will be found best suited for the purpose; or if a leaden bullet is deeply impacted, the tire-fond screw already alluded to will be found convenient, or Luers' sharp-pointed bullet forceps, which are so formed as to work into the lead and take a firm hold.

In all cases of lodgment where extraction is attempted, care must be taken not to injure the great vessels and nerves, nor to cause irritation of the soft parts by extensive incisions or unnecessary violence.

Gun-shot Wounds of Muscular Parts.—These wounds may be divided into four kinds:—(1) Where the missile causes no wound, but simply a contusion of the soft parts; (2) where the missile does not enter the soft parts deeply, but carries away a portion of the skin; (3) where the missile perforates the skin and does not escape (into this various other bodies may be carried, such as portions of uniform, pieces of cloth, buttons, pieces of leather, bone, &c.); (4) where the bullet enters at one point and escapes at another. Gun-shot wounds of muscular parts become painful, swell, and the usual symptoms of septic inflammation set in in from twelve to twenty-four hours. The neighbourhood of a wound in a limb may become discoloured, depending on the amount of contusion and severity of the injury.

The discharge from an ordinary septic gun-shot wound is at first a reddish fluid; after a day or so it becomes darker and thicker; but much will depend on the amount of sloughing likely to take place, as if the parts are much bruised or burnt, which latter condition sometimes occurs from close shots, the character of the discharge will be modified, and separation of the dead from the living parts will be longer delayed. Following the separation, there will be discharge of purulent matter, which gradually diminishes. As the wound fills with granulation, this discharge may continue for an indefinite period, in consequence of retention in the wound of some foreign body, such as a piece of clothing

or a splinter. It is, therefore, necessary at each dressing to make a most careful inspection of the wound, and remove anything which the introduction of a probe may detect.

The treatment must be conducted on general principles, and the remarks made on contused and lacerated wounds have an especial bearing on these injuries. "The fate of the soldier," Nussbaum says, "is in the hands of the surgeon who first attends him." The best course for a simple bullet wound in soft parts will be as directed on p. 59. But in the case of a lacerated wound, it should be washed out with a chloride of zinc or other lotion ; all foreign matter should be removed, and a light dry absorbent antiseptic dressing, as, for instance, a few folds of iodoform gauze which had been previously dipped in a sublimate solution (1-4000), and well covered over by folds of sal alembroth, or one of the other prepared lints or wools, should be applied and kept in position by firm but even bandaging, and as much rest given as circumstances will permit. Great attention should be given to the ready escape of discharge, and free drainage is to be considered of the first importance. Should inflammation set in, warm wet boric lint should be applied under an oil-silk or guttapercha covering.

Dr. Cammerer, Surgeon-General of the German Army, has published his experiences in Roumania during the last Russo-Turkish war.* "The cases came from Plevna, and had been subjected to three, four, and five days' previous transport, and arrived at the Roumanian hospitals with wounds swollen and inflamed. Yet, although an interval of seven days from the receipt of injury had occurred in most of the cases, these septic wounds were converted into aseptic ones by repeated washings out with 5 per cent. carbolic solution, and by the external application of moist jute dressings. The surface of the part injured was first washed with soap and carbolic, shaved, and again washed. All foreign bodies were removed from the wound, ill-conditioned granulation tissue scraped away, the 8 per cent. solution of chloride of zinc applied, followed by careful drainage and jute dressing externally, which was renewed at first every twenty-four hours.

"All the surgeons unite in stating that after an interval of fourteen days gun-shot injuries may be made aseptic. All the wounds of the soft parts, with few exceptions, did well under the treatment described. Three wounds which involved the knee, and two which implicated the elbow-joint, recovered like simple wounds of the soft parts ; one of the former cases was a perforation by bullet of the condyles of the femur. In six weeks the patient was able to go about with a movable joint. In a second instance, the bullet remained lodged in the bone, but the patient recovered in a month with a movable knee-joint. The third made a similar recovery after a transverse wound through the synovial pouch. The treatment consisted in making free incisions into the articulation, washing it out with strong carbolic solution and applying moist jute."

In the German Military Hospital at Belgrade, in 1886, Dr. Fränkel was able, by the aid of antiseptics (iodoform, corrosive sublimate, and carbolic acid), to carry out conservative treatment with most brilliant

*MacCormac's *Antiseptic Surgery*.

results. Out of one hundred and fourteen gun-shot fractures (many involving the larger joints) not one required amputation, and the writer strongly urges in all such injuries the use of antiseptics, with partial resection if required, in preference to major operations.*

This experience would urge the necessity of trying to render wounds aseptic after the patients reach the field hospitals, even if the first dressings have been imperfect, as they are likely to be should the number of wounded be great, and the interval prolonged between the time of injury and arrival of the wounded at the field hospitals.

Bayonet, Lance, Sword, and Arrow Wounds.—Bayonet and lance wounds come under the head of punctured wounds; sword, of incised; and arrow wounds as a combination of lacerated and punctured. The latter only will be considered here, as the former have been already alluded to.

Arrow wounds are not likely to be met with in warfare between civilised countries, but arrows are still in use among savage tribes, and as the army or naval surgeon might be called upon to exercise his skill in the treatment of such wounds, the following information may be found useful.

Mr. Hamilton describes the point of entrance of an arrow as being "indicated by a narrow slit, the margins of which are slightly discoloured, resembling very much the wound made by a small ball. The wound of exit resembles the wound of entrance, except that it is not discoloured, and is somewhat larger." He continues, "Suppuration can seldom be avoided. Profuse hæmorrhage, extensive abscesses, empyema, and tetanus are among the most frequent complications of these accidents, when only the external or fleshy portions of the body are implicated."

The great difficulty to be overcome in the treatment is to remove an arrow which has lodged without leaving its head.

"If the arrow has passed nearly through, so that its point can be felt upon the opposite side, the surgeon should cut down upon it by a counter incision, and extract it by that route, as suggested by Larrey; and in order to facilitate its removal in this direction, he may, as soon as the head of the arrow is withdrawn, and the end of the shaft to which it is attached can be seized by the forceps, cut off the opposite end of the shaft close to the skin by a pair of bone nippers; or if he finds the head and the shaft separated, he may withdraw the shaft on the one side and the head on the other, taking care, however, that the tendinous string (a string which attaches head to shaft) is brought out with the head, otherwise it may be left in the track of the wound. The same practice may sometimes be adopted—namely, making a counter incision to reach the head, even though the head is not felt, provided the surgeon can determine the length of the shaft, and consequently the probable position of the head.

"An arrow having penetrated bone, an attempt should first be made to extract it by rocking it to and fro in a direction at right angles with the plane of the groove which is made on the outer or feathered end of the shaft."

* *International Journal of Medical Sciences*, vol. ii., p. 553. 1886.

In the treatment of arrow wounds, the first indication is to withdraw the extraneous substance, and then, bleeding having been arrested, thoroughly disinfect the track, provide sufficient drainage, and so try and prevent the occurrence of septic inflammation. Long and deep incisions will often be necessary to effect dislodgment, especially if the arrow is impacted in the head of the bone, or buried at considerable depth among the muscles and aponeuroses. The best probe for ascertaining its situation is the finger.

Full anodynes should be given to prevent nervous distress and severe pain.

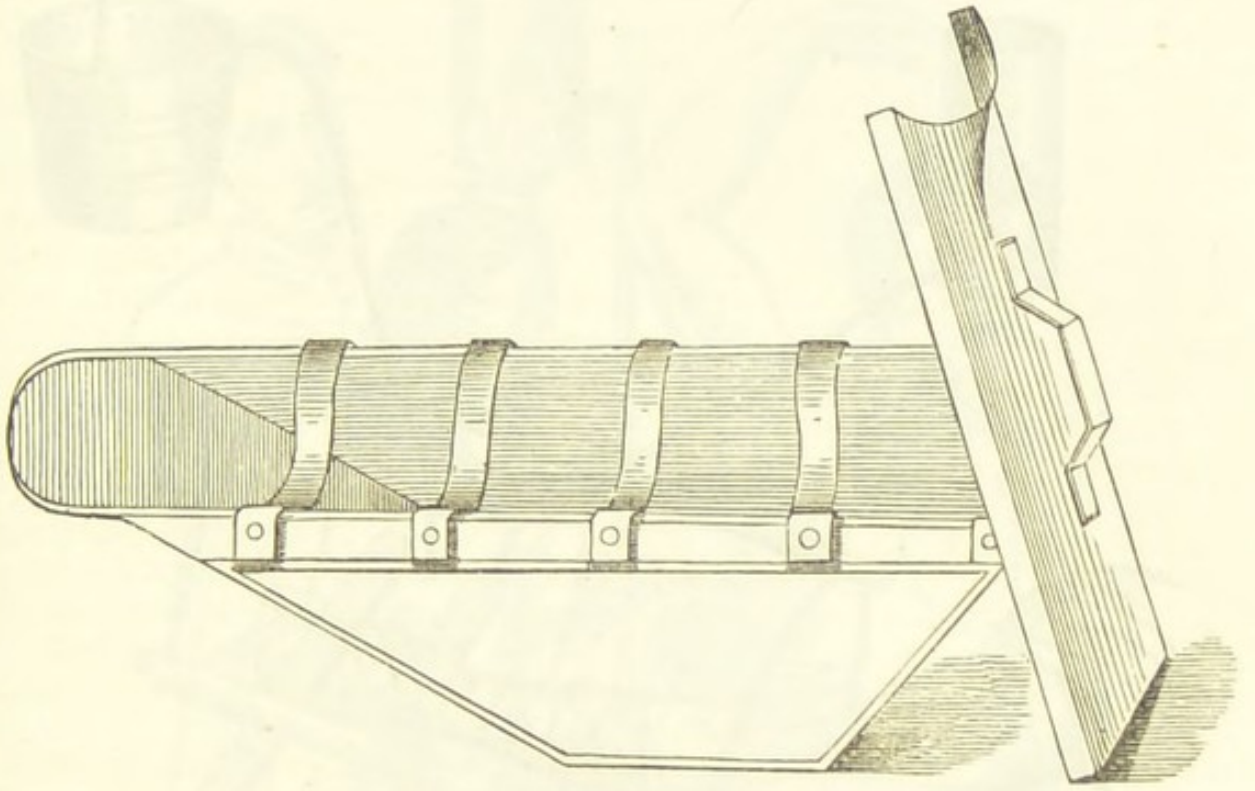


Fig. 69.—Foot Bath.

The Use of Bandages.—Hamilton, of the U.S.A., remarks:—"No part of the dressing of a gun-shot wound has more value, when judiciously employed, than a roller. At the same time, nothing is capable of doing more harm. If a roller is carefully applied to the limb at an early period,

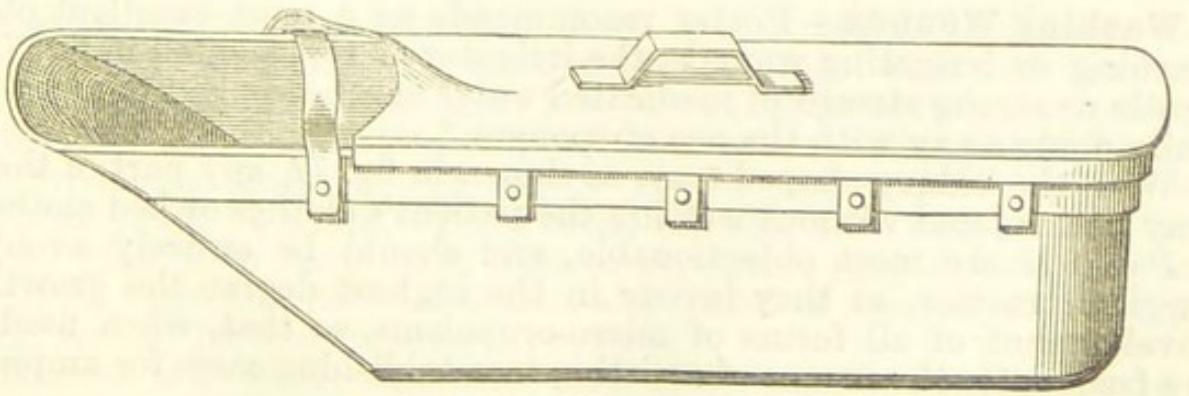


Fig. 70.—Arm Bath.

much of the bleeding is prevented, and most of the blood which does escape flows out freely from the orifices, which are left open purposely; and thus we are apprised not only of the amount of bleeding, but those extensive intermuscular extravasations are avoided."

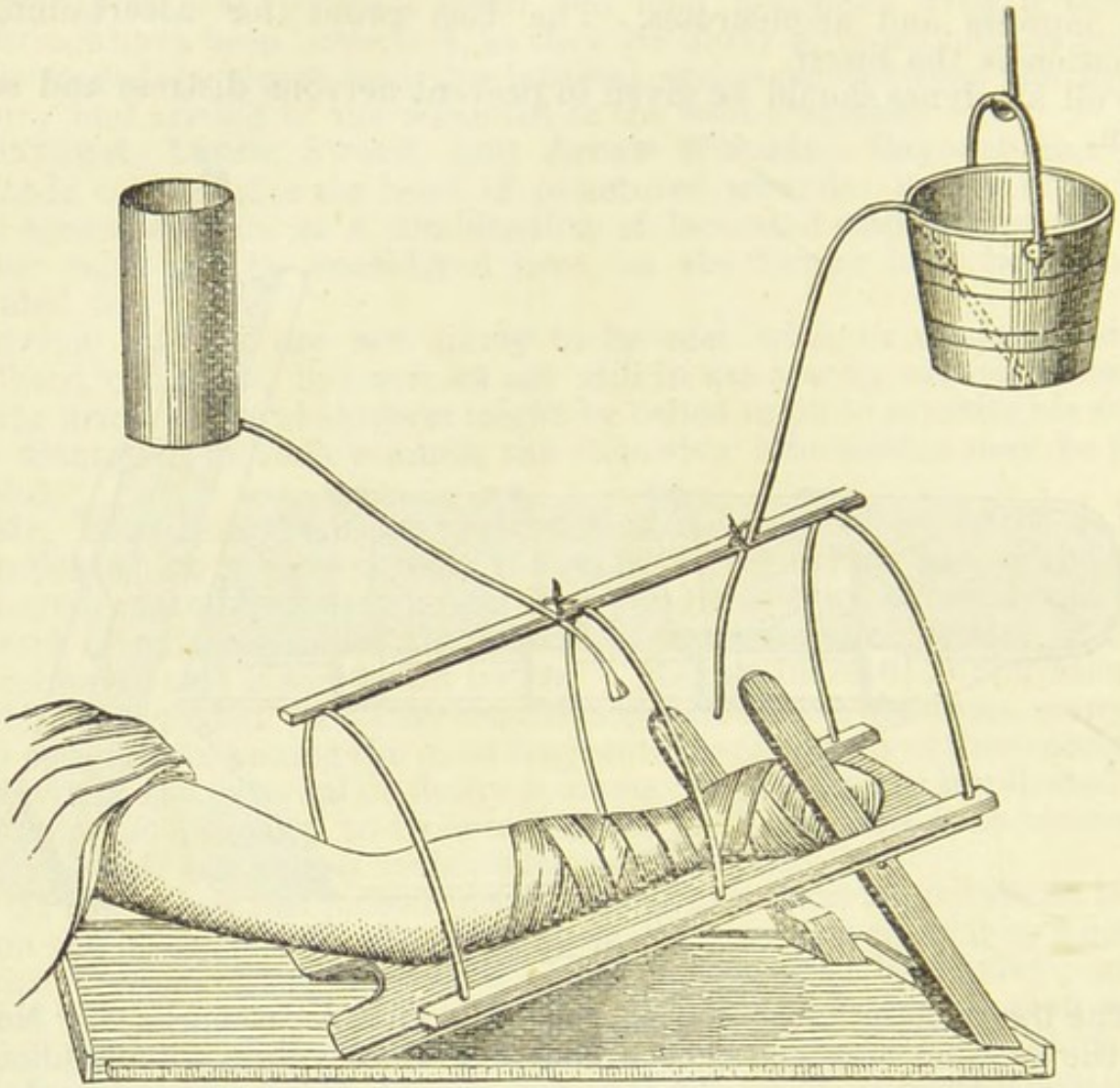


Fig. 71.

Washing Wounds.—Porter recommends as a most excellent plan for washing or irrigating wounds, the irrigator as represented in fig. 72. A gentle or strong stream of medicated water can be applied to any wound, quite doing away with the use of sponges.*

With the kidney-shaped tray, as shown in fig. 72, any part of the body may be irrigated without wetting the patient's clothes or bed clothes.

Poultices are most objectionable, and should be entirely avoided in surgical practice, as they favour in the highest degree the growth and development of all forms of micro-organisms, so that, when used, they are frequently the means of assisting in establishing cases for amputation

* This plan of irrigation was seen by the writer in the German hospitals, Versailles, during the Franco-German war, 1870-71.

which might otherwise have turned out favourably, if not indirectly the cause of a fatal pyæmia.

Constitutional Treatment.—The constitution frequently requires looking after, and every effort should be made to increase the force of vitality by suitable medical and dietetic means, so that the system may throw off and get rid of any pathogenic micro-organisms that may gain access to the wounded part.

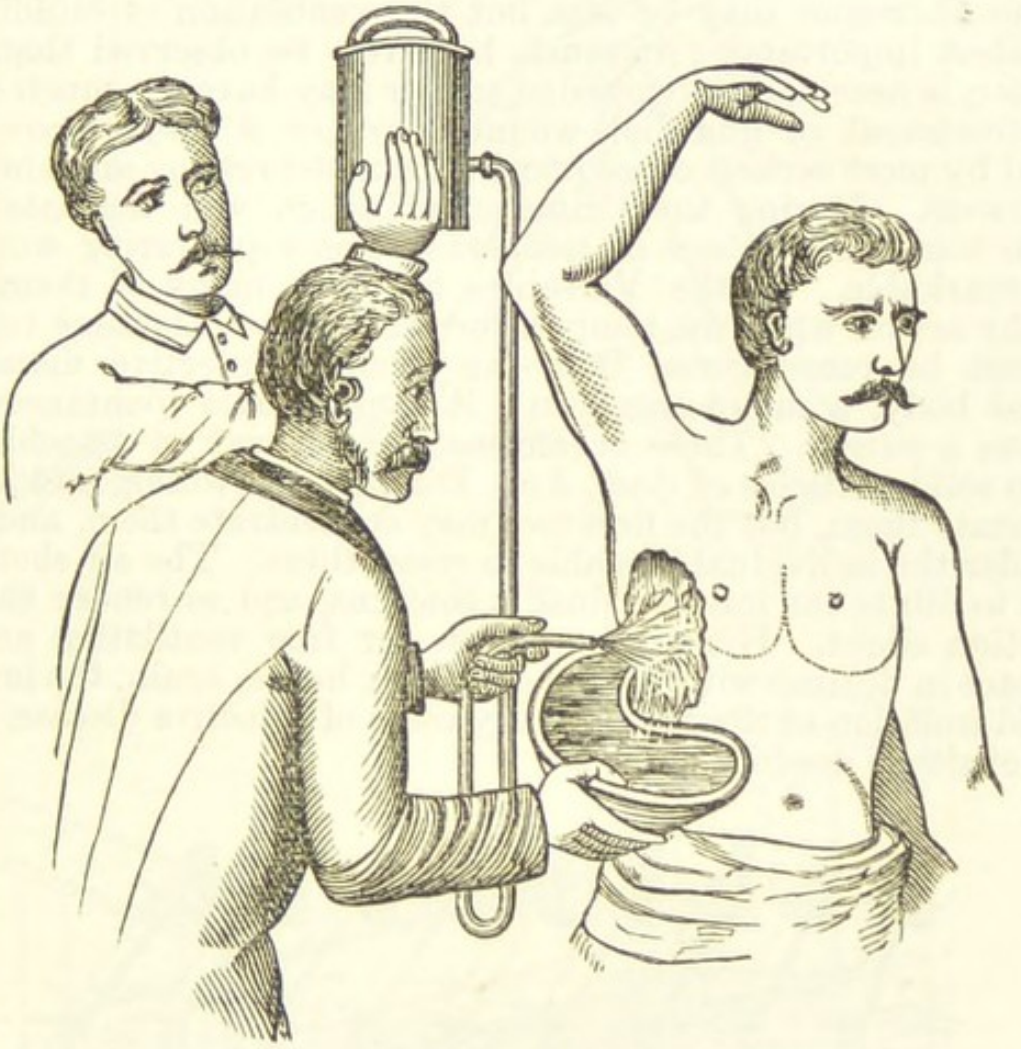


Fig. 72.

Cases in which there has been much loss of blood, besides previous exposure and fatigue, require most careful feeding. It is well to remember that "beef-tea as a food ranks low, there is little in it to repair tissues, and less in it to sustain life. It falls far below milk, which furnishes force-producing material. If biscuit-powder and a little butter, with pepper and salt, be added, or fine bread-crumbs, then beef-tea is a food." A good plan is to have some sago or arrowroot jelly already prepared, and then, when the beef-tea is hot, a spoonful of the jelly can easily be added, and no further cooking is required.

"Alcohol is a readily-oxidisable form of hydrocarbon, and is one of the most easily assimilable forms of food as well as a stimulant, and very frequently it can be taken and utilised when no other form of food is

available It thus differs from other stimulants, as ammonia or ether, which are not foods, and their administration must be accompanied by food and alcohol."—*Fothergill.*

Sanitary Treatment.—The surgeon should observe strict sanitary precautions about the patient's person, bedding, and clothing, and, when it is possible, ample *cubic space* should be given to each person; wounded men require at least 1,200 feet each in buildings. In huts and tents the allowance may be less, but the ventilation of buildings is of the greatest importance; it must, however, be observed that, though ventilation is necessary, a wounded soldier may have too much of it, and in the treatment of gun-shot wounds *too low a temperature* may be attended by most serious consequences, from depressing and lowering the vital powers. During the Crimean campaign and the late Franco-Prussian war, the influence of temperature on suppurating wounds was most remarkable. In the Versailles hospitals many of them took an unhealthy action when the temperature of the wards became very low.

It must be remembered that the virus of infective disease is an organised body, a micro-organism; it cannot arise spontaneously, but only from a parent. These organisms have a way of attaching themselves to solid particles of dust, &c. Dirt, overcrowding, and hunger do not generate them, but the first two may concentrate them, and the last will render the individual less able to resist them. The air should be so fresh as to dilute the infected dust it contains, and so render the chance of infection slight. Hence the reason for free ventilation and ample cubic space in dealing with wound diseases; hence, again, the importance of a rigid isolation of the first or early cases of infective disease, even if a change of site is needed.

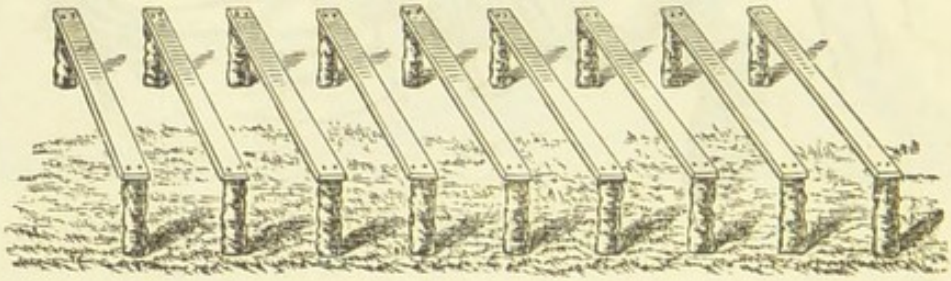


Fig. 73.

Extemporised Bedsteads.—Bedsteads are most essential for the comfort and protection of patients; they may be improvised as already shown by figs. 16 and 17, or by two rows of stakes driven into the ground, rising 14 inches above the surface, and standing 10 inches asunder (fig. 73). The width of the frame must be determined by the bedding, and the number of stakes by the necessary length. Simple trestles made up of rough wood serve well to rest stretchers upon (see fig. 74), and convenient cots can be easily constructed from rough packing-case wood, &c. (*vide* fig. 75).

Extemporised mattresses may be made with blankets or sheets stitched

together, so as to form a bag, and filled with straw, hay, dried leaves, ferns, hair, torn-up paper, or shavings of wood. Neudôrfer strongly recommends fine wood shavings as being soft and elastic.

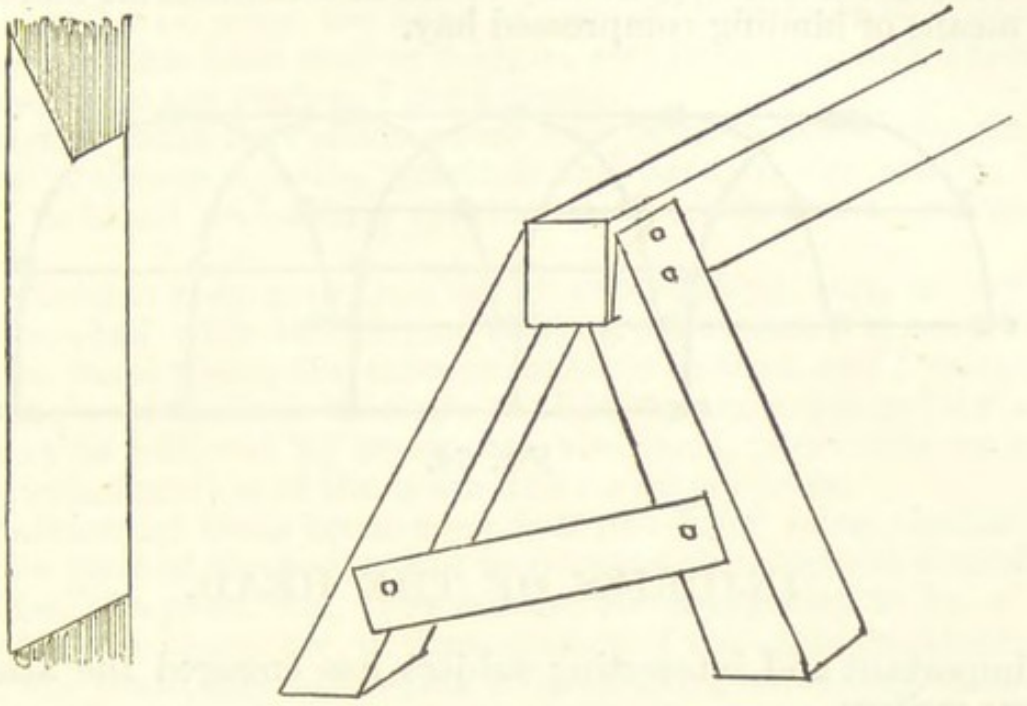


Fig. 74.

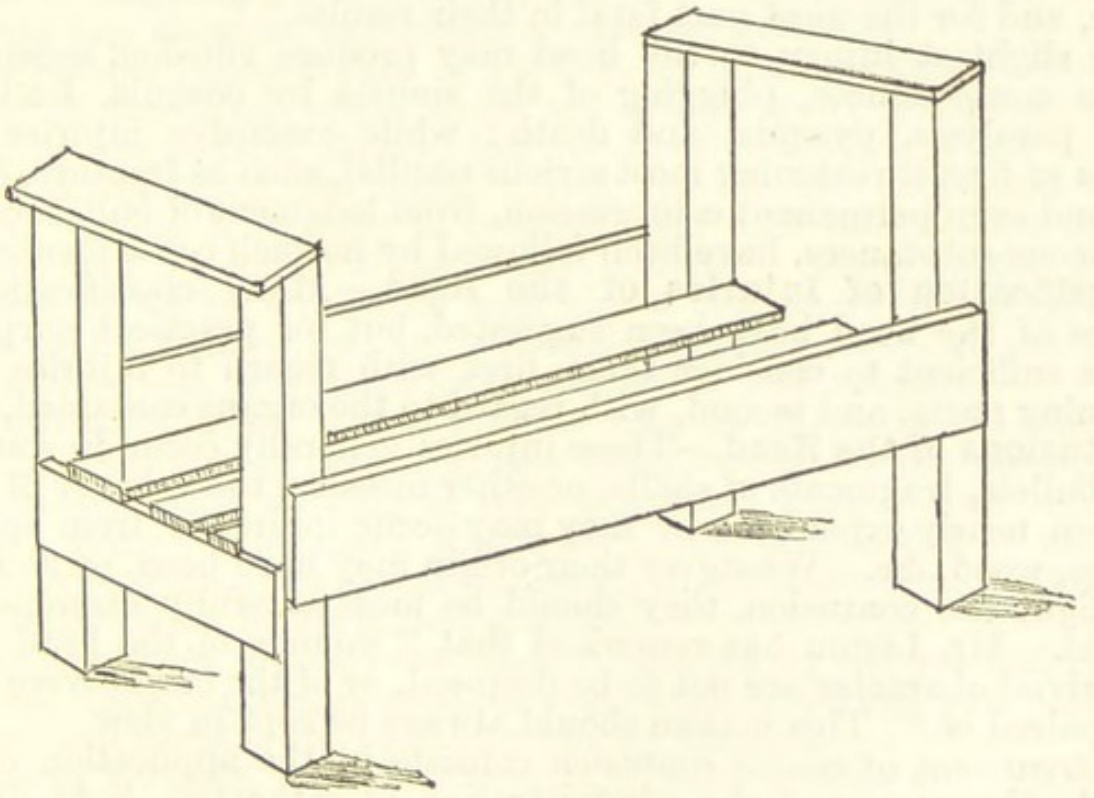


Fig. 75.

Extemporised bed cradles for the protection of wounded limbs from the weight of bed clothes, or as a means for supporting gauze to prevent the

invasion of flies, or in the adaptation of tubes for irrigation (see fig. 71), are most important as part of hospital equipment. They may be constructed from hoops of small barrels, split bamboo, telegraph wire (fig. 76), or from metal bands, generally found in commissariat stores, having been a means of binding compressed hay.

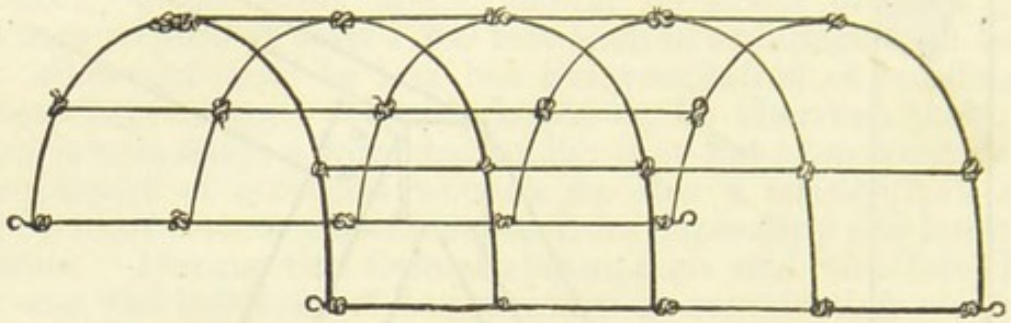


Fig. 76.

INJURIES OF THE HEAD.

This important and interesting subject has engaged the attention of numerous writers.

Mr. Guthrie remarks: "Injuries of the head affecting the brain are difficult of diagnosis, doubtful in their character, treacherous in their course, and for the most part fatal in their results." *

The slightest injury to the head may produce effusion, encephalitis and its consequences, plugging of the sinuses by coagula, leading to coma, paralysis, pyæmia, and death; while extensive injuries (their aspects at first threatening most serious results), such as fracture, depression, and even permanent compression, from lodgment of bullets or other extraneous substances, have been followed by no such consequences.

Classification of Injuries of the Head.—Many classifications of injuries of the head have been suggested, but for practical purposes it will be sufficient to consider them first, with regard to injuries of the containing parts, and second, with regard to the organs contained.

Contusions of the Head.—These injuries generally occur in war from spent bullets, fragments of shells, or other missiles, the velocity of which has been nearly expended; or they may occur indirectly from splinters of stone, wood, &c. Whatever their origin may have been, or no matter how slight the contusion, they should be most carefully examined and watched. Mr. Liston has remarked that "wounds of the head of the most trivial character are not to be despised, or of the most severe not to be despaired of." This maxim should always be kept in view.

The treatment of simple contusion consists in the application of cold water to the part, and the administration of cathartics, light diet, no stimulants, and most perfect quietness.

Severe contusions, accompanied by swelling due to blood effusion, are

* *Commentaries*, p. 286. London, 1853.

sometimes difficult to distinguish from depressed fracture, the centre of both giving to the hand a hollow or depresssed feeling. To the inexperienced these bloody tumours are a source of great perplexity, but they will be in general distinguished by their having a well-defined margin or wall, and when the hand is passed over from the sound part, it will first feel this hard wall or margin, and then suddenly experience a soft depression in the centre of the tumour.

In a fracture with depression there will be *no* defined margin or soft centre, the depression being gradual and hard to the touch; besides, there will be in all probability symptoms of compression accompanying the injury.

These effusions may give trouble by suppurating, but, as a rule, they become absorbed with the use of cold applications. When, however, suppuration takes place, the tumour must be incised, and free exit made for the escape of matter. Severe contusion, accompanied by an open wound, may be followed by erysipelas, abscesses, periostitis, or necrosis, as well as inflammation of the brain and its membranes.

The treatment of these contusions does not differ from similar injuries in any other part of the body; but to prevent the common complications of erysipelas, abscesses, &c., they require the treatment to be of a most careful antiseptic character, in consequence of the close proximity of the brain and the possibility of a septic inflammation extending to it.

Contused Wounds, with Fracture of the Cranium, without Depression.—These injuries but seldom occur, and, as regards the fracture, are difficult of diagnosis; a fissure through both tables may exist, without producing any alarming symptoms or external evidence.

Mr. Erichsen (*Lancet*, Jan. 5, 1878, p. 2) mentions that in blows on the side of the head where there are symptoms of compression and bulging at the seat of injury, the result of a fissure in the cranium through which blood has come, giving rise to the projection of the temporal muscle, it is right to trephine, and that the position selected should be over the course of the middle meningeal artery, which may be discovered by taking a point an inch and a half above the zygoma and an inch and a half behind the external angular process of the frontal bone; where these two points meet, the artery will be found.

Furrowing of Outer Table.—There may be furrowing of the outer table without injury to the inner, this being caused by the passage of a ball across the skull, striking in such a position that it does not enter, in fact, a graze of the bone, which, as a rule, is followed by most unpleasant symptoms, such as inflammation, if not laceration, of the brain and its membranes, necrosis, and abscess.

In the treatment the surgeon must be guided by the amount of constitutional disturbance and cerebral symptoms, applying local antiseptic remedies, and keeping the patient perfectly tranquil.

Contused Wounds, with Depression.—These injuries are, as a rule, so connected with the consideration of compression, that it is scarcely necessary to touch on the subject here. It may, however, be stated that patients have recovered from such injuries without the depression being elevated.

Sir A. Cooper, Abernethy, and Dupuytren, recommended that if the depression did not produce symptoms of compression, it was best not to interfere. Sir William MacCormac remarks on this subject: "One point, regarding which opinions vary somewhat, is respecting the treatment of depressed fracture unaccompanied by symptoms, and with an external wound. Where there is no wound, he would be a hardy operator who should cut down upon a depression in the skull, in the absence of any symptoms of compression. When there is a wound, however, the case is different; but even here I question much if the surgeon ought to do more than simply remove such loose fragments as can readily be got at."

On the other hand, Mr. Victor Horsley, whose opinion must be received with the greatest respect, says:* "In depressed fracture of the skull, I wish to urge in the most emphatic manner the necessity of operating upon every such case, whether or not accompanied by an external wound of the soft parts or by immediate symptoms of gravity. It is just these cases when let alone, and particularly where the injury has been received early in life, that the future will almost certainly bring with it not only epilepsy, but also mental defect, persistent loss of memory, and, in fact, general deterioration."

Penetrating Wounds of the Cranium generally prove fatal; but instances have occurred of recovery when the bullet or other missile has been surrounded by lymph, and the brain has become accustomed to its presence. In punctured fractures of the cranium, the operation of trephining, undertaken with the object of removing the broken and displaced fragments of bone should as a rule of practice never be deviated from.†

Fracture of both Tables.—There may be comminuted fracture of both tables, without producing the slightest symptom of compression, the bone having been broken into such small pieces that they rest loosely on the dura mater, and cause no cerebral symptoms.

Fracture from Contre-Coup.—This accident, causing a fissure of the parietal bone, or fracture at the base of the skull, where it is most common, is of rare occurrence in the army. Out of 12,980 injuries of the head during the American War of the Rebellion, there were only two cases recorded of this peculiar injury. The fracture is accounted for by a heavy blow being struck against a hard resisting part of the skull, and the shock transmitted, causing the thinnest and most brittle portion, though at some distance, to give way. This fracture is never depressed, and is very difficult to recognise. In some instances it has been diagnosed by a sensation of crepitus being given to the hand when the head has been gently moved.

The treatment should be entirely constitutional, according to gravity of symptoms, the head being placed on a soft pillow.

Fracture of the Base of the Skull.—A fall from a height, or a blow on the vertex or side of the head, may produce this description of

* *Surgery of the Central Nervous System*, by Victor Horsley. Berlin, 1890.
† Bryant's Lectures, *Lancet*, Sept. 15, 1888, p. 509.

fracture, which usually extends from the point struck across the base of the skull, not unfrequently running through the petrous portion of the temporal bone or into the foramen magnum. This is a most serious accident, and very commonly attended by fatal results; still, there are instances of persons having lived for a considerable period after such injuries. Writers on this subject have endeavoured to lay down rules or particular signs and symptoms for certain seats of fracture in the base of the skull, but, unfortunately, such definite information does not help one in the treatment; it may, however, assist the surgeon in forming his diagnosis.

A fissure extending through the *anterior fossa* may be accompanied by extravasation of blood into the orbit or eyelid, or there may be free hæmorrhage from the nose.

Should the *middle fossa* be implicated, there will very likely be fracture through the petrous portion of the temporal bone, with injury to the tympanum; there will then be a discharge of blood or serum from the ears.

When the *posterior fossa* has been fissured, there may be some difficulty in distinguishing the exact nature of the accident, unless the fracture passes through the petrous portion, and then there will be the characteristic signs of such an injury.

Mr. Erichsen considers that "there are two signs, the occurrence of which, separately or together, leads to strong presumptive evidence in favour of the existence of this kind of fracture. These are, first, the escape of blood from the interior of the cranium through the ear, nose, or into the orbit; and secondly, the discharge of a serous fluid from the ears, and occasionally from other parts in connection with the base of the skull." He further says: "Bleeding from one or both ears after an injury of the head may arise from any violence by which the tympanum is ruptured, without the skull being necessarily fractured. If, however, the hæmorrhage be considerable, trickling slowly out of the meatus in a continued stream, if the blood in the external ear pulsates, and more especially if the bleeding be associated with other symptoms indicative of serious mischief within the head, and if it have been occasioned by a degree of violence sufficient to fracture the skull, we may look upon its supervention as a strong presumption that a fracture of the base of the skull, extending into the petrous portion of the temporal bone, has taken place.

"Hæmorrhage into the connective tissue of the orbit and eyelid, with possibly protrusion of the eyeball itself, accompanies fracture of the orbital plate of the frontal bone. The ecchymosis that occurs in these cases arises from the filtration of the blood from the interior of the skull, through the fracture, into the loose connective tissue contiguous to the injured bone. It differs remarkably in appearance from that resulting from a direct blow upon the eyelid—from a 'black eye.' In the latter case there is bruising of the skin, and the ecchymosis is in a great measure cutaneous of a reddish-purple colour. In the ecchymosis from fracture, the hæmorrhage is entirely subcutaneous. There is probably no bruising of the eyelid, but this is tense, greatly swollen, and of a

purple colour. The extravasation can clearly be seen not to be in the skin, but to shine through it."

The discharge of serum from the nose or ear, which in the latter "wells up" as quickly as it is removed, and may flow to the amount of several ounces, is generally admitted as a certain sign of fracture of the base of the skull.

Scalp wounds frequently occur to artillerymen by being thrown off the gun carriage when going very fast. When such accidents occur, the wound should be treated antiseptically. The hair should be shaved and the torn scalp should be thoroughly purified with a 1 to 20 carbolic solution, allowing the solution to go into all parts of the wound, whether the membranes or brain substance be exposed or not, the parts should then be brought together by wire sutures if necessary, and drainage tubes must also be inserted. The wound should now be covered with some dry absorbent dressing as sal alembroth wool, boric, or salicylated lint, over which is put a layer of cotton wool, the whole being kept in place by a good bandage. The dressing should not be changed oftener than is absolutely required. Care should be taken to evacuate any abscesses that may form at an early period by adequate incisions.

Sabre wounds on the top of the head are not by any means so dangerous as those on the side. Sabre cuts will generally admit of being at once replaced, and in many instances, with the aid of a few stitches and proper supporting bandage, they adhere without further trouble. With section of scalp, cranium, and even brain, from a sabre, recovery may take place.

Injuries of the head affecting the brain have been divided into injuries from concussion and injuries from compression or irritation of the brain.

Concussion appears to be a shock communicated to the nervous system, in consequence of some external injury or violence producing disturbance, if not positive injury, such as laceration of the substance of the brain itself. The functions of the brain may be temporarily suspended, insensibility being slight and transitory, or it may be prolonged for several hours, or the patient may sink without recovering consciousness.

The symptoms and signs of concussion are influenced by the extent of the injury to the brain. When very slight, the feelings may be only faintness, giddiness, or mental confusion; but when the injury is severe there will he insensibility, and the surface of the body will be cold and pale; the sufferer, when spoken to in a loud tone, may answer in an incoherent manner, falling again into a state of semi-unconsciousness; muscular power is lost, the pulse feeble, the bladder and bowels act involuntarily, the pupils are contracted, breathing appears to have ceased, circulation has been suspended. This condition may last for a few minutes or hours, and is the first stage; its duration depends on the severity of the shock. In the second stage stupefaction continues, though the patient may be cognisant of being moved or roughly handled. It may be possible to rouse him, which partial consciousness is in favour of there being no compression: and when the pupils are contracted (both being alike) it is also a symptom in favour of there being no compression.

Vomiting may occur, which is generally considered a good sign, as it stimulates the heart's action, and causes the blood to flow through the vessels of the brain. As circulation is being gradually established, the pulse becomes fuller, and the surface warmer. When the injury has been more severe, the symptoms are more marked; there is complete prostration, eyes glassy, pupils may be contracted or widely dilated, surface cold, and, in fact, the patient appears moribund. These symptoms may last for hours, or merge into the severer complications of compression, and ultimately be followed by epileptic convulsions.

In concussion the breathing is rarely stertorous, a symptom which, if present and continual, might be considered as one of compression.

Treatment of Concussion.—In the first stage, or that of collapse, the patient should be let alone and allowed to rally; but if it is extreme or unusually prolonged, an endeavour should be made to revive the energies of the nervous system and circulation by application of warmth to the body by means of hot jars or bottles, blankets, and employment of friction to the surface. Administer warm drinks, but no stimulants, unless reaction cannot be brought about without them, and then they should be given in very small quantities, their action being carefully observed. The administration of an enema, containing some aromatic spirits of ammonia, has been recommended. Reaction having taken place, the object is to try and prevent inflammatory action. There should be perfect quietness, mentally and bodily, in a darkened room, the latter having a decided influence in preventing congestion. Cold should be applied to the head, mercurial purgatives administered, stimulants avoided, or excess in diet or excitement of any kind. Mr. Victor Horsley suggests * that in simple as well as in compound cases of laceration of the brain, if there is any depression of skull, it should be raised; but if not, trephine, freely open dura-mater, wash out clots, remove hopelessly-bruised brain, suture dura-mater, and return bone. By such means the remote or, even sometimes, immediate consequences of epileptic convulsions may be prevented or entirely removed.

Compression means pressure on the brain by a portion of bone, bullet, extravasation of blood, or formation of pus, or anything that may press upon, or enter into its substance, causing characteristic symptoms, some of which are as follows:—Insensibility, breathing heavy, laboured, slow, accompanied by stertor; cannot be roused; there is a peculiar noise caused by the breath being emitted from the corner of the mouth, something like a puff or whiff, caused by the velum pendulum palati hanging down in the mouth; the pulse is usually slower than is natural, but at times irregular and occasionally quick. If the shock has been slight, the countenance is flushed; but if it has been great, it will be found pale and livid. The sufferer may be convulsed and unconscious of anything about him.

The pupils appear to vary according to the part of the brain injured, and are not affected by the degree of injury. At first they are generally contracted, subsequently dilated, or one may be contracted and the other dilated; and as the disease advances, or becomes aggravated, they are

* *Brit. Med. Jour.*, Dec. 6, 1890.

immovable. The lips are usually compressed, and if an attempt is made to give fluids they run out at the corners. There may be paralysis of one side, or of one side of the face; paraplegia or hemiplegia. At first the secretions are retained, subsequently they pass involuntarily.

If the injuries have existed for a day or so, it may be necessary to diagnose between compression from extravasation, from depressed bone, or from inflammatory effusion within the skull. In cases of depressed fracture the symptoms are uninterrupted, and on careful examination the existence of an injured bone will in all probability be discovered. In cases of effusion from pus, lymph, or serum, the result of inflammation causing pressure on the brain, symptoms of cerebral inflammation will precede the symptoms of compression.

Treatment of Compression.—In the case of a wounded soldier suffering from symptoms of compression, the first consideration will be, what is the cause of it? and, if that can be ascertained, what shall be done to relieve him?

In cases arising from causes apparent to the surgeon, such as depression of the inner table of the skull, or depression of both tables, with lodgment of bullet or other missile, the treatment is a matter which will require the most grave consideration.

The wounded soldier should be most carefully examined, with a view of discovering the source of compression, and should the most rigid treatment not relieve the cerebral symptoms, it will be necessary to consider the advisability or otherwise of using the trephine, elevator, or saw; but on this point numerous and adverse opinions have been expressed by some of the most eminent civil and military surgeons.

Mr. Hennen considers that all extraneous matters should be removed; that fractured portions of bone, if loose, should be extracted; and that depressed portions should be elevated when it can be done without the infliction of additional violence, but to keep in view the tendency of the brain and its membranes to inflammation.

Mr. Guthrie remarks with reference to the question—What is to be done where there is breaking down and splintering of the inner table with depression? There can be no hesitation in answering that in all such cases the trephine should be applied, although no symptoms should exist, with a view of anticipating them. He considers that the danger resulting from the application of the trephine in such cases bears no proportion to the risk incurred by leaving the broken portion of the bone as a constant cause of irritation.

Sir T. Longmore says that when irregular edges, points of pieces of bone, or foreign substances are forced down, and evidently penetrate, not merely press upon the cerebral substance, or where abscesses manifestly exist in any known site, and relief cannot be afforded by simpler means at the wound itself, trephining is a proper operation to be resorted to for effecting the necessary relief; but in all other cases harm will probably be avoided by abstaining from trephining, while benefit will be effected by simply resorting to long-continued constitutional treatment.

Dr. Stromeyer, of the German Army, abandoned the practice of trephining in 1849, though in the early part of his professional career he

advocated it in complicated fracture of the skull, and after the Franco-German war, 1870-71, he expressed himself as follows: "I have tried to exclude entirely from military practices the use of the trephine as useless in some, and unnecessary in other cases." He considers a state of coma from depressed skull no more as an indication for applying the trephine, than a comatose state in typhus as an indication to rouse the patient from it by any means except those which are in accordance with his general state—as cold, for instance, but not stimulants. As soon as the fragments of the skull become detached by suppuration, the comatose state ceases by itself.

Porter says—"These are the rules which guide us in private practice, but I found in my experience in the army that they did not hold good. The injuries of the head are there so much more violent that I am inclined to think non-intervention to be the safer practice. I believe I have seen more injuries of the head recover without trephining than with. The opinion I have formed on this most important subject, after some experience in military practice, is that when symptoms of compression exist from depression of the inner table, or both tables, with splintering or extravasation, it is necessary to remove the cause, if possible, by some surgical means; and, that of the instruments in use, the trephine is the most objectionable, requiring considerable force, and consequently liable to cause additional injury to the sensitive brain and its membranes. I therefore consider the use of the elevator, Hey's saw, the chisel and mallet better suited for the operation than the trephine."

When surgical interference is necessary, too much care in the manipulation of instruments cannot be observed during the operation, but if careful antiseptic precautions are taken there is no undue risk in trephining; if, however, the operation is delayed until septic inflammation has supervened then the results are not likely to be satisfactory.

There is no operation that requires greater nicety or delicacy than the removal or elevation of depressed bone or extraneous bodies from the surface or substance of the brain; but to secure success much is required in the after-treatment, such as perfect quietness, cold to the head, and avoidance of any excitement. During the Indian Mutiny, 1857, at the battle of Sultanpore, a soldier of the 10th Foot was wounded in the head causing a depressed fracture, which rendered him insensible. The surgeon of the regiment elevated the depressed bones, and sensibility immediately returned. The sufferer was progressing satisfactorily, when the necessity for shifting camp produced great disturbance, and brought on a train of unfortunate cerebral symptoms from which he died.

Some authorities have raised a question as to the best period for using the trephine—that is, on the first or seventh day. Mr Guthrie expresses himself in the following terms:—"I do not hesitate to say the first, believing the violence to be greater when done on parts already in a state of inflammation than when they are sound." Another eminent authority remarks on this point—"Danger does not arise from early operation, but from delay." There is no doubt that if it is necessary or advisable to use the trephine or elevate the bones, the sooner the operation is

performed the better, so that the cause of irritation may be at once removed.

There are certain parts of the skull to which it is recommended not to apply the trephine; for instance, over the venous sinuses, the anterior angle of the parietal bone, the course of the sagital suture, and near the base of the skull.

Sir W. Fergusson says—"The trepan may be applied in any part of the side or upper portion of the cranium, and a knowledge of anatomy will indicate where the bones are thick, or the reverse, and also where the meningeal artery or the sinuses are in danger. The latter, I should imagine, may always be avoided; the former, if it is necessary to operate over its course, may possibly be cut across, as at the side of the cranium it often runs into a canal of bone instead of being merely in a groove. A small pin of wood in such a case would suppress the bleeding, and any escape that might happen ere this could be introduced would probably be rather an advantage than otherwise; for, generally, those who require this operation have been in robust health previously.

"The irregular thickness of the bones at different parts should be remembered, and the pressure of the teeth should be made light or heavy in proportion. At the frontal sinuses, Sir Charles Bell recommended that the inner table should be taken out with a smaller-headed trephine than that which has been first applied; the larger external opening permitting the entire circumference of the cutting margin of the latter instrument being placed directly on the surface within. Such an operation must, however, be rarely required in this situation."

Suppuration within the cranium has been divided into subcranial, intrameningeal, and cerebral. By subcranial is understood a deposit of pus between the skull and dura-mater. It occurs opposite the seat of injury or part struck. It may be induced by a blow on the head, causing separation of the dura-mater from the bone by disturbing vascular connection and setting up inflammation of the pericranium with necrosis; or by the irritation of splinters of the inner table, as in depressed fracture. With intrameningeal suppuration there is an accumulation of pus in the subdural or subarachnoid spaces, or in the pia-mater. In the intracerebral form there is an abscess in the substance of the brain itself, caused by direct injury, by splinters of bone, bullets, or other missiles, or by contre-coup.

Treatment of Inflammation of the Brain and its Membranes.—The treatment should consist of most vigorous measures, local bleeding by leeches to the temples or behind the ears, mercury, and cold to the head, the hair should be shaved, hot bottles to the feet, frequent enemata of turpentine if necessary, dark rooms, perfect quiet, and spoon diet. Suppuration may be suspected when the inflammatory symptoms are interrupted by a rigor, or accompanied by hemiplegic paralysis on the side opposite the seat of injury. The formation of a puffy swelling on the scalp over the seat of injury has been suggested as the proper position to apply the trephine, but there would be no certainty in finding pus; the trial has, however, been attended by success.

Protrusion of the Brain, Fungus or Hernia Cerebri.—This arises

in consequence of the dura-mater having been torn, or by ulceration taking place after removal of a portion of the skull.

If the dura-mater remains whole, and the wound in the cranium is small, the hernia will not take place, or if a large portion of the cranium has been removed, there will be no protrusion. Mr. Guthrie is of opinion that it is more likely to take place with a small opening than a large one. At first the protrusion may only consist of coagulated blood, appearing within one or two days after the injury, and this is generally a fatal symptom. It may occur at a later period, when it will consist of brain substance and may attain the size of a small orange. It is a very dangerous complication, terminating usually in encephalitis, followed by delirium and coma consequent on inflammatory effusion within the skull.

Treatment.— The protrusion should not be shaved of, but it should be dusted with tannic acid, oxide of zinc, or powdered salicylic acid, when small pressure should be applied, but if it should become very large, this could not be carried out. In any case, the less interference the better.

Application of Trephine as recommended by Sir W. Fergusson.— "The scalp must be sufficiently opened by a

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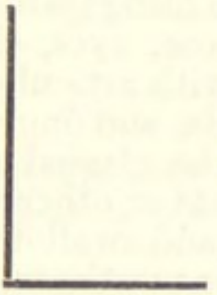

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or any other incision that may be most convenient; next a perforator should be applied to make a hole in the external table, into which the central pin of the trephine should be placed, and then by rotary motion the teeth should be carried into the bone. The external table and the diploë may be cut with bold and free movements, but caution is required when the inner plate is encountered, as also in those parts where there is no diploë, and where the thickness is irregular and uncertain: the centre pin should now be drawn above the level of the serrated edge of the saw, and again, by more cautious movements, the vitreous table must be divided. When the incision is supposed to be nearly completed, the instrument must be removed; an elevator should then be introduced, so as to raise the loosened portion, and the rest of the operation may be conducted according to circumstances. When a foreign substance, blood, or matter, is sought for under the cranium, a circular piece of bone is thus removed; but in the case of depressed fracture, only a little more than a semicircular portion requires to be cut; and this, be it observed by the young student, is taken from the sound portion of the bone, not that which is depressed; for the sole object in applying the instrument in a case of this kind is to permit the introduction of a lever to elevate the portion in fault.

"In using the trephine commonly sold, it is necessary to raise it from the groove from time to time, so as to allow the particles of bone to be brushed away; but the blade being slit up obviates this. However, towards the latter part of the operation it is proper to remove the teeth once or twice, and examine the fissure with the point of a probe, a slip of quill, or any other convenient article, so as to make sure that the dura-mater is not in danger from the skull-cap being thicker on one side of the opening than the other."

Victor Horsley says—"For brain surgery, the head should be shaved and cleansed, the scalp raised by a semilunar flap, the bone is removed by a couple of trephine holes made at the opposite extremities of the area to be removed. The section is completed by Hey's saw and the bone forceps. The dura-mater should be so incised that its edges can be subsequently united by suture." *

WOUNDS OF THE FACE AND ADJACENT PARTS.

Wounds of the face, like those in other parts of the body, may be incised, contused, punctured, and lacerated.

The rate of mortality from these wounds is not great, but they are liable to be attended by serious disfiguration and troublesome complications in lesions of the ears, nose, eyes, cheeks, forehead, tongue, jaws, teeth, and mouth, interfering with articulation, mastication, deglutition, hearing, seeing, smelling, glands, and ducts. The causes of mortality in these wounds or injuries may be classed under the heads of secondary hæmorrhage, lodgment of bullets or other missiles in bone, poisoning the constitution from suppuration and swallowing fœtid pus and decomposed tissues, inability to take food or masticate, neuralgia, and paralysis; the sufferers in some instances, when the bone becomes permanently diseased, being most wretched and miserable from the continued fœtid discharge, preventing them from joining the society of their fellow-creatures.

All wounds of the face show great aptitude for healing. It is, therefore, best to endeavour, with the least possible delay, to cleanse and approximate the parts, bringing them together with fine sutures, while, when a wound has been inflicted by sharp instruments and is not deep, the skin only should be included by the silk; but in the event of the cheek being divided into the mouth, the stitches should be somewhat deeper.

Wounds implicating the Bones of the Face.—In the event of bones being cut into, separated, or displaced, they should be readjusted, and having been cleansed, the skin should be brought over them and stitched, as in the case of an incised wound.

Professor Chisholm gives an account of the plan adopted by medical officers of the Confederate Army in the treatment of wounds of the upper jaw. There was fair result, but much deformity was left in many cases. "Unless the fragments are either completely detached or but slightly adherent, they should not be taken away, but should be replaced with

* *Brit. Med. Journ.*, Oct. 9, 1886.

care, as in time consolidation may take place, and very little deformity will be left. Should some of these fragments die, they will be found loose, often as early as the sixth or eighth day, and should be removed."

Wounds of the lower jaw are acknowledged to be more troublesome than wounds of the upper jaw, and are certainly more numerous. It has been remarked by Dupuytren that they are more dangerous than the upper, but such has not been the case in late campaigns. The great obstacles to be overcome in the treatment of gun-shot wounds and extensive injuries of the lower jaw, are—1st. The difficulty of keeping the bone in proper position, in consequence of its liability to hang down. 2nd. The incessant discharge of saliva. 3rd. The difficulty of feeding the sufferer.

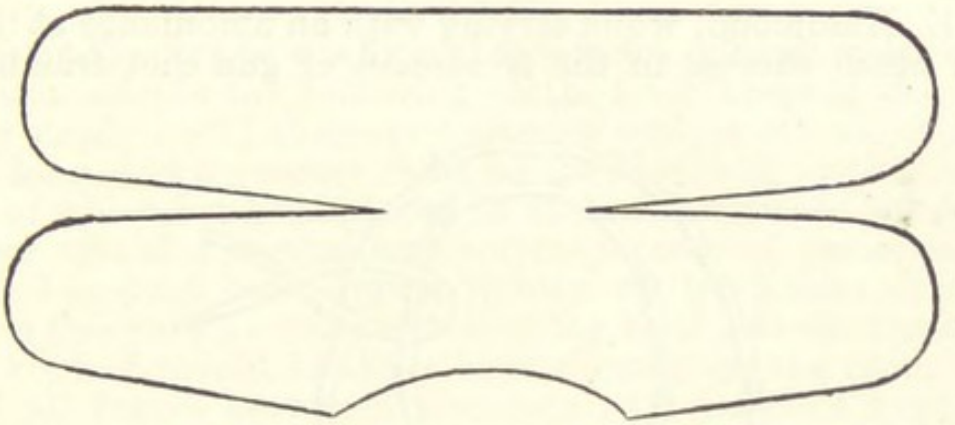

Fig. 77.

After a short time suppuration sets in, and the fœtid smell (which must be relieved by antiseptics) is intolerable to the patient and his attendants.

Many ingenious contrivances have been invented for keeping the jaw in position, some of which are complicated and expensive.

On service a piece of gutta-percha, about one-eighth of an inch thick,

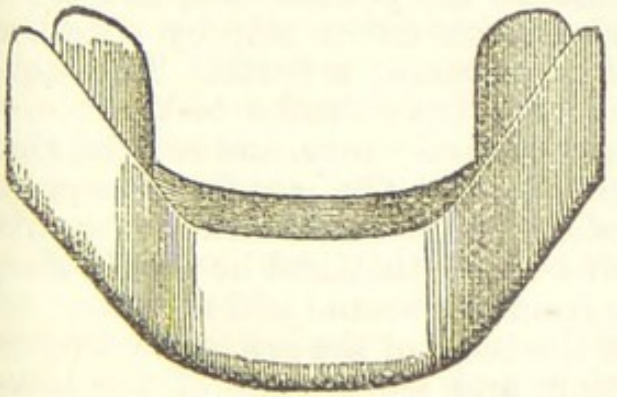

Fig. 78.

Fig. 79.

and cut as represented in fig. 77, softened in boiling water, moulded to the jaw, as shown in fig. 78, and secured by means of a four-tailed bandage

or two handkerchiefs, as shown in fig. 79, makes a comfortable appliance. It may be lined with soft lint or cotton wool, and should be applied with great care.

If an opportunity offers of securing two fragments of bone by fastening together contiguous teeth, it should be done by means of silver wire or silk.

The adjustment frequently checks hæmorrhage, and prevents further mischief from sharp-pointed spicula of bone, which from the hard nature of the lower jaw always exist in gun-shot wounds. The surgeon may not be in possession of gutta-percha, when he may substitute pasteboard, leather, or in fact any substance that can be moulded and give support to the jaw.

Mr. G. E. Hammond, while serving with an ambulance at the siege of Paris, had much success in the treatment of gun-shot fractures of the

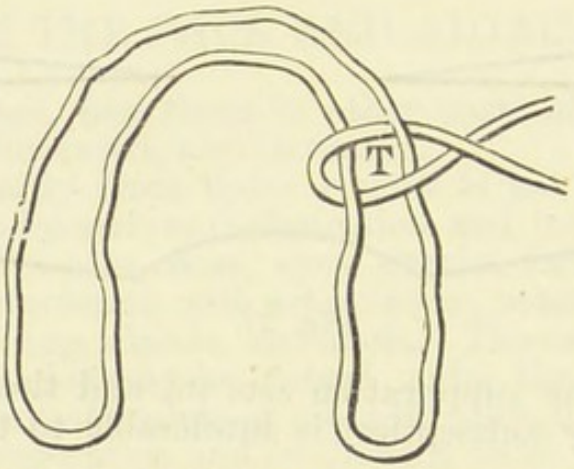

Fig. 80.—Hammond's splint for gun-shot fracture of the lower jaw.

lower jaw, by means of a framework of iron wire, as represented in fig. 80. He first approximates (temporarily) the broken bones by passing a silk thread between and around two teeth on each side of the fracture; he then takes an impression of the teeth in wax, and from it a cast in plaster of Paris. He adjusts the frame on the plaster cast, and when ready places it over the teeth, securing it on either side by wires, as shown in fig. 80. Letter T is intended to represent a tooth. The wires should be cut short, and their ends twisted in between the teeth.

This contrivance renders the jaw comparatively firm, and so solid that the patient can bite steadily on it without pain. The jaw should now be secured at perfect rest. The patient should rinse his mouth four or five times a day with rectified spirits of wine and water, and he should sleep on his side to allow of a free discharge from the wound and mouth.

Erichsen remarks: "In fractures of the body of the lower jaw by gun-shot injury, there is great comminution and splintering of the bone, followed by copious and fœtid discharge, which, being swallowed, may reduce the patient to a state of extreme debility, and thus prove fatal. In these cases Dupuytren recommends cutting through the lower lip, the taking away of the splinters, and, if necessary, resection of the bone."

At the assault on the great Redan, 1855, an officer received a bullet wound at the ala of the right nostril. The bullet entered the mouth, smashed most of his teeth in the upper and lower jaw, broke in the hard palate, lacerated the tongue extensively, and broke the lower jaw in several places. His condition was that of extreme wretchedness; but by adjustments of the parts as far as possible, removal of splinters, and support by means of the gutta-percha splint, he was made comparatively comfortable. The suppuration was profuse, and the wounds remained open for a considerable period, but he so far recovered as to be able to perform the duties of a field officer, having had a false palate and several teeth adapted to his mouth. This officer was supported for several days by fluid nourishments administered through a quill passed well back in the mouth.

Fracture or Fissure of the Symphysis is not difficult of detection. Sir W. Fergusson adopts the following method for keeping the fragments moderately steady:—"I shape two narrow wedges of cork about an inch and a half long, and a quarter thick at the base, and sloping away to a point, one of which has been placed on each side between the teeth: and then I have affixed a wetted and softened piece of pasteboard on the chin, which has next been drawn tightly up, by means of a bandage carried from this part over the crown of the head; as the pasteboard has got dry, a kind of mould has thus been formed on the chin, which has obstructed all future movements so long as it has been kept on. The cork wedges have insured regularity as regards the teeth, and an opening has been left between the incisors, whereby the patient has been fed upon soups and other fluid nourishment. Generally, however, the wedges have become loose, and in the course of ten or fifteen days the patients have become accustomed to restrain the movements of the parts, and without taking particular pains about tightening the bandages afterwards, excellent cures have followed."

The sufferer should be supported by fluid nourishment administered by a tube passed to the back of the mouth, or by a long narrow spoon; indeed, it may sometimes be necessary to support Nature by enemata of beef tea, wine, &c.

Wounds of the Ear.—The external ear may be cut away, or cut off with a sword, or otherwise injured. Instances have been recorded by Paré and Hildanus of the ear having been completely detached, and when replaced healing without any difficulty. Measures should therefore be adopted, on an ear being cut or injured, to replace any pieces, and secure them by means of very fine sutures, taking care to include the outer skin only, and not the cartilage.

Wounds of the orbit include the eyelids, which may be so injured as to cause much loss of tissue, and as after-consequences eversion and inversion. The bones of the orbit may be injured, and result in inflammation of the brain or its membranes. Mr. Hennen records a case in which a bullet was lodged in the orbit without causing injury to the eye or the bones; it was removed on the following day by dressing forceps, was found flattened, and had caused but little irritation to the eye. Such escapes are not often met with. Bayonets and sharp-pointed

weapons perforating the thin orbital plates generally inflict such injury that they are followed by fatal results.

Incised or lacerated wounds of the eyelid and brow should be carefully cleaned, and edges brought together as far as practicable by means of fine sutures, and as quickly after the accident as possible.

Wounds of the eyeball may be divided into penetrating and non-penetrating.

Treatment of injuries to the eye which are likely to be followed by panophthalmitis should be as follows :—

All applications to the eye should be warm and soothing, such as decoction of poppy heads, or a solution of ℥i. of extract of belladonna in a pint of boiling water. A solution of atrophine should be dropped into the eye twice or thrice a day. The patient should be kept in a dark room. The bowels should be freely acted upon at the commencement, and sleep should be produced and pain relieved by opium. At the commencement, salines and diaphoretics may be prescribed, but these must soon give way to quinine, bark, &c. The strength of the patient should be maintained by good fluid food, with a moderate allowance of wine or brandy.—*Lawson.*

"Whenever foreign bodies are lodged in the eye they should be extracted at all hazards. If it is impracticable to find them, the globe should be extirpated in order to preserve the other eye."

In fractures of the bones of the orbital region, it is not judicious to remove fragments, unless they are completely detached, and are acting as foreign bodies.

Injuries of the Nose.—In cases of incised wounds, the parts must be adjusted, and sutures applied in the same manner as for wounds of the ear, taking care that the skin does not curl in, which would prevent adhesion. Should the nose be broken, it is best to try and place it in its normal position ; inserting in the nostrils pieces of gum elastic catheters, or plug with lint or sponge, to prevent deformity of the organ, and contraction of the nasal passages and depression of the nose. These injuries are frequently complicated with violent epistaxis, which may require plugging of the posterior nares.

Wounds of the Cheeks and Forehead.—These wounds are usually the result of sword or gun-shot, and, when the parts are not completely carried away, will heal most readily if properly adjusted and secured. They have, like wounds of the scalp, the same tendency to attacks of erysipelatous inflammation ; it is therefore necessary, during the treatment, to prevent the wound being exposed, and to observe strict dieting and temperance. No matter how small a shred may be attaching a fragment of skin to the face, an attempt should be made to readjust it.

Wounds of the Parotid Duct and Gland.—Wounds of the cheek may be complicated with injuries of the *parotid duct*, and to prevent a salivary fistula being formed, Mr. Guthrie recommends : "If the duct of the parotid gland be implicated by an incised wound, care should be taken to divide the cheek into the mouth, if it should not have been already done ; and to keep the incised wound open until the external one is closed. If a salivary fistula have formed externally, from in-

attention or otherwise, it must be treated according to the ordinary methods adopted in such cases. When a wound of the gland itself becomes fistulous and weeps, which is a rare occurrence, it will be best treated by actual or potential cauterisation, if moderate pressure should fail."

Injury of the lachrymal bones, or sac, causing the tears to run over, which misfortune may continue for life, should be treated by endeavouring to remove obstructions in the duct, and so prevent the distress which must follow from want of early care and attention.

Wounds of the tongue frequently give rise to extensive hæmorrhage, which is difficult to check, if secondary, or occurring several days after receipt of injury, when the process of suppuration is going on and the tongue is swollen and painful. If the bleeding vessels can be discovered, they should be tied, and to do this the tongue must be drawn well forward, or an attempt may be made to restrain the hæmorrhage with styptics, or it may be necessary to tie the lingual artery.

Wounds of the mouth are generally in connection with wounds of the face; but they may be still further complicated with injuries to the pharynx, tongue, spinal cord, jaws, and skull.

WOUNDS OF THE NECK.

Superficial wounds of the neck require the same treatment as elsewhere, the surgeon always bearing in mind the great liability to erysipelas in these parts, with rapid diffuse inflammation and infiltration.

Deep wounds of the neck, such as those produced by stabs, may be accompanied by most distressing symptoms, such as oppressed breathing, nausea, spasmodic twitching of face, paralysis of one or both arms, cough, restlessness, and hiccough.

In gun-shot wounds of the neck, it is scarcely possible to have lesion of one important structure without others being implicated; at the same time it has been generally observed that bullets and other missiles pass in and out between muscles, vessels, and nerves, and even the trachea, without causing much injury to any. This is accounted for by the soft and flexible condition of the structure of the neck offering no resistance.

Wounds of the larger arteries and veins generally prove fatal immediately, but in wounds of the smaller vessels, there is frequently much difficulty in discovering whence the hæmorrhage arises, and what trunk should be tied. Mr Guthrie quotes, with great satisfaction, the opinion of M. Velpeau on this subject: "In hæmorrhage from the neck, the mouth, the throat, the ear, or the skull, everything should be done to reach the branch of the carotid which has been wounded, rather than tie the carotid itself."

Wounds of the Larynx.—In wounds of the larynx the parts must be adjusted and kept in contact by bandages, sutures being considered objectionable. Should a bullet or other missile get into the larynx, it

must be removed by operation, and when extensive inflammation is set up, causing infiltration or œdema, it may be necessary to open the trachea, and insert a tube to allow the sufferer to breathe.

An interesting case is given by the Surgeon-General of the American Army, where the larynx became so obstructed after a wound, that it was necessary to open it and prolong the incision as far as the third ring of the trachea ; the proceeding was successful.

Should clots of blood get into the larynx or trachea, and they are not coughed up, an endeavour must be made to remove them by sucking, or by means of an exhausting pump. Wounds in connection with the larynx or trachea, or in their vicinity, should not be closed till all hæmorrhage has ceased, for fear of suffocating the patient. These wounds may be accompanied by emphysema, causing much distress, which should be treated by small punctures, if it extends ; but as a rule it will pass away when suppuration of the wound commences.

Wounds of the Œsophagus.—For wounds of the œsophagus but little can be done, Nature performing all that is required in healing ; and it is sometimes most remarkable how quickly this is effected. Wounds of the œsophagus may render the patient unable to swallow without much discomfort, or in many cases not at all, when it will be necessary to give him nourishment by a gum-elastic tube introduced through the nose into the stomach, or by enemata of beef-tea, milk, gruel, and other nutritive fluids.

During the Crimean War a complicated case of bullet-wound of the larynx and œsophagus came under Porter's immediate care, the particulars of which may be recorded here : At the assault on the great Redan, the sufferer having mounted the parapet, and while in the act of reloading on his knees, was shot from below by one of the enemy, who was immediately at the bottom of the parapet. He fell on his side, did not feel much pain, but could not speak. On arrival at the camp hospital, two wounds were found in the neck ; the ball had entered at the pomum Adami and made its exit at the anterior edge of the sterno-mastoid muscle of the right side. There was very little hæmorrhage from either wound, and no displacement of the thyroid cartilage. The patient was suffering from a frequent cough with bloody expectoration, loss of voice, and nausea ; bubbles of air appeared at every expiration at the wound of entrance in the larynx ; and when he attempted to drink, some of the fluid came through the wound at the anterior edge of the sterno-mastoid, the wound of exit. This latter symptom continued for five days, and then ceased altogether ; for twelve days the air continued to pass through the upper wound and then ceased. The cough during that time was very troublesome, and the expectoration copious, which caused much loss of rest ; during the first six days there was slight emphysema about the upper wound, but it gradually disappeared.

The treatment consisted at first of antiphlogistic remedies, both local and constitutional ; and lint wet with cold water was kept constantly to the wound. He was fed by means of a spoon passed very far back, containing arrowroot, milk, or tea ; his diet was gradually increased after five days, he was able to swallow bread softened in tea, rice,

and milk; and as inflammatory symptoms subsided, wine, porter, and nutritious diet were allowed. The wounds healed completely, but the voice was much impaired, being little more than a whisper.

WOUNDS OF THE CHEST.

Classification.—Wounds of the chest are divided into penetrating and non-penetrating.

The non-penetrating may be subdivided into wounds of skin, fascia, and other soft coverings of the walls of the thorax, fracture of the clavicle, scapula, sternum, vertebræ, ribs, injury of bones or cartilages, and superficial vessels.

The penetrating may be subdivided into those connected with wounds of pleura, lungs, heart, great vessels, nerves, œsophagus, and thoracic duct.

Non-penetrating wounds may be accompanied by lesions of the internal viscera from violence, causing contusion or rupture of viscera or an important blood-vessel, and, subsequently, by inflammation of the pleura or lungs, giving rise to pleuritis or pneumonia, or both.

Non-penetrating wounds of the soft parts alone differ but little from wounds elsewhere, except that they are much slower in healing, due in all probability to the ribs never being at rest, and consequently the lips of incised wounds cannot be kept in exact apposition.

In dressing these wounds, it is recommended to apply strips of adhesive plaster in such a manner that the ribs may be supported and the wounds relieved from strain; this is best accomplished by placing broad strips of plaster at right angles to the ribs, and a bandage round the chest with narrow strips of bandage over the shoulders, stitched to that on the chest, with a view to keeping it in position.

Simple fractures of the several bones in connection with the chest, such as the clavicle, scapula, ribs, and sternum, must be treated in accordance with the special rules laid down for these injuries. In compound fractures of these bones from gun-shot, where the wounds do not penetrate, much trouble and anxiety may arise from depressed spicula causing inflammatory symptoms and requiring elevation or removal, or giving rise to abscesses, or diseased bone.

Wounds of the external arteries of the chest, producing profuse hæmorrhage, should be secured at both ends, as, from the nature of the surrounding tissues, blood is apt to be extravasated or aneurisms formed.

All external wounds, at first apparently trivial, should be most carefully watched for several days, as inflammatory symptoms of the lungs or pleura may arise, and should be checked with the least possible delay.

Penetrating wounds may be complicated, in the first instance, with emphysema, pneumo-thorax, hernia of the lung, hæmo-thorax, and presence of foreign bodies, and subsequently by hydro-thorax, empyema, fistulous openings, and contractions of the chest.

In wounds of the heart and larger vessels, the result is generally immediately fatal; at the same time instances have occurred where a sufferer with a wound of the heart has lived for several days.

Symptoms of Wound of Lungs.—A penetrating wound of the chest may be accompanied by the following symptoms, which, taken as a whole or in connection with one another, may satisfy the surgeon that the lung has been wounded; but they are not proof positive that such is the case, as all may be present, and yet no wound of the lung:—Shock, sudden collapse, or fainting from hæmorrhage, internally or externally; the escape of blood and air through external wound of pale red colour and frothy; continued issue of blood mixed with mucus from mouth during efforts of coughing; emphysema; deeply-fixed pain in the chest; irritation of larynx and spasmodic cough; difficulty of breathing. Shock, sudden collapse, or fainting, may occur with any severe wound. The escape of blood and air through the external wound may take place, in consequence of a wound of the intercostal or mammary artery, by air having been drawn into the cavity of the thorax during each expiration, expelled during inspiration, and so mingling with the blood. The issue of blood from the mouth, mixed with air, is looked upon as satisfactory evidence of wound of the lung; but it may arise from other causes unconnected with the wound, and may therefore exist without a lung wound.

Emphysema, which was considered by older surgeons to be proof positive of a wound of the lung, is now looked upon as a complication which may be caused by the admission of air into the chest through the external wound, and not finding ready egress during respiration, passes into the cellular tissue in the immediate neighbourhood of the external wound, and therefore cannot be considered as a diagnostic symptom of any value.

The pain in the chest, cough, irritation of larynx, and difficulty of breathing with the continuance of blood in the mouth, or blood *and especially mucus* from the wound, may be considered the most reliable symptoms.

When the wounds occur in civil life, the weapon causing the injury might be procured, and a certain amount of assistance afforded by examining it, and judging of its extent by the stains of blood on it; but in war there is no such help.

It has been recommended to test the wound by holding a lighted candle opposite to it, and direct the patient to take a deep inspiration, when, if the candle is blown upon, it is a proof that the lung has been wounded.

Treatment of Penetrating Wound.—On first seeing a patient with a penetrating wound of the chest, an endeavour should be made to restore animation by the administration of beef-tea and cordials. Should reaction take place, distressing symptoms will cease; hæmorrhage may have been checked, and with a suitable bandage round the thorax, it is possible no bad symptoms will follow; but blood may continue to be poured out in the cavity of the chest, causing pressure on the lungs, and consequent symptoms of distress, or it may come through the external wound, flooding the sufferer.

Blood in Cavity of Chest.—If the blood is being poured into the cavity of the chest, the surgeon will be warned by the cold perspiration, the pallid countenance, faintings, the weak pulse, and distress in breathing,

If he examines the chest he will find it enlarged on the injured side, and the intercostal spaces bulging out. There will be dulness in proportion to the amount of the cavity filled up, and no respiratory murmur, the lung being pressed down.

Ecchymosis is laid down as a symptom or sign of effusion of blood within the chest at a late period. Valentine considers it to be a pathognomonic sign of effusion of blood. He says—"It is very dissimilar to that which occurs after a blow or wound, and which takes place shortly after the accident, being around the wound if there be one, and extending from it. The patient also complains of pain when the bruised part is pressed by the fingers. These characters are not observed in the ecchymosis attending effusion, which always takes place near the angles of the lower or false ribs, descending towards the loins. Its colour is identical with that which appears on the abdomen of persons some time after death—a bright violet (*violet très-éclairci*). It appears about ten days after the receipt of the injury—sometimes later." Should the blood come through the external wound, the diagnosis is simple enough.

Treatment of Hæmorrhage into Cavity of Chest.—It now becomes a matter of serious consideration what is the best line of treatment for this form of hæmorrhage; but before taking it for granted that it is coming from the lungs, an endeavour should be made to try and discover if the intercostal or internal mammary arteries have been wounded. And as a guide to this, it has been remarked that when there is internal hæmorrhage from the latter sources, the symptoms are more gradual than if the blood comes direct from the lungs or pulmonary arteries.

In the event of the hæmorrhage coming from mammary or intercostal arteries, an attempt should be made to tie these vessels, or otherwise close them, for which purpose various plans have been proposed, some of which may be mentioned here:—

Pass a curved needle armed with a ligature completely round the rib, and compress the wounded artery by means of a pledget placed over the orifice and included in the ligature.

Sir T. Longmore describes "Desault's purse," which is a mode of compression, and is as follows:—"Place a piece of linen on that part of the chest at the wound. The middle portion of the linen is pressed by the finger into the wound, so as to form a kind of pouch. This pouch is then distended with sponge or lint pushed into it, till it arrests the bleeding. On stretching out the corners of this linen cloth, the pressure of the plug will be increased. The whole may be secured to the chest by a roller or bandage."

This method Porter used with the most perfect and permanent success, adding to the lint or sponge a little of the solution of perchloride of iron.

Mr. Guthrie considers that wounds of the intercostal arteries rarely give rise to hæmorrhage so as to require a special operation for suppression; but whenever it does so happen, the wound should be enlarged, so as to show the bleeding orifice, which should be secured by one ligature if distinctly open, and by two if the vessel should only be partially divided. The vessel is sometimes so small as to be easily twisted, or its end sufficiently bruised as well as twisted, to arrest the hæmorrhage.

It having been pretty well ascertained that hæmorrhage is from the lung, and the symptoms being urgent, what measures should the surgeon adopt? Many opinions have been expressed on this important and difficult subject.

Sir T. Longmore recommends that "hæmorrhage from the lung itself must be treated on the general principles adopted in all such cases: the administration of cool acid drinks (iced, if ice can be obtained), perfect quiet, and the administration of opium or digitalis.

"When blood has accumulated in any large quantity, and the patient is so much oppressed as to threaten suffocation, all coverings must be removed, and the blood permitted to escape by wound; the wound should even be enlarged, if necessary, so as, with the assistance of proper position, to facilitate its escape. If the effused blood, from the situation of the wound, cannot be thus evacuated, and the patient be in danger of suffocation, then paracentesis must be resorted to."

Dr. Macleod, who had considerable experience during the Crimean War, says that those cases did best in which early, active, and repeated bleedings were had recourse to.

The Report of the Surgeon-General, American Army, on the treatment of chest wounds during the War of the Rebellion, is of the greatest importance; and from the vast number of cases, amounting to 20,264, the success of the treatment without venesection should be a great lesson to the army surgeon, and enable him to decide as to the proper course to be adopted in such cases.

The following is an abstract of the measures used for the different descriptions of wounds:—

In injuries of the thorax, whether attended or not by breach of surface, rest, a comfortable position, and a broad bandage round the chest.

After stanching the bleeding, cleansing the parts, and removing foreign bodies, the further conduct of the surgeon must be governed by the extent and nature of the lesion. All superficial wounds should be closed, with a view to early adhesion. In extensive incisions or lacerations use sutures, but in coughing or movements these are apt to be torn out.

In penetrating wounds, some preferred to support the injured side with broad strips of plaster; this was considered a secure dressing, and acceptable to the patient. The starch bandage was used, but its application was not found convenient.

In profuse primary hæmorrhage the bleeding was arrested, if possible, by ligature or compression, but when impossible to reach the source of the internal bleeding, it was considered best to close the wound and to promote occlusion of the bleeding vessel by general means.

In the general treatment, the uncomplicated non-penetrating wounds required no exceptional measures beyond restriction of diet and the means necessary to insure rest.

In penetrating wounds venesection appears to have been abandoned altogether; hæmorrhage was treated by the application of cold, perfect rest, and the administration of opium. These measures, he says, seem to have generally proved adequate.

Dr. Chisholm's views are given in the Surgeon-General's Report. He deprecates venesection in chest wounds; even when the lung is inflamed he prefers the mild antiphlogistic and expectant treatment to the spoliative. The large success in the treatment of perforating chest wounds in the Confederate hospitals, puts forth in strong light the powers of Nature to heal all wounds when least interfered with by meddlesome surgery. Absolute rest, cooling beverages, moderate nourishment, avoiding over-stimulation, with small doses of tartar emetic, veratrum or digitalis, the liberal use of opium, and attention to internal secretions will be required in all cases; and in most will compose the entire treatment.

Among the pharmaceutical preparations employed by the American surgeons was opium, which appears to be the one on which most reliance was placed; but care should be observed in its administration, as hæmorrhage tends to increase its action. It quiets the nervous system, and indirectly moderates hæmorrhage.

Stromeyer, in his *Experiences of Gun-shot Wounds*, 1866, remarks, under the head of Wounds of Thorax, that, "with the exception of a single instance of venesection, which was at his own suggestion, there was no bleeding for chest wounds." He frequently discontinued wine and coffee, which acted as stimulants, and ordered the patient to take whey, and later on, cod-liver oil. "It is only through tranquility and prudent nourishment that the dangers of chest wounds can be avoided."

Legouest objects strongly to bleeding for wounds of lungs, as being more injurious than useful. He thinks it is better to close the wound, have recourse to exterior stimulants, and to apply ice locally. Should hæmorrhage continue in the cavity of the chest, the wound must be opened if closed, and if too small to admit of evacuation of blood it must be enlarged; should this enfeeble the sufferer, the wound should be reclosed. The patient should lie on the affected side, with a light bandage round the chest.

In former days, excessive bleeding for hæmorrhage from the lungs, the result of a wound, was the general and established practice; but at the present time, and since the Crimean War, quite the opposite method has been and is most in favour; in all probability due to the exertions of the many distinguished and thoughtful surgeons who served in that war. The course now recommended is to close the wound, allow the cavity of pleura to fill with blood, with a view to compression of the wound in lung, and thereby to close the vessel; but should great distress and difficulty of breathing supervene, place the sufferer on the wounded side and allow the blood to come away; and if the wound is not sufficiently large for this purpose, carefully extend it. Should there be two wounds, the uppermost should be closed.

Ice, refrigerating drinks, dilute sulphuric acid and opium, acetate of lead or ergot, may be administered, the patient being placed in a cool room, with little or no food, and no stimulant whatever.

Gun-shot Wounds of both Lungs.—With regard to the effects of a gun-shot wound of both lungs, many cases have been reported of

recovery when both lungs have been penetrated, and dissection has proved that sufferers have lived for several days; but the probability is, that health will never be permanently restored after such an accident.

Extraneous bodies in superficial chest wounds should be carefully removed, and splinters and spicula of bone elevated or removed, if detached. In the event of a ball passing through or round the chest, but not having sufficient velocity to make an exit at the opposite side, being possibly impacted between two ribs, or fracturing a rib, and presenting itself as a small tumour under the skin, it will be necessary to observe great caution in attempting to remove it, as by want of care it may be forced back and fall into the cavity of the pleura, complicating matters very considerably; but, if it is not causing distress, it is better not to interfere, as the missile may become encysted. The operation should be performed during inspiration.

When round bullets were used, it was not an uncommon circumstance for a ball to strike a rib and pass half way round the chest, but with the conoidal bullet this can rarely happen.

Searching for Extraneous Bodies in Chest.—Authorities differ as to the advisability or otherwise of searching for extraneous bodies in the cavity of the chest. Bell, writing in 1800, says—"As for a ball itself, if it be lost in the thorax, it is irrecoverably lost, and no method that we can contrive will enable us either to find it or extract it."

M. Legouest, in speaking of the use of the probe, remarks—"The only inconvenience to which one is exposed in probing a gun-shot wound of the chest, supposing a foreign body to be in it, is not to find that for which one is searching. In fact, when the lung is free from adhesions, it recedes with the pressure of the probe and escapes injury; or if the lung adheres to the pleura costalis, and the internal wound is in relation with the outer, in this case a chest probe or large gum-elastic probe might be introduced into the course of the wounded lung without running the risk of causing more inflammation than the presence of the ball, splinters, clothing, or other extraneous matters." He agrees with Ledran that, if one is fortunate enough to find the extraneous matter in the lung, one must dilate sufficiently the exterior wound, in order to seize it with pincers and extract without obstruction.

Erichsen remarks on the subject of foreign bodies in the chest—"If any extraneous body, such as a bullet, a piece of wadding, or of clothing, have penetrated too deeply into the chest to be readily extracted through the external opening, it would not be safe to make incisions or exploratory researches with a view to extracting it, for though its presence would increase the patient's danger, yet attempts at extraction would not only add to this, but would in all probability be fatal. In many cases, bodies so lodged become surrounded by an abscess, are loosened, and eventually are spat up, or appear at the external wound."

Emphysema, or the infiltration of air into the cellular tissue, is not an unusual accompaniment of wounds of the chest. It may be caused by a spiculum of a broken rib penetrating the pleura and wounding the lung,

or by wounds of the lung or bronchi, where air passes from the lung into cavity of chest and is forced into the external wound; but to secure its taking place in this latter description of injury, it is necessary that the external wound and wound of lung should not exactly correspond, but have an oblique direction. It may also be caused by air entering the chest on inspiration through an external wound, and finding some obstruction on being forced out again at expiration, diffusing itself into the cellular tissue.

Mr. Hennen's experience of this complication was that it occurred in about one in fifty cases of wounds in the chest, and that it is more frequent in confined punctured wounds than in those which are free and open.

Mr. Guthrie is of opinion that it is not so frequent an occurrence as was at one time supposed. He says—"An opening made by a musket-ball rarely admits of emphysema. A slanting wound made by a pistol-ball may sometimes give rise to it. After a long tortuous wound made by swords or lances, it is seen more frequently, but then it takes place shortly after receipt of injury."

Legouest considers it one of the most frequent accompaniments of piercing wounds of the chest.

Emphysema appears in some slight injuries—as, for instance, in the case of a fractured rib, when a small spiculum of bone may penetrate the lung, and cause emphysema in the immediate neighbourhood of the wound; the air will in all probability be soon absorbed by the application of a bandage, or wide strips of plaster round the chest. While serving in India, Porter was called upon to visit a brother officer who had been thrown from his horse and fractured three ribs. He was scarcely able to breathe; there was great pain and considerable emphysema in the immediate vicinity of the broken ribs. A bandage was applied pretty firmly round the chest, when distress in breathing disappeared, and the emphysema subsided in a few days.

Bandaging and strapping must be regulated by the sensation of the patient; and, should either cause distress, it must be at once removed. Should the swelling extend, so as to interfere with respiration, the external wound, if there be one, should be opened, and punctures or scarification made in the cellular tissue. If emphysema is produced by the air being drawn into the cavity of the chest through a wound, and then forced into the cellular tissue, the wound should be closed.

Pneumothorax, or an accumulation of air in the cavity of the pleura, gives rise to the following symptoms:—Dyspnœa, tympanitic resonance of chest, amphoric respiration, metallic tinkling on auscultation, affected side dilated. The patient feels relief by lying on his back or affected side, seldom on the sound side. Relief must be given by reopening the wound in the chest, if one exists, or removing the air by trochar and canula.

Hydrothorax may occur as the result of pleurisy following gun-shot wounds. It may require surgical interference, by the operation of paracentesis thoracis. Its presence is recognised by those general signs which indicate the presence of fluid in the cavities of the pleura.

Hamilton says it may be distinguished from hæmothorax in being preceded usually by the sign of pleuritis or of pleuro-pneumonia, in the absence of those symptoms of prostration which must necessarily accompany large bleedings, and in the greater facility with which the contained fluid flows from one point of the cavity to another on change of position. If paracentesis is required, an aspirator should be used to remove the fluid.

Empyema.—This condition is the result of septic inflammation of the pleura. It consists of a collection of pus mixed with lymph and blood. It is to be recognised by dulness on percussion where the fluid has collected; by dyspnœa or difficulty of breathing, absence of respiratory murmur at the lower and posterior part of the chest corresponding to where the fluid has reached the pleural cavity. These symptoms are all influenced by the position of the patient. There may be *ægophony*. If the effused fluid has filled one side, that side is enlarged; the ribs are immovable and partly raised; the intercostal spaces will be more or less filled up, and the surface of the chest will be found smooth. There will be absence of all breath or voice sounds.

If the empyema is general the lung may become pressed against the spine, and, if the left pleura be filled, displacement of the heart may take place to the right side; or, if the effusion is to the right side, the liver may be pushed down below its normal level. There may be œdema of the back, which was looked upon by the older writers as distinctive of effusion into the chest. There may be cough, but it has no characteristic feature in connection with empyema. In some instances the empyema is localised and may be situated between the lobes of the lungs; when this is the case, as the abscess increases the lung becomes compressed in all directions. The fluid will have to be removed by an operation.

"The space between the fifth and sixth ribs, an inch to an inch and a half in front of the mid-axillary line, will probably be found the best in most cases. The interval between the ribs is wide enough here to admit a large tube readily, the covering of soft parts is not too thick, and the drainage obtained is efficient, and there is no risk of the opening becoming obstructed either by the expanding lung or the diaphragm."—*Erichsen.*

A grooved aspirator needle should be used, and if, after its introduction, pus escapes, a bistoury may be passed along the groove and a free incision made, a drainage tube should then be inserted, and free drainage established.

In introducing the point of the needle or trochar, with which the aspirator is adapted, care must be taken not to wound the intercostal artery; it is therefore best to keep the point of the instrument *nearer the lower* than the upper rib, and to press it forward rather quickly, so as to avoid pushing the pleura before it. It is not advisable to remove any portion of a rib unless the case is of a very chronic nature, or when the ribs are found to be so close together as to render it impossible to insert a drainage tube. If it is necessary to remove a portion of rib, make an incision over the rib, divide the periosteum along the length of

the portion of rib to be removed, then reflect the periosteum by means of an elevator from off the portion of the rib, divide the rib with cutting forceps at either end, and the piece of rib will be easily removed from its bed.

Hernia of the Lung or Pneumocele.—This complication may occur immediately after receipt of injury, while the chest wound is open or when it has healed. This latter is a rare occurrence, but may take place when the intercostals have been much injured and weakened. It has been known to occur from fractured ribs without any wound, the pleura and intercostal muscles having been ruptured. This description of hernia should be treated by supports, the tumour having been pushed back. When there is an extensive wound of the chest, it may occur by violent efforts in coughing or in expiration.

The tumour presents a livid appearance, and if not soon returned will become gangrenous. "Or, from exposure the prolapse shrinks, becomes dry and carnified and covered with granulations, gradually diminishes in size, and finally cicatrises over, and has been known to return spontaneously into the cavity of the thorax. A prolapse of omentum through the walls of the chest may be mistaken for a prolapse of the lung. Such protrusions are to be discriminated from prolapse of the lung by their soft, fatty, reddish, and irregular feel and appearance and by the absence of crepitation."—*Lyell.**

It is resonant on percussion, and if a stethoscope is applied to it a crackling or rubbing sound will be heard. It may be returned if seen at once, provided it has not been strangulated, or it may be removed by the knife or by ligature.

Mr. Guthrie recommends—"It should be allowed to remain, or be only so far returned, if it can be so managed, as to rest within the edges of the divided pleura and fill up the gap made by the incision, over which the integuments should be accurately drawn and retained. The adhesion of the lung to the pleura costalis arrests the inflammation, and may prevent its progress in other parts of the cavity.

"Whenever the protruded lung has been completely returned, more inflammation has followed than where it has been allowed to remain under the precautions recommended. The protruded lung, when left uncovered and unprotected, soon looses its natural brilliancy, dies quickly, shrinks, and becomes livid without being gangrenous. In such cases, the protruded part may be removed ; but it should never be separated at its base from its attachment to the pleura costalis by which it is surrounded."

M. Legouest recommends that the tumour be allowed to fall off, and he advises dressing it in the ordinary manner, protecting the parts from injury and preventing inflammation. Above all, to repair the lesions which have favoured the formation of the rupture.

Wounds of the Pericardium or Heart.—These injuries may occur from severe blows on the chest, by puncture, stab, or gun-shot. The pericardium may be injured and the heart escape.

When the pericardium is injured, the patient appears in a state of

*Art. "Injuries of the Chest," *Holmes' System of Surgery*, vol. i.

collapse, or death takes place immediately. The former is usually followed by inflammation, oppression, dyspnœa, great appearance of distress, small pulse, and pain at the seat of injury. The wound should be closed, if large; the sufferer kept perfectly quiet, and strict antiseptic treatment enforced.

Wounds of the Heart.—When the heart is wounded, the injuries may not penetrate into the cavities. Instances have been known where foreign bodies have lodged and become encysted in the structures of the organ.

In penetrating wounds the results have been immediately fatal from loss of blood and shock, but sufferers have lain for several days in consequence of the wound closing by contraction, or by the lodgment of a coagulum preventing effusion of blood into the pericardium or pleura.

"It is recorded that in cases which immediately prove fatal, the wounded man appears to spring off the ground, or falls dead without convulsion or apparent knowledge of being injured. If the injury does not prove fatal immediately, there will be collapse followed by great distress and oppression of breathing, anxious countenance, pulse very weak, pallid face. Subsequently there may be all the complications of inflammation of the endocardium.

"The external wound should be accurately closed and all escape of blood prevented, provided, in doing so, suffocation is not induced by blood filling the cavity of the pericardium or pleura, in which case relief may be obtained by allowing some blood to escape."

Wounds of the Diaphragm.—John Bell, in speaking of these wounds, remarks—"Though wounds of the diaphragm are not material in themselves, yet the diaphragm can hardly be touched but in mortal wounds, *i.e.*, wounds touching both cavities—viz., of the thorax and of the abdomen, when most frequently the stomach, lungs, pericardium, or heart are either wounded or are soon inflamed, and so drawn into disease."

The surgeon may recognise these wounds, first by the position of the injury in either chest or abdomen, and if there are evidences of a missile or weapon having penetrated; also by the following symptoms—hiccough, spasmodic or jerking breathing, pain in the top of shoulder, or loss of power in the arm. There may be nausea or vomiting, and if the liver has been injured, jaundice may occur. If the stomach or intestines have been wounded, blood will, in all probability, appear either by vomiting or in the stools.

"A wound of the diaphragm may give rise to a hernia in the chest; it will, therefore, be necessary for the sufferer to remain in the upright position during the process of recovery, to avoid bending as much as possible; and, in the event of recovery taking place, care should be observed in eating small quantities and standing erect after meals, avoiding bending or straining, as a wound of the diaphragm is supposed never to close except under rare and peculiar circumstances. A patient, therefore, once wounded through that muscle would always be liable to hernia."

Hennen says—"Of the wounds of the diaphragm, I have never met one

unconnected with injuries of one or both cavities which it divides, or in which symptoms of their being affected did not appear; although I have met with one instance where a musket ball passed along from the sternal to the vertebral connection of that septum, precisely following the curvature of the ribs. The prevention of inflammation is the leading indication of cure; but injuries are frequently found on dissection, which were not at all indicated during life by any peculiar symptom."

An operation for the relief of this hernia has been proposed by Guthrie, which, though formidable, he says cannot be compared as to danger with the incision of 12 or 14 inches long through the walls of the abdomen, which has been in some instances successfully made for the removal of diseased ovaria. The opening should be a straight incision through the wall of the abdomen, large enough to admit the hand immediately over the part where the diaphragm is supposed to be injured. It should be closed by a continuous suture throughout the skin. *The secondary causes of death* after lung wounds may arise from hæmorrhage, pneumonia, pleuritis, bronchitis, ulceration of lung tissue, empyema, pyæmia, gangrene of the lung, tetanus.

WOUNDS OF THE ABDOMEN.

Classification of Wounds of the Abdomen.—These wounds are usually divided into penetrating and non-penetrating. The dangers to be contended with in all wounds of the abdomen are hæmorrhage and diffused septic peritonitis; and, of course, the greater extent of injury, especially internal, the greater probability of these formidable complications.

The prognosis of wounds of the abdomen is very unfavourable, the diagnosis very obscure, and the results of treatment discouraging.

It is, therefore, most important that the question as to the penetration of the abdominal cavity should be settled as speedily as possible, and this can be most easily determined by passing a probe into the wound. Of course, due care must be taken in this, as in the case of all wounds, to introduce such instruments only as are perfectly clean and aseptic, but if proper precautions are taken there can be no objection to this course, more especially as the information sought for is of the first importance. MacCormac adds*: "And if this fail to clearly establish the fact or otherwise of penetration, the wound should be enlarged and explored to its termination either in the parietes or more deeply."

"Abdominal section for penetrating wounds is steadily gaining adherents, it being admitted that the mortality has been materially decreased since its introduction, and that the intrinsic risk of an abdominal section for exploratory purposes is, if properly performed, very slight. It must always be remembered that to wait for symptoms of perforation of intestine to appear in a case of penetrating abdominal wound is greatly to decrease the chance of recovery, and some surgeons advocate immediate exploration in all such cases."—*Year Book*, 1890.

Non-penetrating wounds, uncomplicated, without injury of the internal viscera, require no special line of treatment. If there are

* *Abdominal Section*, by Sir W. MacCormac, F.R.C.S., 1887.

incisions or lacerations of the abdominal walls, the parts should be adjusted and kept in position by means of sutures or stitches, sufficiently deep to keep the divided structures in exact co-aptation and so prevent ventral protrusions. The quilled suture appears to have answered the best purpose (fig. 81) in the American War. The sutures should be allowed to remain until the fourth or fifth day, and the loop of each double thread then being cut, the pieces should be withdrawn simultaneously in opposite directions. If carbolised gut sutures are used, they will soften and come out by themselves. The position of the sufferer during treatment should be such that the muscles of the abdomen are relaxed by elevating the shoulders and head, and flexing the lower limbs.

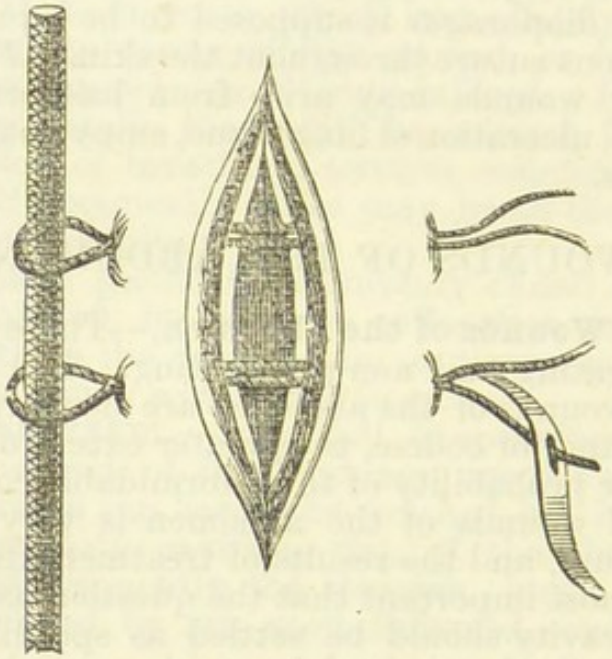

Fig. 81.—Application of the quilled suture to an incised wound.

A bullet may strike the abdomen obliquely and pass between the muscles and the skin, or between the peritoneum and the muscles, giving rise to alarming symptoms, causing violent pain, vomiting, and general derangement, such as prolonged collapse, followed by extensive peritonitis or suppuration. In the event of suppuration, an early opening should be made to prevent the possibility of pus perforating the peritoneum.

Should a bullet or other missile be lodged deeply in the abdominal walls, Guthrie suggests that it is often better left alone, unless it prove troublesome. This, according to the extensive experience of Mr. Otis, "is unsound;" he considers there are no other exceptions to the general rule of extracting foreign bodies, than the instances in which they are so situated in vital organs that their extraction may immediately jeopardise life. It is, he says, especially important to extract them from the abdominal walls, as they present a constant source of danger while they remain.

Complicated non-penetrating wounds, the result of contusion, may be accompanied by extensive injuries to some of the viscera or bones, and are generally the result of wind-balls, explosions, blows, falls, kicks from men or horses, or the passage of the wheel of an artillery-wagon or gun-carriage over the body. Death may result in a very short time from shock, or hæmorrhage, or peritonitis, or subsequently from sloughing or abscesses in the abdominal walls. The shock in these cases is of the severest description, amounting in some instances to prolonged collapse, and is probably connected with an internal hæmorrhage that is going on. Porter saw an instance of an artilleryman being thrown from the limber while in rapid motion, a wheel passing obliquely over the abdomen and pelvis; he was immediately attacked by prolonged collapse, vomiting, pains, bloody urine, and great restlessness, from which he never rallied, and expired in a few hours. The *post-mortem* examination gave evidence of extensive hæmorrhage into the peritoneal cavity, it being full of large clots. There was a fracture of the left ramus of the ischium and pubes. There was no external wound of any consequence, the skin being only a little congested where the wheel had passed over it.

Ruptures of the liver are by no means speedily or even necessarily fatal; they may be and usually are so from great extravasation of blood or bile, but the patient may live for a considerable period, though he may eventually succumb to septic peritonitis.

Pain, collapse, hæmorrhage, dulness on percussion, bilious vomiting, followed by peritonitis, white stools, jaundice, and saccharine diabetes, are the symptoms usually ascribed to rupture of the liver; only the three latter are characteristic.

Rupture of the Gall Bladder is always fatal. The best guide to the position of the gall bladder is the outer border of the right rectus muscle as it approaches the end of the tenth rib. An incision, 2 inches or 3 inches long, from this point directly downwards is that most usually resorted to to expose the viscus.—*Barker.*

Rupture of the Spleen.—Next to the liver, this viscus is represented as the most frequently lacerated of the abdominal organs, but such cases are by no means always fatal. Extended lacerations are followed by profuse internal hæmorrhage, severe shock to the system, coldness of the surface, great anxiety, pain in the seat of injury, and death. In India this accident often follows blows over an enlarged spleen.

Rupture of the Kidney, though well protected by its position in the loins, is not an infrequent accident. The symptoms usually present are, excessive collapse, pain referred to the lumbar region, retraction of testicle, and very likely pain in the testicle itself and low down in the abdomen; numbness in the upper part of thigh, bloody urine, frequent desire to pass water, and (should the patient survive) there will, in all probability, be infiltration or extravasation into the subserous connective tissue, which is more likely to occur in injuries to the posterior surface, and peritonitis in injuries of anterior surface. Infiltration is soon followed by septic inflammation, which will be recognised by rigors, fever, dry brown tongue, and œdema of the parts in the neighbourhood of the

wounded kidney. Should the kidney be severely contused there will, in all probability, be hæmaturia.

Rupture of the Stomach generally proves fatal from the shock alone or irrecoverable collapse. The extent of laceration, the contents, and degree of repletion of the organ at the time of rupture, influence the result. Should life be prolonged, the sufferer will complain of acute and constant pain radiating from the seat of injury. Hæmatemesis is a constant symptom followed rapidly by peritonitis.

Rupture of the Intestines, both of large and small may be recognised, as remarks Jobert, by sudden and excessive meteorism produced by the escape of intestinal flatus into the peritoneal cavity, but this symptom is regarded by others as not being uniformly present in intestinal rupture. Should the patient live long enough, the stools will be mixed with blood, the shock and collapse will be very great; but there will be difficulty in identifying the particular part injured. The part struck will, however, be an assistance in pointing out the seat of mischief. Emphysema of the abdominal wall may result from rupture of the intestine. This symptom is characterised by an inelastic, doughy, puffy, crepitating swelling of the connective tissue. In wounds which to all appearance are non-penetrating, or where there is no protrusion, this symptom is considered to be valuable in proving the existence of wound of the intestine.

Rupture of the Bladder.—The bladder, especially if at all distended, may be injured by falls, blows, or the impact of large spent projectiles. The organ may be paralysed by the concussion of shot upon the parietes of the abdomen. In the Soudan campaign of 1885, an officer when in the saddle had fastened his field case to the pommel; a fragment of shell struck this case violently against his abdominal parietes, temporary paralysis of the bladder followed, accompanied with pain and severe distress.

If the bladder is ruptured from direct violence within the peritoneum, and it is unrecognised, it is certain to cause death. Two cases of this accident have been reported by MacCormac.* The symptoms were in both cases much alike, a history of a full bladder, the story of direct violence, inability to micturate, though there was the desire to do so. Catheterism failed to draw off urine beyond some blood-tinged drops. In one case the catheter passed through the rent in the bladder and could be felt in the abdomen. Abdominal section was performed in each case and the rent in the bladder sewn by Lembert's method; both recovered.

Treatment.—In the general treatment of these injuries, the first step should be to try and restore the sufferer from the shock and collapse by keeping him very quiet, applying warmth to the extremities, and placing him in a comfortable position. Absolute rest should then be enforced, the patient not being moved or allowed to move himself. Caution should be observed in the employment of restoratives and stimulants, in consequence of their liability to cause too much reaction and induce internal hæmorrhage. If, however, reaction does not set in, the surgeon will have to consider the probability of there being a rupture of one or more of the viscera, and any symptoms of peritonitis would at once suggest this complication. "The presence of prolonged and profound shock,

* *Lancet*, December 11, 1886.

the duration of the shock is of greater importance than its intensity, a small and quiet pulse, and hurried respiration, associated with acutely severe, persistent, and localised pain increased on pressure, while the temperature remains either normal or subnormal, indicates the nature of the injury and points to the necessity of the operation of abdominal section."* On the ground that prolonged shock is usually due to internal hæmorrhage, which if not checked will certainly lead to a fatal termination.

Penetrating Wounds of the Abdomen, with protrusion of the viscera, are serious, whether incised, lacerated, punctured, or gun-shot.

Protrusion of the Intestine.—If the wound in the abdomen has been made by a cutting or lacerating instrument, or by a round ball or rifle bullet, it may be followed by protrusion of some portion of the contents of the abdomen, the omentum, mesentery, or intestine being most usual. The protruded mass is always very large in comparison with the aperture from which it escapes, and is held very tightly by the lips of the wound. If left unreduced, the mass will soon become gangrenous from pressure ; it should therefore be cleansed in warm, weak antiseptic lotion, and returned into the cavity of the abdomen, after which the wound is to be closed by sutures which should include the peritoneum as well as other tissues. Mr. Erichsen suggests that the abdominal muscles should be relaxed by bending the thigh upon the abdomen, when the protrusion may be pushed back by steady pressure upon it, but no force should be employed. If the parts cannot be reduced, the aperture through which they have escaped must be enlarged in the direction upwards. In replacing them, care should be taken that they are fairly put back into the cavity of the abdomen, and not pushed into the sheath of the rectus or in front of the peritoneum.

"If omentum protrudes, when it can be returned, do so after thorough purification, and then stitch the abdominal walls, including the peritoneum, close together. Where, from adhesions or other sufficient cause, this cannot be done, or where the omentum is very dirty, it would be the safest practice, especially in the case of a person with strong muscular parietes, to stitch the deepest part of the omentum to the deepest part of the wound, cut off the remainder, and close the skin over all."—*Cheyne.*†

Gangrene of Protruded Intestine.—Should the protruded part of an intestine become gangrenous from continued contraction and exposure, it should not be reduced, but an incision should be made through it, or the gangrenous part removed, so as to clear away fæces and admit of an artificial anus, by attaching the cut edges of the bowel to the wound in the abdomen.

Wound of Protruded Intestine.—Protruded intestine may be punctured, incised, lacerated, or completely divided. Some difference of opinion among surgeons has existed as to the proper method of dealing with the wounded gut.

Guthrie recommends—"When the wounded bowel protrudes, or the

* *On Abdominal Section*, Sir Wm. MacCormac, p. 36.
† *Antiseptic Surgery.*

external opening is sufficiently large to enable the surgeon to see or feel the injury by the introduction of his finger, there should be no difficulty as to the mode of proceeding. A puncture or cut, which is filled up by the mucous coat so as to be apparently impervious to air, does not demand a ligature. An opening which does not appear to be so well filled up as to prevent air and fluids from passing through it, cannot usually be less than two lines in length, and should be treated by sutures. When the intestine is more largely injured, in a longitudinal or transverse direction, or is completely divided as far as, or beyond, the mesentery, the continuous suture is absolutely necessary."

Mr. Travers advocates the stitching up of a wounded intestine, and bases his opinion on the result of experiments which proved that when a wounded gut was sown up and returned into the abdomen, the lymph was effused on the external surface of the bowel consequent on such an operation, and the stitches rapidly cut their way into the interior of the bowel, and were passed away into the stools.

From the great experience obtained during the American War of the Rebellion, it was found that in all punctured and incised wounds of the intestinal canal attended with protrusion, the safest practice consisted in closing the intestinal wound by suture and reducing the protruded viscus, unless its structure was irretrievably disorganised, when the adoption of the alternative of establishing a preternatural anus was compulsory.

MacCormac writes*—"Enteroraphy (a term used for suturing a wounded or divided intestine) is at the present time admittedly the best method of treatment for all punctured and incised wounds attended by protrusion, unless the parts are so damaged that an artificial anus seems preferable. The formation of an artificial anus is in the highest degree undesirable, and certainly unnecessary in those cases where the injury does not extend more than half-way around the calibre of the tube, or where the convexity of the bowel is wounded, and probably in all cases where the mesenteric attachment is intact." The intestinal wound having been, therefore, duly closed by suture, it should be returned in the abdominal cavity, and the abdominal wound at once closed also.

Penetrating Wounds of the Abdomen without Protrusion.—If the wound has without doubt penetrated the abdominal cavity, the next question that arises is, what injury, if any, has been occasioned to the enclosed viscera? Professor Parkes† states, as a result of his experiments on animals, "that no shock was observed apart from symptoms attributable to loss of blood, and wherever severe prostration occurred, there was always extensive hæmorrhage to account for it Gun-shot wounds of the intestines are attended with considerable hæmorrhage, great and prolonged shock, lowered temperature, feeble and rapid pulse, restlessness, severe pain, great anxiety, rectal tenesmus; there is always extravasation of fæces into the peritoneal cavity, although it is very rare for any sign of it to appear externally. The absence of this symptom, therefore, would be no proof that the intestine was not wounded. Air

* *On Abdominal Section*, by Sir William MacCormac, F.R.C.S., p. 13.
† *Gun-shot Wounds of Small Intestines*, by C. T. Parkes, M.D. Chicago, 1884.

in the abdominal cavity, emphysema around the wound, a larger escape of blood than the injury to the parietes will account for, are among the symptoms which help to indicate intestinal injury. The occurrence of bloody stools is usually a late symptom." Shock, as mentioned above, accompanies all penetrating gun-shot wounds. When it becomes more and more severe with increasing exhaustion, jactitation, feeble pulse, and respiration, we may conclude internal hæmorrhage is taking place, and we usually find the cavity filled with blood out of all proportion to the size of the vessels injured. Even in the case of small vessels there is a remarkable persistence in the flow of blood following their severance due to the laxity of the tissues, the absence of pressure, and the lack of the peculiar influence of the atmosphere.—*Parkes.*

Wounds of the Liver may consist of slight groovings or divisions of the peritoneal investments only; penetrations with a single outlet; long perforations; extended lacerations; wounds complicated by the presence of splinters from ribs, of fragments of clothing, of balls, and other foreign bodies. If patients escape the early danger of hæmorrhage they are liable to die of septic peritonitis. At the same time, serious injuries of the liver are not necessarily fatal. When a portion of the lacerated liver-substance protrudes at the external wound, it may be safely removed by ligature.*

Wounds of the Kidney are frequently associated with wounds of the liver, spleen, diaphragm, stomach, intestines, or spine. Punctured and incised wounds are uncommon, though shot wounds are not very infrequent. These wounds are very dangerous, but not necessarily mortal, unless the peritoneum is also wounded, and urine escapes into the cavity of the belly, when fatal peritonitis is almost inevitable.

When the kidney has become protruded it may be removed, as evidenced by a case reported by Surgeon-Major M. Marvand of an Algerian regiment, in which an Algerian woman, who had been severely wounded in the lumbar region, where the kidney was drawn out of the wound, between the lips of which it remained strangulated. A silk ligature was passed around the pedicle of the extruded organ, and at the end of some weeks the kidney was separated. After two months she was discharged well. Nephrectomy has now been performed in many cases with successful results.

Parkes remarks: Bleeding from slight lacerations of the spleen, kidney, or liver can be controlled by actual cautery lightly applied after abdominal section. Slight lacerations only at some point on the surface were closed by bringing together the peritoneal surfaces of the organ over the wound by means of the continued suture, but severe perforating and lacerated bullet wounds of the kidney and spleen could not be treated successfully in any other way than by an absolute removal of the injured organ.

Wounds of the Stomach may be recognised by the position of the wound, its depth and direction, the escape of food or drink, vomiting of blood, pain, faintness, thirst, singultus, tympanitis, pallor, cold extremities. The extravasation of the contents of the stomach is probably

* *The Medical and Surgical History of the War of the Rebellion*, Part II., vol. ii., p. 147.

the only pathognomic sign of the division of its walls. Much difference of opinion exists as to the proper rules of practice in punctured wounds of the stomach. If the opening is somewhat small, it is recommended it should be closed with the interrupted suture by means of a delicate needle and fine gut. In more extensive wounds, the continued suture, or one of its numerous modifications, may be applied.

MacCormac writes: "Where there is a fair presumption that a wound of the stomach has occurred, abdominal section should be performed, the opening in the stomach sutured, and the external wound closed, a practice much to be preferred to attempting the formation of a gastric-fistula. When the wound is on the anterior side or at all accessible, and not complicated with otherwise fatal injury, it should be thus dealt with, as bleeding is arrested, extravasation prevented, and the abdominal cavity can be cleansed and disinfected." *

Treatment of Penetrating Abdominal Wounds.—In endeavouring to form an opinion as to the part injured, the surgeon will find much help from collateral evidence; from the size of the instrument that inflicted it, the position and direction of the wound, and the character of any stains which may appear on the wound or clothing.

Parkes states: "Nothing can possibly be more uncertain and erratic than the track of a bullet through the body; any slight obstruction is sufficient to divert it from the direct line of flight. No reliable inference as to the course of a bullet can therefore be made from the position of the wounds of entrance and exits." And he further adds: "The wounds of entrance and exit of the bullet should not be disturbed in any manner except to control bleeding or to remove foreign bodies when present." His experiments also prove how useless it is to expect that the intestines will escape being wounded after the passage of a bullet through the abdomen. In a case, therefore, of a penetrating bullet wound, we may assume that the intestines must also be wounded; and Parkes' experiments prove that the hæmorrhage will be severe and *out of all proportion* to the size of the vessels injured, and that it cannot be controlled without an abdominal section.

Again, if the intestine has been wounded, it is absolutely certain that there will be extravasation of the contents of the bowel into the abdominal cavity, though there may be no sign of this externally.

As these two results—viz., hæmorrhage and extravasation—are the certain causes of septic peritonitis, "it will be more reasonable," says MacCormac, "to submit the patient to the less serious risk incurred by abdominal section than to leave him in the deadly peril, from the consequence of a wounded intestine or a bleeding vessel, on the mere assumption that they may possibly have escaped injury. But, although there may be uncertainty as to the extent of the lesion, it is surely better to solve the doubt by an exploratory abdominal section which may afford the only possible means of rescue. The operation is practically useless after twenty-four hours have elapsed, or when general peritonitis and great collapse have set in. A moderate amount of peritonitis, however, by no means contra-indicates the operation."

* *On Abdominal Section*, by Sir William MacCormac, F.R.C.S., page 30.

If it is decided to operate and explore the abdomen, every precaution of an antiseptic nature should of course be taken. The temperature of the room should be high, the bowels and bladder should be empty, the surface of the abdomen should be thoroughly cleansed, and the greatest care taken about the cleanliness of the operator's hands and instruments. Parkes says that the incision through the *linea alba* is the best method of procedure, as it at once gives command over the entire cavity; therefore, any lesion likely to result in harm is far less liable to be overlooked; it is the least vascular part of the walls; incisions thereof are more easily and perfectly co-aptated than elsewhere, heal readily and soundly, and, as a consequence, the on-coming cicatrix is less likely to be followed by ventral hernia."

The operation is incomplete unless the entire intestinal track be examined as well as the stomach and other viscera. The best way is to seek the cæcum first and then trace the small intestine upwards for its length. All bleeding points must be secured and the clots swept away. Parkes thinks that bullet openings in the bowel not implicating the mesenteric border, may be dealt with by drawing the peritoneal surfaces together after turning in the torn edges of the wound, and thus converting it into a linear wound. If several openings exist close together, it is better to resect the portion of intestine involved.

When the points of injury are widely separated from each other and extensive damage done at each point, several resections of a length of the tube, just sufficient to include the injured portions, must be made. Perforations passing through the mesenteric surface of the intestine are the most difficult to treat, and even slight ones require a complete excision. Parkes states that in his experiments upon dogs, immediately after division of the intestine there follows an instantaneous, regular, and considerable contraction of the calibre of the tube close up to the divided edge caused by the action of the circular muscular fibres. The diameter is often lessened more than half by this contraction; this persists for a time, but is soon followed by an eversion of the mucous membrane which rolls out and over the constricted portion in a remarkable manner. This protrusion of mucous membrane forms a serious obstacle to easy and close approximation of the ends of the bowel in the efforts to bring them together by suture; it is, however, never to be cut away as it gives strength and support to the sutures.

In all instances in the experiments where a perforation was severe enough to require a resection of the wounded part it was found advantageous to leave, if possible, a strip of bowel near the mesenteric junction, taking out the wounded portion by means of a V-shaped incision. The part left acted as a support to the wound, avoided division of the blood-vessels at this point, opposed the action of the longitudinal fibres, and in no instance in which this plan was adopted was there any appearance of separation of the wound, or any displacement of stitches. The point of attachment of the mesentery with the bowel will usually be found the most troublesome to manage in applying the sutures for restoring a complete division. The difficulty arises apparently from the manner in which the folds of peritoneum separate from each other before passing on

to invest the bowel, leaving a little triangular interval filled with loose connective-tissue, fat, and blood-vessels. If the suture fails to include the muscular coats of the intestine as well as the peritoneum at this point, the junction will surely give way and extravasation result. To make this point secure, the greatest care must be taken in placing at least three sutures, and these should always be the first sutures applied. In placing the remaining sutures to complete the junction, after placing the three sutures mentioned at the mesenteric surface, apply one at the most convex surface and then one half way down on each lateral surface. After this the remainder can be introduced easily and rapidly. Fine Chinese twist silk is the best material for sutures, and ordinary straight sewing needles were found to be the most convenient. The sutures should not be drawn too tight. They must be drawn only sufficiently close to bring the surfaces fairly in contact, the subsequent swelling from obstructed circulation will hold the surfaces firmly together until glued to each other by the rapidly forming adhesive lymph.

If only a small portion of intestine has been resected, the mesentery, after all bleeding points have been checked, may be taken up by a running suture and then stitched down to the bowel at the seat of operation, making, as nearly as possible, a continuous surface of mesentery.

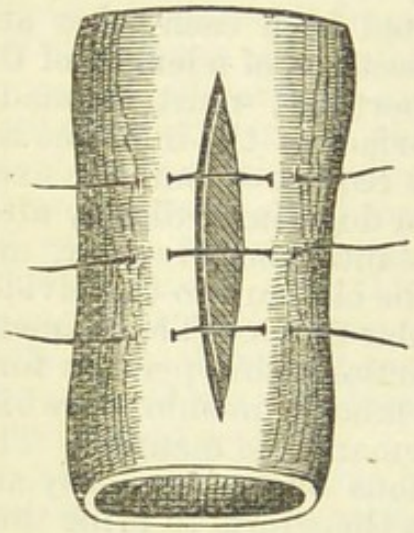

Fig. 82.—Interrupted sutures of Lembert.

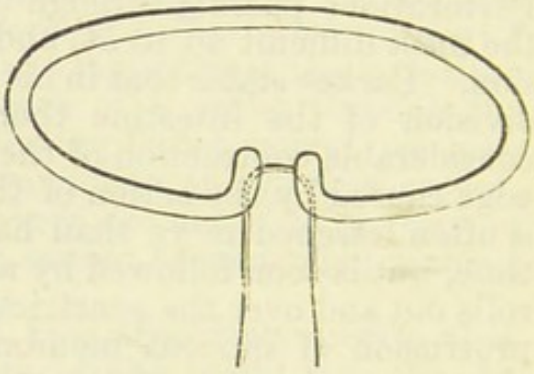

Fig. 83.—Shows the inversion and approximation of the serous surfaces.

If a large portion of bowel requires removal, a triangular piece of mesentery will have to be excised.

To prevent extravasation after the intestine has been divided several clamps have been invented, but in any case, before completing the division, the contents should be pressed back and the bowel trusted to an assistant's fingers which are said to be the best form of clamp if available.

The sutures should be introduced by means of a fine round sewing needle, armed with a fine sewing silk, after Lembert's method (see fig. 82). They must include at least one-third of an inch of bowel-tissue

passing through only the peritoneal and muscular coats and never including the mucous membrane. The everted mucous membrane must be carefully inverted, and needs no further treatment. Parkes thinks that it makes no difference whatever what kind of suture is used, so that the principle of positively securing the application of two broad surfaces of peritoneum in contact with each other is certainly carried out. Jobert's, Gely's, and Czerny's double row of sutures were all given a fair trial, but none of them resulted as well as this modified Lembert's stitch.

After the intestines have been dealt with, the peritoneal cavity will require a thorough cleansing and this, in the opinion of the most experienced men, is best done by flushing. Sufficient warm water must be used until it returns quite clear. Mr. Meredith* writes "that drainage and flushing have revolutionised abdominal surgery. The employment of drainage tubes of small calibre, and duly protected against septic decomposition, had done much to render drainage safe and efficacious. The plan of flushing, combined with drainage, has proved of immense value in abdominal operations, especially when undertaken for injury to, or rupture of, the hollow viscera. The addition of antiseptics to the water used is fraught with the risk of poisoning, even the precaution of using water previously boiled is not essential to success provided a fluid was used which was not itself contaminated with septic material." All sponging should be avoided. In closing the wound the deep stitches must be passed before any are tightened. After the sides of the wound have been brought together by the deep stitches, which must embrace the whole thickness of the abdominal walls, finer stitches may be put in to bring the edges of the skin in contact. M. Pozzi, of Paris, when closing a wound made in abdominal section, stitches the different layers separately, he first sews up by continuous gut-suture the peritoneal edges, then the aponeurotic edges, and lastly the skin and subcutaneous tissue; by this means he thinks he gets a firmer scar. If thought necessary a drainage tube must be passed into the most dependent part of the cavity and brought out at the lowest angle of the wound. The dressing should consist of abundant folds of sal alembroth wool, or other dry absorbent antiseptic material retained in place by sufficient pressure by means of a bandage. After most abdominal operations the patient should be kept without food for from twenty-four to forty-eight hours. A small quantity of iced soda-water or barley-water may be given to allay thirst. The position of the patient is important; it should be one that admits of the abdominal muscles being relaxed.

How far this practice of abdominal section for injury can be carried out in the field has yet to be decided. Here the hurry, the dirt, and confusion, the want of repose and sufficient assistance, all tend to make the operation difficult. It is not an operation that could be attempted at a dressing station, and when the unfortunate man arrives at the field hospital it will in most cases be too late. M. Delorme of the Val de Grâce writes—"When a citizen of a large town has his abdomen penetrated by a bullet either in an attempt at suicide or homicide, he

* Paper on "Present Position of Abdominal Surgery," read before Medical Society by W. A. Meredith.—*Brit. Med. Journ.*, April 19th, 1890.

finds in a hospital the conditions most favourable for the success of the immediate treatment which may be thought necessary in his case. But how different is the situation which presents itself to the soldier wounded in battle. Suffering from intense shock, in a state almost moribund, he will at first have to wait long hours before he can be attended upon. Then, not till after he has been subjected to a rough and ready carriage, will he receive the aid of the ambulance surgeon. This ambulance has nothing of the complete and useful arrangements of the operating theatre; it is fitted hardly sufficiently for the most ordinary operations of field surgery." He concludes by saying, "the wounded in the field who have bullet wounds of the intestine do not find themselves, except under rare circumstances, under conditions which allow of an abdominal section. The operation is unfitted for the ambulance, and when the wounded men reach the field hospital it is too late."

Peritonitis.—The surgeon must ever be on the watch for the approach of diffused septic peritonitis, which is the great danger to be apprehended in all injuries of the abdomen. It is accompanied by tenderness all over the abdomen, especially at the wound, tympanites, vomiting, hiccough, a hard, quick, and small pulse, great heat of skin, and anxious expression of countenance. It is also attended with an abundant coagulable exudation, which, in the case of septic peritonitis, will soon become puriform and the cause of acute septic poisoning. Hence the indications for treatment have undergone a complete change, and several surgeons advocate the same methods as we successfully apply to other septic inflammations, namely, a free incision and drainage. The peritoneal cavity then should be opened and the fluid be allowed to escape, the cavity should be then and subsequently washed out with warm weak boracic acid solutions, or with warm water alone. Carbolic acid or corrosive sublimate should not be used for this purpose. A drainage tube should be inserted. Mr. Lawson Tait * says—"There are three modern details, the adoption of which has certainly contributed above all others to make our work in abdominal surgery successful. They are the cleansing of the peritoneum by water, the use of the drainage tube, and the use of saline purgatives in the early stage of peritonitis following operations. Even when we have cleansed the peritoneum thoroughly of all dirt in which germs are likely to multiply and to produce their poisonous effects, and used a drainage tube properly placed, we may yet have in thirty-six or forty-eight hours indubitable evidence of the onset of peritonitis in a large proportion of cases. The prompt use of the turpentine enema and seidlitz powder will arrest the peritonitis and divert the case from its fatal issue with as great certainty as anything I know in the practice of surgery."

The absorbing power of the peritoneum is great; if, therefore, the exudation be small in amount it may be so rapidly absorbed that no decomposition may take place and micro-organisms, if few in number, will also disappear and be excreted. This leads us to see that the administration of opium is a mistake owing to its restraining influence on

* Present state of Abdominal Surgery. Medical Society. *Brit. Med. Journ.*, April 17, 1890.

all absorption and excretion. Mr. Meredith points this out, and also explains that the rationale of giving saline purgatives in the early stage of peritonitis could only be explained by their promoting absorption and excretion.

Foreign Bodies Lodged in the Cavity of the Abdomen are not of uncommon occurrence, and instances have been adduced when they have become encysted and ultimately eliminated by stool. The act of exploring shot wounds of the belly for lost missiles could only be undertaken after due consideration, but now that abdominal section has been so established it would not seem more dangerous to perform it for the purpose of removing a foreign body, as a bullet, from the cavity of the abdomen than to do so for an ovariotomy or an intussusception.

Colotomy.—Mr. Christopher Heath recommends the following operation (*British Medical Journal*, December 1, 1887):—Place the patient on the right side, with a pillow under the loin, in order that the left loin may be thrown into greater prominence. Then measure a point midway between the anterior and posterior superior spines of the ilium, and from that point draw a vertical line upwards to the last rib. This line will give you the position of the bowel. Then make an incision 4 inches long, somewhat obliquely, between the crest of the ilium and the last rib, half of the incision being on each side of the vertical line marked out. It should be slightly oblique, running parallel to the last rib. In making this incision, you divide the skin, subcutaneous fat, the external oblique and latissimus dorsi muscles, thus exposing the internal oblique; you now expose the fascia lumborum, which you carefully divide on a director. You have now exposed the loose fat about the kidney and colon in the anterior part of the wound, and the edge of the quadratus behind. The bowel may be found just in front of the quadratus lumborum, and should be brought into the wound with the hooked finger; its posterior surface should be exposed. With a large curved needle you pass a stout silk thread through the skin to one side of the ink mark across the bowel, and again through the skin at a corresponding point on the other side of the mark, repeating the proceeding at the other end of the incision. Thus, the colon is held to the margin of the wound before being opened. A transverse incision is now made into the bowel between the threads, and, the finger being introduced, the two loops can be drawn out, and, on dividing them, you have four threads to fix the bowel to the wound only requiring to be tied. The rest of the incision on each side of the bowel is then closed by ordinary sutures, and the operation is completed.

WOUNDS AND OTHER INJURIES TO THE SPINE.

Injuries of the spinal cord may be divided into concussion and compression, the same as injuries of the brain, to which they bear much resemblance.

Concussion may occur directly or indirectly, as, for instance, from a blow, or by falling from a height on the buttock.

Mr. Alexander Shaw says, in his remarks on Concussion of the Spinal

Cord—"But certain cases of injury of the back are met with in which paraplegia has directly or shortly afterwards occurred, and in which, upon examination of the spine after death, no fracture, displacement, extravasated blood, or anything capable of compressing the cord, can be discovered. The explanation therefore given is, that the spinal cord had been damaged by concussion."

The following symptoms of concussion are usually present from direct violence:—Pain at the seat of the injury, vomiting. If the phrenic nerve is irritated, hiccough, and feeling of constriction round the body will be present. When the vagus nerve is irritated, there will be a sense of suffocation, with probably irregular action of the heart and distressing vomiting. There may be loss of power over the sphincters of both bladder and anus, with incontinence or retention of urine or fæces, or the bladder only may be affected.

In concussion from indirect violence, the symptoms are sometimes insidious and protracted, and do not show themselves until the more apparent injuries are recovered from. For instance, after an explosion men, who have been badly burnt or otherwise obviously injured, after recovery from these injuries often develop a secondary train of nervous symptoms, which quite unfits them for the performance of their duties, and renders them utterly miserable and helpless. They become nervous and timid, and different from their former selves.

Treatment.—In treating these injuries, absolute rest to the parts is the principal object to be arrived at.

Mr. Erichsen, who appears to have made a special study of this subject, says—"The importance of rest cannot be over-estimated. Without it no other treatment is of the slightest avail." He considers it of the utmost importance to insist upon absolute and entire rest, for this reason, that not infrequently patients feel for a time benefited by movement, but nothing can be more erroneous than this idea, for the patient will invariably be found to fall back into a worse state than had previously existed. With this rest, which should be in the prone position, he recommends chloral to procure sleep, and the bromide of potassium to allay the irritability. Counter irritation may be applied to either side of the spine, and, if there are inflammatory symptoms present, ice may be used with advantage. Subsequently tonics in the form of iron, strychnine, and cod-liver oil.

Compression of the spinal cord may be induced by injuries to the vertebræ, such as fractures, dislocation, penetration by gun-shot wounds, or by extravasation of blood or pus. The symptoms produced depend much upon the position of the injury.

These injuries are of the greatest importance to the patient, as much will depend, as regards the future of the sufferer, on the amount of damage inflicted.

In dislocations or fractures without an external wound, the symptoms which generally present themselves are shock to the nervous system, profound collapse, pain in the seat of injury, tumefaction of injured part, unevenness or depression of projections in the process of the vertebræ, and paralysis of the body below the level of fracture.

Paralysis in Injury of Spine.—The extent of paralysis differs according to the part of the spinal column injured, as, for instance, with a fracture or dislocation in the cervico-dorsal region, all the body below seat of fracture will be paralysed, and if the injury to the cord has been above the origin of the first dorsal nerve which joins the axillary plexus, some impairment in the motion and sensation of the upper extremities will be discovered; but the principal danger overhanging the patient is connected with his respiration.

Injuries of the spinal column, above the origin of the phrenic nerve, are attended with instant death.

Fracture and dislocation in the dorsal region between the fourth and tenth vertebræ causes complete paraplegia. The bladder and rectum will be paralysed, and bed sores are sure to form.

In fractures or dislocation of the lower lumbar vertebræ, there may be no paraplegia or paralysis, if the injury is below the second lumbar vertebra, in consequence of its being below the level of the spinal cord, which terminates there.

Treatment.—No attempt, it was said, should be made to reduce a fracture or dislocation of the spine. Means should simply be adopted to support nature by means of nourishing diet, to prevent sloughing bed sores by placing the sufferer on a water bed or soft mattress, the urine should be drawn off regularly, and great cleanliness observed. The bowels may be moved involuntarily at first; but afterwards be constipated, when they should be relieved by enemata.

In penetrating wounds, where the vertebræ may be driven in on the cord, splinters, articles of clothing, and muscular tissue may have to be elevated, extracted, or removed. With a view to enable the surgeon to do this, the trephine, elevator, or small saw may be had recourse to.

The Trephine in Injuries of the Spine.—Sir T. Longmore, in speaking of the use of the trephine in these injuries, says—"In injuries of the vertebral column and spinal cord occurring in military practice, the mischief is usually so complicated and extensive, and the medulla itself so bruised, that the cases must be very rare, indeed, in which the operation of trephining, if justifiable in any case, can offer the slightest prospect of benefit." He mentions that M. Baudens extracted by means of an elevator a ball which had lodged in the eleventh dorsal vertebra, and was causing compression with complete paraplegia. The paralysis disappeared immediately after the extraction of the bullet; but tetanus came on four days afterwards, and proved speedily fatal.

Mr. Victor Horsley writes*—"I have now trephined the spine nineteen times with one death, that is from shock. Personally I view the operation in the majority of cases as possessing the only risk of sepsis. As regards fractures of the spine, unquestionably we ought to operate without delay in all cases where displacement or crepitus indicates compression, and when extension directly after the accident clearly fails to reduce the deformity."

The course recommended to be adopted in applying the trephine is first to make an incision in the line of the spinous process about an inch deep

* *Brit. Med. Journ.*, Dec. 6, 1890.

and 6 inches in length, or according to the extent of the injury, through the skin and muscles, which should be cleared away on either side of the spine, and the bony structure exposed to admit of the trephine being applied. Before using the instrument, loose pieces of bone should be elevated and removed, care being taken not to push any spicula into the spinal cord.

Hey's saw and cutting pliers will be found most useful in dividing processes or arches.

Mr. Shaw considers that, "in injuries of the spine, except in those cases of fracture high in the spine, in which respiration has been interrupted, the paralysis is not the direct cause of the fatal termination."

In cases of fracture generally, "the chief dangers to life arise from extensive and exhausting sloughs and bed sores, morbid conditions of the bladder and urinary organs generally, and in a certain degree derangement of the bowels. These are indirect effects of the paralysis. But if they be overcome, the mere loss of motion and sensation in the limbs, and inability to control the action of the bladder and rectum, will destroy life, or be inconsistent with the patient enjoying good health.

INJURIES TO AND WOUNDS OF THE PELVIS.

Classification of Injuries to and Wounds of the Pelvis—Under this heading will be considered shot fractures of the innominate bones and sacrum, and wounds of the contained parts, namely, of the bladder and rectum, and wounds of the genital organs.

As compared with penetrating wounds of the abdomen, wounds of the pelvis are far less fatal. In wounds of the abdomen, hæmorrhage and diffuse septic peritonitis are the chief sources of danger; in wounds of the pelvis, cellulitis with gangrene, urinary infiltration, necrosis with exfoliation and protracted suppuration, paralysis and pyæmia are the more common causes of death.

Contusions of the Pelvis.—Contusions of a slight form require no difference in their treatment from similar injuries in other parts of the body; but they may be of a severe nature, as from a spent cannon-shot or fragment of shell, producing great extravasation of blood under the integuments or gluteal fascia. These swellings will, as a rule, disappear after repose and local application of stimulating lotions.

Fractures, Dislocations, and Gun-shot Injuries.—In striking the pelvis, large solid shots occasion such frightful disorders that death ensues before inflammation has time to set in, the soft parts are lacerated or pulpified and the bones comminuted. Rifle bullets cause a very great variety of comminutions, even slight shot fractures of the pelvis are long in healing. Much of the gravity in shot perforations of the pelvis will depend upon whether the missile fractures the bone on entering and so drives the splinters inwards, or fractures the bone on emerging and so drives the splinters outwards.

Dr. Stromeyer has pointed out the liability of wounds of the pelvis to

pyæmia when the missile enters posteriorly and so traverses the thick gluteal muscles before fracturing the bone, the long shot tracks favouring septic inflammation and sloughing.

Shot Fractures of the Ilium.—The frequency with which balls are embedded in the ilium is considerable, and most readily, of course, in the spongy parts of the bone. Ostitis followed by caries and necrosis with protracted suppurations are the results, and these injuries are also apt to be complicated by irritation of the branches of the sacral and sciatic nerves with consequent neuralgia, paralysis, or muscular atrophy. The bone may be largely and variously comminuted.

Shot Fractures of the Pubis are more fatal than those of the ilium, and owing to the toughness of this bone it is seldom much splintered by bullets; caries is a less common result. The excess of mortality is due to a greater frequency of sloughing of the pelvic fascia, of injuries of vessels and nerves, and of urinary and fæcal extravasation.

Shot Fractures of the Ischium are less common and less fatal than analagous lesions of the pubic bone; the bullet is sometimes found impacted. Pelvic cellulitis with deep suppurations are frequently the result of shot fractures of the ischium, and in some instances these injuries are associated with injuries of the femur, or of the genital organs.

The Sacrum is less liable to fracture from ordinary external violence than the other bones of the pelvis, because of its thickness, its spongy texture, and situation, but these conditions afford no exemption from shot fractures. Fractures of this bone may be accompanied by injury to the rectum or bladder, and paralysis and other disorders referable to lesions of nerves are common.

Experience shows the importance of removing detached fragments of bone after shot fracture of the pelvic bones, and of using energetic means for the removal of the balls.

Baudens recommends that when a missile perforates the ilium and lodges under or in the iliacus or psoas muscle, it is safer to seek it through an incision similar to that made for ligation of the common iliac artery, rather than to enlarge the shot canal in the bone.

WOUNDS OF ORGANS OF MICTURITION.

Wounds of the Bladder.—Shot wounds of the bladder are very dangerous. The Report of the American War says that in very few instances were the recoveries complete, and it was rare to find the functions of the bladder perfectly restored. If the part of the bladder covered by peritoneum is perforated by the shot there is little or no hope, but if both orifices are below this and free egress for the urine is provided, either through a catheter or through the shot tracks, recovery may be looked for in a considerable number of cases.

Shot wounds of the bladder may be complicated by the presence of foreign bodies in the cavity of the organ, such, for instance, as the projectile itself, fragments of bone, portions of clothing, bit of integument

or hair, &c. These extraneous bodies can sometimes be extracted through the wound, and sometimes they are discharged by the natural channel; most frequently, however, they remain, become encrusted with phosphatic deposits, and have to be removed by operation.

The only pathognomic sign of wound of the bladder is the escape of urine by the artificial opening, pain, frequent micturition, and bloody urine are uncertain signs. Urinary infiltration, followed by septic poisoning, is the cause of death in a large proportion of cases; if the urine gains access to the peritoneal cavity, diffuse peritonitis is likely to be the result; if it permeates the pelvic fascia, sloughing and diffuse suppuration will follow.

Every effort should be made to prevent urinary infiltration; if the wound were from a stabbing or cutting instrument, and it was believed that the wound was of an intra-peritoneal character, an abdominal section should be undertaken with a view of suturing the vesical wound and of flushing the peritoneum with warm weak boric water. In any case the attempt should be made to restore the passage of the urine by the natural channel, to prevent distension of the injured organ, and to evacuate blood and other foreign matter accumulated in its cavity.

Puncture of the Bladder.—The surgeon is sometimes called upon to perform this operation for retention of urine consequent on injuries of the urethra. Mr. Cock's method, per rectum, is the most simple, and is as follows—"The patient is to be placed and held in the position for lithotomy, and brought well to the edge of the bed. The operator is then to introduce the index finger of the left hand into the rectum with the palm upwards, and to feel for the prostate, and, if possible, for the bulging base of the tense bladder beyond it, some little pressure above the pubes may help in this attempt. The pulpy point of the index finger is then to be held in the median line, just below the spot at which the puncture is to be made. The surgeon, with his right hand, is then to take from his assistant the canula, well oiled, and fitted with the blunt pilot trochar, and introduce it into the rectum upon his left index finger, passing it well up to the point selected for puncture. He is then to steady the canula and hold it firmly in position with the thumb and three outer fingers of the left hand, and withdraw the blunt trochar. The sharp trochar is then to be introduced through the canula, and having reached its end, the handle with the canula is to be depressed and then driven home in a direction upwards and forwards, in a line towards the umbilicus. The trochar should then be withdrawn, and the canula pressed well home and secured. A plug may be placed in the canula to retain the urine."

The operation of lithotomy may be required in war time for the removal of bullets or other missiles from the bladder. The operation (lateral) is thus described by Sir W. Fergusson—"The point of the blade of the scalpel should be entered about $1\frac{3}{4}$ inch in front of the anus, about a line's breadth to the left of the raphe, pushed through the skin, and carried by a kind of sawing motion down the left side of the perineum, about $1\frac{1}{4}$ inch beyond the anus, the middle of the incision being at equal distances from the latter part and tuberosity. Next, the blade should run along the

surface of the exposed fat and cellular tissue, and then the point of the forefinger of the left hand should be thrust into the wound a little in front of the anus, so as to penetrate between the accelerator urinæ and the erector penis muscles—the knife being applied to any part which offers resistance; when, with a little force to separate the tissues, the tip of the finger can be placed upon the membranous portion of the urethra, and the groove in the staff may be distinctly felt. The point of the blade, with the flat surfaces nearly horizontal, should now be carried along above the finger, made to perforate the urethra about three lines in front of the prostate, and then be slid along the groove until it has entered the bladder, having slit open the side of the urethra, and notched the margin of the prostate in its course. The forefinger of the left hand should next be slipped slowly into the bladder along the staff, in such a manner as to cause dilatation of the surrounding textures, and its point should be moved about in search of the stone, which, being found, should be retained in position near the neck of the viscus; then the staff should be removed, and the forceps introduced along the upper surface of the finger, slowly withdrawing the latter as the former makes progress: this will be denoted by a gush of urine, at which instant the blades should be separated, when, on gently approximating them, the stone will in all probability be felt enclosed."

WOUNDS OF THE ORGANS OF GENERATION.

Wounds of the Penis, Perineum, and Urethra.—Missiles have been known to traverse the penis and perineum, and otherwise injure these parts. In wounds where the urethra has been laid bare, a catheter should be introduced and tied in; and, if the wound be clean, with edges in such condition that adhesion might be anticipated, they should be brought together by interrupted sutures; but, if much lacerated, it will be necessary to wait patiently the process of healing by granulation, taking care that the urethra is kept free by the introduction of a catheter whenever the patient requires to pass water. When the laceration has been so extensive that closing by granulation is impossible, it is best to try and retain the direction and patency of the urethra as far as practicable by frequently introducing a sound or catheter, and afterwards closing the wound by a plastic operation.

Erections are a great hindrance to the healing of wounds of the penis, they tend to induce hæmorrhage and necessarily break up incipient adhesions, retarding union. The parts should be lightly dressed, the bed should be hard, regimen spare, and excitement avoided. Camphor and hyoscyamus may be given with advantage.

Retention of urine is not uncommon with laceration of the urethra; an attempt should first be made to pass a catheter, which should be done with the greatest gentleness; the surgeon should pass the catheter as far as it will go; he should then place the patient in the lithotomy position and proceed to cut down, in the mesial line of the perineum, upon the end of the catheter, and from this opening he should endeavour to pass

a female catheter or tube into the bladder, and if he succeeds in passing it, he should tie it in. If this is impossible from the torn condition of the urethra, the bladder should be punctured. On the first appearance of infiltration deep and free incisions are necessary.

Foreign Bodies in the Urethra.—The urethra may be obstructed by foreign bodies being driven into the canal by projectiles, or expelled from the bladder, such as fragments of bone, clothing, and small projectiles. When situated near the meatus, it is possible to remove them with a small forceps, a bent probe, or metallic loop; but should such simple means be unavailing, it will be necessary to resort to incision, which would be more prudent than incurring any danger to the canal by persistent efforts at extraction.

Wounds of the Scrotum, when uncomplicated, are not very serious, and require but little interference; open wounds should be closed by sutures, and the parts dressed antiseptically and well supported. It may be laid down as a general rule that all incised or lacerated wounds of the genitals should be closed by sutures, if the parts can be possibly brought together. Balls may lodge in the scrotum without doing any injury to the testes or other parts, they should be removed.

Wounds of the Testes cause intense pain extending to the lumbar regions attended by faintness and, often, by vomiting and even collapse. They may be severely bruised, shattered, or detached from the cord. Of 586 cases of this group reported as having occurred during the American War, the largest proportion consisted of lacerated wounds of one or both testes.

Relief must be afforded by the administration of opium, the organ should be well supported and cold or warm water applied. Should there be any portion of either testicle partially detached, or extensively lacerated, it may be removed, as in all probability it will become diseased. Guthrie removed the bruised and shattered remains of testes and epididimis to expedite the cure.

Wounds of the Spermatic Cord are generally associated with wounds of the testes; they are of infrequent occurrence, and rarely lead to fatal consequences; it may, however, be necessary to ligature the spermatic artery in cases of violent hæmorrhage from it.

WOUNDS OF THE ORGANS OF DEFÆCATION.

Wounds of the Rectum and Anus.—Lacerated and incised wounds of these regions are rare in war, the parts being more or less protected, but shot wounds of the rectum are not infrequent.

During the Crimean War and Indian Mutiny, Porter saw only one example of this description of wound, which occurred to a soldier who, while attending to the calls of nature in an advanced trench in the squatting position, was struck with a fragment of a shell, which removed the scrotum as if it had been done by a knife, lacerated the buttocks, and divided the sphincter ani, causing violent hæmorrhage and involuntary

passing of stools. The misery and intense suffering of this patient can scarcely be described, and as the healing process was entirely by granulation, he was a long time under treatment.

Incised wounds of the rectum and anus heal very readily, but from their close proximity to the bladder and peritoneum, inflammatory symptoms must be looked for and checked. The bowels should be kept in a state of perfect repose, and strict cleanliness of the parts observed.

Shot wounds of the Rectum are generally complicated with fractures of the pelvic bones or injury of the bladder, and most commonly prove fatal from pelvic cellulitis with diffuse suppuration, or from secondary hæmorrhage. Should a patient with such a wound survive, he will in all probability suffer from a stercoral or urinary fistula, kept open by discharges from carious bone or the occasional escape of sequestra. These injuries may also give rise to paralysis with incontinence of fæces, obstinate constipation, stricture, muscular contraction, and recurrent abscesses.

Dupuytren recommended a division of the sphincter in cases where the fæces were retained and overflowed through the perforation in the upper part of the gut. This practice was adopted with most satisfactory results during the American War and the Franco-German War of 1870-71. Possibly forcible dilatation of the sphincter by means of both thumbs of the surgeon would suffice, as this paralyses the sphincter for a time; the dilatation should be slowly and steadily effected by working the thumbs in opposite directions until the anus is perfectly flaccid.

Hæmorrhage of the Rectum should be promptly attended to; a bladder may be introduced and dilated with ice water directed from a tube attached to an inverted bottle or irrigator. In serious hæmorrhage the gut must be dilated by a speculum (fenestrated), and the bleeding vessels secured if possible. It may, however, be necessary to apply the actual cautery, galvanic current, or perchloride of iron.

WOUNDS OF THE EXTREMITIES.

Classification of Wounds of the Extremities.—These wounds may be divided into contusions, lacerations, incisions, or punctures of soft parts, injuries of bones or joints, all of which may be complicated with wounds of the great arteries or nerves.

With regard to contusions, lacerations, incisions, or punctures, their treatment has already been remarked upon; it is therefore unnecessary to refer to these again. Injuries of bones and joints will now be considered, and, in connection with them, wounds of arteries and nerves.

General Remarks on Gun-shot Fractures.—"Bones may be injured by having the periosteum contused or removed, as when a bullet is flattened against them, giving rise to periostitis, exfoliation or throwing off of scales, and frequently to disease of the medulla, or formation of deep abscesses producing great constitutional disturbance."

Bones may be fractured—which injuries, as in civil life, are divided

into simple, compound, and comminuted; but in consequence of the instruments or weapons which inflict them in war, they, as a rule, present peculiarities to the army surgeon not met with in civil life, where accidents to bones generally arise from falls, kicks, or muscular action: whereas in the army, fractures are for the most part caused by direct violence, by spent cannon-shot, bullets, slugs, grape-shot, fragments of shell, and other missiles causing many complications.

Simple Fractures are probably the most rare of all kinds met with on active service; but should such occur in the field, the surgeon will have much to consider, as, from any want of care, or from improper adjustment of splints, the broken ends of the bones may protrude through the soft parts and form a compound fracture.

There may be great contusion of the soft parts, which will interfere with the adjustment of the splints, and add to the difficulties in transport. Numerous plans have been invented and proposed for the transport of fractured limbs, such as plaster of Paris bandages, wire-trough splints of the French, and various splints made from materials which may be found at the time of the injury, as already described under the head of "Extemporary Appliances" (p. 32, *et seq.*)

Compound Fractures are usually produced by the direct contact of a bullet or other missile with the bone, and consequently inflicting most serious injury to the bone itself and surrounding parts, but not necessarily producing a comminuted fracture, as might be expected.

Partial Fractures.—Sir T. Longmore describes partial fractures, which he says "can scarcely be produced by any other agents besides projectiles, and which are rare accidents in civil practice. They are:—1. Removal of portion of a bone by the projectile making a furrow in its passage across its surface—grooving it. 2. Removal, splintering off, of longitudinal fragments from the external cylindrical part of a bone. 3. Removal of a part of the bone by completely punching out a portion, thus leaving a hole through the entire substance of the bone. 4. Partial fracture, by driving inwards parts of the external cylinder, and causing the fragment to lodge in the cancellated structure. This latter partial fracture is generally attended with lodgment of the projectile also. Among the complete fractures, those attended with general comminution in the neighbourhood of the part of the bone struck, with dispersion of the fragments among the surrounding soft tissues, and those which may be spoken of as 'resecting fractures,' can hardly be caused accidentally, except by fire-arm projectiles." And lastly, "indirect fissured fractures," which he describes as a fissured or linear fracture occurring at some distance from the point of impact of the projectile, with an interval of sound bone between the seat of known fracture and the indirectly produced fissure. This distinct and separate fissure in the shaft of a long bone would account for inflammation, and persistent irritation being set up in a limb at a distance from the known seat of injury.

Considerations respecting the management of Simple and Compound Fractures in the Field.—In arranging for the management of tractures in the field, many difficulties have to be contended with—first, fhe transporting of patient from field to fixed hospitals, then the securing

of proper beds, ventilation, and nursing. If an attempt is made to save a limb extensively fractured, the surrounding skin should be scrupulously cleaned, the wound, if very small, should be closed by antiseptic lint or wool, and every endeavour made to form a scab, whilst splints or plaster of Paris are so applied as to ensure absolute rest to the broken bones. But if the wound in the soft parts is large, or if it has been exposed for some time before coming under notice, the whole wound should be thoroughly washed out by a strong antiseptic lotion, such as a 1-500 sublimate or a 1-20 carbolic solution, or by one of chloride of zinc, 40 grs. to the oz., or by tincture of iodine, 1 drachm to 10 oz. of water. The best way to do this is by means of a catheter and syringe, the solution used should be made to go into all the interstices of the wound, but yet must not be forced into the connective tissue around the seat of injury, a thorough drainage must be established, then the wound should be dressed with some of the absorbent and antiseptic wools or lints, as the salicylated, or sal alembroth wool, iodoform gauze, &c.; but if these cannot be obtained, then the best dressing would be free and frequent irrigation with some antiseptic solution, and a covering of oil-silk immediately over the wound, protected by means of soft tenax, carbolised tow, or cotton wool. The greatest care should be taken to avoid all retention of discharge, counter-openings being made when necessary. Supposing the wound to keep aseptic, the blood clot in it should not be disturbed but be most carefully protected.

Mechanical appliances are now so perfected that, with the exception of some fractures of the femur, there is no lesion of the bones of the extremities that surgeons need have the slightest hesitation in transporting for considerable distances, prior to inflammatory symptoms setting in, care being observed as to the adaptation and application of splints.

Dr. Stromeyer remarks on this important subject—"Above all things it appears to me to be necessary, that cases of gun-shot fracture of the thigh should not be transported to a distance, but should be carried on a stretcher to the nearest house, and the treatment carried out there, even at the risk that the wounded should fall into captivity."

Gun-shot Fractures of the Upper Extremities are less dangerous than in the lower, circumstances being as nearly as possible alike.

Gun-shot Fractures of Humerus.—Guthrie remarks—"An upper extremity should not be amputated for almost any accident which can happen to it from musket-shot; and there is scarcely an injury of the soft parts likely to occur which would authorise amputation as a primary operation."

Sir T. Longmore considers that "unless the bone be extremely injured by a massive projectile, or longitudinal comminution exist to a great extent, especially if also involving a joint, or the state of the patient's health is very unfavourable, attempts should always be made to preserve the upper extremity after a gun-shot wound."

The experience of the American War gives authority for conservatism in dealing with shot fractures of the humerus, except in most aggravated cases. Drs. Warren and Chisholm in their manuals advise attempts to save the limb even when the fracture is complicated by division of the

brachial artery, and M. Legouest considers that shot comminution of the humerus, even when complicated by wound of the brachial artery, does not render amputation "indispensable."

A case is related of a soldier in India receiving a sword cut, which divided his arm, bone and all, with the exception of the vessels and nerves, and the muscles on the inner side, yet he recovered, the bone of the arm uniting.*

Mr. Guthrie recommends that when the splinters extend far into the shaft of the humerus, it may be proper to amputate the whole extremity, especially if the great artery and nerves be wounded; if, however, the head is not injured, the amputation should take place immediately below the tuberosity, and not at the joint, so as to retain the round appearance of the shoulder.

When the shaft of the humerus is much splintered, detached pieces should be removed, fragments of clothing or foreign bodies extracted, points of sharp splinters should be cut off, and the arm placed on a convenient splint, pillow, or cushion, giving it perfect support and rest.

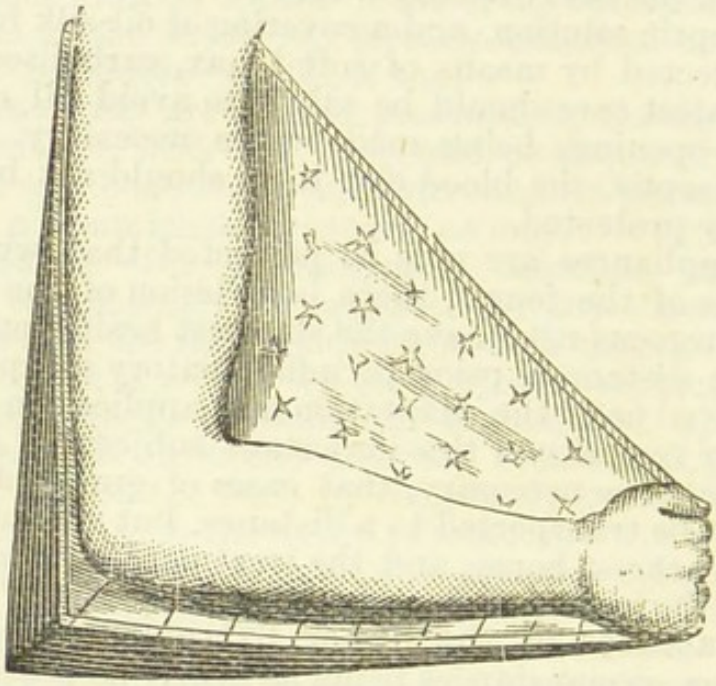

Fig. 84.

For this purpose Dr. Stromeyer has designed a cushion, the utility of which he was so good as to demonstrate to me† at Versailles, during the late Franco-German War. An illustration can scarcely do credit to this admirable contrivance, which affords perfect security and comfort to the injured limb, and with which every army hospital should be supplied.

"The cushion may be described as a right-angled isosceles triangle, 4 inches thick at the apex, which rests against the chest and supports the elbow, the forearm being bent at a right angle with the arm. The cushion gradually thins down till the base is a mere edge, and of the two

*Macleod's *Notes on the Surgery of the Crimean War*, p. 304. †Porter.

other angles, one is passed up into the axilla, while the other rests on the chest under the wrist, as represented in fig. 84. The cushion is readily fastened in its place by a tape round the neck, and one round the body, as seen in fig. 85. When this simple apparatus is applied, the arm rests upon it beautifully supported, and in excellent position. Whilst lying in bed, nothing beyond the ordinary dressings are required for the wound, and if the patient needs to be transported from one place to another, or is fit to walk about, this can be arranged for with the utmost facility, as

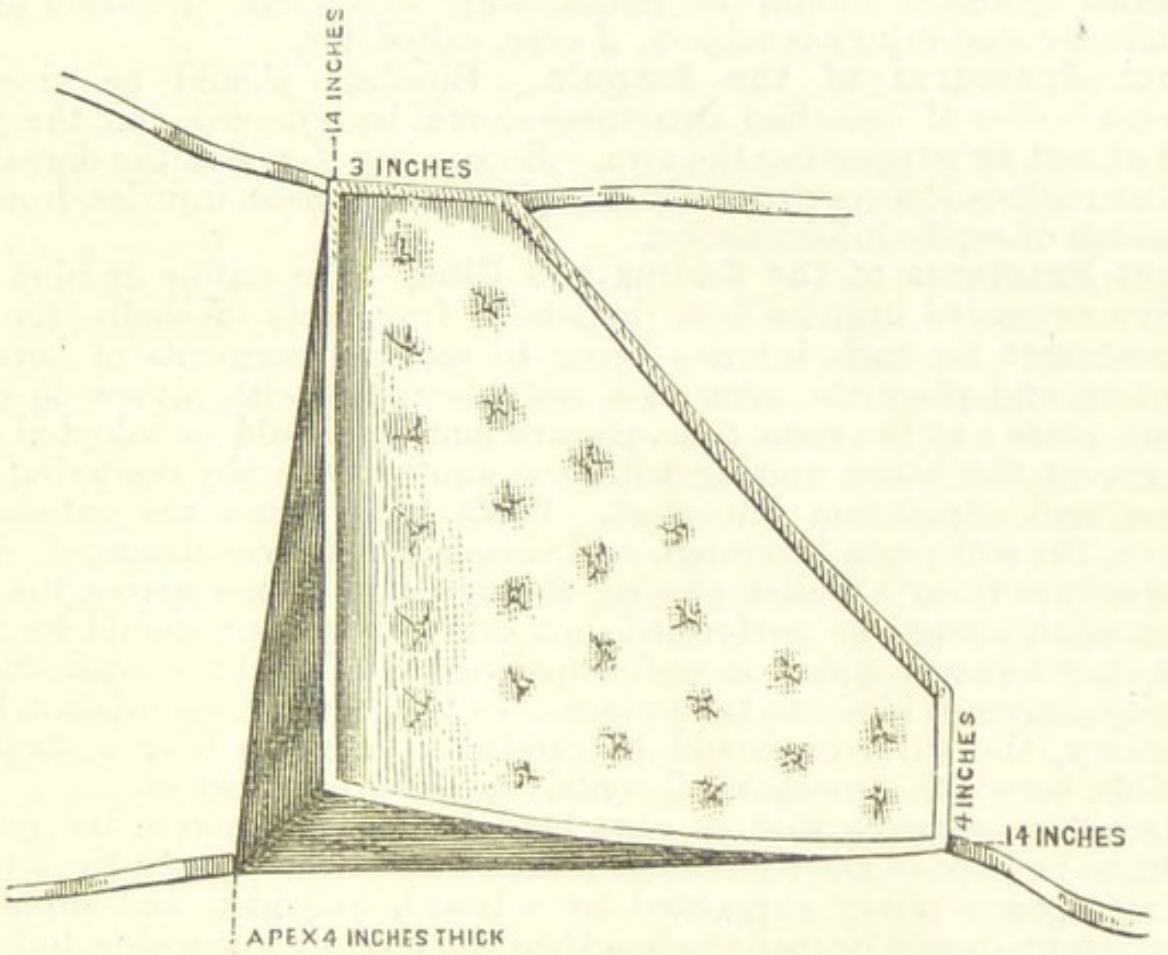

Fig. 85.

cushion, arm, and all can be bound by a broad bandage to the body, and thus form an immovable whole."* Stromeyer informed Sir W. MacCormac that so highly did he estimate the value of this cushion, as to consider it the most valuable appliance he had invented during his life. Sir W. MacCormac has tried the mode of treatment and found it answer every purpose, and recommends a good-sized cushion, of which the sides measure about 14 or 15 inches in length. Porter says he used this appliance, and cannot speak too highly of it, but it requires different measurements for different persons.

Hamilton, of the United States Army, in the treatment of gun-shot injuries of the humerus, usually employs a single splint made of felt, leather, or gutta-percha, long enough to extend over the top of the

* *Notes and Recollections of an Ambulance Surgeon*, by W. MacCormac, p. 96.

shoulder on the one hand, and to the lower part of the elbow on the other, and broad enough to encircle one-third of the circumference of the arm. By moulding, or otherwise fitting the upper part of the splint over the top of the shoulder, it will be prevented from becoming displaced downwards. He considers that bandages have, as a rule, been applied too tightly.

Injury of the head of humerus (*vide* "Injury of Joints").

Shot Fractures of the Clavicle.—As in fractures of the long bones detached splinters should be immediately extracted. Excision of the clavicle for shot injury is seldom, if ever, called for.

Shot Fractures of the Scapula.—Bleeding should be arrested, Foreign bodies of detached structures should be removed, and the parts kept at rest by supporting the arm. Burrowing of pus in the dorsal and lumbar regions is a very common complication in these injuries, from the extension of septic inflammation.

Shot Fractures of the Radius and Ulna.—The radius or ulna may receive extensive injuries from bullets or fragments of shells, the rule of treatment for such injuries being to remove fragments of bones or splinters, and place the arm on a suitable splint with a view to union taking place; at the same time, passive motion should be adopted early to prevent the bones uniting with one another, thereby rendering pronation and supination imperfect. When both bones are extensively broken, the soft parts lacerated, and vessels and nerves damaged, which often occurs from a bullet passing through both bones across the arm, amputation should be performed, but every endeavour should be made to save a forearm which is well supplied with blood; mortification is consequently not likely to take place. In the event of amputation being necessary, the surgeon should be careful to leave as long a stump as possible, to which a mechanical contrivance can be attached.

Hamilton suggests that in case both bones are broken, the patient ought to be kept in the recumbent position on the back, with the forearm resting upon a pillow supported by a board, extended and supinated. No attempt should be made to lengthen the limb by apparatus, but daily attention should be given to the position of the bones, and, as far as possible, they should be kept in line.

Shot Wounds of the Hand.—In wounds of the hand, as little as possible of the injured parts should be removed, and, above all, the value of the thumb or a finger should be carefully considered in any operative measures. In extensive wounds from cannon-shot, or fragments of shell, amputation of the hand may be necessary; but wounds from bullets generally damage one or two metacarpal bones, or may pass between two, only injuring the soft parts.

There may be very troublesome hæmorrhage from wounds of the palm of the hand; this is best arrested by freely exposing the bleeding vessel by enlarging the wound, boldly clearing away all coagula, and applying a graduated compress, this should be regularly and methodically done, and the hand well raised, but should this fail by the hand swelling and threatening to become gangrenous, the radial and ulnar arteries will have to be tied above the wrist.

Shot Wounds of the Metacarpal Bones.—When the metacarpal bones are injured, that is, splintered, the wound should be enlarged and the fragments removed, taking care that the tendons are not injured or interfered with, if untouched by the missile. Generally speaking, the extensor and flexor tendons are injured, the result being stiffness of the fingers to which they belong. Guthrie recommends that, when one or more fingers are destroyed, and the metacarpal bones injured, they are to be sawn or cut off but not removed at the carpus, although an opening into the joint of the carpus will generally do well, if skin can be saved to cover it. In all cases of amputation of one or more fingers, the metacarpal bones, if injured, should be left as long as possible, and particularly that of the index finger when the thumb remains.

Shot Wounds of the Fingers.—The phalanges may be broken, when, if in a single finger, a splint composed of wood, gutta-percha, or other suitable material, should be placed on the palmar surface of the entire length of the finger, a piece of lint, cotton wool, or other soft texture being first laid against the skin. If several fingers are broken, the splint should cover the whole palmar surface, the wrist-joint being left free.

Incised Wounds of the Forearm and Wrist.—The hand, wrist, and forearm are liable to sword-cuts, which frequently injure the bones or joints. It is seldom necessary to do more than close the wounds, and support the parts by suitable splints, after all divided tendons and nerves have been accurately approximated by catgut sutures.

Gun-shot Fractures of the Lower Extremities are far more dangerous and serious than those of the upper; and as to fracture of the femur, either simple or compound, it will, on active service in the field, cause the surgeon grave anxiety, and perplex him as to the best measures he can adopt, for opinions vary much on this subject.

Shot Fractures of the Femur.—An important question for the consideration of the army surgeon is—What is best to be done for severe gun-shot fracture of the thigh with an army on the move, as transporting a sufferer with such an injury is a very serious matter? Stromeyer is of opinion that it is best to leave the sufferer in captivity. Esmarch is, doubtless, of the same opinion, as, during the Holstein War, he entrusted such wounded to the enemy, rather than allow them to suffer from transport. There are, unfortunately, occasions where it is not possible to carry out this excellent advice of Dr. Stromeyer, which in European warfare, and under the privileges of the Geneva Convention, should be adhered to. But supposing the contest is with savage tribes, as has lately occurred with the British forces in the Soudan, that the distance is considerable to a permanent hospital, that the roads are bad, and transport indifferent, what, then, should be the course of action?

During the Ashantee expedition, 1874, a soldier of the 42nd Highlanders experienced a simple shot fracture of the right femur at Amoaful, and by means of a long side splint was safely carried to the port of embarkation; and during the Perak expedition, 1875, two soldiers of the 10th Regiment had the lower third of the right femur fractured, but without comminution. Both were safely transported with the aid of ordinary splints.

But a patient suffering from a severe gun-shot fracture of the middle

or lower third of the thigh could scarcely be carried a considerable distance over bad roads (such as occurred in Western Africa) without further endangering his life. Porter thought that the chances of preserving life would be increased by immediate amputation, there being no doubt that, to secure success for conservative treatment, the sufferer must not have to undergo lengthened transport, fatigue, or privation. An amputation of the thigh having been performed, the stump can be easily secured for the safe transport of the patient.

In gun-shot fractures of the upper third of the femur under the foregoing circumstances, the surgeon should try and conserve the limb on account of the great mortality attending amputation in this region.

Sir T. Longmore says—"The results so far accumulated, while indicating the propriety of practising conservatism in gun-shot fractures of the upper third, on the other hand, inculcate amputation to be the safest practice in gun-shot fractures of the middle and lower third of the femur." Such is the general opinion, but it may subsequently be modified, as it is shown by Sir T. Longmore "that the modern rifle bullet makes small holes, is apt to split bones without always tearing the periosteum completely, and this, together with improved methods of treating the flesh wounds, may render it possible to save limbs that would otherwise have to be lost." But the question, how far it is possible to ensure rest, will always form a leading feature in determining what course to pursue with shot-fractures of the femur in the middle and lower third. In these, as in fractures of the head and neck of the bone, it is the life of the patient that is at stake, and not whether it is possible to avoid a mutilation. Therefore, with a compound fracture of the femur in the middle or lower third, and with the certainty of continual unavoidable moves, experience says that amputation is the man's only chance of life.

Guthrie, referring to the result of treatment of forty-three selected fractures of the thigh, which were attempted to be saved under his own direction at the battle of Toulouse, reports that of this number thirteen died; twelve were amputated at the secondary period, of whom seven died; and eighteen retained their limbs. But he considers the result most unsatisfactory, notwithstanding the care and attention bestowed upon them.

"Nearly all the wounded, after this battle, had every possible assistance and comfort from the second day after the action. The hospitals were well supplied with bedsteads, no inconsiderable point in the treatment of fractures. Every broken thigh or leg was in the straight position, and the success was greater than on any previous occasion. Nevertheless, with all these advantages, there can be little doubt that, if amputation had been performed in the first instance on the thirty-six out of forty-three who died or partially recovered, some twenty would have survived, able, for the most part, to support themselves with a moderate pension, instead of there being perhaps five, or at most ten, nearly unable to do anything for themselves." The least dangerous and most likely to be saved, he considers, are fractures of the lower third, or at most of the lower half, of the thigh bone; and when

they do not communicate with the knee-joint, an attempt ought always to be made to save the limb.

Mr. Alcock remarks on this subject—"I do not agree with Mr. Guthrie;" and though he admits his experience is more limited, still he is of opinion that the expediency on service of ever delaying the removal of the limb with a complete fracture of the femur lower third from gun-shot wound appears to him doubtful. This only refers to soldiers; with officers the results are less unfavourable.

During the Crimean War, the treatment of this injury afforded a subject of great interest. Sir T. Longmore informs us that the practice of conservative measures, as a means of preventing amputation, was not encouraging. Of the three modes of treatment, resection was the most fatal, conservative treatment next, and amputation least fatal. The first was uniformly fatal; the deaths among cases treated without operation were 82 per cent.; the deaths among those treated by amputation, almost hopeless cases included, were 65·2 per cent.

In the official history of the Crimean campaign, the recoveries after amputation in the upper third were 12·9, in the middle third 40, in the lower third 43·3 per cent. of the cases treated; but the distinction is not made in regard to the recoveries without amputation.

Stromeyer, who has had great experience, has favoured us with the following opinion:—"I differed from Guthrie in one essential point—that of his preferring amputation for gun-shot fractures of the thigh to conservative treatment. Guthrie puts too much stress upon the imperfections of conservative treatment, the result of which is often a very disabled limb, whose possession does not make the patient very comfortable. But these imperfections admit of improvement, while a *high amputation gives no prospect of better chances;* it will always remain a very dangerous operation. Our first object is to save a man's life, and the second to make him comfortable, but not in his grave. My results of conservative treatment in gun-shot fractured thigh during the first three campaigns of 1849, 1850, and 1866, did not go beyond 50 per cent. healed. I saw the reasons of our failures, tried to avoid them, and went on with conservative treatment. In the two campaigns in Schleswig-Holstein (1849 and 1850), the patients had to be carried to considerable distances. After the battle of Lanzensolza, in 1866, I was unable to prevent many cases from being spoiled by an injudicious use of plaster bandage. It was in Floing, near Sedan, where we succeeded in saving 77 per cent., twenty-seven amongst thirty-five patients, who had been carried to no great distance, and were treated *without putting much restraint* on their shattered limbs."

"According to my opinion, the great principles to be followed in compound fractures in general are:—(1) Dressing the wounds without lifting the limb; (2) avoiding constriction; and (3) not irritating the muscles in straining them by mechanical contrivances. A gun-shot fractured thigh permits a weight to be suspended to it sufficient to keep the limb a little at rest, though perhaps not sufficient to give the limb its proper length, except in very few cases."

"The most common case is, that for some time after the accident the

muscles retain a tendency to retract which is increased by opposition, but which ceases by-and-by in a favourable position of the broken limb."

It appears remarkable that such eminent authorities as Stromeyer and Guthrie should differ on this point; but the fact is, that Guthrie formed his opinion from experiences in the Peninsular and Crimean campaigns, where fractures of the femur were treated under circumstances totally different from the experiences of Stromeyer, who in all probability was enabled to secure proper accommodation, food, and attendance for his wounded; whereas, during the Peninsular and Crimean Wars every discomfort and inconvenience that man could be subjected to were present with the British army, which unfortunate circumstances gave conservative treatment the disadvantage.

Pirogoff, in 1849, after great mortality from thigh-amputation for gun-shot fractures was induced to try conservative treatment in ten cases of bad compound fracture of the thigh, which did well not only without operation but without treatment of any kind. He was also of opinion that the application of a permanent paste bandage would render the transport of such wounded possible. During the Crimean War he experienced 90 to 95 per cent. death-rate in primary thigh amputations as did the French; but in the German hospitals, during the war of 1870-1871, more than thirty cases of recovery from gun-shot fractures of the upper and middle thigh were met with; whereas, of thigh amputation only twenty-one survivors were found, and in none of these had the operation been performed in the upper third.

During the early part of the siege of Sevastopol when the wounded were subjected to every discomfort that can possibly be imagined,—when the best bed was a bundle of brushwood without blankets in a bell tent on a mud floor, the prospects of treating a compound fracture of the femur conservatively were most unfavourable, and that of amputation little better; but of the two, amputation in the middle or lower third gave the sufferer the best chance. Again, take exposure in a tropical climate, with intense heat, indifferent accommodation, and want of competent nursing, amputation would no doubt be attended with more favourable results. It is, therefore, only under certain conditions, such as good accommodation, food, ventilation, and attendance with suitable appliances, that conservative treatment should be attempted.

Dr. G. H. B. Macleod (who closely observed these injuries in the Crimea) remarks—"It can hardly be doubted that the great straining after conservatism which influenced all the surgeons of the army was one main cause of the mortality which attended these injuries." Again he says that, "under circumstances of war similar to those which occurred in the East, we ought to try and save compound comminuted fractures of the thigh when situated in the upper third, but that immediate amputation should be had recourse to in cases of like accident occurring in the middle or lower third."

Erichsen considers (though doubtless there are exceptions to this, as to all general rules in surgery) that all compound fractures of the lower third of the femur occasioned by gun-shot require amputation.

Mr. Hamilton of the U.S. Army, in his remarks on gun-shot fractures

of the thigh, says- "We have not in our possession full statistics of the present war, but sufficient facts have come to our knowledge to indicate that there has been, on the part of our surgeons, a large amount of conservatism, especially in reference to the treatment of gun-shot injuries to the thigh. Our own impression is that in those injuries conservatism has ruled too much, and that amputations have been too little practised."

To guide the surgeon as to when he ought not to attempt to save the limb, but proceed to amputation at the thigh after a gun-shot fracture, he lays down certain rules, which are as follows:—

"When a patient has to be carried far over rough roads, and without adequate support to the limbs.

"When the bones are greatly comminuted.

"When the patient suffers great pain, or violent spasms continue in spite of opiates and rest.

"When the soft parts have suffered great contusion, as in the case of a fracture from solid shot or shell.

"When there is very extensive laceration of the soft parts.

"When the principal arteries or nerves are involved in the injuries.

"When the fracture implicates the knee-joint, or even when it is near the knee-joint."

"Under the following circumstances we would not, as a rule, resort to amputation:—

"When the ball has entered the head, neck, or trochanteric portion of the femur; if any surgical operation is demanded in these cases, it is usually ex-section.

"When the fracture is just below the trochanters; experience having shown that very few recover after these amputations.

"When the fracture of the femur is caused by a pistol-ball, by a round musket-ball, or by any missile whose force is nearly spent.

"It will be understood that the last observation has reference solely to the less degree of comminution which these missiles usually occasion.

"The following conditions must be added as essential to the success of conservative measures:—

"All pieces of bone which are only slightly attached to the soft parts must be removed.

"All foreign bodies, such as fragments of balls or other missiles, pieces of cloth, wadding, &c., must be carefully taken away. Whatever binds or obstructs the external opening, and prevents the free escape of blood or of pus, must be divided or removed.

"The limb must be placed in a position of absolute rest, and must remain at rest. It must not be confined by tight bandages, or forcibly extended by apparatus.

"If the knee-joint be implicated, it must be laid freely open and placed at perfect rest, without adhesive straps, bandages, or other means of compression.

"During the whole treatment, the limb must be handled with great care and not lifted roughly or carelessly. When sinuses form, the matter must be let out by direct or counter-openings, and not by violent pushing and thumbing.

"When spicula of bone present themselves they must be removed.
"The patient must be supplied with good nourishing diet."

Examination of Wound.—The condition of a fractured femur from a rifle bullet is always a matter of great obscurity, and it is therefore impossible to decide what steps should be adopted without making a most careful examination with a view to ascertaining the extent of injury.

Long and deep incisions may have to be made, and the extent and number of them will depend upon the size and number of the splinters. It has been recommended that the wound of exit is the proper place to look for sequestra, as the ball, in passing through or traversing a limb, naturally carries them with it.

The depth of splinters in muscles is not to prevent incisions being made, nor should their proximity to large vessels or nerves interfere with a diligent search after them. It is of the most vital importance that completely detached splinters, as well as articles of clothing, the bullet itself, or other foreign bodies, should be removed, and with the least possible delay.

The limb will soon swell, and become very painful, and the longer the operation is postponed the more painful is the case to the unfortunate patient, the more difficult to the surgeon, and the prospect of saving the limb more unfavourable.

Much care will be required in removing small fragments in the after-treatment, and giving free vent to pus both in the neighbourhood of the wound and along the axis of the bone when abscesses form in connection with unobserved splinters.

Sequestra and the Classification of them.—Dupuytren has divided sequestra into three classes—viz., Primary, Secondary, and Tertiary. The primary are those wholly separated; the secondary those partially adherent probably by a slight piece of tissue; and the tertiary those which become necrosed. There are generally longitudinal sections into which the bone is split which are sometimes capable of consolidation. The wholly separated portions should be at once removed, as, if not, they soon set up irritation, abscesses, pyæmia, and the usual terrible results.

Some doubts have existed as to the advisability of removing those under the class secondary or those partially adherent, from the supposed possibility of consolidation taking place; but it is now generally admitted that, in doubtful cases, or in those where the adherence of the sequestra is but slight, it is best to remove them; the chances are so much in favour of their becoming wholly detached, and acting as foreign bodies, that the disadvantages of such a contingency are in no way counter-balanced by the fortunate circumstance of consolidation, which is remote. Guthrie, Roux, Baudens, Legouest, and Begin were in favour of their removal, but possibly modern antiseptic treatment may not always demand this.

Extension in Treatment of Gun-shot Fractures of the Femur.—In treating gun-shot fractures of the thigh-bone by conservative surgery, most competent authorities agree that it is best to keep up extension to a moderate degree; but, in the event of a portion of the bone being re-

moved, there will be a space between the broken ends; if, therefore, strong extension is made, the ends of the bone will be drawn asunder, and continued irritation of the muscles and surrounding tissues will be kept up.

To prevent shortening is almost an impossibility; it will, therefore, be best to allow the ends of the bone to approximate, which the muscles will do of themselves, and all that can be done is to keep the limb straight if possible. The less interference the better.

Stromeyer observes—"Do not be too anxious to remove all the fragments of fractured and displaced bones. Do not be too eager to maintain extension of the fractured limb, and abstain from frequently lifting the fractured limb for the purpose of cleanliness."

Contrivances for the Treatment of Shot Fractures of the Femur and Bones of the Leg and Foot—(1) **The Femur.**—*While simple fractures of the shaft* may be put up in the semi-flexed position of Pott, the straight one of Desault and Liston, or on the double-inclined plane, or by any of the numerous modifications of either, it is otherwise with the *compound fractures* resulting from gun-shot. Hence numerous contrivances and apparatus have been invented for the more convenient treatment of shot fractures of the thigh-bone; in fact, any one who has ever had to treat such an injury on service can bear testimony to the difficulties and dangers to be encountered.

Mr. Hamilton does not recommend "the long straight splint, with the usual means of extension and counter-extension, in any of its various forms unless in rare cases. A perineal band can rarely be borne in gun-shot fractures of the thigh, and a long broad side-splint is always very much in the way of dressings." The method he recommends is, "laying the limb upon the mattress, or some sufficiently firm and even support, on the same or nearly the same plane with the body, making the extension by a weight attached to a cord drawn over a pulley, while the counter-extension is made with the weight of the body by elevating the foot of the bed. This is the plan, more or less modified, which has been adopted in a large proportion of the cases which we have seen under treatment; and, we think, with the best results.

"With the straight position, the limb may rest directly upon the bed, but for the purpose of dressing the wounds, the limb may be moderately lifted or suspended by a frame and cotton bands.

"When extension is applied it should be moderate and only sufficient to steady the limb, or to prevent the ends of the broken bones from pressing into the flesh. For this purpose we apply a broad band of adhesive plaster along each side of the leg from the knee downwards, and secure these in place with a roller, covering certain portions of the limb with cotton wool before applying the roller to prevent excoriation. The end of the adhesive plaster should be laid over a small block below the sole of the foot, which block must be of sufficient width to protect the malleoli from the pressure of the bands. A small rope knotted at one end is then to be run through a hole in the centre of the block and carried over a pulley at the foot of the bed. The pulley must be so high that the extension shall lift the heel a very little from the bed."

Mr. J. T. Hodgen has invented an apparatus by means of which the limb is maintained in a straight position, while at the same time it is lifted from the bed and rendered more accessible (fig. 86). "The apparatus is composed of four nearly parallel bars and a foot-board; two of the bars constituting the base, and the remaining two, covered by transverse slips of cloth, being intended to receive and support the limb.

"The longitudinal bars are 42 inches long, and the upper bars are elevated 4½ inches above the lower; the space between them diminishing from the upper to the lower ends, being 12 inches at the groin, 8 at the knee, and 4 at the foot. The foot-board is 14 inches high, 4½ inches wide, and is supported by a cross-piece or foot underneath, 15 inches long.

"The transverse strips of cloth, each 2½ inches wide, are placed in contact, and adapted to the inequalities of the limb.

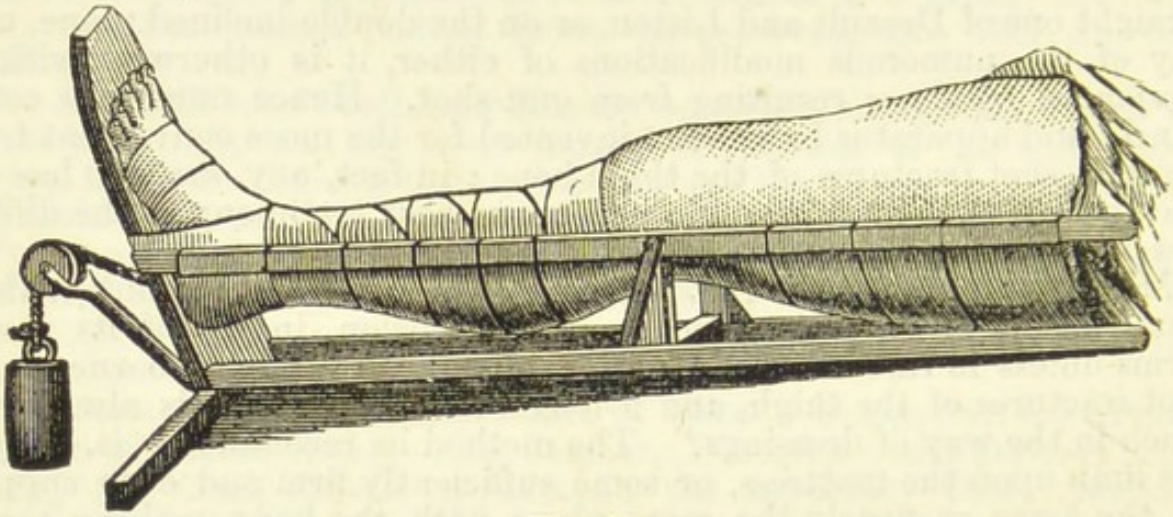

Fig. 86

"Adhesive straps are secured to the sides of the leg by a roller, and brought around the foot-piece; a cord, to which is suspended a weight, is made fast to the centre of the foot-piece and passed over a pulley, and this constitutes the extension. The counter-extension is made by lifting the foot of the bed 4 or 6 inches."

Mr. Hodgen has also invented a splint whereby the limb can be suspended, which it appears he has substituted for his own "cradle." "It is made of iron wire (size No. 2), and resembles in many points Dr. Smith's anterior splint, but its mode of application is not the same. Strips of cloth are laid across the splint from side to side, and upon these the limb is laid. The centre and upper extremity of the splint are kept asunder by strong bows of iron wire, so arranged that they can be put on or taken off without disturbing the dressings. When applied the inside wire must be bent upwards at its upper extremity so as to make room for the pubes. Extension is made by adhesive plaster, and the whole apparatus is finally suspended to the ceiling, or to some point above, by a rope and pulley" (fig. 87).

Dr. Nathan R. Smith of Baltimore has introduced a splint for fracture of the thigh, which no doubt will answer for simple or compound injuries.

It is a double-inclined plane, made of wire and intended for suspension. The splint is placed above the limb instead of underneath.

It is composed of a frame made of stout wire (size No. 10), (fig. 88). Its length should be sufficient to extend from the anterior-superior spinous process of the ilium to a point beyond the toes, the lateral bars being separated 3 inches at the upper end, and $2\frac{3}{4}$ inches at the lower end.

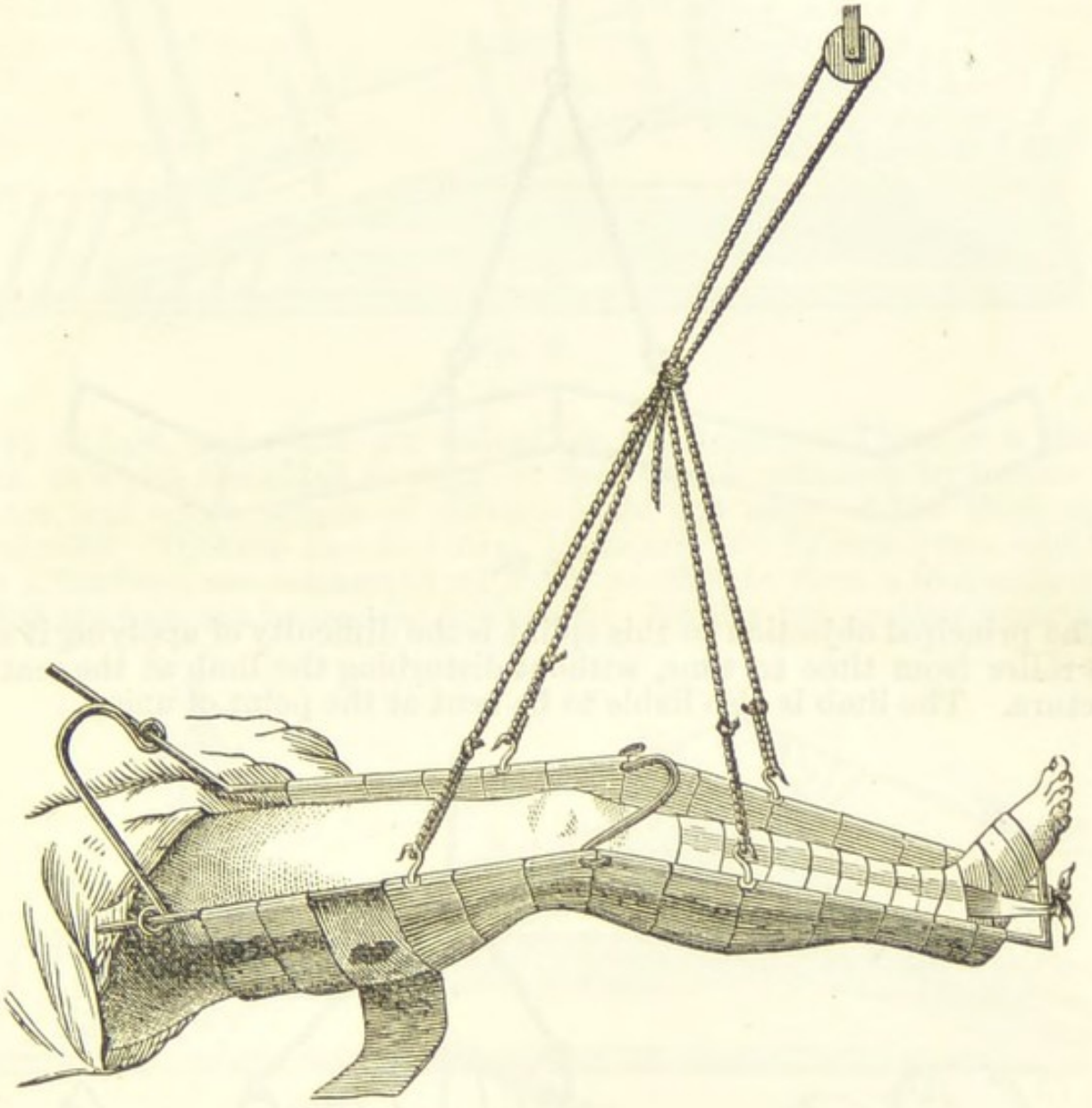

Fig. 87.

Before being used it is covered with cotton cloth to protect the limb from immediate contact with the wire. The limb is then secured to the splint by successive turns of a roller from foot to groin (fig. 89).

When this splint is applied to a broken femur one of the hooks, to which the suspending cords are attached, should be made fast to the splint about opposite the seat of fracture, and the other should be secured a little above the middle of the leg; while the point of attachment in

the ceiling, or to the frame from which the suspension is made, should be a little in advance of the knee and not perpendicularly above it. This will secure a certain amount of extension and counter-extension upon the thigh.

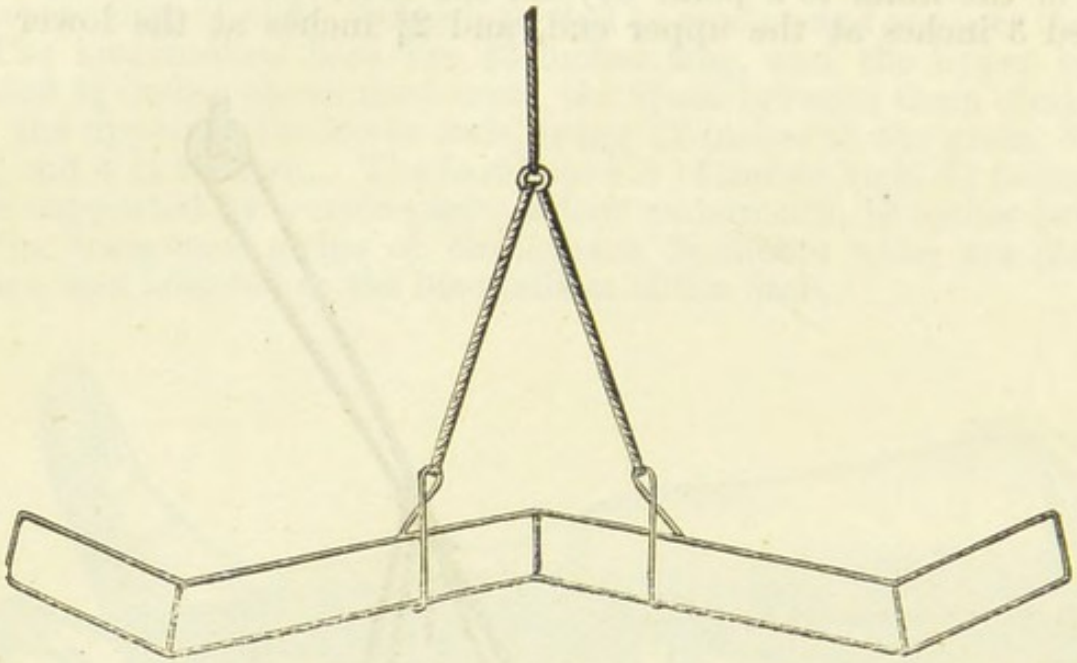

Fig. 88.

The principal objection to this splint is the difficulty of applying it and the roller from time to time, without disturbing the limb at the seat of fracture. The limb is also liable to be bent at the point of union.

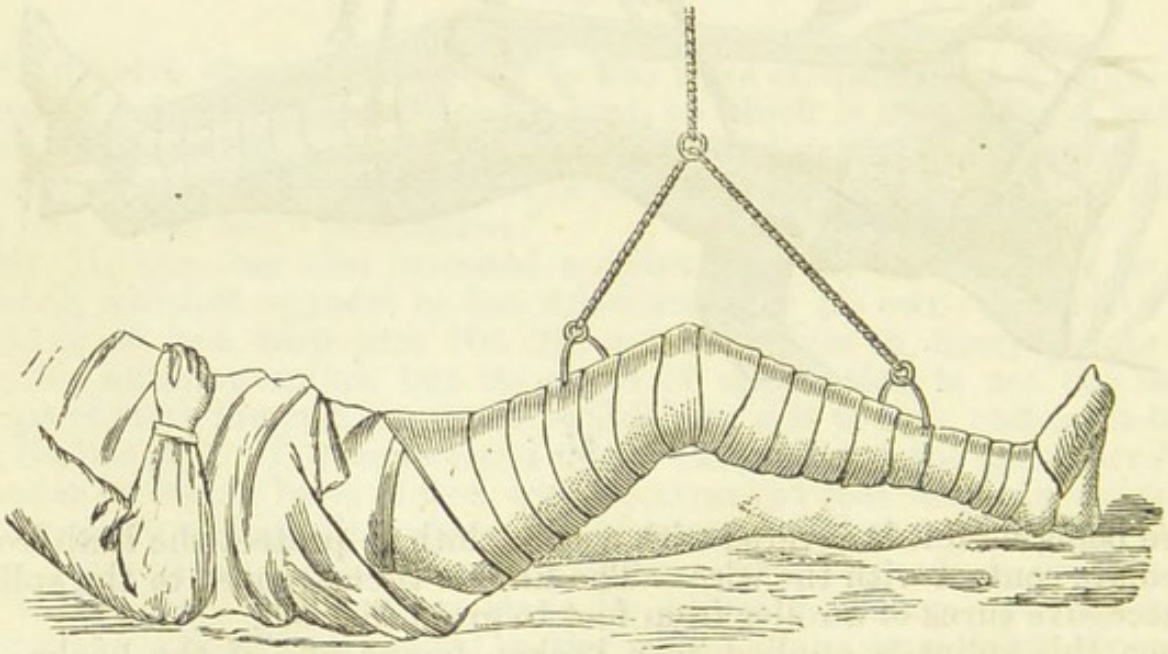

Fig. 89.

Professor Esmarch, in his work on bandaging (1866), describes a splint for gun-shot fractures of the thigh, which is very easily made, portable,

and can be used for placing the limb in a straight or double-inclined position. It consists of two planks, on which the upper and lower leg

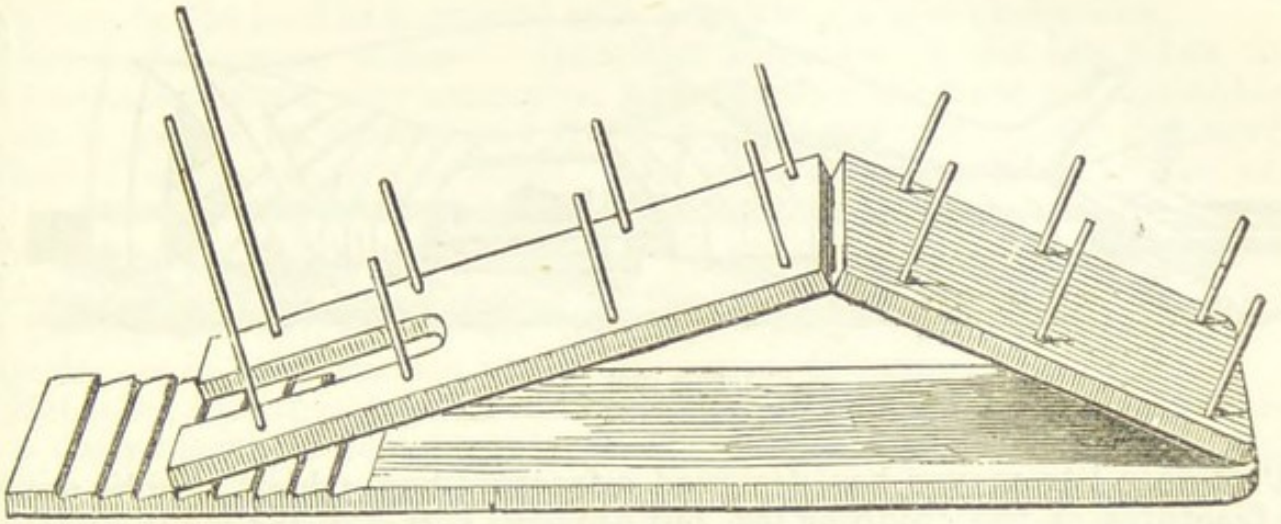

Fig. 90.

are to be laid, and which are united by two hinges. There is a third plank, to which the plank to support the thigh is attached by means of a hinge, and which admits of movement to any angle of the thigh and leg planks. To keep the foot firm, there are two 10-inch pegs, which, with a bandage, are connected with one another to form a foot support, so that the foot can be pressed against it. Similar but smaller pegs are

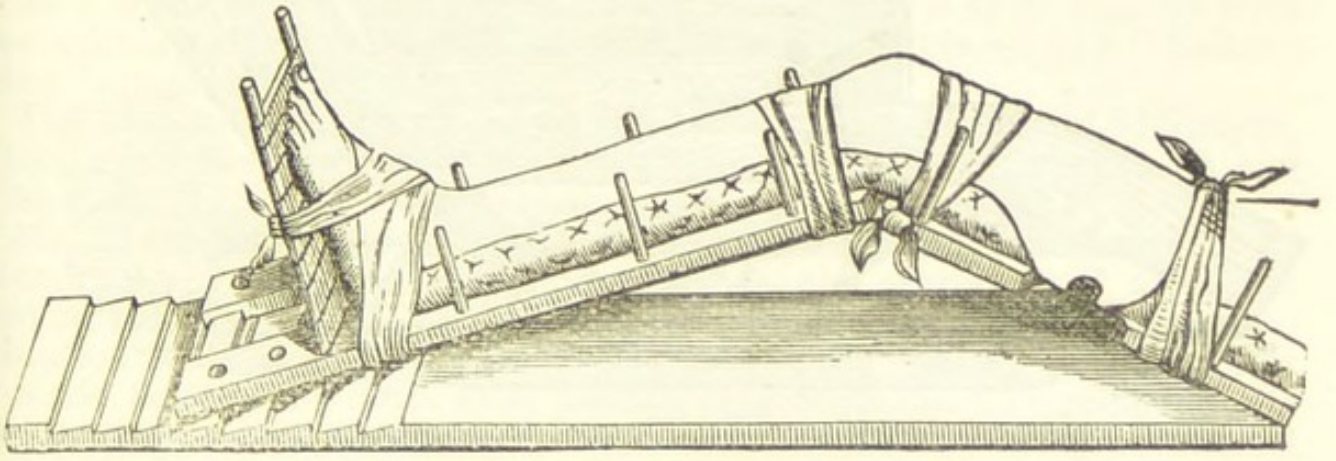

Fig. 91.

placed on the sides of the plank, fixed on both sides, so as to keep the pads in position. If it is necessary to raise the foot, a brick should be placed under the apparatus at that end (figs. 90 and 91).

It is of the greatest importance to make a good slit for the heel in the splint for the leg to avoid pressure.

In compound fractures, where the aperture exists in the posterior and outer part of the limb, Erichsen has found a long splint, made of oak, and bracketed opposite the seat of the injury, the most convenient apparatus,

enabling the limb to be kept of a proper length, and the wound to be dressed at the same time (fig. 92).

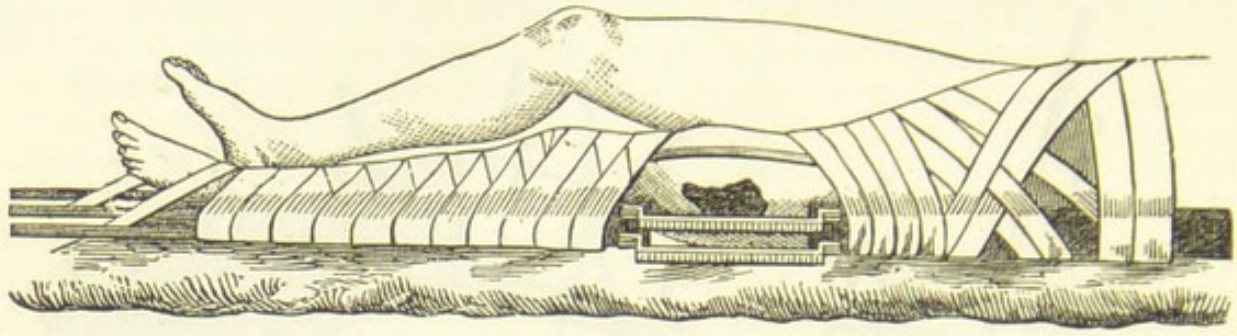

Fig. 92.

Professor Stromeyer has designed a fracture-box, which may be used for fractures of the thigh or leg, but appears better suited for the latter

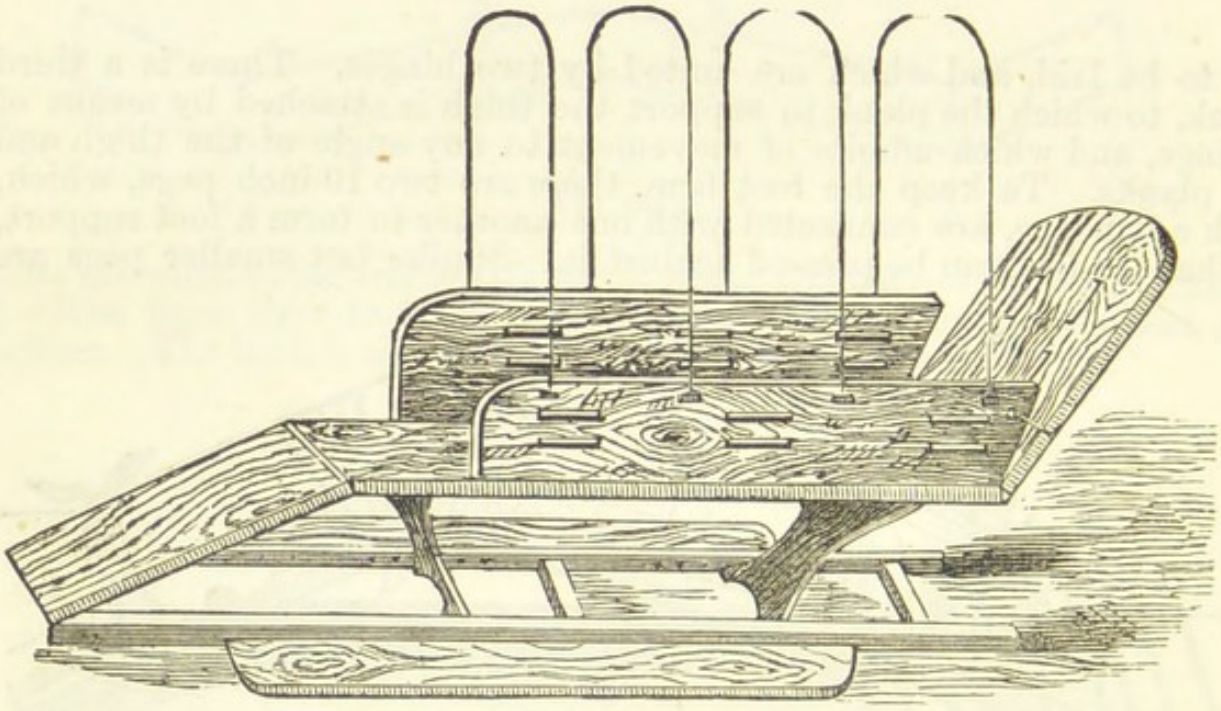

Fig. 93.

(fig. 93). It consists of a double-inclined plane, supported on a frame, with hinged brackets, which can be moved so as to place the box at a convenient angle. The thigh-piece, sides, and foot-board are attached to the bottom of the box by hinges, and so constructed that all fold into one convenient package. The sides and foot-board are perforated to admit of bandages being passed through. An intelligent carpenter should be able to make an apparatus of this kind in a short time.

(2) **Gun-shot Fractures of the Leg-bones—Tibia and Fibula**—uncomplicated with injury to the great vessels and nerves, or when the knee or ankle are not implicated, admit of an attempt being made to

save the limb. Splinters should be removed, and irregularities sawn off, if necessary.

Guthrie recommends that the leg should be placed in the straight position on the heel as a general rule, admitting a few exceptions.

Sir T. Longmore writes—"Gun-shot fractures of the leg, when the comminution is not very extensive, when neither the knee nor the ankle-joint is opened by fissure, and the soft parts are not widely damaged, admit of conservative treatment. But when the fragments at the site of impact are dispersed and driven deeply into the surrounding tissue, when the remaining portions of the shaft are much splintered, when one of the neighbouring joints is penetrated, and especially when both bones of the leg are involved in the injuries, amputation under ordinary circumstances in field practice is the only course to pursue."

But here, too, the question of movement must be considered. If there is a daily march to be encountered, a gun-shot injury of the leg, that would probably do well with rest and good antiseptic treatment, may, if continually moved, entail a fatal result: whereas an amputation would have enabled the sufferer to have reached his home alive though mutilated.

Numerous splints of different designs and composition have been invented for fractures of the leg, but all tending to the one object, that of fixture. In the field, when the sufferer may have to be moved, the plaster of Paris bandage will be found most convenient. In the subsequent treatment, when placed in a fixed hospital, he will derive great comfort from a common box splint with sides so arranged with hinges that they can be let down to examine the wound without disturbing the limb. If the flesh wound is not extensive, the limb may be put up with the ordinary side splints with pads and the whole placed in a "Salter's sling" apparatus.

The limb may also be placed on the double-inclined plane of M'Intyre, which appliance answers on service for fractures of the thigh as well, and with a firm bed gives great ease and comfort to the sufferer.

Mr. Hamilton* writes—"When both bones are broken completely asunder by a rifle-ball or other large shot, the surgeon will not often find it prudent to attempt to save the limb. In general, the comminution is even greater than in fractures of the femur. If an attempt is made to save the limb, loose floating fragments must be removed and the limb placed in an easy position, being sustained by moderate lateral pressure. Neither extension nor counter-extension can generally be made to any purpose."

"It is impossible to lay down any absolute rules as to the position which the limb should occupy; sometimes the fragments will be found most at rest when the leg is made straight upon the thigh; but in the large majority of cases the position of moderate flexion will be required, the limb either resting upon its side, as recommended by Pott, or upon its posterior surface, as is most generally practised. Whatever form of apparatus may be used, the foot will require always the support of a

* *Treatise on Military Surgery*, p. 414.

foot-board, and the heel must never be permitted alone to sustain the weight of the foot."

(3) **Wounds of the Foot and its Bones.**—The bones of the foot when injured by rifle-ball or other missile present as a rule serious complications owing to their being numerous, of soft texture, and liable to run into a state of caries from the slightest injury.

There may be injury of some of the many tendons, of the vessels, nerves, and strong fascia.

It is difficult to extract splinters or foreign bodies, and, if the injury to the bone is extensive, an attempt to save the foot is not recommended, as the disease produced will ultimately render amputation necessary, which, if done at first, would prevent much suffering. When it is decided to interfere by operation, the foot, or part of it, should be removed as soon as possible. The importance, however, of preserving the heel either by Syme's or Pirogoff's operation cannot be exaggerated.

A missile will sometimes lodge in one of the bones of the foot, doing but slight injury to the surrounding textures. An attempt should then be made to remove it, or the bone.

Shot Wounds of the Os Calcis.—The heel may be struck by cannon-shot or bullet, only destroying a portion of the os calcis. By due attention in removing spicula of bone and making free openings for the exit of matter the limb may be preserved.

Wounds of Bones of the Toes.—In wounds of the bones of the toes, only such as are extensively fractured should be amputated. Much can always be done by removal of splinters of the bone, or foreign bodies, and by strict antiseptic treatment. Wounds of the toes, however, are generally in connection with other injuries to the foot. It is of the utmost importance to preserve the big toe even when circumstances necessitate its being the only one that can be saved.

WOUNDS OF JOINTS.

In the treatment of gun-shot wounds of joints, much of the success will depend upon the size and description of joint, the extent of injury done, the age and constitution of the sufferer, and the time after receipt of injury that treatment has been commenced, and the available means for carrying out that treatment.

Patients who have undergone excision or resection require constant care and attention, abundant cubic space, and pure air; every facility for securing cleanliness, proper dieting, nursing, surgical skill, and most perfect rest. The suppuration as a rule is always copious, and there is therefore great susceptibility to pyæmic poisoning. It is, therefore, necessary to calculate as to the possibility of securing favourable conditions before resection or excision is selected in preference to amputation, this latter operation not requiring the same amount of attention in the after-treatment, or the same prolonged rest and confinement indoors.

Professor Hanover, of Copenhagen, is not favourable to the operation

of resection of joints. In his writings, he says that he has formed his opinion on the cases he has seen among the Danes who were wounded during the war between Germany and Denmark in 1864, and being one of the members of the Pension Committee he has had an opportunity of annually inspecting these cases. "In the majority of instances the patients reported to be cured were left with useless dangling limbs, and the Danish surgeons, as well as the patients, both agree that amputation would have been preferable; for it would have saved the latter from being burdened with limbs which are not only cumbersome and powerless, but also sources of frequent pain, atrophy of the extremity in which the resection has been performed, coldness, numbness, and contractions." *

Professor Hannover's remarks have been reviewed, and the reviewer naturally points out that most surgeons must be familiar with some cases in which not only full use of the hand and fingers has been retained after resection of one of the large joints of the upper extremity, but considerable power in certain movements of the whole limb. Even one such successful instance is sufficient to annul a general condemnation of the operation itself.

The late Dr. Loeffler, of the Prussian Military Medical Service, who operated in some of the cases referred to by Professor Hannover, has stated that in various instances the Professor relied upon certificates furnished by surgeons in different parts of Denmark, not for scientific purposes, but with the object of showing the necessity for a continuance of the pension to the invalided soldiers who had been the subjects of the wounds which led to the operation of resection.†

It is quite possible, as Dr. Loeffler suggests, that the same attention may not have been given to the after-treatment as in Germany, and that the climate of Denmark is not very favourable for patients after resection.

Mr. Erichsen, in his valuable work on surgery, gives the following as indications for excision:—

1. Excision may be required in bad compound dislocations and fractures into joints, especially in gun-shot injuries, more particularly in those of the head of the humerus and of the elbow.

2. As a substitute for amputation in cases in which the joint is so extensively diseased that the patient will be worn out by the discharge, or pain, unless it be removed. Here a useful limb may be secured by the sacrifice of the diseased part.

3. In some cases of articular disease, in which amputation would not be justifiable, excision may be performed in order to hasten the cure, and thus to save years of suffering to the patient.

4. Excision may be performed in cases in which amputation is not practicable, as in disease of the hip-joint, or of the temporo-maxillary articulation.

5. As a substitute for other and less efficient treatment, in order to

* *British Medical Journal*, January 15, 1870.
† *British Medical Journal*, May 28, 1870.

restore the utility of a limb or joint, as in osseous anchylosis of the elbow, or in faulty osseous anchylosis of the knee.

If the injury to the joint is not of such a nature as to require amputation or excision at once, it probably may be saved if free incision is made into it, all small loose fragments of bone or cartilage removed, and the cavity well washed out with a corrosive sublimate lotion (1-500), drainage tubes inserted, and the part covered with a dry absorbent dressing and rendered as immovable as is possible. In about three weeks or earlier, Cheyne recommends passive motion to be begun.

Wounds of the Shoulder-Joint.

All wounds of the soft parts in the proximity of the shoulder-joint are deserving of the greatest consideration. Neudörfer specially remarks on this, and says—"It occurs that wounds which do not open the joint primarily injure the same to such an extent, that in a short time complete suppuration of the joint ensues." An obscure case of this group occurred in a soldier of the 23rd Regiment, who was wounded during the Ashantee expedition of 1874. A leaden slug entered the head of the left humerus without fracturing the bone, or opening the capsule of the joint, or causing much primary irritation; five months subsequently inflammation and suppuration of the joint set in, for which Porter performed excision of the head of the bone. (See *Army Medical Reports for* 1873.)

Should the joint be laid open by a sabre cut, or slightly wounded by a rifle-bullet, the soft parts not much lacerated, no large vessel or nerve wounded, and the constitution of the sufferer good, the wound ought to be well washed out, a drainage tube inserted, so that, by careful attention and dressing, and keeping the limb at perfect rest, recovery may take place. Should the head of the humerus be splintered, the articulating surface injured, the soft parts only slightly damaged, and no wound of great vessel or nerve, the operation of excision is advocated, which, in the hands of British surgeons, has been found most successful, and has given the sufferer a comparatively useful limb.

Sir T. Longmore records, during the Crimean War, that of thirteen resections of the shoulder-joint in the English army, there was only one death; eight of these were primary and five secondary operations; and that, during the New Zealand campaign, several resections were performed with remarkably successful results.

Partial Excision of the Head of the Humerus may be performed, but the results heretofore have not been altogether satisfactory. In the reports of the American War, fourteen cases of partial excision are recorded, in seven of which the arm was useless. In the same reports cases are given in which 3, 4, 5, and even 6 inches of the shaft of the humerus as well as the head were excised, some of the patients recovering with fair power of the hand and forearm, and others without any impairment. Mr. Otis, in analysing the treatment of 2,328 cases of wounds of the shoulder-joint, arrives at the following conclusion:—

1. That in slight shot injuries of the shoulder-joint an expectant conservative treatment is justifiable,

2. If a ball is impacted in the head of the bone, or if the epiphysis is much comminuted, unless there is injury to the blood-vessels and nerves, or very grave injury of the other soft parts, primary excision should be practised.

3. Concomitant fractures of the acromial end of the clavicle, or of the neck or processes of the scapula, or of the upper third of the shaft of the humerus, do not necessarily contra-indicate excision of the shoulder.

4. Intermediary excisions should seldom or never be practised. If, in an attempt at expectant conservative treatment, intense suppurative inflammation arises, it should be combated by free incisions, drainage, antiseptic applications, &c., and every endeavour should be made to avoid inflicting another wound upon the inflamed medullary tissue, and to await the second stage before undertaking operative interference.

5. The after-treatment of securing comparative immobility and support of the limb, efficient drainage of the wound, and the ulterior after-treatment of judicious passive and active movements of the arm, are of essential importance in restoring the functions of the member.

Wounds of the Elbow-Joint.

Punctured and incised wounds of the elbow may usually be treated on a conservative plan, with every hope of recovery, reserving secondary excision until rendered necessary by inflammatory disorganisation. The bones forming the elbow-joint may be slightly injured by sabre cut, bullet, or fragment of shell. In the event of the external wound being slight, and the bone only partially damaged, that is, splintered about the condyles, olecranon, or radius, or if a bullet or other foreign body is lodged in the lower end of humerus or condyles, it will be necessary to remove all loose splinters, to extract the foreign body, to wash out the wound, and to follow a strictly antiseptic treatment. The joint will in all probability be stiff, but the patient will have the advantage of a forearm and hand; and here it is that experience may do so much in saving a wounded soldier from excision or amputation. By careful examination with the finger immediately, or as soon as possible after receipt of injury, the exact condition of the joint may be ascertained, and the necessary operative measures at once carried out.

Guthrie observes—"When the articulating ends of the humerus, radius, and ulna are wholly or in part injured by a musket-ball, it was formerly the custom to amputate the arm in such instances of great mischief; an operation which should be superseded by that of excision of the joint."

Excision of the elbow-joint, in the hands of British military surgeons, has been attended with most happy results. Porter says he has seen some useful limbs after the operation capable of lifting weights, and unaccompanied by pain or numbness.

The Period of Election for Excision of the Elbow.—We have it on the authority of Heyfelder and other experienced surgeons that, as in amputation after shot wounds, a favourable result of the operation is so much more to be expected the earlier the resection is performed.

Amount of Bone to be removed in Resection.—By the experience recorded in the reports of the American War, complete resections were thought to give more favourable results, both in preserving life and utility of limb, than partial ones. The removal of the head of the radius, or of one of the condyles, or the upper extremity of the ulna, seemed more liable to be followed by inflammation, extensive and prolonged suppuration, or by anchylosis, than the removal of the entire joint. Considerable doubt, however, exists as to the correctness of this opinion; when, for instance, the elbow-joint is exposed, the ligaments torn, and the injury to bone confined to the lower end of the humerus, would it be safer to remove the articular ends of the radius and ulna? or, again, if the articular ends of the bones of the forearm were injured, ought the condyles of the humerus to be also removed? The fact of depriving an uninjured bone of its articular end would be a sufficient argument against such a course.

In disease Mr. Syme recommended the removal of the articular extremities. In operations for injury, Mr. Otis appears to consider *a priori* that there is not the same need of inflicting additional injury by a section of healthy bone, and the deduction seems to be sustained by facts, excellent results having been obtained when the joint ends of either the upper or forearm have been removed after complete exposure of the joint, and the uninjured portions of the articulation have been unmolested.

An interesting and instructive case is recorded by Sir W. MacCormac (*British Medical Journal*, January 22, 1876), in which a soldier during the Franco-German War received an injury of the shoulder and elbow on the same side, in which he excised both joints with most satisfactory results.

Wounds of the Wrist-Joint.

The wrist being a complicated joint, gun-shot injuries to it are liable to be followed by most serious results, and, as the structures are so superficial, *resection as a primary operation* is not likely to be successful. Its close connection with flexor and extensor tendons renders them liable to consolidation with their sheaths, and thus to cause stiffness of the joint.

Sword cuts opening into the joint if seen early should be cleaned, the soft parts and all tendons brought together by means of sutures, and the hand and forearm supported on a splint, until firm union has taken place, when flexion and extension should be exercised to try and avoid a stiff joint.

M. Legouest makes the following important observations regarding recent wounds of the wrist:—Shot fractures of the wrist, where the region is traversed in its long diameter, and is the seat of much shattering (*délabrements*), require amputation in the forearm. Where the joint is perforated from before backwards without great damage, by extracting splinters the limb may be preserved.

Of six complete excisions of the wrist during the American War, one proved fatal after recourse had been had to amputation. The five others recovered with the functions of the hand much impaired, but, all things

considered, in a better condition than if they had been subjected to amputation.

Sir J. Lister has endeavoured, with most happy results, to render the operation of excision of the wrist successful, and his operation should, if practicable, be selected, being least liable to injure the important structures near the joint. His recommendations for after-treatment should be attended to.

The Expectant Treatment.—In selecting cases for this method of treatment, the surgeon must be guided by the amount of destruction of soft parts and bone, bearing in mind M. Legouest's practical hints. From the experience of the American War, injury of one of the large arteries complicating these fractures was not always regarded as an absolute counter-indication of expectant conservative treatment. In 707 cases treated on the expectant method, confined abscesses occupying sheaths, bursæ, and synovial sacs, and leading to extensive adhesions and contractions, were amongst the most frequent complications.

The wound should be treated by the strictest antiseptic methods, and the parts should be supported without constricting bandages upon a padded splint. Free incisions should be made when suppuration has taken place, and movements of the finger and hand should be commenced as early as practicable.

When the wrist is so severely injured as to preclude all hopes of saving it, amputation through the joint may be had recourse to.

In applying bandages to the wrist the fingers should be left free, and occasionally moved to prevent anchylosis.

Gun-shot Wounds of the Hip-Joint.

These wounds are without doubt the most dangerous of all joint wounds. They are difficult to recognise, they are frequently not discovered through want of proper care, and the immobilisation of the joint, which is the chief requisite for successful treatment of joint wounds, is more difficult to carry out than with any other joint.

Military surgeons in former days looked upon gun-shot wounds of the hip-joint as simply hopeless, and considered that the wounded died, except in very rare cases, just as much after one mode of treatment as after the other. Mr. Hennen makes these observations—"Injuries occasioned by balls lodging near or about the joint of the hip are amongst the most serious in military surgery; the fever, the profuse discharge, the tedious exfoliation, all tend to sink the patient, and are but too often fatal. In some of these the course of the ball is so obscure, and its place of lodgment so uncertain, that it can only be detected after death." These remarks entirely bear out the experience of most surgeons of the present day, but the mortality statistics of the Franco-German War of 1870-71, give evidence that hip-joint injuries are not absolutely hopeless, and an endeavour should in consequence be made to try and bring about more happy results, either by judiciously conducted conservative treatment in properly selected cases, by excision of the joint, or removal of splinters, or by amputation.

Professor Langenbeck* has pointed out a mode of determining the situation of the hip-joint. "It is known that the position of the hip-joint may be demonstrated, if we construct a triangle whose base intersects the trochanter major, while the femur and the anterior-superior spine of the ilium form the points of an acute angle. If the entrance or exit of the shot is within the compass of the triangle, or if the direction of the shot canal falls within this space, then the hip-joint will probably be implicated. The joint will be most directly involved when the bullet penetrates close below the anterior-inferior spinous process, or nearly $1\frac{5}{8}$ inch below the anterior-superior spinous process, and in the direction of the median line. The spongy part of the head of the femur will be injured in such a case, and, as a rule, smashed to atoms. If the entrance of the bullet be close below and external to the spine of the pubis, and if its exit be in the region behind the trochanter major of the same side, as a rule, the hip-joint will be implicated with probable separation of the edge of the acetabulum. When the entrance and exit wounds are in front or behind the trochanter major, injury to the neck of the femur with openings of the hip-joint capsule may be assumed for certain."

Conservative Treatment.—Langenbeck has also pointed out that some gun-shot wounds of the hip-joint, and even most severe cases, may be cured by conservative treatment; that the surgeon should decide after the first examination if conservative treatment be admissible, or if operative interference must be resorted to; hip-joint wounds should, therefore, be quickly recognised, or weighty difficulties offer themselves; and whatever plan of treatment is adopted, it should be carried out in a rational manner from the moment of injury. He gives 88 cases of gun-shot wounds of the hip-joint, treated conservatively during the Franco-German War of 1870–71, in which 25 were cured and 63 died, equal to 71·59 percentage of deaths, against 31 treated by resection and extraction of the head of the femur, in which 4 were cured, 26 died, and 1 was doubtful, equal to 73·87 percentage of deaths.

For conservative treatment he first selects all the lighter hip-joint injuries, in which it is impossible to determine the exact diagnosis directly after wounding. He lays great stress on the importance of conservative treatment, even when the bladder and rectum are implicated, or complicated injuries of both organs exist. According to Langenbeck's way of thinking, conservative treatment should not be adopted, either for intra- or extra-capsular fractures of the neck of the femur, if the continuity of the bone is quite destroyed.

As recovery from these wounds hardly ever occurs without suppuration in the joint, consolidation of the fracture must be looked upon as impossible, and necrosis of the head of the femur, at all events in intra-capsular gun-shot fracture, as unavoidable. We must, therefore, he says, consider that complete separation of the neck of the femur and splintering of the head and neck of that bone should be excluded from conservative treatment, and that resection or extraction of the head should be performed either primarily before the expiration of the first twenty-four hours, or

* *Surgical Observations on Gun-shot Wounds of the Hip-joint*, by B. von Langenbeck. Translated by T. F. West, F.R.C.S.

directly after the expiration of the infiltration period, and before suppuration commences.

To carry out conservative treatment with the possibility of success, Langenbeck considers that the first and most important task is the immobilisation of the joint, and the suitable position of the patient. The wounded should therefore be left in the nearest field hospital, the first immovable bandage should be applied on the battlefield, and be so arranged that the probable unavoidable further transport to the first station of the army hospital, perhaps on a railway ambulance wagon, may be undertaken without great injury to the wound.

A plaster of Paris bandage well put on, surrounding the pelvis and the entire extremity, would best answer these requirements, but as they are troublesome of application, and require much time and too many experienced hands, Langenbeck does not recommend them during a great battle, but suggests flat hollow splints, fitting round the back of the pelvis and of the entire wounded extremity, leaving the fore part of the hip-joint free. He also speaks in favour of the "zinc tablets" suggested by Dr. Schön of the Austrian army.

Permanent extension by means of a weight is of the greatest importance. Active probing of the shot canal is objectionable, especially when it has been decided to treat the wound conservatively, as it must impair the chance of a favourable healing. With regard to extraction of the bullet, he is of opinion that if it is perceived in the neighbourhood of the joint, its extraction is necessary. Bone splinters, if they lie quite loose in the wound, may be extracted, especially if they are likely to interfere with the shot canal, or prevent the discharge of secretions from the wound. Repeated vigorous attempts to take bone splinters out of fresh wounds are altogether inadmissible. Free incisions are of the greatest importance for letting out blood which may be retained in the joint, or for collections of matter. Ice is recommended in Germany in the treatment of all recent joint wounds.

Excision of the Hip-joint for gun-shot wounds was performed in the Crimea, in the Schleswig-Holstein campaigns, during the American War of the Rebellion, and during the Franco-German War of 1870-71, but the result with few exceptions was far from satisfactory, due in many instances to the want of proper means for carrying out the after-treatment. Yet, till Professor Langenbeck published his experiences, excision was advocated for certain wounds in preference to conservative treatment, and with suitable means for the after-treatment, one cannot but think it would be preferable, seeing the splendid results which the operation sometimes affords in civil life.

Excision was first recommended by Mr. Guthrie as a substitute for amputation at the hip-joint; he limited the operation to injuries of the head and neck of the bone, or with little extension beyond these parts.

Mr. Hamilton, U.S.A., considers that when a ball has entered the head, neck, or trochanteric portion of the femur, if any surgical operation is demanded in these cases, it is excision.

Mr. Otis gives three periods for performing the operation of excision of the hip-joint.*

These periods he defines thus:—*Primary*, those performed in the interval between the reception of the injury and the commencement of the inflammatory symptoms, a period rarely exceeding in duration twenty-four hours, but it may be prolonged to thirty-six or forty-eight hours. *Intermediate*, those performed during the persistence of the inflammatory stage, a period extending over two or three months. *Secondary*, those performed after inflammation has subsided, when the local lesions have become analagous to those resulting from chronic disease.

He writes—"A study of the history of over 20,000 major amputations, and of more than 4,000 excisions of the larger joints definitely teaches that, in operations for traumatic causes, there is a wide difference in the results of those performed immediately after the reception of the injury, those performed during the existence of inflammatory action, and those done after the symptomatic fever and inflammatory symptoms have abated."

Mr. Otis says—"122 cases comprise the greater number of gun-shot fractures of the upper extremity of the femur, involving the hip-joint and treated on the expectant plan, which were uncomplicated by lesions of the pelvis, or of the great vessels or nerves. Of these, 114 proved fatal, and the average duration of life after the reception of the injury was thirty-one days." "I continue," he writes, "to share the conviction of Guthrie and the elder authors as to the uniform fatality of such injuries when abandoned to the resources of nature. I am fortified in this opinion by the fact that none of the officers of the regular staff have ever observed an unequivocal instance of recovery under such circumstances, by the testimony also of a majority of the surgeons of the volunteer staff, and the concurrent testimony of a large number of those regimental surgeons who acted as chiefs of divisions, who aver that they have never seen a recovery from an undoubted gun-shot injury of the hip-joint treated on the expectant plan. *Expectant treatment is to be condemned in all cases in which the diagnosis of direct injury to the joint can be clearly established.* Experience teaches that considerable portions of the shaft may be with propriety removed with the head, neck, and trochanters in cases in which splintering extends below the trochanter minor. The necessity of accurate diagnosis cannot be insisted upon too strongly, since there can be little doubt that gun-shot fractures of the *upper third* of the femur not involving the articulation are best treated by conservative measures. In fractures or excisions of the upper extremity of the femur, no apparatus or dressing yet devised ensures entire rest under such circumstances."

All experience thus points out the necessity of excising the head and neck of the femur when completely fractured by a bullet. To attempt to carry out an expectant treatment unless the patient can be promised absolute rest for some time afterwards is to insure a fatal result. The

*Circular 2—A Report upon Excision of the Head of the Femur. War Department, Washington, U.S., 1869.

only course is to excise the parts within the first twenty-four hours if possible, and, therefore, the first examination should be most carefully conducted with the finger, so that accurate knowledge may be acquired of the exact nature of the injury. Antiseptic treatment, however important and valuable, will not suffice without an operation in a case of this kind if the one factor *rest* is wanting.

Amputation at the Hip-joint for gun-shot wounds, notwithstanding its great mortality, cannot be altogether discarded. Mr. Guthrie laid it down as a principle that in all cases of accident, whether from shot, shell, or railway carriage, no man should suffer amputation at the hip-joint, when the thigh bone is entire. Cases requiring it are those in which a wound of the artery is accompanied by a fracture of the femur, or in the event of the principal artery being wounded during the course of treatment, or its not being possible to saw the bone through immediately below the trochanter major, and when sufficient flaps cannot be preserved to close the wound thus made.

The following rules as regards amputation at the hip-joint, which are laid down by Mr. Otis, appear highly practical—(1) When the thigh is torn off, or the upper extremity of the femur comminuted with great laceration of the soft parts, in such proximity to the trunk that amputation in continuity is impracticable; (2) when a fracture of the head, neck, or trochanters of the femur is complicated with a wound of the femoral vessels; (3) when a gun-shot fracture involving the hip is complicated by a severe compound fracture of the limb lower down, or by a wound of the knee-joint. There are two other possible contingencies under which primary or early intermediate coxofemoral amputations for injury may be admissible—(1) When, without fracture, a ball divides the femoral artery and vein near the crural arch; (2) when a gun-shot fracture in the trochanteric region is so complicated by extensive longitudinal fissuring as to preclude excision.

Langenbeck, in referring to the dangers of amputation at the hip-joint, gives as a prime cause the lateness at which the operation is usually performed after receipt of the injury. He considers it should not be done during the period of infiltration, or after pyæmic or septicæmic symptoms have appeared, but that the proper period is in the course of the first twelve to twenty-four hours. If, however, the right moment for amputation is neglected, resection is admissible as the only means of saving life, with a view to amputation being performed later on, when the patient is under more favourable circumstances.

Symptoms of Gun-shot Fractures of the Hip-joint.—With complete separation of the head or of the neck of the femur, the symptoms are the same as fractures of the neck of the thigh in civil practice. Discharge of synovia is represented as being absent more frequently than present; this is peculiarly remarkable in wounds that go direct into the joint from the groin, but not with those where the wound aperture lies further back; the absence of synovia, however, does not prove that the hip-joint is uninjured. Langenbeck lays down as one distinct sign the swelling of the articular capsule by blood and synovia, ichor and pus, which is most plainly witnessed in the neighbourhood of the groin, where

the articular capsule is superficial. The large vessels are forcibly lifted by the continually swelling capsule, so that the femoral artery seems to beat close under the skin.

Gun-shot wounds of the trochanter, and injuries of the soft parts near the hip-joint require the greatest care, even when there is no evidence of the joint being injured, because the subsequent inflammation and suppuration may ultimately extend to it. The trochanter major, remarks Professor Langenbeck, as the projecting point in the outline of the thigh shows the centre of the hip-joint, so the bullet may lodge in the joint if it is projected in that direction. The dilatable bone substance allows the bullet to press forward into the joint without leaving behind a shot canal that will fairly admit the probe, and one is too easily led to believe that the ball has passed through, or fallen out of the apparent shot canal.

It is now considered good practice in gun-shot wounds of the upper part of the femur, when the fracture does not extend beyond the trochanter or is in the trochanter itself, to simply remove the splinters and secure absolute rest for the patient.

The exact position of the trochanter is often of the greatest importance, hence these measurements have great diagnostic value.

"**Nélaton's Line** consists of a line drawn from the anterior-superior spine of the ilium to the tuber ischii. If the trochanter be at its proper level, this line ought to touch its upper border when the limb is straight. The importance of this line is, that when the head of the femur is in its normal situation, it touches the summit of the trochanter in every degree of flexion or extension of the limb. If the trochanter be displaced in any direction a corresponding change in its revolution to this line will ensue. There is, however, the fallacy that abduction raises the trochanter above the line and adduction brings it below the line."

"**Bryant's Ilio-Femoral Triangle** is formed by placing the patient in the recumbent position; then drawing a line from the anterior-superior spine of the ilium directly backwards, another line also from the anterior-superior spine to the summit of the trochanter, and a third, or base line, directly upward from this to the first line, a triangle will thus be formed. The oblique line corresponds to the first part of *Nélaton's* line and may be taken, just as Nélaton's, as the diagnostic line for dislocations of the head backwards; whilst Bryant's base line is the test line for all cases in which the neck of the femur is shortened, or the head of the bone thrown upwards. In this method of measuring there is the same fallacy as in Nélaton's."

"**Giraud-Teulon's** method, although somewhat complicated, appears to be free from all sources of error. It is founded upon the fact that the middle of Nélaton's line corresponds to the centre of the acetabulum. Any shortening of the femur by fracture, or any dislocation, will necessarily alter the distance between the lower end of the femur and this point. The measurement is thus carried out. Find the distance from the anterior-superior spine of ilium to the tuberosity of the ischium, and from the same point to the inner condyle, and from the tuberosity to the inner condyle. Then draw a triangle on a sheet of paper, the three sides

of which are equal to these three measurements; find the middle point of the line corresponding to the measurement between the tuberosity and the spine, and from that draw a line to the apex of the triangle. This line corresponds to the distance of the inner condyle from the centre of the acetabulum, and must be contrasted with a similar line obtained by measurements of the sound side."*

Wounds of the Knee-Joint.

Wounds of the knee-joint are most serious. The admission of air containing germs into a large sac lined by synovial membrane, producing septic inflammatory action with in all probability diarrhœa and hectic from septic blood-poisoning, render these injuries beyond hope of recovery without surgical interference, unless they are treated antiseptically from the first. The treatment generally hitherto admitted as being the best is that of amputation, but there are surgeons who advocate resection, or even attempts at conservation.

Mr. Hennen, after his great experience, says—"In my own practice I have met with only two cases where the limb was saved after serious injury to the knee-joint, and in one of them only was the perfect use of it restored."

Mr. Guthrie considers that "wounds of the knee-joint from musket-balls, with fracture of the bones composing it, require immediate amputation."

Dr. Macleod, who appears to have taken a special interest in this class of wounds, visited every one he could hear of in camp while in the Crimea, and avers that he never met with one instance of recovery in which the joint was distinctly opened and the bones much injured by the ball, unless the limb was removed.

Dr. Stromeyer recommends primary amputation for gun-shot injuries of the knee-joint. He is not in favour of resection, and is thus opposed to Professor Langenbeck, whose system is non-interference.

Langenbeck very strongly advocates conservative treatment. Immediate amputation or resection he reserves for cases where fragments of bone are actually severed, or where shattering of the bone ends is complicated with considerable tearing and loss of soft parts. He uses plaster of Paris bandages, ice, and antiseptics. In 1866, out of 18 cases, 11 were cured by conservative treatment.

Dr. Carl Reyher in the last Russo-Turkish War had a remarkable success, he divides his cases into "primary antiseptic," that is, cases which were treated aseptically from the first, and which had not been *fingered* or probed in any way; "secondary antiseptic," or, cases where the wound had been examined or treated in some way opposed to aseptic principles; and "non-antiseptic" cases. He had 46 cases of gun-shot injury to the knee-joint, 18 were primary antiseptic cases, of which 3 died, and 15 recovered with movable knee-joints—percentage of mortality 16·6. Forty were secondary antiseptic, 34 died, 1 recovered—percentage

* *Science and Art of Surgery*, Erichsen, 8th Edition.

of mortality 85. Twenty-three were non-antiseptic, 22 died—percentage of deaths 95·6.

In his primary antiseptic cases, Reyher either washed out the wound, if small, with an antiseptic solution, removed any foreign body present, drained and treated it by a dry gauze dressing; if, however, the apertures were large, and splinters of bone had to be removed, he carried out Lister's treatment with all details of gauze, spray, &c.; or, he did not wash out the wound at all, but simply contented himself with purifying the exterior, and applying an antiseptic dressing. The former practice was adopted when the wound was gaping, and when there was a suspicion that portion of the clothing, &c., had been carried in with the bullet; the latter practice, where the edges of the skin were lying together, and where it was thought that the bullet had not carried any extraneous matters in with it. Bergmann also got some remarkable results. He had 15 cases of fresh gun-shot wounds of the knee-joint after the storming of Telisch and Gorni-Dubnik. These were all treated by careful cleansing of the skin by a carbolic solution, and then applying masses of salicylated wool, and over all a plaster of Paris bandage. Of these 14 recovered, 2 after amputation, and 1 died.—*Cheyne.**

Sir T. Longmore sums up from all the experience gained regarding gun-shot wounds of the knee-joint, that when the damage is slight, and early immobilisation and antiseptic treatment can be carried out, conservative treatment should be adopted. When, however, these cannot be obtained, and when the patients are liable to be moved frequently, or to long distances, hurriedly and without adequate protection, and when the injury is excessive, amputation above the joint is the only remedy.

"In all cases in which antiseptic treatment is impossible, conservative treatment contrasts most unfavourably with primary amputation in the lower third of the thigh. When amputation is determined on, the operation requires to be performed early, and this necessity for early amputation in penetrating bullet wounds of the knee-joint when antiseptic treatment is impossible, is recognised by all modern military surgeons."—*Erichsen.*†

Excision of the knee-joint is an operation which should not be attempted unless under the most advantageous circumstances; when every possible care and attention can be given to the after-treatment; when the patient can have good air and diet, and every appliance that the surgeon may require, together with absolute rest. These circumstances are not likely to exist in the field, though they may be available in the stationary hospitals in European warfare.

If an attempt be made to save the limb without operation, the joint should be thoroughly washed out by a 1-20 carbolic, or other antiseptic lotion; thorough drainage either by tubes or fresh incisions, and the envelopment of the whole joint in salicylated or mercurialised cotton wool is required, and the limb should be immobilised on a splint.

But if, from the nature of the injury, an operation is deemed necessary, the safest course to adopt is to amputate at the lower third of the thigh,

* *Antiseptic Surgery.*

† *Science and Art of Surgery*, Erichsen, 8th Edition.

and the sooner it is done the better, as inflammatory symptoms soon set in after such injuries, followed by suppuration of the joint; abscesses appear among the muscles of the thigh burrowing along the bone after depriving it of its covering; the patient rapidly becomes exhausted by hectic, when interference by amputation will be too late.

In incised wounds of the knee-joint, if not complicated, it is best to try and save the limb by enlarging the wound if necessary, thoroughly washing out the joint with an antiseptic lotion, providing for complete drainage, enveloping it in an antiseptic dressing, and rendering the limb immovable by splints; should, however, inflammation set in and pus form, free exit must be given to the matter, and the most careful antiseptic treatment by frequent washing out with mercuric chloride, or other antiseptic lotion, must be carefully attended to.

Wounds of the Patella.

The patella is occasionally fractured by a bullet or other missile, and if complicated with injuries to the other bones it will be impossible to save the limb. Should, however, the patella be struck in front and only split, an attempt should be made to save the limb.

If antiseptic treatment is available, the fragments may be wired together with the same successful results as attend the operation for ordinary fracture, but any liability of the patient to sudden or frequent moves would render the treatment difficult.

In all injuries to the patella, the limb should be placed in the straight position with a well-padded splint underneath, and the heel slightly raised.

Wounds of the Ankle-Joint.

In these injuries much depends on the amount of damage done to guide the surgeon in the treatment. If the bones are not extensively injured, and the posterior tibial artery and nerves are intact, an attempt should be made to save the foot; but, like all injuries to joints in which the surgeon might wish to save the limb, and indeed where it might be considered advisable, the circumstances as regards rest, care, attention, &c., as already described, should influence him.

Stromeyer, in wounds of the tibio-tarsal articulation, recommends the expectant treatment. He is opposed to resection of this joint, which was not successful in the Franco-German war of 1870-71. His plan of treating gun-shot wounds of the ankle is simply to keep the parts perfectly immovable, and extract the pieces of splintered bone, as they become detached.

Langenbeck is in favour of resection, which operation he performed with success in the German-Danish War of 1864, and the Bohemian War of 1866. He has had nine recoveries out of eleven operations. He recommends subperiosteal resection, and complete immobilisation of the parts after the operation.

Erichsen considers that if the bones be not too extensively comminuted,

an attempt, and probably a successful one, may be made to save the limb. In such cases extraction of fragments and excision of the splintered ends are necessary; and modified operations, partial excision by means of gouge, forceps, and Hey's saw, will be found more successful than the formal operation.

If the large vessels and nerves have been cut across, and the bones very extensively shattered, amputation will be the proper course to pursue.

Legouest admits that there are many instances of success when resection of the ankle-joint has been performed, but he considers that the seriousness of lesions of this articulation, the danger of the operation, and the uncertainty of definite results, justify him in rejecting resection of this joint in a general way, as he has already rejected that of the wrist.

WOUNDS OF NERVES AND TENDONS.

Nerves may be injured by contusion, compression, or distention, by laceration, by partial or whole division, by puncture or incision. Foreign bodies may be imbedded in them, or they may be included in a ligature, any of which may give rise to most serious symptoms, both local and constitutional, such as intolerable pain, inflammation, contraction of muscles, with more or less paralysis of the parts supplied by them.

Treatment.—If exposed, the parts must be thoroughly cleansed, the ends of the nerve, if divided, accurately brought together by catgut sutures, and every endeavour made to get union by first intention.

Compression of nerves, as from the pressure of tumours, aneurisms, dislocations, fractures, and the contraction of cicatrical tissue, is apt to set up neuritis. The effects of pressure may lead to loss of sensation and paralysis, wasting, and degeneration of muscles; in the course of time, however, the nerve may recover its function. Neuritis, if once set up is very troublesome; its symptoms are described by Erichsen as intense pain and tenderness in the line of the affected nerve; sensation is variously modified in the parts supplied by the nerve; there may be numbness or tingling or anæsthesia, in other cases there may be intense pain; occasionally there are spasms, but more commonly there is weakness or paralysis of some of the muscles supplied.

The tender nerve should be freely blistered and the affected limb put at rest. Constitutional conditions, as gout, rheumatism, malaria, and syphilis, must be duly treated; it is in these cases that nerve stretching has been attended with success. By the stretching the conducting power of the nerve is abolished, but the continuity of the nerve is not destroyed, and restoration of function gradually returns.

The local application of belladonna, chloroform, aconite, blisters, subcutaneous injection of morphia and of sulphate of atropia in the proportion of $\frac{1}{2}$ gr. and $\frac{1}{25}$ gr., the administration of mercury, or division of the nerve may be tried. The local use of cocaine in a 4 per cent. solution might be of use.

Tendons may be divided by sword-cut or other sharp weapon, or

ruptured by over-exertion, when it will be necessary to place the limb in such a position that the muscles may be relaxed, and so approximate the divided ends. In a wound, the ends should be carefully brought together with catgut sutures, and great pains taken to obtain union by first intention.

When the tendo-Achillis has been cut or ruptured, an apparatus may be constructed by placing a strap, like a dog-collar, above the knee, from which a cord is attached to a loop in the back of a shoe or slipper; by tightening this cord the muscles are relaxed.

When the extensor tendons of the fingers are divided, the hand must be placed in the straight position on a splint.

ANÆSTHESIA.

Chloroform.—When administering chloroform it is advisable to have near at hand and ready for use a battery of electricity, some ammonia, and a pair of spring forceps for drawing the tongue forward. Recently-wounded men require no preparation for its administration, but a little stimulant such as wine or brandy may be given about half an hour before the chloroform is administered. The patient should be placed in the recumbent position with the head thrown well back.

There have been considerable discussions of late as to the way in which chloroform affects the vital organs; on one side, it is urged that it is the respiratory centres that are primarily affected, and the heart secondarily; on the other, that chloroform has a direct effect upon the heart itself.

Surgeon-Major Laurie, I.M.S., thinks that the experimental data of the Hyderabad Commission* prove—1, that the administration of chloroform is free from risk if the breathing is perfectly regular throughout and the inhalation is stopped as soon as the patient is fully under its influence; 2, that chloroform never causes death by sudden stoppage of the heart; 3, that death from chloroform is always the result of an overdose; 4, that the danger of overdosing is enormously increased by holding the breath, struggling, asphyxia, or anything which causes the patient to take gasping inspirations; and 5, that the inhibitory action of the vagus nerve, which is called into play in threatening and actual poisoning with chloroform, is a safeguard.

S. M. Laurie says—"That the true art of giving chloroform, to prevent overdosing, consists not only in concentrating your attention on the breathing, but in keeping it absolutely regular throughout the administration, and in stopping the inhalation whenever the breathing is irregular. and directly the patient is fully under the influence of the anæsthetic." No instruments should be used for the administration of chloroform, but an open cone or cup with a little cotton wool is best, and care should be taken to give it at first largely diluted with air. The administration should be guided as to the effects entirely by the respiration, if possible, the patient's chest and abdomen should be exposed during chloroform

* "Report of the Second Hyderabad Chloroform Commission."—*Lancet*, Dec. 18, 1890.

inhalation, so that the respiratory movements can be seen by the administrator. If there is any interference with the respiration in any way, if the breath is held, or there is a stertor, the inhalation should be stopped until the breathing is natural again. If the breathing becomes embarrassed the lower jaw should be pulled or pushed forward from behind its angles, so that the lower teeth protrude in front of the upper. This raises the epiglottis and frees the larynx. At the same time the respiration should be assisted artificially until the embarrassment has passed off. The tongue should at the same time be drawn forward by means of a pair of catch forceps.

On the other hand, Dr. J. A. M'William reports,* as the results of his research, that during chloroform anæsthesia the blood-pressure is lowered and the heart's action is weakened. Dilatation of the heart occurs to an appreciable extent, even when chloroform is administered gently and mixed with abundance of air. There is no distinct change in the rate of the heart's action when dilatation occurs. A sudden and complete cessation of the cardiac rhythm is never caused by the inhalation of chloroform. Cardiac failure occurs by a more or less sudden enfeeblement and dilatation of the organ; not by a complete cessation of rhythm. Cardiac failure sometimes occurs in this way a considerable time before the respiration stops, though generally the respiration stops before the heart has become incapacitated. Changes in the respiration assert a most important influence upon the effects of chloroform administration. An amount of chloroform which can be given with safety during easy breathing may speedily become dangerous during deep rapid respiration. Free dilution of air gives no security against an overdose. A percentage that gives safe anæsthesia during ordinary breathing may lead to fatal collapse if given during exaggerated respiration.

The experiments also prove that the difference between the action of chloroform and ether is not simply a difference of intensity. There is commonly seen a very striking and important difference between the relative influence of the two anæsthetics upon certain functions. Ether can abolish the conjunctival reflex, and induce profound anæsthesia with no appreciable direct effect on the heart; while chloroform, in causing a less deep anæsthesia, in which the conjunctival reflex is not abolished, may directly cause marked dilatation of the heart.

Several fatal cases of chloroform-poisoning have occurred of late, and in each of them it has seemed that the heart suddenly gave way, and ceased without giving any previous warning; and in several of these cases the heart was proved to be fatty. It is difficult to see how this sort of accident can be altogether avoided, as there is no way of detecting that a heart is thus affected. But it seems to point to the rule of administering ether, unless the nature of the operation about to be undertaken forbids the use of an inhaler, or if there is considerable bronchial irritation present, when ether would be contra-indicated on account of the distress it would occasion. Whoever in the present day undertakes to administer chloroform, should give his undivided attention to the patient, and must

* "Report on an Experimental Investigation of the Action of Chloroform and Ether," by Dr. J. A. M'William, M.D. *Brit. Med. Jour.*, October 11, 1890.

never be tempted to allow his interest in the surgical proceedings that may be going on to blunt his observation, or cause him to relax his vigilance.

Ether is now much used, and has obtained the credit of being much safer than chloroform. It has, however, two great disadvantages, which are, that it requires a large quantity to produce anæsthesia, also a bulky instrument for its administration, both of some consequence on active service.

Mr. T. Pridgin Teale writes so appositely on the subject as to render it expedient to give his remarks in full. He says,* "Ormsby, of Dublin, invented the inhaler in which the exhaled warm air, charged as it is with ether, was received into an india-rubber bag and breathed over and over again, thus economising the heat of about 90 per cent. of the exhalations and reducing the waste of ether. This idea was taken up by Clover and developed into the present form of inhaler, which, as far as I know, is unapproached by any method of giving ether that has come into use.

"To administer ether badly is to bring it down nearly to a level with chloroform as to safety, and to render it inferior to chloroform as to comfort to the patient. A bad etherist will cause fear, coughing, distressing sense of suffocation, excitement, struggling, blueness of lips, mucous rattling in the trachea and bronchi. He will take many minutes, five to ten, in getting his patient under the anæsthetic, will use twice or thrice as much ether as is needful, will keep his patient when unconscious overcharged with ether, in a state of profound stertor, and will now and then set up a dangerous bronchitis. A good etherist will win the confidence of his patient, even of the most timid, by judicious encouragement, and by first applying the mouthpiece alone. As confidence becomes established he adds the reservoir and then the india-rubber bag, slowly turning on the ether as tolerance of the vapour becomes established, and unconsciousness begins to steal on. Then he more rapidly increases the proportion of ether, and the patient quickly falls into complete anæsthesia. Such an administrator will, in nine cases out of ten, have his patient ready for operation in two or three minutes, and not infrequently in about a minute and a half, without a struggle, without coughing, often without even a transient sense of suffocation, and with the expenditure of about half an ounce of ether, and will but need about one ounce of ether for each quarter of an hour that the anæsthesia is kept up. In such a case we need fear no danger at the time, nor subsequent bronchitis.

"The advantages to the operator of using ether instead of chloroform are very great. In the first place, his anxiety is less, his fear of a fatal issue is less, and when obliged to trust to an inexperienced administrator, as he must do at times in sudden emergencies, he can more efficiently keep an eye on the patient's condition, and superintend the administrator, than when chloroform is used.

"In the second place, there is a saving of time, a patient being brought under the influence of ether in two or three minutes, whereas chloroform, in my experience, needs eight or ten.

* "Address in Surgery," by T. Pridgin Teale, F.R.C.S., F.R.S., Leeds, 1889. *Brit. Med. Journ.*, Aug. 17, 1889.

"In the third place, under ether return of consciousness to pain generally lags behind the return of mental perception, and thus anæsthesia can easily be re-established without interrupting the operation. So marked is this fact towards the end of a prolonged operation, that sometimes the surgeon may continue to operate for ten minutes or a quarter of an hour without re-application of the inhaler, and even converse with his patient whilst stitching up a wound. This is hardly, or rarely, the case with chloroform."

Local anæsthesia may be induced by freezing a part, either by the use of a freezing mixture, or by the rapid evaporation of ether from its surface. The former is managed by mixing some powdered ice and salt, and then applying it in a muslin bag until the skin is white and insensible, the latter by the use of Richardson's spray producer, which is a far more convenient form than the freezing mixture.

Lately, the use of cocaine has been much recommended for producing local insensibility to pain. Cocaine is an alkaloid obtained from the leaves of the *Erythroxylon coca*—its salt the hydrochlorate is soluble in water, and is used in a 4 per cent. and 2 per cent. solution. Mr. Hartridge says it is of considerable value as a local anæsthetic in disease of the cornea where photophobia is a prominent symptom, for the removal of foreign bodies from the cornea; in all operations affecting the cornea and conjunctiva only; in cases of cataract extraction where it is undesirable to give ether or chloroform. It is of little value in operations involving the skin unless injected into the skin itself and not under it. It has been used to produce anæsthesia of the larynx, pharynx, and other parts. In cases of supra-orbital neuralgia, a 10 or 20 per cent. solution in oil of cloves rubbed into the part, affords almost immediate relief. Its effects pass off in from 6 to 10 minutes. "It is a mydriatic and paralyzes the accommodation. Its aqueous solution is apt to grow fungi, and bad effects upon the eye have been attributed to these fungoid growths." *Martindale.*

In some cases fainting and sickness with other toxic effects, as fixity of gaze, temporary visual defect with slight delirium, are reported as following its use for purposes of local anæsthesia; but the inhalation of nitrate of amyl quickly puts an end to them.

AMPUTATION.

Under this heading will first be considered the question as to the proper period for performing amputation for wounds requiring it in warfare; secondly, cases demanding it; and, thirdly, the most approved methods of operating.

Mr. Hennen remarks, in his work, 1818—"The propriety of amputation in the field being admitted, the question naturally suggests itself. What is the proper period—instantly on receipt of the wound, or consecutively? The practical reply is, with as little delay as possible."

Sir T. Longmore considers that, in respect to the particular time at which primary amputation is to be performed, the general practice of the

present day is, when the operation is inevitable, to perform it as soon as it can be done, provided the more intense effects of the "shock," where it has supervened on the injury, have passed away.

Mr. Guthrie is of opinion that when the wound of an extremity is of so serious a nature as to preclude all hope of saving the limb by successful treatment, it should be amputated as soon as possible; and, further, the advantageous results of primary amputations, or those done within the first twenty-four hours, or at most forty hours, over secondary amputations, or those done at the end of several days, or of three or four weeks, have been so fully and firmly established as no longer to admit of any dispute.

In the present day primary amputations are discouraged at the dressing stations on the field of battle, because of the extreme difficulty in carrying out an antiseptic line of treatment in such a situation.

Amputations in warfare have for a very long time been divided into primary and secondary. Mr. Alcock has introduced a third period, "the intermediary," and these three have been accepted by many surgeons to denote periods in which amputation may or may not be performed.

He defines the three periods as follows:—Primary, or the period between the receipt of the injury and the appearance of inflammatory symptoms; intermediary, or the period when the inflammatory action has commenced, and is more or less capable of disturbing the animal economy; secondary, when the violence of the inflammatory symptoms and sympathetic fever have abated, that is, when the suppurative stage is fully established.

It is now generally admitted that when amputation is necessary, it should be performed at once, the condition of the sufferer being duly considered, that is, if the shock exists to an alarming extent, it is best to delay the operation, and administer cordials, apply warmth to the extremities, and wait till reaction is established; but if it be not very intense, the operation can be performed under the influence of chloroform with the most satisfactory results. Macleod remarks, with regard to the use of chloroform, that by its use the fear of intensifying the shock is obviated.

Amputations after septic inflammatory action has set in are generally attended by most unsatisfactory results. Operations or examination of wounds should never be performed during the intermediary state or period of inflammation, when the constitution is in a most unfavourable condition for such undertakings, and all operations are likely to be attended by the most serious results.

Secondary amputations are not so successful in military as in civil practice, when the operation is generally performed for disease and not for injury. In warfare the cases requiring it are profuse hæmorrhage, which does not admit of the ordinary measures of suppression; gun-shot fractures, when the bones do not unite, and the patient is worn out with suppuration, irritation, necrosis, caries, and all the painful accompaniments of a shattered and useless limb; and cases when traumatic gangrene has attacked a severely contused limb.

Patients who have been subjected to secondary amputation should be placed in most favourable hygienic conditions : their constitutions having already suffered renders them peculiarly liable to the occurrence of pyæmia, sloughing, and phagedæna.

Cases demanding Amputation.

In wounds of the extremities these cases will be found described according to particular regions, but here they will be considered generally.

Cases demanding Amputation, then, are as follows :—

When a bone is fractured and there is laceration of the main arterial trunk supplying the limb, provided the vessel cannot be tied ;

When there is a fracture complicated with destruction of the principal arterial and nervous trunks occurring in the course of a large limb ;

When a whole limb is carried off, a rugged stump merely being left ;

When there is a comminuted fracture, accompanied with extensive lesion of the soft parts, or with rupture of the principal artery and nerve ;

When a limb is completely crushed and disorganised ;

When there is a compound fracture of a large limb, with rupture of the principal artery and nerve ;

When the principal vessels and soft parts have been carried away, though the bone be uninjured ;

Extensive injuries of the shoulder, elbow, wrist, and ankle joints, may require amputation ; but unless there is splintering into the shaft of the long bones, loss of soft parts, or injuries of the principal artery and nerve, resection or excision should be performed.

Different Methods Considered.

Amputation and Disarticulation may be performed by the circular method, the oval method, or by flaps of different shapes, and by skin flaps with a circular cut through the muscles.

Much discussion has taken place as to which is the best plan during warfare. The circular method was generally practised by the German surgeons during the Franco-German War, and was attended by satisfactory results.

Esmarch prefers the circular incision, as the arteries are cut transversely, while by the flap operation an oval opening is made in the vessels, and it might easily occur that the whole lumen of the vessel was not included in the ligature.

The operations recommended for injuries when an army is moving are skin flaps and circular cut through the muscles. The advantages of these operations are—that the flaps are not so liable to be displaced in transport ; there is less care required in the after-treatment, and it has been suggested by many authorities that the skin forms a better covering to the end of the bone than muscle, and is more in accordance with nature, none of those parts of the body where there is most pressure having other covering than the skin. The late Mr. Teale practised

amputation by the rectangular flaps, the anterior being long and the posterior short. The disadvantages of this plan of operation consist in the necessity of sawing the bone at a higher point when one long flap is made, than when two shorter ones of equal, or nearly equal, length are fashioned.

In gun-shot wounds it appears especially unsuited, as in many injuries requiring amputation good double flaps may be formed from the soft parts, and a joint may thus be saved. Take, for instance, injuries below the knee or elbow, in which, if one long anterior flap is formed, it must be at the sacrifice of the joint and the consequent increased risk to the life of the sufferer by the high amputation.

In cutting skin flaps, Sir Jos. Lister particularly cautions young operators against directing the edge of the knife towards the skin in raising flaps of integuments. He says,* "such a practice necessary in anatomy will, if carried into an amputation, most seriously endanger the vitality of the flap, which derives its supply of nourishment from vessels ramifying in the fat. I am satisfied that integument designed to form a covering for the stump is often made to slough for want of scrupulous attention to this simple point." Also he says, "that the skin should always be cut perpendicular to its surface, for if it is levelled off to a thin edge it is not only unsuited in shape for adaptation with a view to primary union, but the margin may slough for lack of nutriment. Again, in transfixing a limb it is desirable that this should be done in a continuous manner, for if the instrument be thrust in for a certain distance and then partially withdrawn and made to follow a new track, the punctured wound first made may cause very troublesome hæmorrhage, if a considerable arterial branch happen to be divided by it. The operator should always stand so as to be able to control with his left hand the part which he removes. In tying vessels, the catgut ligature with short cut ends has none of the inconveniences of the long threads of silk or flax formerly employed; there is no objection to tying mere oozing points however numerous. The principal veins may also be tied, as the dread of exciting phlebitis by such treatment is entirely groundless."

Mr. Heather Bigg, the experienced mechanician, in a recent work,† offers some valuable suggestions to surgeons. He says the amount of covering to be left over the end of a stump should not be excessive, for it is a rule never to take any bearing on an operative end of a stump if it can possibly be avoided. After a Pirogoff, a bearing can be entirely taken on the end of the stump, but in this case it is a natural surface and not an operative one. With amputation through the ankle (Syme's) or through the knee-joint, some bearing can generally be taken on the stump ends, although the entire weight of the body cannot usually be borne on them. Hence, whenever actual section of bones exist in the stump end, bearing cannot be taken, and a full and padded covering of muscle is useless. The greatest care should be taken in rounding the ends of the cut bone, especially in the case of tibia and bones of the forearm.

* *Vide* Holmes' *System of Surgery*, vol. iii.
† *Artificial Limbs and Amputations.*

Mr. Bigg, regarding stumps in the view of providing for them artificial limbs, also says, "If possible, preserve the tread of the foot; this depends chiefly upon the great toe, with its metatarsal bone. If this cannot be done preserve the heel (Pirogoff or Syme). If this is impossible, preserve the knee with sufficient of the lower leg to utilise it, and amputate somewhere in the middle third of the leg for those who can afford an artificial foot, but for the labouring man a hand's breadth below the knee is the best suited for the bucket leg. Amputation through the condyles of the femur interferes very materially with the strength of the artificial knee, so that section through the femur just above the condyles is to be preferred."

Double Amputation.

It sometimes occurs that a soldier has two limbs so severely injured that amputation of both is necessary. Porter had an opportunity, during the Crimean War, of seeing one instance of this description of injury, in which he performed amputation of one leg above the knee, while his colleague removed the other shortly afterwards.

Double amputation has been performed at the same time by different surgeons, with a view to lessen the continuance of shock to the system, which would result from doing two operations in succession; but, to undertake anything so serious, the surgeon must be guided by the condition of the patient, as, if he is greatly depressed with continuance of the shock, the performing of a double amputation might be followed by most serious consequences. Under such circumstances, it would be better to remove one limb first, and after the shock produced by the operation had passed off to remove the other. There is no doubt, however, that if the sufferer could bear the double operation at the same time, the prospects would be more favourable.

After-treatment of Stumps.

It may be necessary to transport an unfortunate sufferer with a stump or stumps only recently made. The surgeon will then have an anxious time in so arranging that the patients are not unnecessarily knocked about. The stump should be supported by a piece of thick gutta-percha or strong board being placed underneath it and secured, and the whole enveloped in folds of cotton-wool or tow. It is surprising how soldiers recently operated upon bear transport, and what very slight injury is caused by it, due attention, of course, being paid to the nature of the conveyance and efficiency of the attendants.

Sir Jos. Lister says, "In the thigh, and also in the leg, great advantage is derived from bandaging upon the posterior surface of the stump outside the dressing, a trough of Gooch's splint (scored deal), on which the stump rests smoothly, being rendered independent of movement or irregularity of pillow."

Flies.

In camp and tropical hospitals, the greatest care is required to counteract the persistent efforts of these insects to deposit their ova in wounds, and to prevent the generation of larva in them; but the modern forms of dressing if carefully applied ought to quite prevent this accident.

Maggots in Stumps.

In warm climates maggots are very apt to infest wounds and stumps; the carbolic spray will in all probability act as a preventive to this disgusting circumstance. Porter experienced an instance of their rapid generation in India after the battle of Sultanpore. He amputated the leg of a native in consequence of a gun-shot wound. The stump was dressed with lint moistened with cold water, and secured for transport. On the second day after the operation, a considerable journey having been performed, on proceeding to dress it, the inside presented a living mass of maggots, which were removed and the case progressed most favourably. By keeping lint saturated with turpentine on the outer dressings, no more maggots appeared. Creasote in solution, common salt, and carbolic acid solution will expel them from a wound.

Bloodless Operation.

Professor Esmarch introduced what is known as the "bloodless operation," whereby a surgeon can remove a limb or excise a joint below the main trunk of an artery, without losing a drop of blood, and with but little assistance from others, two great advantages in warfare.

Sir Jos. Lister has somewhat modified the method of applying the elastic bandage. He has shown that an equally good result can be obtained by raising the limb straight up for two or three minutes, and gently rubbing the veins towards the trunk. "By this means the limb is rendered bloodless, both by emptying the veins and by contraction of the arteries, and then an elastic bandage can be bound tightly round the extremity at a suitable distance from the part about to be operated upon." The writer has invariably adopted this plan of late years, and in operations upon bones the convenience of a bloodless operation is very great. The objections to Esmarch's method of first enveloping the limb with an elastic bandage is that, in the case of suppuration, pus and putrid septic matter may be forced into the interstices of the sound tissues. Lister also remarks that he would hesitate in applying the continuous elastic bandage to a part affected with soft cancer. Again, the thick caoutchouc tube has in the case of the arm, where the soft parts are comparatively scanty, produced serious paralytic effects.

Without due precautions hæmorrhage is apt to occur after a bloodless operation. This, as a rule, may be checked by irrigation of the wound with iced water, by securing everything that showed a lumen, including

veins as well as arteries, by exposure of the wound, or by washing it with a strong solution of chloride of zinc, or with hot iodine water.

Approved Methods of Amputating.

Amputation at the Shoulder-joint.—Hamilton of the U.S. Army recommends the following proceeding:—The arm lying nearly against the side of the body, with a large bistoury or a small dissecting-knife an incision is commenced at the middle point of the extremity of the acromion process, or two or three lines above this point (fig. 94), and carried perpendicularly downwards one inch and a half, the knife being made to cut deeply until it touches the head of the humerus. At this point the

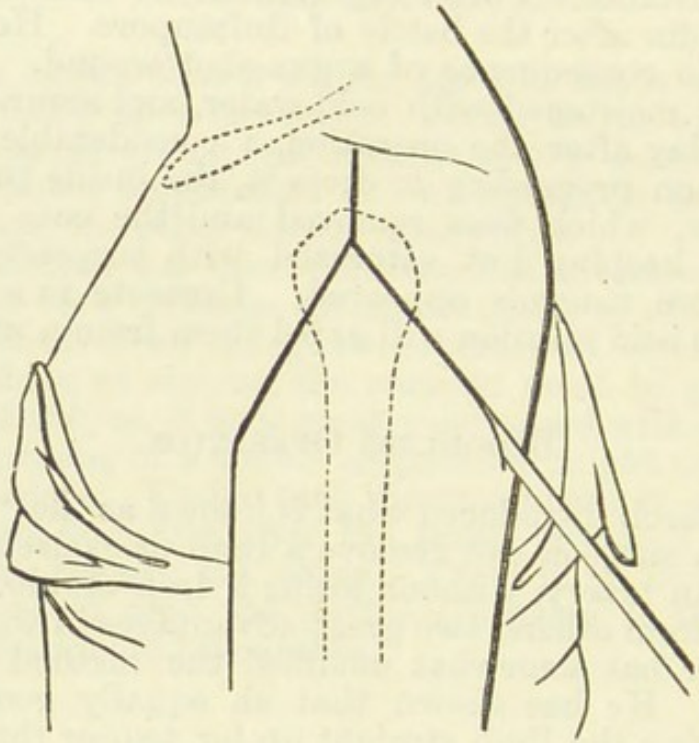

Fig. 94.

knife is carried obliquely, and rather abruptly, outwards and downwards to the centre of the lower margin of the axilla on the under side of the arm; in this second step of the incision, the tissues are divided down to the bone until the axillary margin is reached. From this point to the termination of the incision, only integuments are divided, so that we may avoid wounding the axillary artery. The knife is again introduced over the head of the humerus, at the point where the perpendicular incision became oblique, and it is carried down upon the inside of the arm in the same manner as we have described upon the outside.

One assistant pulling asunder the lips of the wound upon the top of the shoulder, while a second carries the elbow slightly across the body, and rotates the head of the humerus outwards, so as to expose the capsule and the long head of the biceps, the surgeon divides them with his knife, and at the same moment the head of the humerus springs from its socket.

The knife is then passed under the head of the bone from above, and as soon as the face of the instrument has fairly reached the surgical neck of the humerus, an assistant standing at the head of the patient pushes the thumbs of both hands into the wound above the knife, while the fingers remain in the axilla. He thus grasps and controls the axillary artery. The operation is completed by carrying the knife downwards close to the bone until the apex of the tegumentary wound in the axilla is reached, and then cutting almost directly outwards. Care must be taken not to sever the parts containing the artery until the knife has arrived at the lower margin of the axilla.

Spence's modification, which Erichsen says is especially adapted for gun-shot wounds of the upper end of the humerus, consists in carrying the vertical incision farther forward, and commencing it just external to and below the tip of the coracoid process, as in excision of the shoulder-joint. The incision ought to expose the tendon of the long head of the biceps lying parallel to it. This may be turned on one side and the joint opened and examined; and if, from the state of the parts, it be still considered necessary to amputate, the operation is completed by making an oval incision through the skin from the end of the original cut, taking care not to go so deeply on the inner side as to wound the vessels. The outer flap is then dissected up so as to enable the surgeon to get his knife internal to the head of the bone between it and the axillary artery. The assistant follows the knife with his hands and grasps the vessels, and the operation is finished by dividing the tissues left uncut at the inner side.

Amputation of the Shoulder-joint by Transfixion.—Lisfranc approved of this method, which Erichsen thus describes:—"A long narrow-bladed knife should be used. One assistant must have charge of the limb; another should raise the flap; and a third must follow the knife as it cuts behind the humerus and grasp the posterior flap with the axillary artery, so as to prevent hæmorrhage from this vessel. An assistant holding the arm away from the body, so as to relax the deltoid somewhat, the knife, instead of being entered by a puncture, should make a small cross-cut, about an inch in extent, at the point at which transfixion is to be practised, so as to prevent that jagging of the integuments by the heel of the instrument which would otherwise occur. If the operation be on the right side, the surgeon stands before the patient, and the point of the knife should be entered about an inch in front of the acromion (fig. 95), and being carried directly across the joint and capsule, should pass out at the posterior border of the axilla. If on the left side, the surgeon stands behind, and the point of the knife must be entered well behind the spine of the scapula, at the posterior border of the axilla, carried across the anterior aspect of the joint, and brought out to the inner side of the coracoid process. In either case, the large flap containing the deltoid muscle must then be cut with a sweep of the knife downwards, and, as soon as made, raised by another assistant. The heel of the knife is now to be laid on the head of the bone, the capsule of joint cut across, and the attachments of the muscles to the tuberosities divided. After the head of the bone has been turned out of the glenoid

cavity, the knife must be passed behind it and carried down for a distance of about 3 inches close to the bone at its inner side. The surgeon then cuts across the soft parts, so as to form the posterior flap. In doing this, the assistant to whom this part is entrusted must follow the knife with his hands, grasping firmly the whole thickness of the posterior flap, so as to compress the axillary artery, and thus prevent the occurrence of hæmorrhage.

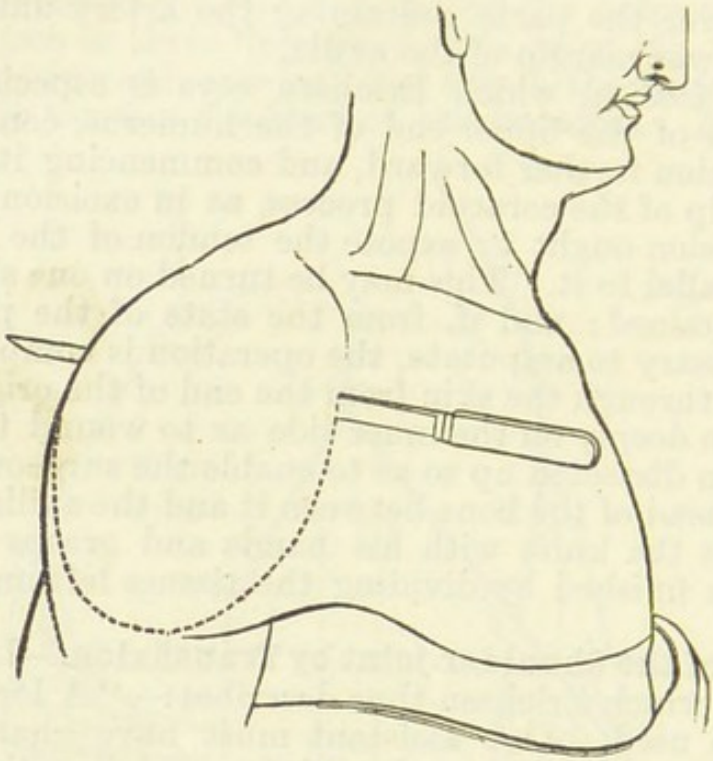

Fig. 95.

Sir W. Fergusson recommends that a bistoury be used for these operations, instead of the more imposing-looking amputating knife; but with such an instrument the first flap on the left shoulder would be made by cutting from the skin towards the joint.

Amputation of the Arm (Circular).—"The arm being held out, and an assistant drawing up the skin, one circular incision is made through the integuments, which are forcibly retracted and detached from the deeper structures by a few touches of the point of the knife, and doubled back to the extent of an inch and three-quarters, or more, according to the thickness of the arm, another is made down to the bone (fig. 96). These incisions should be made with slight divergences so as to cut the skin and muscles rather longer in front and behind than at the sides."

The flap operation in the upper arm is most conveniently done by double transfixion, though the flaps may be cut from without inwards without difficulty. The limb being held away from the trunk by an assistant, the operator grasps the biceps with the brachial vessels and nerves, and draws them well up, and entering the point of the knife upwards close below the thumb, passes it in front of the humerus,

depressing the point as it appears on the opposite side close to the operator's fingers. With a steady sawing movement, a flap from 2 to 3 inches long is cut, with the skin left longer than the muscles. Drawing up the flap with his fingers, the operator presses the knife behind the bone, and cuts a slightly larger flap behind, bringing out the knife

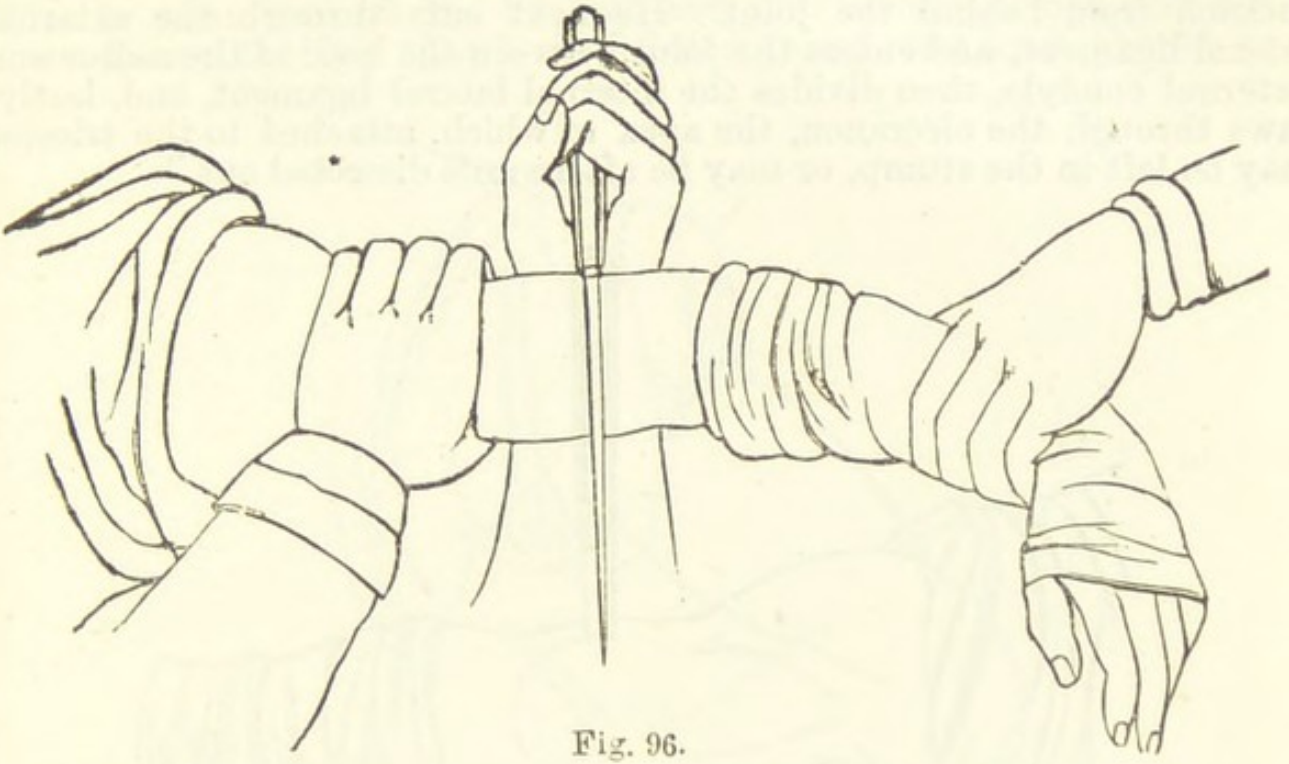

Fig. 96.

abruptly at last. Both flaps being gently retracted, the knife is swept round the bone, which is then sawn through, the thumb and fingers of the left hand protecting the soft tissues. The brachial artery will be found in the anterior flap with the median nerve and the ulnar nerve will be a little posterior. The artery, if cut too long, may be conveniently shortened, and the nerves should always be drawn out and cut short by an inch or so. The inferior profunda artery will be found in company with the ulnar nerve, and the superior profunda with the musculo-spiral nerve in the posterior flap.—*Heath.*

In very muscular arms the modified circular skin flaps, and circular cut of muscles would give the best results.

Amputation through the Elbow-joint can be performed by the circular method or by flaps. If by the circular, Hamilton recommends "that the incision should commence at least 3 inches below the joint. The integuments being retracted, the head of the radius should be sought, and the external lateral ligament severed; after which, having divided all the muscles, including the tendon of the biceps and the brachialis anticus, the coronoid process of the ulna will be easily made out; the anterior ligament and capsule may now be severed more completely, then the external lateral ligament. By moderate pressure upon the forearm the joint will now open sufficiently to admit the saw, if it is thought desirable to sever the olecranon process. It is a matter of

indifference, perhaps, whether we dissect out the olecranon by cutting the triceps from behind, or divide it with the saw applied as we have directed."

Flap Method.—"This is performed by passing the knife through the muscles in front of the joint, and cutting upwards and forwards, so as to make a flap from the forearm. Then the operator makes a transverse incision from behind the joint. He next cuts through the external lateral ligament, and enters the joint between the head of the radius and external condyle, then divides the internal lateral ligament, and, lastly, saws through the olecranon, the apex of which, attached to the triceps, may be left in the stump, or may be afterwards dissected out."

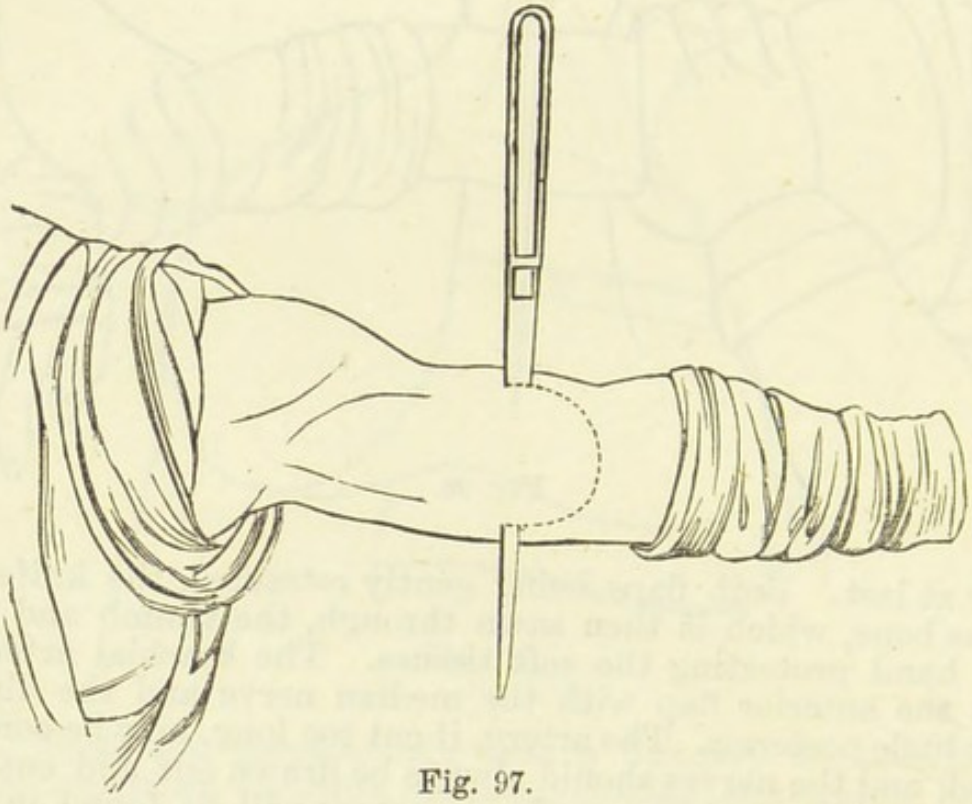

Fig. 97.

Amputation of the Forearm.—In performing this operation, as long a stump should be left as possible, so as to give the patient more power over any artificial limb that may be fitted to it. "The flaps should be about a couple of inches in length, and well rounded, the hand being placed in a mid-state between pronation and supination. The dorsal flap is best made by cutting from without inwards; the line of incision commencing just at the palmar aspect of the under part of the ulna, being carried forward for a little distance parallel to this bone, and then across the back of the arm in a slightly curved manner, until it reaches the palmar aspect of the radius; it must then pass along this until it reaches a point opposite to that at which it commenced, and the flap thus made must be dissected back. The palmar flap is next made by transfixion. As soon as it is cut, the bones are cleared by a couple of sweeps of the knife, and the interosseous membrane is divided; they are

then sawn together. The vessels are cut long at the end and on each side of the palmar flap."

Sir W. Fergusson recommends in performing this operation, "to have the elbow slightly bent, and the hand placed in a state of pronation (fig. 98). A blade about 6 inches long should be passed from one side to the other, behind (or above) the bones; it should then be carried downwards, so as to come through the tendons and skin about an inch and a half lower down; the flap thus formed being raised, the knife should next

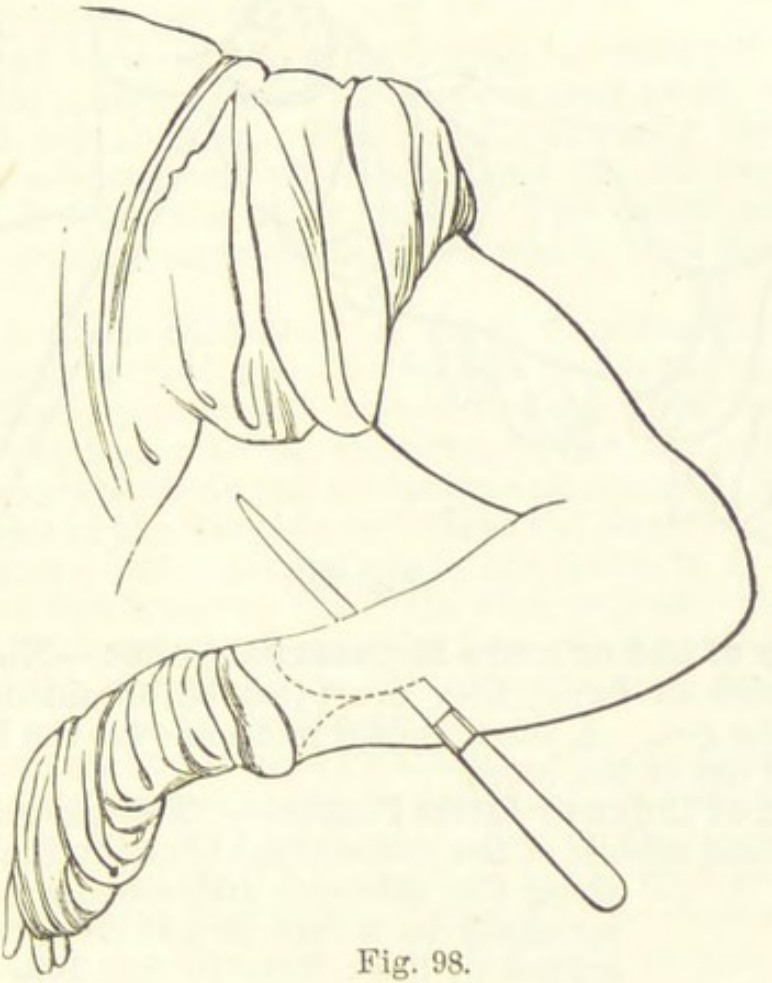

Fig. 98.

be passed across close in front of the bones, and carried obliquely downwards, when a second flap, similar in size and shape to that already made, will be formed; both of these should now be drawn slightly upwards, and after all the textures close upon the bones have been divided, the saw should be applied close to the roots of the flaps, and the part separated."

Amputation of the Wrist (Flaps).—"A semi-lunar incision is made across the back of the wrist, its extremities being at the styloid processes, and its centre reaching down as far as the second row of carpal bones. This flap being dissected up, the joint opened behind, and the lateral ligaments cut through, the knife, being placed between the carpus and bones of forearm, is made to cut out a flap from the anterior surface of the palm (fig. 99). The pisiform bone often causes, by its projection

into the palm, a difficulty in cutting the anterior flap; if not dexterously avoided by the edge of the knife, it had better be taken at the joint with the soft parts of the flap, and afterwards dissected. The nerves and tendons must be shortened, the styloid processes removed, and the skin brought together by sutures."

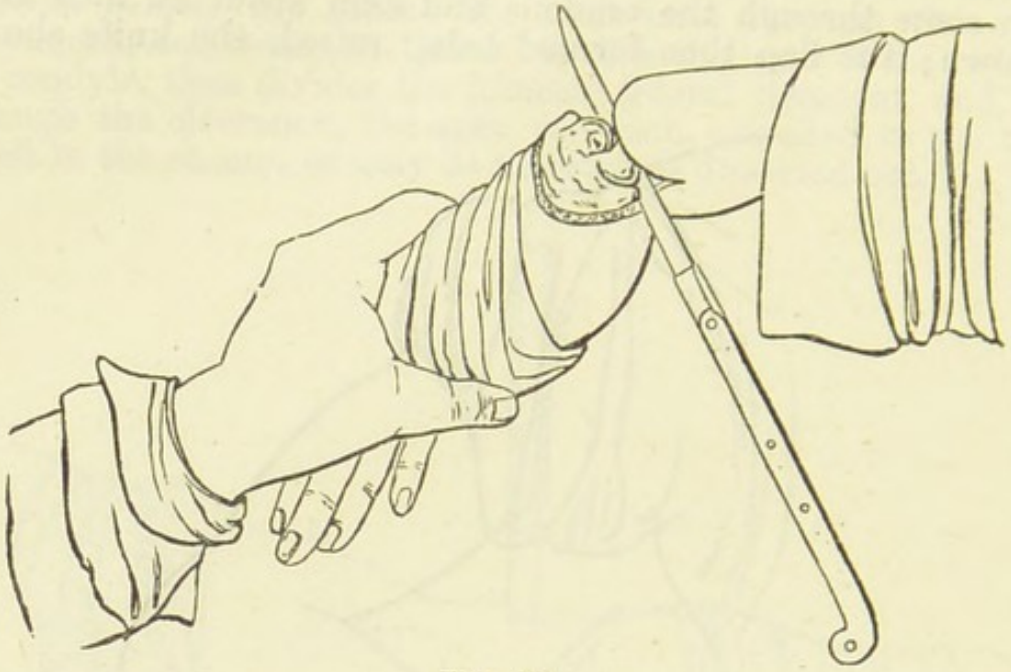

Fig. 99.

Amputation of one or more Metacarpal Bones.—No rules can well be given for incision or flaps; they must just be obtained where and how they can best be got. A single dorsal incision over the bone will allow it to be dissected out of the hand.

Amputation of Index or Little Finger.—"The knife should be applied over the back and middle of the metacarpal bone, and carried downwards along the side and under-surface of the joint, and up again to where it was first entered, as represented by dark lines in fig. 100. After this the soft parts near the bone must be divided, and then the forceps may be used in such a manner as to cut the bone obliquely, so that there shall be no angular projection towards the skin."

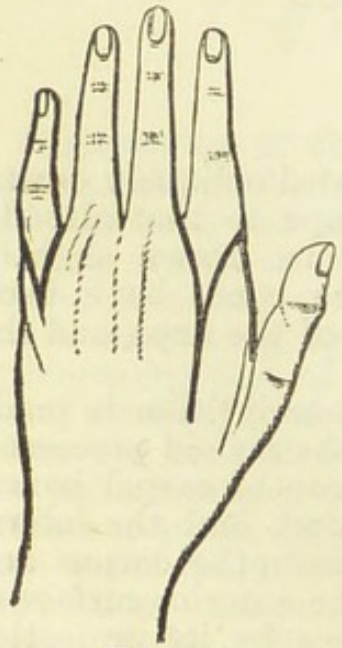

Fig. 100.

Amputation of the Metacarpal Bone of the Thumb may be performed in many different ways. The method recommended by Erichsen is as follows:—"The mode of proceeding must vary according to the side operated upon. When the left thumb requires amputation, the point of a long narrow bistoury should be introduced well on the palmar aspect of the carpo-metacarpal articulation, carried over this, which it opens, and the dorsum of the hand as far as the web of the index finger; the point of the knife should then be

pushed downwards through the ball of the thumb, transfixing this, and issuing where the incision commenced. It is next made to cut outwards, keeping close to the metacarpal bone, which is readily twisted out, the remaining attachment being separated by a few touches of the knife. In amputating the right thumb, it will be necessary for the surgeon, if he adopt the method just described, either to use his left hand, or to cross his hands in an awkward manner. In order to avoid doing this he may reverse the steps of the operation with advantage; first transfixing the ball, and making the anterior flap, then cutting over the dorsum, opening the joint, and turning out the bone."

"The metacarpal bone of the thumb may be removed through an incision on its radial margin, where the surgeon may avoid cutting either the extensor or flexor tendons. The distal extremity should first be detached from its connections, when the bone can be used as a lever whilst separating it from the other parts. The radial artery will be endangered whilst cutting some of the fibres which bind the bone to the os trapezium."

Amputation of a whole Finger.—"If the third or fourth digits require amputation, it should be performed as follows:—An assistant holds the hand, separating the fingers at each side of the one to be removed. The surgeon, holding the finger to be removed, enters the point of a long straight bistoury exactly above the metacarpo-phalangeal joint and cuts from the prominence of the knuckle right into the angle of the web, then turning inwards there, cuts obliquely into the palm to a point nearly opposite the one at which he set out. He then repeats this incision on the other side, makes tense the ligaments, first at one side, and then at the other by drawing the finger to the opposite side, and cuts them. The tendons being cut, the finger is detached."

Amputation through the Second Phalanx.—"If the distal phalanx be so much crushed that a flap cannot be obtained, two short semi-lunar lateral flaps may be dissected from the sides of the second phalanx, which may then be divided by the bone-pliers at the spot required."

Amputation of a Distal Phalanx.—"There is no choice as to a flap, the nail preventing an anterior one; so a flap long enough to fold over must be cut from the pulp of the finger in either of two ways. 1. Holding the fragment to be removed in the left hand, and bending the joint, the surgeon makes a transverse cut across the back of the finger, right into and through the joint, cutting a long palmar flap from within outwards as he withdraws the knife. 2. Making the long flap by transfixion, it may be held back by an assistant, and the joint cut into."

Amputation at the Hip-joint.—Numerous methods have been described for performing this operation.

Sir William Fergusson recommends the following proceeding:—"The table should be stout, of a convenient height, not so broad as to prevent the surgeon and assistants being in close contact with the patient, and a folded blanket, with a couple of pillows, should be on its upper surface. The patient's breech should be brought close to the margin of the table, and the sound limb should be fastened to one of its legs. An assistant should stand immediately behind the surgeon, whose chief duty will be

to raise the first flap and compress the femoral artery; another should stand opposite to hold the pelvis steady, and assist in keeping the patient's body from slipping. A third may also be useful at the shoulders to aid in this, as, from so much of the body being beyond the table, and perhaps also from the mode of operating, there is a chance of the pelvis falling over the margin; a fourth should have the limb entrusted to his care, and he, with the other who has charge of the artery, should

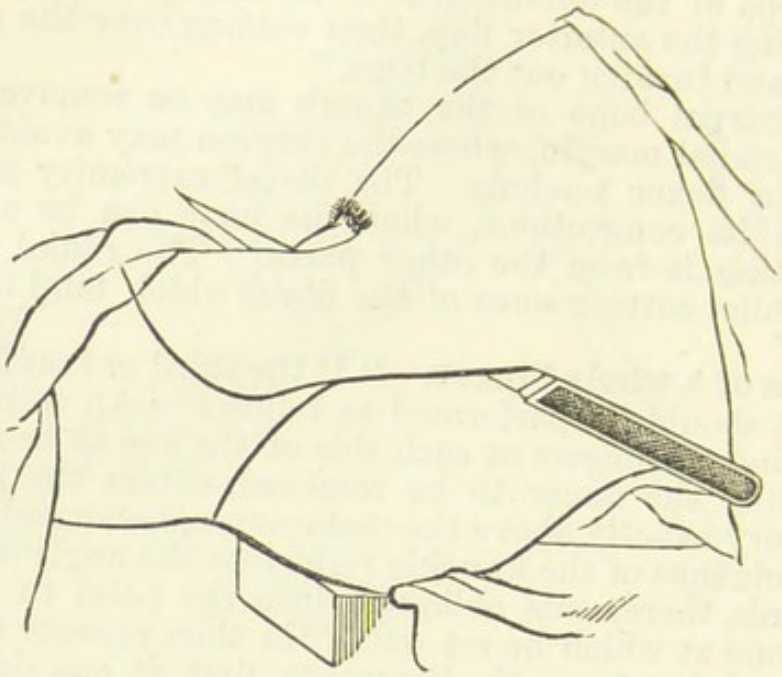

Fig. 101.

clearly understand the intended movements of the surgeon; and that the immediate and satisfactory accomplishment of the operation depends much on the simultaneous movements of the whole three.

"The surgeon, standing on the outside of the limb, should insert the point of a long knife about midway between the anterior-superior spinous process of the ilium and trochanter major, keeping it rather nearer the former than the latter; he should then run it across the front of the neck of the bone, and put it through the skin on the opposite side (fig. 101), about 2 or 3 inches from the anus; next he should cut downwards and forwards, so as to make a long flap from the anterior of the thigh, about 7 or 8 inches in length. When the blade is entered, the limb should be held up, and even slightly bent at the joint; the instrument will then pass along more readily than if all the textures were thrown on the stretch; moreover, there is greater certainty of passing it behind the main vessels, and even dividing some of the fibres, if not the whole of the iliacus internus and psoas muscles. As the knife is carried downwards, the assistant, who stands nearer the patient's trunk than does the operator, should slip his fingers into the wound and carry them across to grasp the femoral artery between them and the thumb; this he may do from the inside or outside at will, and with the right or left hand,

as may be most convenient, the same grasp enabling him to raise the flap as soon as it is completed. The flap being raised, the point of the knife should then be struck against the head of the bone, so as to divide the anterior part of the capsular ligament and any textures in this situation which may not have been included in the flap. To facilitate this part of the operation, the knee should be forcibly depressed by the assistant who holds it; the head of the bone will thus be caused to start out of its socket, and if the round ligament is not ruptured by the force, a slight touch with the edge of the knife will cause it to give way. At this period, depression being no longer required, the assistant should bring the head of the femur a little forward to allow the knife to be slipped over and behind it; and when it is in this position, it should then be carried downwards and backwards, so as to form a flap shorter than that in front, the last cut in the skin completing the separation of the limb.

Mr. Furneaux Jordan first divides the soft parts circularly low down in the thigh, and then dissects out the bone from among the muscles and from the acetabulum through a long incision on the outer aspect of the limb, when the soft parts are comparatively thin and the blood-vessels inconsiderable, a long boneless stump being the result. Sir Jos. Lister writes—* "It does not seem to me necessary to push it to the extreme degree advocated by Mr. Jordan, I would advise the following as the method to be generally adopted:—

"'Supposing the right limb operated upon, the knife is entered at the posterior part of the great trochanter and carried down longitudinally for about 8 inches (if the patient be an adult male), and then drawn across the limb in front and behind through the skin and fat, in the form of two crescentic incisions, which meet at the inner side of the limb at a point an inch or two lower down than the extremity of the outer longitudinal cut. The semi-lunar flaps mapped out by the crescentic incisions are then dissected up as in a modified circular operation, the integument being raised about 2 inches higher than their angle of union at the inner side of the thigh, after which the muscles are divided when they are exposed and the head of the bone dissected out; or the femur may be sawn off below the trochanters, and then the head seized with strong forceps and dissected out.'"

"Such a mode of operating, besides the diminished danger from shock, has the great advantage of making truly aseptic treatment easy, instead of almost impossible, as it is when the copious sero-sanguineous discharge, which takes place from so large a wound, is poured out within a very few inches of the anus, which is the case after the ordinary operation. After the operation which I have advised, the inner end of the wound having been closely stitched, and drainage tubes introduced at its outer part, there is sufficient space for an effective antiseptic dressing, and which will often be a matter of life and death where so large an extent of irritable and absorbent surface is concerned."

Mr. Marsh writes—"The advantages of the Furneaux-Jordan operation are, that hæmorrhage is much more easily prevented from the offsets of the internal iliac which bleed so freely when divided in the transfixion

*Holmes' *System of Surgery*, vol. iii.

method; in this method they have already spent themselves as muscular branches, so that it is enough to compress the external iliac in the groin. No large vessels are cut in the incision on the outer aspect of the thigh, and the stump thus formed is of such dimensions that an artificial limb can be easily worn."*

This operation or some form of it will probably commend itself to army surgeons as a simple method of amputating in such severe gun-shot injuries as may lead them to consider disarticulation requisite.

Mr. Davy has suggested a very ingenious mode of compressing the common iliac artery, by introducing into the rectum one end of a smooth wooden cylinder 2 feet in length and about 1 inch in diameter, passed in sufficiently far to permit it to be pressed down upon the vessel on the brim of the true pelvis, when the other end or handle of the instrument is carried to the thigh of the opposite side, and then raised so that the rod may act as a lever for which the anus serves as a fulcrum. In most cases in which Davy's lever has been employed, it has answered to admiration.

Amputation of the Thigh may be performed by the circular method, by the lateral flap operation, by the antero-posterior flap operation, or flaps may be taken from any opposite aspects, or Teale's method may be adopted.

The operation may be performed immediately above the knee, in the middle of the limb, or in its upper third. In the middle and upper thirds of the thigh, the antero-posterior flaps leave the best results, and give the best covering to the bone; but amputation above the knee is best done by lateral flaps, which, however, are difficult to retain in position, and therefore if the patient is certain to have frequent moves, the surgeon might think the antero-posterior preferable.

Antero-posterior Flap Operation.—"In ordinary cases the anterior flap may first be made, and posterior one subsequently fashioned by transfixion. If, however, the patient is very much emaciated, it is difficult to get a good cushion from the anterior part of the thigh in this way; and it is consequently preferable to follow the plan recommended by Mr. Luke, of making the posterior flap first by transfixion, and the anterior one afterwards by cutting from without inwards. In some instances in which the tissues at the posterior part of the thigh are much diseased or injured, whilst those on the anterior aspect of the limb are sound, a very good stump may be fashioned by cutting a long square anterior flap by transfixion, and then cutting at one stroke of the knife through the soft parts at the posterior aspect of the limb, in a somewhat oblique direction, from below upward."

"If the patient be excessively muscular, and the amputation be a primary one, it is better to make skin-flaps with a circular incision through the subjacent soft parts."†

Amputation through the Knee-joint may be performed with a long posterior and short anterior, or with a long anterior and short posterior

* *Diseases of Joints*, p. 421.

† *Science and Art of Surgery*, by Erichsen, vol. i., p. 55.

flap. The former method, however, should only be chosen when the long anterior flap is impossible.

The operation by means of a long anterior and a short posterior flap is thus performed:—"A long square flap, rounded at the corners, is made by dissecting up the integuments and the patella from the front of the joint. The articulation is thus opened; the ligaments are then divided, and a short posterior flap formed by cutting from within outwards.

"The management of the patella is an important question. Erichsen thinks it is decidedly better to leave than to remove this bone; and to prevent it being drawn up on the anterior part of the thigh, the flap should be turned up, and the tendinous insertion of the quadriceps divided. The cartilaginous surface of the femur in these amputations may be sawn off if it is unhealthy."

Carden's Amputation at the Condyles of the Femur.—"The operator standing on the right side of the limb, seizes it between his left forefinger and thumb at the spot selected for the base of the flap, and enters the point of the knife close to his finger, bringing it round through the skin and fat below the patella to the spot pressed by his thumb; then turning the edge downwards at a right angle with the line of the limb, he passes it through the spot where it first entered, cutting outwards through everything behind the bone. The flap is then reflected, and the remainder of the soft parts divided straight down to the bone; the muscles are then slightly cleared upwards, and the saw is applied."

Fig. 102 represents the outline of the incision, and fig. 103 the stump.

Mr. Carden lays great stress on the following points:—"Whilst tying the popliteal artery in this situation, there is a tendency to secondary

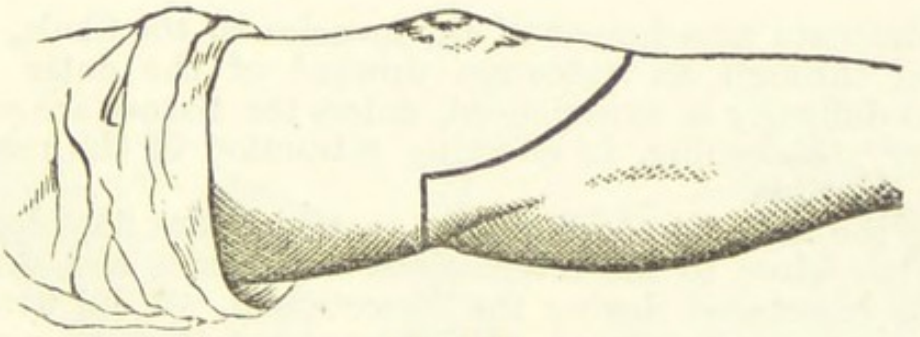

Fig. 102.

hæmorrhage from the vein, in consequence of its close proximity to the artery. This occurred in two cases, and on re-opening of the stumps the closure of the vein was found to be prevented by the stroke of the artery. The vessels should be gently separated for an inch upwards. The dressing may be of the lightest and simplest kind, and it is of the greatest importance that they should be loosened and the stump examined early."

In performing this amputation, it should be remembered that nowhere does the skin retract so much as at the back of the knee-joint, and therefore full allowance must be made for it.

* "**Amputation of the Leg** may be performed either just below the

* Holmes' *System of Surgery*, vol. iii.

knee, in the middle or lower third. If the operation is too close to the knee, the stump is apt to become flexed, and so become an inconvenience; and if it is in the lower third the stump is too long for convenience. In the amputation below the knee-joint 4 inches of tibia should be left. Antero-posterior skin flaps of equal length may be made, and the bones divided somewhat higher up; or, again, the modified circular operation is applicable in this situation. But the former method by long anterior flaps is greatly to be preferred to any other on account of the excellent covering it affords, with the cicatrix out of the way of pressure. In this operation, the posterior flap, being short, may be made of integument only without any risk of sloughing; on the other hand, the anterior flap being somewhat lengthy, should be raised so as to contain a good deal of muscle. A difficulty in retracing the soft parts from the bones arises

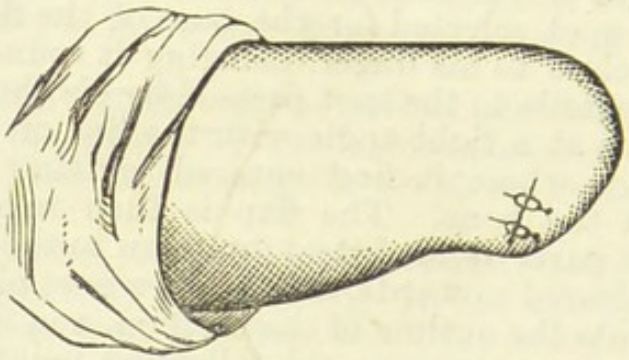

Fig. 103.

from the intimate attachment of the muscles to the fibula, but if these are divided through an extension upward of the outer longitudinal incision, no difficulty is experienced, unless the tissues are condensed by inflammatory thickening, in effecting retraction of the remaining soft parts from the tibia.

"Again, the anterior tibial artery, on which the flap depends for its nutrition, lies close to the interosseous membrane, and would be very liable to be punctured during the dissection if we did not follow Mr. Teale's advice in conducting it. He pointed out that, in consequence of the looseness of the cellular connections of the interosseous membrane, there is no difficulty in separating the parts in front from its surface with the finger tip, while dividing with the knife the attachments of the muscles to the bones. In this way the artery is secured from any chance of injury.

"Immediately above the ankle the operation is performed as follows:— The diameter of the limb having been ascertained by spanning it, a straight longitudinal incision of that length is made at the inner side of the leg, and on the outer aspect another similar incision directly over the fibula and extending an inch higher up. The lower ends of these incisions are connected by cutting across the front of the limb in a direction transverse in the main but rounded off where it joins the lateral lines. The knife is next carried round the back of the limb to the bones from the

upper ends of the internal incision to a point exactly opposite to the outer side, which will be about an inch below the upper end of the outer incision, the instrument being carried in a line slightly convex downwards, so as to form a very short posterior flap. The anterior flap is then raised in the manner above mentioned, including everything in front of the bones and interosseous membrane, after which the tibia and fibula are cleared as high as the level of the upper end of the outer incision, the finger tip being still used in detecting the parts anterior to the interosseous membrane. In order to avoid splintering the fibula it is best to saw both bones at the same time, and to finish the fibula before the tibia. The sharp angle of the spine of the tibia should be removed.

"In amputating through the calf on the same principle, the operation is similar, except that owing to the redundancy of muscle in the posterior flap in a largely developed calf, when the posterior flap is apt to drag down the skin of the front of the leg on the sharp edge of the tibia and induce ulceration, the anterior flap need not be longer than two-thirds of the diameter of the limb; but to compensate for its diminution the posterior flap must be made at least half as long as the anterior by carrying the knife round the back of the limb at an angle of forty-five degrees through the integuments, and dissecting them up to the level of the upper end of the inner part of the incision before cutting towards the bones, so as to get rid of the heavy and contractile mass of the sural muscle.

"When there is not enough sound tegument to admit of the long anterior flap, the modified circular of Mr. Syme proves highly valuable.

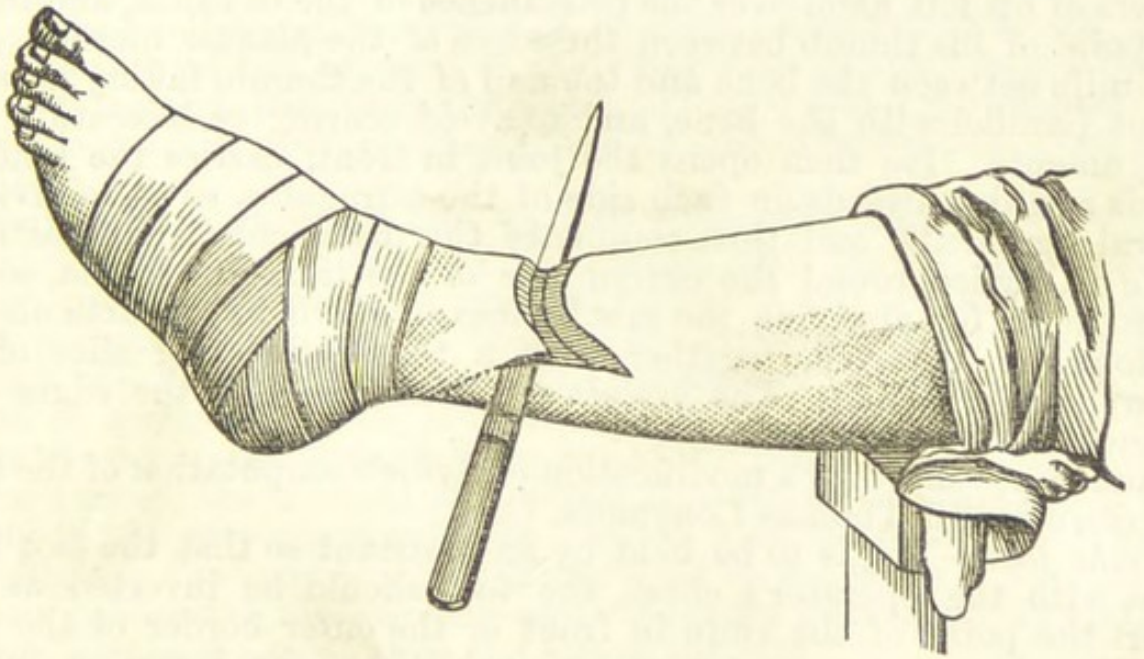

Fig. 104.

It is done thus. The skin and fat are divided by two crescentic incisions with the convexity downwards so as to form short antero-posterior flaps of the integument, which is then dissected up considerably higher than

their angle of union, after which the operation is completed as in the ordinary circular method."—*Lister*.

Disarticulation of the Foot at the Ankle-joint (*Syme's Amputation*).—The foot being held at a right angle to the leg, the point of the knife is introduced immediately below the malleolar projection of the fibula, rather nearer its posterior than anterior edge, and then carried across the bone to the inner side of the ankle, where it terminates at the point *exactly opposite* its commencement. That will be *below* and *behind* the internal malleolus.

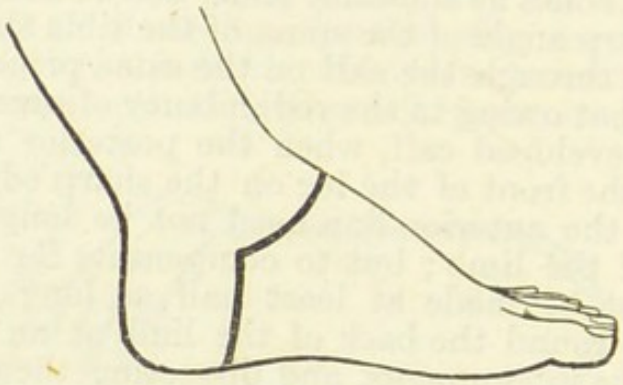

Fig. 105.

The extremities of the incision thus formed are then joined by another passing in front of the joint (fig. 105). The operator next proceeds to detach the flap from the bone, and for this purpose, having placed the fingers of his left hand over the prominence of the os calcis, and inserted the point of his thumb between the edges of the plantar incision, guides the knife between the bone and the nail of the thumb, taking great care to cut parallel with the bone, and to avoid scoring or laceration of the integuments. He then opens the joint in front, carries the knife outwards and downwards on each side of the astragalus, so as to divide the lateral ligaments, and thus completes the disarticulation. Lastly, the knife is carried round the extremities of the tibia and fibula, so as to afford room for applying the saw by means of which the articular projections are removed, together with a thin connecting slice of bone covered by cartilage. The vessels are then tied, and the edges of the wound stitched together.

Staff-Surgeon Parry's modification of Syme's amputation of the foot as described by Sir Thomas Longmore, C.B.:—

Right foot.—Leg is to be held by an assistant so that the foot is on a level with the operator's chest, the foot should be inverted at first; insert the point of the knife in front of the outer border of the tendo-Achillis about one quarter of an inch above its insertion into the calcaneum, carry the incision around the outer malleolus about half an inch below its extremity, continue it across the instep till it reaches the upper and inner border of the tubercle of the scaphoid which will be readily felt by the finger. Continue the incision obliquely across the plantar aspect of the foot, cutting well down to the bones, immediately

in front of the pad of the heel to its outer border, and connect this with the point of entrance of the knife in the first incision. See that all the tissues are divided down to the bone. Take hold of the heel flap by its external border, dissect it back by cutting always on the bone to detach it from the calcaneum, divide the tendo-Achillis so as not to derange its connections with the integument, and uncover the whole calcaneum in this way. Now proceed to dissect the internal portion of the flap, keeping the edge of the knife close to the bone, so that the posterior tibial artery, &c., may remain intact in the soft tissues of the flap. Do this by short

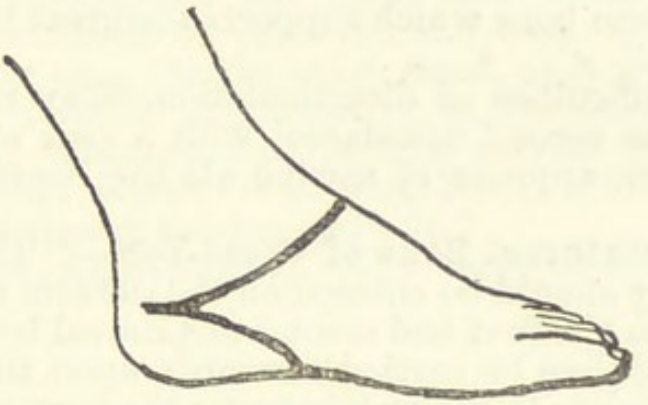

Fig. 106.

cuts, keeping the edge of the knife always on the bone, whilst an assistant takes charge of the flap and draws it back. The upper edge of the internal malleolus being reached the joint is opened and the foot separated.

Left foot.—Reverse the order of incision. Commence at the tubercle of the scaphoid and proceed to the outer edge of the tendo-Achillis for the first incision, then from the scaphoid follow round the plantar surface of the foot to the same point as the first incision ended in. Then proceed as above.

Amputation through the Tarsus (*Chopart's Operation*).—"In the first place, the articulation of the cuboid with the os calcis (which lies about midway between the external malleolus and the tuberosity of the fifth metatarsal bone), and that of the navicular with the astragalus (which will be found just behind the prominence of the navicular bone in front of the inner ankle), must be sought for, and a semi-lunar incision be made across the dorsum from one to the other. The flap of the skin being turned, the internal and dorsal ligaments that connect the navicular to the astragalus are to be divided with the point of the bistoury, recollecting the convex shape of the head of the latter bone. The ligaments connecting the os calcis and cuboid are next divided; and, lastly, a flap is to be procured from the sole of the foot."

Amputation of all the Metatarsal Bones (*Hey's Operation, as described by himself*).—"I made a mark across the upper part of the foot, to point out as exactly as I could the place where the metatarsal bones were joined to those of the tarsus. About half an inch from this mark, nearer the toes, I made a transverse incision through the integuments

and muscles covering the metatarsal bones. From each extremity of this wound I made an incision (along the inner and outer side of the foot) to the toes. I removed all the toes at their junction with the metatarsal bones, and then separated the integuments and muscles forming the sole of the foot from the inferior part of the metatarsal bones, keeping the edge of my scalpel as near the bones as I could, that I might both expedite the operation and preserve as much muscular flesh in the flap as possible. I then separated with the scalpel the four smaller metatarsal bones at their junction with the tarsus, which was easily affected, as the joints lie in a straight line across the foot. The projecting part of the first cuneiform bone which supports the great toe I was obliged to divide with a saw."

To avoid the difficulties of disarticulation, Skey recommends cutting off the head of the second metatarsal with a pair of pliers. Baudens, Guérin, and others, approve of sawing all the bones across in the line desired.*

Removal of Metatarsal Bone of Great Toe.—"The point of a strong and broad bistoury should be entered on the dorsum of the foot over the interspace between the first and second metatarsal bones, as far back as possible; it should then be carried forwards upon the ball of the great toe, to a point opposite to the web between the toes, and thence made to sink into the sole of the foot in a line parallel with the outer margin of the bone; the flap thus formed should be dissected back, its plantar aspect being kept as thick and fleshy as possible. The surgeon next passes the knife between the first and second metatarsal bones, and cuts directly forwards through the centre of the angle between the great and the second toes. In doing this, care must be taken that the edge of the knife is not directed too much towards the metatarsal bone of the great toe, lest it hitch against one of the sesamoid bones. The surgeon next seizes the extremity of the toe, and pressing it well inwards, passes the point of the bistoury deeply into the angle of the wound, where, by the division of some tendinous and ligamentous fibres that constitute the key of the joint, he opens the articulation, and detaches the bone by lightly touching its ligamentous attachments.

"When the bone is to be partially removed, the operation must be performed in the same way; the incisions, however, not being carried so far backwards." †

Removal of Metatarsal Bone of Little Toe.—"This is best done by entering the point of the knife just behind the tubercle of the bone, carrying it forwards and inwards in the line of its articulation, with the cuboid, to the centre of the fourth digital interspace, and thence forwards to the web of the toe; the knife is next carried round the plantar surface of this, the incision being continued obliquely into that which has been made on the dorsum of the foot. The small flap thus formed is well dissected down, the knife passed round the under surface of the bone, and the joint opened by the toe being forcibly drawn outwards, and its ligamentous connection lightly divided." ‡

* Bell's *Manual of Operative Surgery*, p. 70.

† Erichsen's *Science and Art of Surgery*, vol. i., p. 111, 9th Edition. ‡ *Ibid*, p. 112.

Amputation of Distal Phalanx of Great Toe.—When possible, a long flap should be made from the plantar surface, by laying the edge of the knife over the dorsal aspect of the joint, cutting through it, and turning the edge of the knife round close to the bone, so as to cut out a long flap from the ball of the toe.

Amputation of a Single Lesser Toe: Second, Third, or Fourth.—"This operation is exactly on the same principle as that described for amputation of a whole finger, but it should be remembered that the metatarso-phalangeal joint is more deeply situated in the soft parts than is the metacarpo-phalangeal; and thus the commencement of the elliptical incision which is to surround the base of the toe must be proportionally higher up. On the other hand, as it is very important to avoid as much as possible any cicatrix in the sole of the foot, the plantar end of the incision need not be carried to a point exactly opposite the one from which it set out, but it will be sufficient if it reaches the groove between the toe and sole."

Teale's Operation (Amputation).—This plan of operation Mr. Teale

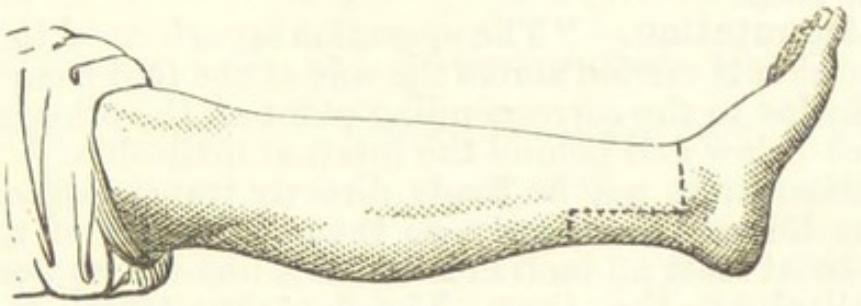

Fig. 107.

introduced "to procure a more useful stump, and in the hope of somewhat diminishing the mortality of the operation. It is proposed to amputate by a long and a short rectangular flap, the long flap folding over the end of the bone being formed of parts generally devoid of large blood-vessels and nerves, whilst those important structures are contained in the short flap. The size of the long flap is determined by the circumference of the limb at the place of amputation, its length and its breadth

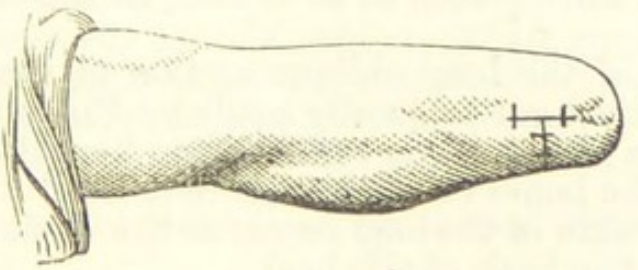

Fig. 108.

being each equal to half the circumference. The long flap is therefore a perfect square (fig. 107), and is long enough to fall easily over the end of the bone. In selecting the structures for its formation, such parts must be taken as do not contain the larger blood-vessels and nerves. A flap so

formed will be for the most part anterior in position as far as regards the general aspect of the body, but superior when the patient is in the recumbent position, as during the after-treatment. The short flap, containing the chief vessels and nerves, is in length one-third of the other. The flaps being formed, the bone sawn, and arteries tied, the long flap is folded over the end of the bone ; each of its free angles is then fixed by sutures to the corresponding free angle of the short flap. One or two more sutures complete the transverse line of union of the flaps. At each side the short flap is united to the corresponding portion of the long one by a point of suture, and one suture more unites the reflected portion of the long flap to its unreflected portion. Thus, the transverse line of union is bounded at each end by a short lateral line at right angles to it" (fig. 108).

Lister thinks this operation should be restricted to the lower part of the leg and just above the knee, when by turning to account the integument over the patella, which is not used in ordinary operations, the anterior flap may be made of the requisite length without specially high division of the bone.

Pirogoff's Amputation.—"The operation is performed in the following way:—An incision is carried across the sole of the foot from the tip of the external malleolus to the corresponding point on the other side, that will be half an inch below and behind the internal malleolus.

"This incision must not be made directly transverse to the foot, but should incline forwards obliquely, so that the centre of the incision in the sole may be at least an inch in front of a line drawn across from the tip of one malleolus to the other. The flap thus traced is dissected for about two lines. Disarticulation of the astragalus is then effected in the usual way by an incision across the front of the foot.

"The foot is now forcibly extended to the greatest possible extent, and a narrow amputating or a butcher's saw is applied to the upper and back part of the os calcis behind the astragalus, and the bone is cut obliquely downwards and well forwards ; the malleoli are then removed, and a thin slice of the tibia, with the articular cartilage, taken off. The opposed osseous surfaces must then be accurately adjusted, the movable flap well supported by a broad strip of plaster, and the limb laid on the outer side with the knee placed so as to take off the tension of the tendo-Achillis."

The advantages of the long oblique section of the os calcis over the shorter almost vertical cut originally made by Pirogoff, are, as Busk has pointed out, that a larger surface of bone is brought into contact with the sawn ends of the bones of the leg, there is less tilting of the os calcis, and that the thick skin of the heel serves as the basis of support instead of the thin skin of the back of the heel.

Sub-periosteal Amputation.—To prevent attenuation of the end of the bone or necrosis, Langenbeck has proposed that its divided surface should be covered with a long flap of periosteum formed in the course of the amputation. Dr. R. Schneider holds that Langenbeck's proceeding does not always lead to such good results, and that the single flap of periosteum may slough. He recommends two short flaps of periosteum,

each flap being carefully retained in connection with the superjacent muscular and other soft parts.

EXCISION.

Cheyne remarks— * "Excision of joints is now rarely performed, for with aseptic treatment an incision into a joint and the insertion of a drainage tube is generally sufficient in cases where formerly excision, or even amputation, would have been required."

Esmarch writes — "Since regeneration of a joint is generally most complete when only one articular end is removed, it is advisable, if the injury to one articular end is very extensive, only to resect this and to leave the other intact. This is particularly true of the upper extremity."

The above remarks apply to excision of joints in disease for the most part of youth, but the operation has much greater risks and difficulties in the case of gun-shot injuries in the field.

Excision of the Head of the Humerus.—This operation may be performed in several different ways ; they consist of a single vertical incision, and its modifications of ⌐ and T shaped ones ; also the flap operation of U shape. Larrey recommended the single long incision, extending in a line from the acromion, through the fibres of the deltoid, for about 4 or 5 inches. This operation is thus described :—"The patient lies on the side opposite to the affected or injured limb. The surgeon then enters the knife a little to the outside of the coracoid process, and carries it downwards and outwards for about 5 inches, cutting down to the bone. He then cuts across the capsule any adhesions that may exist, and the attachments of the muscles inserted into the tubercles of the humerus. The assistant, who has charge of the limb, facilitates this part of the operation by drawing it well across the chest, and pushing the head of the bone backwards and tilting it outwards, so as to cause it to project. The surgeon, carefully clearing it all round, has the soft parts well retracted, and then, taking the limb in his own hands, pushes the head of the bone out of the wound, so as to admit of the easy application of the saw by which it is removed."

Mr. Hamilton remarks on this subject :—"In gun-shot or other comminuted fractures of the head of the humerus, demanding ex-section, the surgeon will find it necessary, in general, to make for himself a larger opening than the single longitudinal incision will furnish. It will be necessary, then, to make an oval or V-shaped incision, so as to form a flap, having its base upwards."

Sir William Fergusson is of opinion that the surgeon should not limit himself to one mode of procedure, but should rather, trusting to his anatomical and manipulative skill, adapt his measures to the peculiarities of the case. He recommends the adoption of a plan similar to that originally

* *Antiseptic Surgery.*

followed by Morel. The patient being seated or laid on his back, an incision should be made with a strong bistoury, commencing opposite the coracoid process, and ending about an inch behind and below the root of the acromion. It should be semi-lunar in shape. The extreme convexity should be about 4 inches under the acromion, and thus the greater portion of the deltoid will be included in this flap. The skin and deltoid being divided, the flap should be drawn upwards, a few touches of the knife being sufficient to separate the loose connections of the muscles. A bold incision should next be made through the tendons attached to the tuberosities of the humerus, dividing them and the capsule at the same time to such an extent as to permit the head of the bone being turned out by a slight twist. This part should then be laid hold of with the lion forceps by the surgeon or an assistant, and held steady while the saw is used to separate as much as may be necessary. If the operation is done for a shattered bone, its head cannot be thrust out like the end of a lever, as thus directed ; and therefore the surgeon must make use of his fingers or any convenient hook or forceps to enable him to raise the fragments.

Much of the success in rendering a limb useful after excision of the head of the humerus depends upon early passive movements, followed up by regular exercises with weight and pulley.

Excision of the Clavicle.—It may be necessary to remove this bone wholly or partially, and to perform the operation it is necessary to make a free incision along its whole length ; it should then be disarticulated or sawn through at its acromial articulation, and dissected out from without inwards, the sternal end be forcibly twisted outwards, and all attachments carefully cut, great care being paid to the numerous small veins in this position.

Excision of the Scapula (*Syme's Operation*).—Make an incision from the acromion process transversely to the posterior edge of the scapula, and another from the centre of this one directly downwards to the lower angle of the bone. The flaps formed being reflected back, separate the scapular attachment of the deltoid, and divide the connections of the acromial extremity of the clavicle. The division of the subscapular artery will cause a great gush of blood, but it should be caught and secured without delay. The joint and around the glenoid cavity should next be cut into, and the finger hooked under the coracoid process, so as to facilitate the division of its muscular and ligamentous attachments ; and then, by pulling back the bone with great force by the left hand, the remaining attachments should be divided with rapid sweeps of the knife.

Excision of the Elbow-joint may be performed in three different ways —by a simple longitudinal incision, or by the H or ⊢. The longitudinal incision is by far the best. It will require a cut 4 inches in length having its centre opposite the tip of the olecranon. The triceps muscle will thus be divided into two portions, the inner one of which is the more firmly attached to the ulna, while the outer portion is continuous with the anconeous muscle, and sends some tendinous fibres to blend with the fascia of the forearm. The power of extension depends greatly upon these tendinous fibres, and every effort should be made to preserve

them. Any transverse cut is therefore to be greatly deprecated. In carrying the incision in this direction, Erichsen recommends that "the edge of the knife should always be kept against the bones, and their sinuosities closely followed, so that the ulnar nerve, being dissected out from behind the inner condyle, may escape injury. If the incision be properly planned, and the knife kept in contact with the bone, the nerve ought not to be exposed during the operation, more particularly as it is usually imbedded in a quantity of plastic tissue. When the posterior part of the joint has been laid bare in this way, the knife should be carried round the tip of the olecranon, and the process removed with cutting pliers. By forcibly bending the joint, pushing the forearm upwards, and lightly touching the ligaments with the point of the knife, the interior of the articulation will be fully exposed. By means of a small narrow saw, the articular end of the humerus is separated from the rest of the bone; the upper end of the ulna and the head of the radius may either be removed in the same way or by cutting pliers."

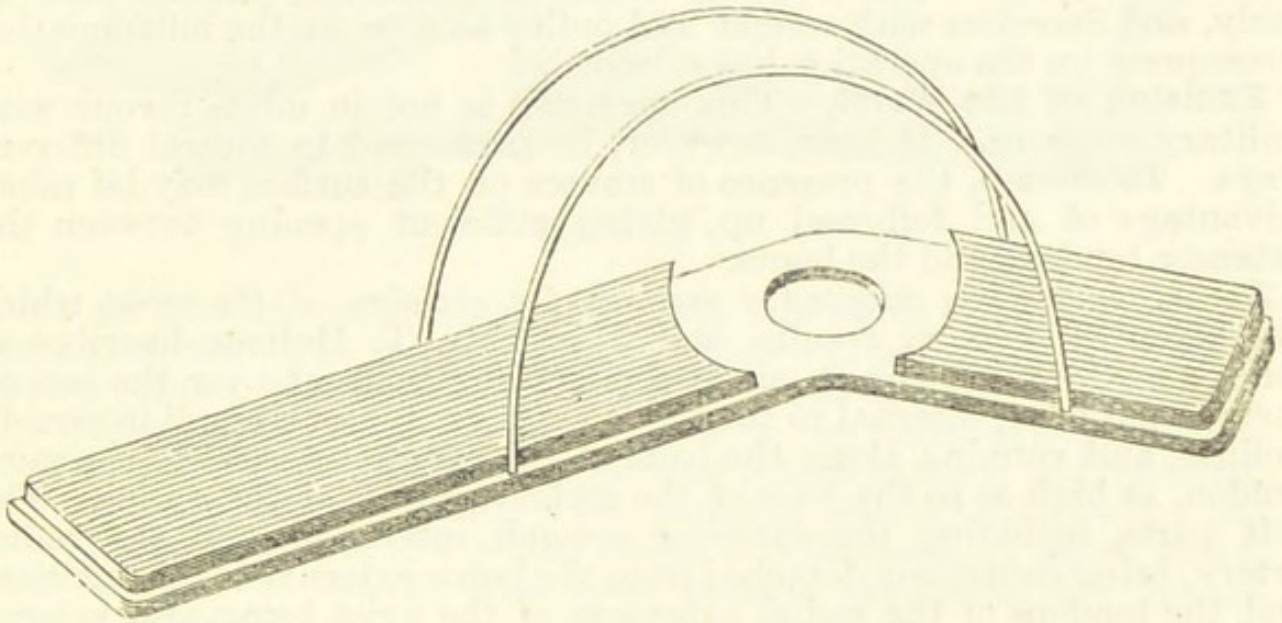

Fig. 109.

After the operation, the limb should be laid upon pillows nearly in the extended position; or Esmarch's splint may be applied (fig. 109).

This splint, which Dr. Stromeyer designed for the more convenient treatment of excision or resection of the elbow-joint was improved upon by Professor Esmarch; by means of it the arm can be raised up, without the joint being disturbed. It is made from two of Stromeyer's arm splints, of which the under is uncushioned, but the upper one stuffed with wadding and covered with oilcloth, and at the region of the elbow a wedge-shaped piece is sawn out (fig. 109). The upper arm-piece of this splint is retained in position with the forearm piece by means of two hoops of strong wire. The arm rests on this splint, which can be raised by means of the wire, while the bandages and dressings are quickly removed from the lower splint, and which, after it has been cleaned and the wound dressed, can be replaced.

Numerous contrivances have been invented for placing the elbow on after resection, but an ordinary soft pillow answers all purposes, on which the limb should rest in nearly the extended position, so that the cut portions of the bones may be in close approximation with one another.

"At the end of a week or ten days, when granulations have sprung up, the arm may be put on a slightly bent leather splint, and as the healing goes on this may gradually be flexed, until at last it is brought to a right angle.

"Until the contraction of the cicatrix has fully taken place, and the neighbouring tissues are quite firm, the joint should be supported by one lateral leather splint on the inner side of the arm. The splint should then be removed, the arm put in a sling, and passive motion had recourse to, in order to prevent osseous anchylosis."

Ingenious splints have been designed by Drs. Hodgen and Volkman, Messrs. Butcher and Heath, but an ordinary firm pillow will be found to answer all purposes, care being taken to commence passive motions early, and exercises with weight and pulley as soon as the inflammation consequent on the operation has subsided.

Excision of the Wrist.—This operation is not in much favour with military surgeons. It may, however, be performed in several different ways. In disease, the presence of sinuses on the surface may be taken advantage of and followed up, giving sufficient opening between the extensor tendons and the bones.

Sir J. Lister has adopted a method for excision of the wrist which has given satisfactory results, and which Mr. T. Holmes describes as follows:—"An incision is made commencing in front over the second metacarpal bone, internal to the tendon of the extensor secundi internodii pollicis, and running along the back of the carpus internal to the same tendon, as high as to the base of the styloid process of the radius. The soft parts, including the extensor secundi internodii, and the radial artery, being cautiously detached from the bones external to this incision, and the tendons of the radial extensors of the wrist being also severed from their attachments, the external bones of the carpus will be exposed. When this has been done sufficiently, the next step is to sever the trapezium from the other bones with cutting pliers, in order to facilitate the removal of the latter, which should be done as freely as is found convenient. The operator now turns to the ulnar side of the incision, and cleans the carpal and metacarpal bones as much as can be done easily. The ulnar incision is now made. It should be very free, extending from about 2 inches above the styloid process down to the middle of the fifth metacarpal bone, and lying near the anterior edge of the ulna. The dorsal line of this incision is then raised, along with the tendon of the extensor carpi ulnaris, which should not be isolated from the skin, and should be cut as near its insertion as possible. Then the common extensor tendons should be raised, and the whole of the posterior aspect of the carpus denuded, until the two wounds communicate quite freely together; but the radius is not as yet cleaned. The next step is to clean the interior aspect of the ulna and carpus, in doing which the pisiform

bone and the hooked process of the unciform are severed from the rest of the carpus, the former with the knife, the latter with the cutting pliers. In cleaning the anterior aspect of the carpus, care must be taken not to go so far forwards as to endanger the deep palmar arch. Now, the ligaments of the internal carpal bones being sufficiently divided, they are to be removed with blunt bone forceps. Next, the end of the ulna is made to protrude from the incision, and is sawn off, as low down as is consistent with its condition, but in any case above its radial articulation. The end of the radius is then cleaned sufficiently to allow of its being protruded and removed. If this can be done without disturbing the tendons from their grooves it is far better. The operator next attends to the metacarpal bones, which are pushed out from one or other incision

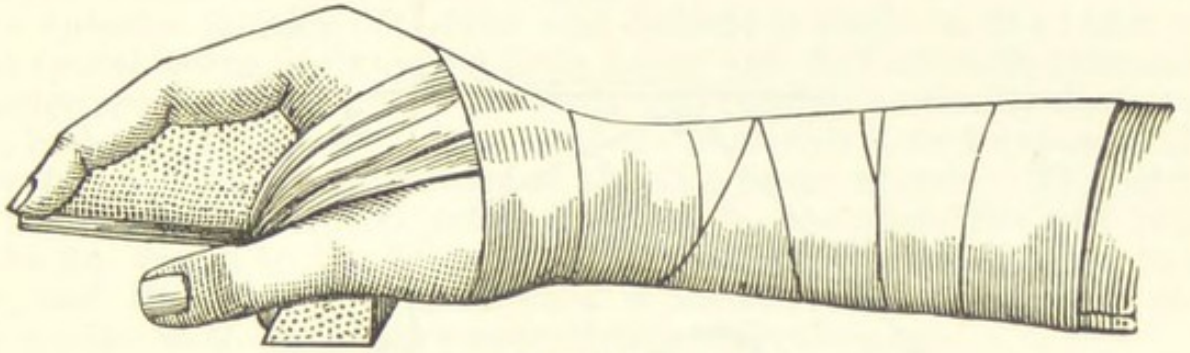

Fig. 110.

and cut off with the pliers so as to remove the whole of their cartilage-covered portions. The trapezium bone, which was left in the early stage of the operations, is now carefully dissected out, so as to avoid any injury to the tendon of the flexor carpi radialis or to the radial artery, and the articular surface of the first metacarpal bone is then exposed and removed. Lastly, the cartilaginous portion of the pisiform bone is taken away; but the non-articular part is left behind unless it is diseased, in which case it should be removed entire. The same remark applies to the hooked process of the unciform.

"In order to ensure motion, particularly in the fingers, passive movements should be performed from a very early period after the operation. For this purpose, Lister places the limb on a splint with the palm of the hand raised by a large wedge of cork fixed below it, so that the joints of the fingers can be moved without taking the limb off the apparatus," (fig. 110).

MacCormac reports most favourably on an apparatus of Professor Esmarch for treating cases of resection of wrist-joint. "The hand and arm are placed in a prone or semi-prone position on the splint (fig. 111), whose form is such as to leave the wrist exposed and easy to be got at for the application of dressings. The whole apparatus *en fonction*, consisting of a suspending rod, a plaster of paris or other form of bandage, and the splint, is represented in fig. 112, and the facility with which the patient can move about in bed, or readjust the position of his arm, is at once perceived."

Excision of the Carpal Ends of the Bones of the Forearm.—Mr. Skey

recommends the following operation:—"The joint is exposed on the dorsal surface by two lateral incisions of 2 inches in length, united by a transverse line made below the projecting bone. The flaps, being raised,

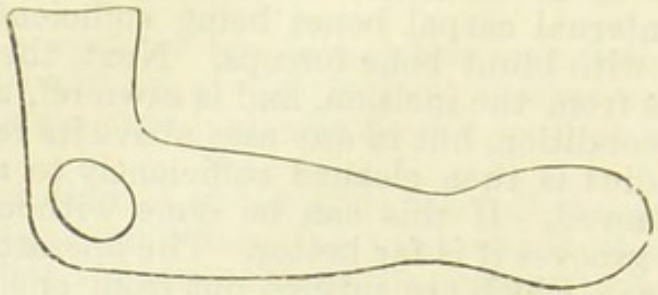

Fig. 111.

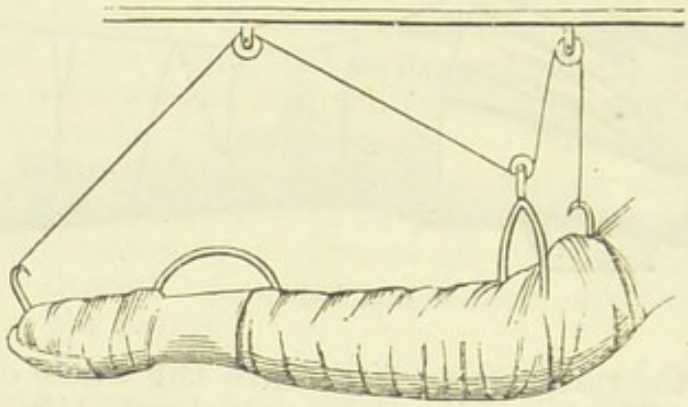

Fig. 112.

the tendons are exposed, and should be separated from the radius by a knife passed underneath them in forcible extension of the hand backwards. Along this line the fine blade of a metacarpal saw may be readily passed, which, being jointed at the point, can be fixed to its back after passing across the tendon. The blade of a knife passed half an inch under the radial artery will protect it from injury."

Excision of the Hip-Joint.—This operation may be performed by incisions of such shapes as may suit the surgeon's convenience for removal of the damaged bone; and in the event of the injury being from a gunshot, there will be an open wound which may be extended. There are, however, certain methods laid down by different authorities. Professor Gross prefers a semi-lunar flap of the gluteal muscles with the convexity downwards. This plan of incision, he considers, has the advantage, not only of allowing free access to the joint, but also of affording a ready outlet for the discharges. The superior extremity of the femur being thus exposed, is thrust out of the opening by carrying the limb across the sound one, rotating it inwards, and then pushing it up, when it is to be divided by means of a narrow saw. The great trochanter, however sound, should always be included in the operation, otherwise it will be sure to interfere more or less seriously with the healing process by projecting into the wound.

Mr. Marsh advises in disease of children a straight incision 2 or 3 inches in length to be made from the apex of the great trochanter obliquely in the direction of the fibres of the glutei, and extending down to the back of the joint. The capsule, if still present, is then opened, the situation of the neck of the femur or its remains is ascertained, the bone is divided with a saw or cutting forceps and the fragment is removed. The floor of the acetabulum is then carefully explored and any sequestra that are detected are extracted. The section of the femur should next be examined; it may, in rare cases, be necessary to cut away the great trochanter. Such a step, however, so largely interferes with the future usefulness of the limb that it should be if possible avoided. An interrupted long splint, or weight extension (3 lbs. or so) is employed to steady it with the aid of sand-bags.*

The anterior incision of Lücke and Schede is made on the outer side of the crural nerve beginning a little below and half an inch internal to the anterior-superior spine of the ilium and passing vertically downward 4 or 5 inches. The internal border of the sartorius is first exposed, then the rectus and the outer border of the ileo-psoas muscle. The limb is now flexed, abducted, and rotated outwards, the sartorius and rectus muscles are drawn to the outer side, the psoas and iliacus muscles to the inner, and the capsule thus exposed is incised; the subsequent steps being similar to those in other operations.—*MacCormac.*

In gun-shot injuries, however, it will be necessary to vary the steps of the operation according to the peculiar features of the case; if there were a large wound behind, no surgeon would dream of operating by the anterior one of Lücke, and *vice versâ*. It is an operation that should never be undertaken lightly in the field hospitals on account of the extreme difficulty of the after-treatment, and it may be perhaps an open question if such an operation had not better be postponed and undertaken as a secondary one in the stationary or base hospitals.

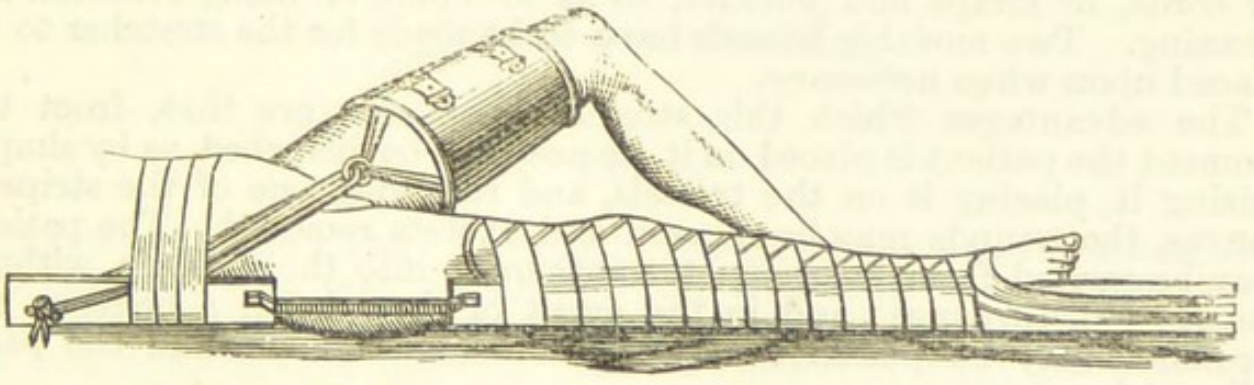

Fig. 113.

Many splints have been designed for the after-treatment of excision of the head of the femur. For permanent hospitals, Mr. Sayer's splint (wire breeches †) is perhaps the best; but for field hospitals, where

* *Disease of Joints*, p. 322.
† *British Medical Journal*, July, 1871.

appliances may have to be extemporised, a long splint as shown in fig. 112, which is similar to Erichsen's appliance, seems well adapted, and can be easily made. To secure rest, a certain amount of extending force, and the straightening of the limb, should be the surgeon's aim.

In treating a case of excision of the head of the femur at Netley, Porter adopted the stretcher and bed as represented in figs. 114, 115.

The stretcher (fig. 114) consists of a substantial beech or ash frame with handles, and of such a size that, when placed on the mattress, the wood-work falls over its sides, and does not come in the way of the patient's arms or the hands of the attendants.

The canvas bottom is divided into five portions; the three centre are 6 or 8 inches wide; these are attached to the framework on one side by means of straps and studs, and on the other by straps and buckles, by which they may be pulled tight. They are removable at will, and enable the surgeon or attendant to dress the wound when the stretcher has been

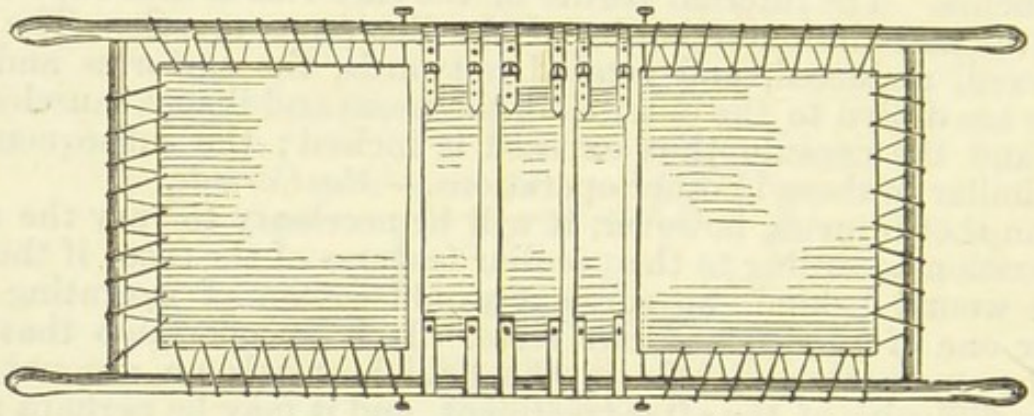

Fig. 114.

raised. The canvas at the top and bottom of the stretcher may be secured by cords, or straps and buckles, so as to admit of being removed for cleaning. Two movable tressels have to be made for the stretcher to be placed upon when necessary.

The advantages which this stretcher possesses are that, from the moment the patient is placed on it, he need not be disturbed, as by simply raising it, placing it on the tressels, and removing one of the strips of canvas, the wounds may be dressed and excreta removed. The patient may be carried from one room to another, or into the open air, without the least disturbance; and in the event of there being a bedsore, the stretcher may be placed on tressels for a short time, and the parts relieved from pressure.

The Bed speaks for itself, as represented in fig. 115, the chief features in it being the firm foundation for the mattresses by having the bedstead boarded. The top mattress is divided into three portions, the centre one of which has a round hole 10 inches in diameter in its centre, into which the patient's nates fit. This centre piece may be removed to facilitate dressing, as represented in the illustration.

Fig. 116 represents a crossbar arranged with straps and buckles at each

end, intended to be inserted between the sides of the stretcher, so as to prevent their bowing inwards when the straps attached to the canvas are pulled tight. It may be brought into use by gently moving the head portion of the top mattress, so as to allow of its being inserted underneath the stretcher.

Sir W. Fergusson recommends that the extension should be made from the opposite thigh (fig. 113), round the upper part of which a socket is fixed, to which the band is attached. The splint being bracketed, dressings can be applied with ease, and extension made by means of a weight.

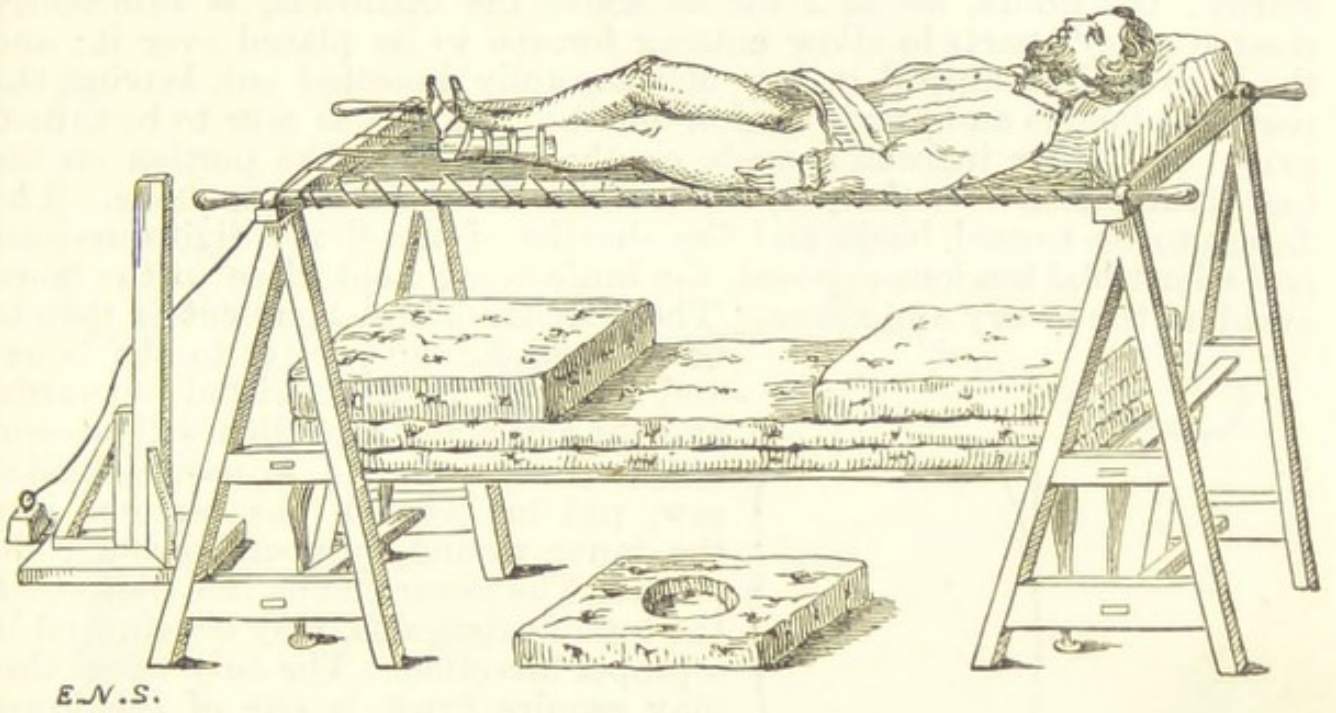

Fig. 115.

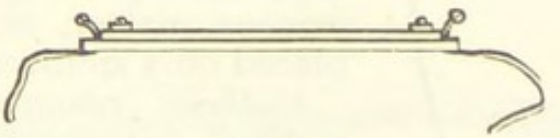

Fig. 116.

Excision of the Knee.—In excising the knee-joint for gun-shot injuries, the army surgeon may be able to take advantage of a wound already existing in forming his incisions, instead of adhering to any plan of incision as laid down in civil practice. He has, however, many plans to select from—such as the straight transverse incision; two parallel incisions, one on each side of the patella; an H-shaped incision; a horse-shoe incision; or, as Mr. P. Watson recommends, "a semi-lunar incision, raising a long flap from the anterior surface of the articulation."

But the operation is never likely to find favour in the field. Injuries to the joint that would lead to such an operation would be much better

met by amputation above the knee, which would probably enable the patient to be carried with due regard to his safety, whereas, after excision, rest is absolutely necessary, and if this could not be ensured the operation in all probability would only have a fatal result.

Excision of the Ankle.—For removal of the entire joint Mr. Handcock devised the following method:—"The foot is first laid on its side, and an incision is made over the lower 3 inches of the posterior edge of the fibula. When it has reached the lower end of the malleolus, it forms an angle, and runs downwards and forwards to within about half an inch of the base of the outer metatarsal bone. The angular flap is reflected forwards; the fibula, about 2 inches above the malleolus, is sufficiently cleared of soft parts to allow cutting forceps to be placed over it; and the bone is then nipped in two and carefully dissected out, leaving the peroneus longus and brevis tendon uncut. The foot is now to be turned over. A similar incision is made on the inner side, the portion on the foot terminating over the projection of the inner cuneiform bone. The flap is to be turned back, and the sheaths of the flexor digitorum and posterior tibial tendons exposed, the knife being kept close to the bone, avoiding the artery and nerve. The internal lateral ligament is then to be severed carefully close to the bone; and now the foot is twisted outwards, and the astragalus and tibia will present at the inner wound. A narrow-bladed saw, put in between the tendons into the inner wound, projects through the outer. The lower end of the tibia, then the top of astragalus, may be sawn off in a proper direction. The only vessel that may require tying is one of the lower branches of the peroneal artery. The wound may be closed with sutures, except that part opposite the breach of osseous matter, and the leg and foot placed on a splint with a footboard.

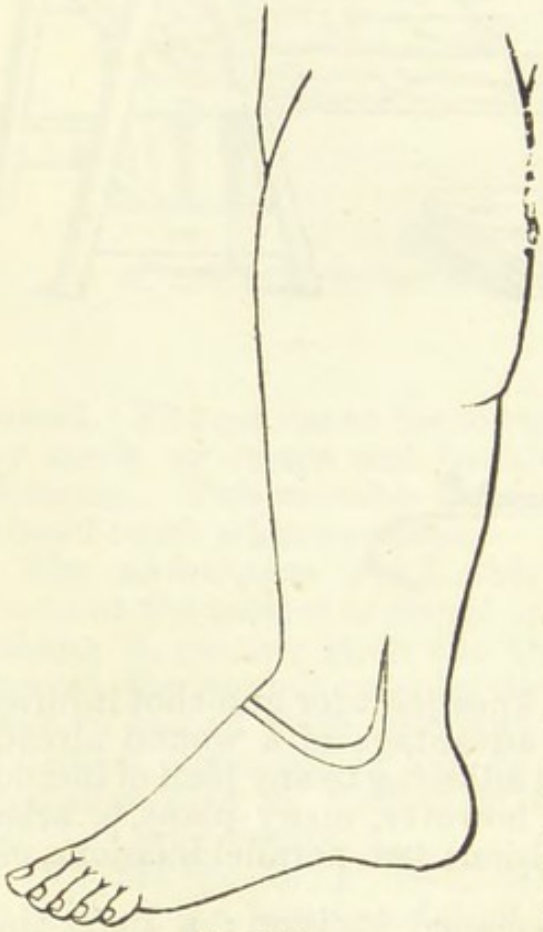

Fig. 117.

Guthrie recommends the following method for excision of the ankle:—"Begin the incision behind the external malleolus, an inch and a half above its lower extremity, and carry it downwards and then forwards across the front of the ankle-joint (fig. 117), then under the internal malleolus and upwards, close behind the process, the extent of an inch and a half; this incision should merely divide the skin, and should not, on any account, wound the subjacent parts. Raise the flap thus made, and, placing the leg on its inside, detach and turn aside the peronei tendons from the groove behind the external malleolus. Cut through the external lateral ligaments of the ankle-

joint, keeping the knife close to the end of the fibula; then with the large bone scissors, or nippers, cut through the fibula from one-half to three-quarters of an inch above its junction with the tibia, and, after dividing the ligamentous fibres connecting the two bones, remove the malleolus externus. Turn the leg on to its outer side, and cut through the internal lateral ligament close to the tibia, to avoid wounding the posterior tibial artery; this will allow the foot to be dislocated outwards, and the lower end of the tibia to be brought well out through the wound. An assistant keeping the foot and tendons out of the way, the lower end of the tibia is to be removed with a fine saw to the same extent as the fibula, or as high as the injury or disease

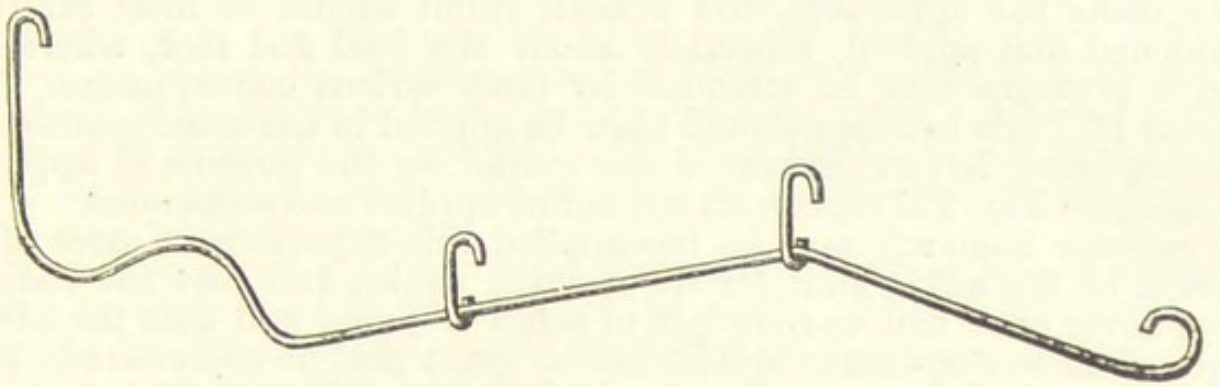

Fig. 118.

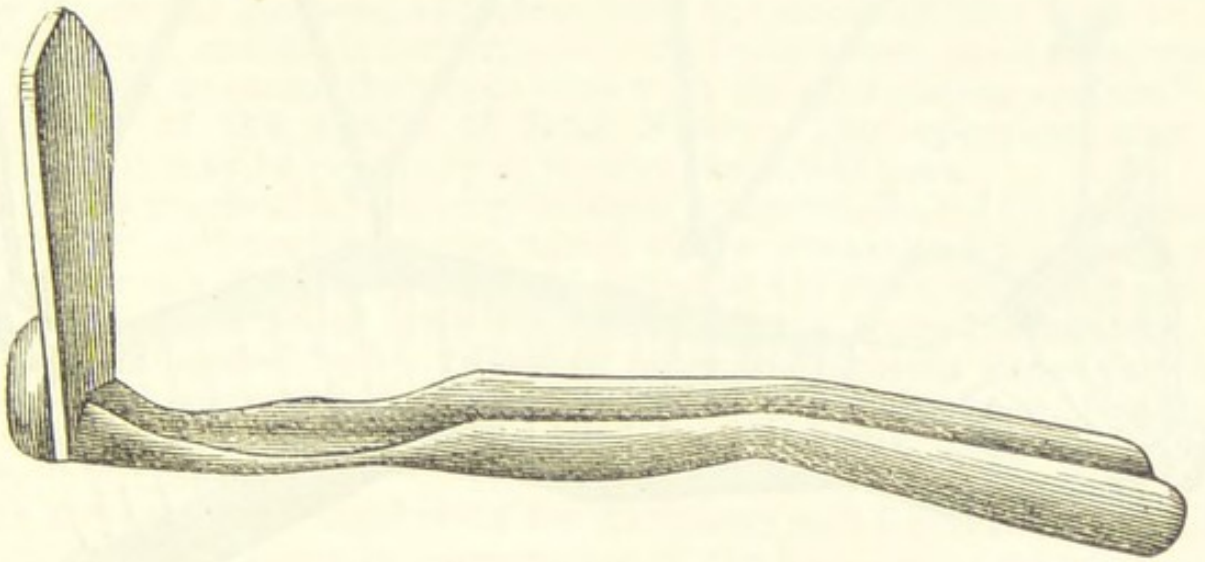

Fig. 119.

requires. The articulating surface, or injured part of the astragalus, is then to be removed, after which the foot is to be returned to its proper position, and the cut surfaces of the tibia and astragalus brought into close approximation, and so kept by suture, strapping, and bandage. The limb is to be placed on an outside leg splint, having a foot-piece to it."

Professor Esmarch has designed a splint for the after-treatment of excision or resection of the ankle-joint; he found the great utility of such

an apparatus for resection of the elbow-joint, and in consequence applied it to the ankle.

It consists of a strong piece of iron wire placed in front of the limb, extending from the toes to the groin, and bent at convenient angles to suit the front of the ankle and the knee, taking care that an arch is formed with it immediately above the seat of operation. Hooks should be formed with the wire at either end, and two or three loose ones attached for the purpose of suspension (fig. 118). Underneath the limb should be placed a wooden splint, hollowed out and cut to an angle to correspond with the bend of the knee. Firmly secured to this is a foot-board, placed at right angles, which gives support to the foot, and forms a base for the plaster of Paris bandage (fig. 119).

In using the apparatus, the wooden splint should be most carefully cushioned and applied, especially about the heel and foot, where any undue pressure may be attended by most serious consequences. The plaster of Paris bandage should then be applied in the usual manner, an opening being left at the seat of the wound for the purpose of applying dressings. Fig. 120 represents the splint applied and suspended.

Professor Esmarch says he has applied this apparatus in cases of resection of the ankle-joint for six or seven weeks, and that the patients have never once had to complain of aches or pains, and that the advantages of these suspension splints are so great that he recommends them most earnestly for war service, as well as in time of peace.

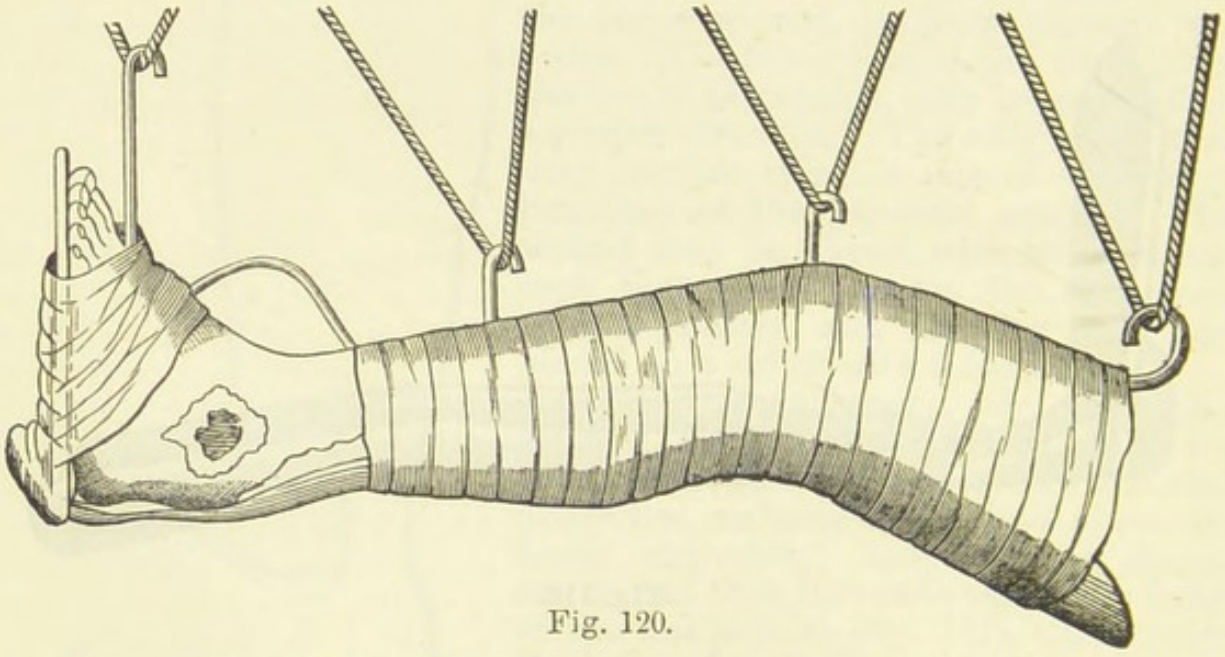

Fig. 120.

Excision of the Os Calcis.—"The patient lying on his face, a horse-shoe incision is carried from a little in front of the calcaneo-cuboid articulation round the heel, along the side of the foot, to a corresponding point on the opposite side. The elliptic flap thus formed is dissected up, the knife being carried close to the bone, and the whole under-surface of the os calcis exposed. A perpendicular incision, about 2 inches in length, is then made behind the heel, through the tendo-Achillis, in the mid-line

and into the horizontal one. The tendon is then detached from its insertion, and the two lateral flaps are dissected up, the knife being kept close to the bones, from which the soft parts are well cleared. The blade is then carried over the upper and posterior part of the os calcis, the articulation is opened, the interosseous ligaments are divided, and then, by a few touches with the point, the bone is detached from its connection with the cuboid. This bone, together with the astragalus, must then be examined; and if any disease be met with, the gouge should be applied."

Excision of the Astragalus.—"A curved incision should be made from one malleolus to the other, something like that made at the beginning of Syme's amputation. The ankle-joint is then to be laid freely open, and the whole upper part of the diseased bone exposed. Then the ligaments connecting it to the scaphoid are to be severed, and the bone is to be levered up, when the interosseous ligament connecting it with the os calcis will, if entire, be felt, and can be readily divided. All that is then necessary to complete the operation is to clean the back part of the bone, which should be done with care, in order to avoid injury to the tendons and vessels which lie near it.

"The bone might also, no doubt, be removed by two lateral incisions similar to those used in excision of the ankle. This would avoid the injury to the tendons and vessels incidental to the above method; but would be more laborious."

Excision of other Tarsal Bones.—"No formal directions are required for excising the other *tarsal bones*. The soft parts are to be thrown aside by crucial incisions, radiating from the sinuses which lead to the diseased bone, and the latter removed, care being taken, in all cases where it is possible, to excise the whole bone with the articulating surface."

Excision of the Shafts of Long Bones.—This operation may be partial, or it may be necessary to remove the whole bone.

As far as practicable, the subperiosteal operation should be performed. An incision sufficiently long to admit of the working of the chain-saw should be made along the superficial aspect of the bone, when the periosteum must be detached with the handle of the scalpel, raspatory, or chisel recommended by M. Ollier, or other instruments suited for that purpose. A chain-saw may then be passed under the bone, the shaft divided, and the separated portion, being seized with a strong forceps, carefully detached.

The Subperiosteal Operation for Excisions and Resections has been recommended by many in consequence of the bone being reproduced to some extent, and tendons and muscles detached entire from the bone. It, however, has its disadvantage in being tedious; the periosteum, too, is liable to slough. It is doubtful if the reproduction of bone is a benefit, at least in resection of the joints, and it is frequently difficult to remove the diseased bone without detaching the periosteum from the healthy.

ENUCLEATION OF THE EYE.

Enucleation of the Eye.—The patient is to be fully anæsthetised. The operator to stand behind the patient's head. The instruments required

are a stop speculum, fixation forceps, curved scissors, and strabismus hook. The eyelids to be widely separated by the speculum, and the globe held steady by seizing the conjunctiva with the forceps near the margin of the cornea. The conjunctiva is then divided all round and close to the cornea, leaving only sufficient for the forceps to hold on by. The capsule of Tenon is at the same time opened by carrying the deeper blade of the scissors well beneath the conjunctiva close to the sclerotic. The strabismus hook is now passed into Tenon's capsule, and glided beneath the tendon of each muscle, which is divided with the scissors between the hook and the globe. The globe is now pressed forwards by the fingers of the operator, and made to protrude through the palpebral aperture. The scissors are now introduced either at the inner or outer canthus, having their concavity towards the globe. As they reach the back of the eye the blades are opened, and they are pushed in till they are felt to grip the optic nerve, which is then divided. One or two more snips are now required to sever the oblique muscles and any remaining tissues, and the globe is removed. Hæmorrhage is easily stopped by firm pressure with small sponges and cold water. A light compress should now be applied.—*Juler.*

AFFECTIONS OF STUMPS.

Affections of Stumps may be divided into primary and secondary.

The Primary consist in hæmorrhage, spasm of the muscles, excessive pain, septic inflammation, osteo-myelitis, and inordinate retraction of the soft parts exposing bone.

The Secondary consist in necrosis, neuralgia, strumous degeneration, fatty degeneration, aneurismal enlargement of vessels, exfoliation of bone, contraction of the tendons in the neighbourhood of the stump, and the formation of neuromata.

With regard to the treatment of these affections—

a. **Hæmorrhage** will be considered under that head, p. 199.

b. **Spasms of the Muscles** may be relieved by shifting of position, by bandaging, or by the administration of anodynes.

c. **Excessive Pain** must be relieved by anodynes.

d. **Septic Inflammation** may be relieved by the application of such antiseptic applications and dressings as will combat and interfere with the septic causes of the inflammation.

e. **Osteo-myelitis** has been considered under that head.

f. **Inordinate Retraction** of the soft parts, exposing bone. Nothing can be done for this until the inflammation consequent upon the operation has subsided, when it will be necessary to open up the stump, and remove the exposed bone.

g. **Necrosis.**—The stump must be opened, and bone removed higher up.

h. **Neuralgia.**—Soothing anodyne applications, such as opium, belladonna, stramonium, or cocaine; if due to neuromata they should be excised.

i. **Strumous Degeneration.**—Secondary amputation may be advantageously performed.

j. **Aneurismal Enlargement** of the vessels are very rare. Mr. Cadge has reported one case of it.

k. **Exfoliation of the Bone.**—As little interference as possible, since in time the dead portion will be thrown of.

l. **Contraction of the Tendons** in the neighbourhood of the stump. If causing inconvenience, and giving annoyance, the tendons may be divided.

m. **Maggots in Stumps** have been already considered on p. 161.

HÆMORRHAGE.

The occurrence of hæmorrhage from wounds in war may be divided into primary or immediate, intermediate, and secondary.

Some writers on military surgery are of opinion that **primary hæmorrhage** to a dangerous extent is comparatively rare, and it is generally admitted that few cases come under the notice of surgeons on the field of battle; this, however, may be in consequence of severe injuries to large arteries proving fatal almost immediately, and the sufferers do not then come under the notice or observation of the surgeon. Mr. Hamilton, of the U.S.A., remarks—"It is one peculiar feature of gun-shot injuries that, in proportion to the number and severity of accidents, profuse arterial hæmorrhage is rare. The wounds inflicted by the missiles employed are generally contused and lacerated, seldom incised; and the same general laws as to bleeding, which govern contused and lacerated wounds elsewhere and from other causes, govern here."

Wounds of Arteries.—Arteries when wounded by an extremity being torn off by round shot or shell seldom bleed. Nature endeavours to establish a cure by the coats of the vessel retracting and contracting, and subsequently by adhesive inflammation.

When a large vessel is only partially injured, the hæmorrhage from it may prove fatal in consequence of this contraction not taking place.

An artery is liable to be seriously injured by a blow or contusion; a bullet has in this manner passed between an artery and a vein without opening either, but has caused gangrene of the limb. When the principal artery of a limb is obstructed from any cause, no cold or constricting bandages or plasters should be applied to it, but a flannel bandage may be rolled round it, so as to increase its temperature and establish collateral circulation.

Bullets have been known to pass between an artery and a vein, injuring both and establishing a communication, causing what is known as an *aneurismal varix.* Surgical interference is not recommended in such accidents, unless a very large tumour is formed, which is likely to give way and endanger the life of the patient, when the artery should be cut down upon, and a ligature applied on each side of the wound.

Lacerations of the inner coats of an artery may be caused by considerable violence, which may also give rise to gangrene, or at a later period to dissecting aneurism.

The external or middle coats of an artery may be cut or torn through, while a thin, undivided, inner portion preserves the integrity of the canal.

If such an accident be recognised, the arterial trunk should be tied above and below the injury without delay, though there be no hæmorrhage.

Punctured Wounds of Arteries.—Guthrie recommends "that in all cases of punctured wounds, when pressure can be effectually made, and especially against a bone, it should be tried in a graduated manner over the part injured, in the course of the artery above and below the wound." But pressure of various kinds, as by the finger, graduated compress, &c., can only be considered as temporary expedients. The rule to be followed in all cases where the nature of the injury is clearly recognised, and the artery at all accessible, is to enlarge the wound sufficiently and tie the artery above and below the puncture, dividing its continuity between the two ligatures so as to allow both ends to retract.

Diffused traumatic aneurism may be the result of a wounded or ruptured artery; the blood is poured out into the surrounding tissue, but is limited in its extent by coagulation and pressure of the neighbouring parts. There is no sac. The treatment in these cases is to lay open the tumour, remove coagula, and ligature the vessel above and below the wound in it.

Circumscribed traumatic aneurism may be induced in two ways from wounds of arteries:—

First: A vessel having received a puncture, the external wound heals, the blood is extravasated into the neighbouring tissue; this becomes dense and firm, is surrounded by layers of fibrine, and from continued pulsation a sac is formed. This form of aneurism is liable to occur in punctured wound of the palmar, radial, ulnar, and temporal arteries.

The treatment should be, if a small artery, to lay the tumour open, remove coagula, and ligature the artery above and below the seat of injury. It may, however, be necessary to tie the main trunk in the event of the vessel being very large, which should be done close to the sac.

The second form of circumscribed aneurism may be induced from a similar wound, as above, but both external wound and wound of artery heal, the cicatrix of the latter becomes weak and gradually dilates from the pulsations; or it may be produced by a bullet bruising the artery and weakening its coats. A tumour is formed which may attain a considerable size. This form of aneurism is more likely to occur in large arteries, such as the axillary, femoral, and carotid.

The treatment recommended is to try and consolidate the tumour by pressure on the main trunk. If this does not succeed, the vessel may be ligatured at the tumour, or it may be necessary to ligature the main artery at a distance from the sac. Should the sac be very large and likely to give way, or should it give way, the practice recommended is to lay it open, turn out coagula, and ligature the artery above and below the wound.

Treatment of Secondary Hæmorrhage after Ligature of Femoral Artery in Continuity.*—Ligature of external iliac as a remedy is condemned, and pressure is strongly recommended, the best method for which is as follows:—The limb should be carefully bandaged with a moderate amount of tightness from the toes to above the knee. Along the course

* *St. Bartholomew's Hospital Reports*, 1874.

of the femoral below the wound should be placed a pencil thickly covered with lint, and a roller carried up over this. On the wound itself a carefully made graduated compress, over which a bandage should be carried, ending in a spica at the groin. Another compress might be placed over Poupart's ligament, to exercise a certain amount of pressure upon the epigastric and common femoral arteries. Over the compress on the wound, Skey's tourniquet should be applied and kept tight for at least some hours. Should bleeding recur, the whole arrangement should be readjusted. A Liston's long splint might be of advantage in preventing the involuntary movement of the muscles.

The following rules with regard to the treatment of wounded arteries are now generally adopted, for some of which I* am indebted to Mr. C. H. Moore (see Holmes' *System of Surgery*, vol i., p. 749) :—

Wounded arteries which do not readily cease bleeding, and which can be conveniently secured, should be tied.

Moderate hæmorrhage from an artery which cannot be reached without enlarging the wound, should be stopped by a graduated compress, compression upon the arterial trunk above the wound may be added if it is thought advisable. Violent arterial hæmorrhage requires the wound to be enlarged and the vessel tied.

No operation should be performed with the object of securing a wounded artery unless it be actually bleeding. This rule has been specially laid down by Mr. Guthrie; nevertheless, it may be departed from when the torn extremity of a large artery is seen or felt to pulsate, and its permanent closure by natural means appears doubtful. An artery which has recently ceased to bleed may also be cut down upon and tied in certain emergencies. Such practice may be judged to be right, when delirium tremens supervenes upon the injury, or when, as in some military movements, the wounded are ordered to be transported to another position. Mr. Holmes considers this rule may be departed from in cases in which the surgeon judges, by the severity of the previous bleeding, that a large vessel has been wounded that the hæmorrhage will probably recur, and when the patient must be left at a distance from competent aid.

A wounded artery when requiring a ligature should be tied in the place where it bleeds; nevertheless, since it is sometimes impracticable to tie the vessel in the wound, the trunk should then be secured at the next convenient place above the bleeding orifice. Mr. Guthrie inculcated this principle, and says :—"No operation is to be done for a wounded artery in the first instance, but on the spot injured, unless such operation not only appears to be, but is impracticable."

The greater number of competent authorities of the present day agree with Mr. Guthrie in his recommendation to cut down directly upon the wounded part of the injured artery, for the following reasons :—That the ligature of the main trunk at a distance above it would only stop the direct supply of blood to the limb; but it would not interfere with the anastomosing circulation, and blood would find its way to the distal aperture of the artery; that it may not be possible for the surgeon to ascertain the exact artery the bleeding is coming from unless he looks

* Porter.

for it, and instances have been known where main trunks of arteries have been tied, and the hæmorrhage has been from some small vessel unconnected with it. Stromeyer is of opinion that the plan of tying a wounded artery at the spot often does very well in minor vessels, but it frequently fails in the femoral artery. The large vein accompanying the artery has often been torn or bruised by the same bullet. After tying the artery at the spot, the vein often becomes totally impervious, and the hæmorrhage recurs, or the limb becomes gangrenous. It may be proper, in some cases, to gain time by putting a ligature above the wounded spot; before new hæmorrhage occurs, the vein may have undergone a favourable change. In other cases it is better to amputate.

The external wound should be taken as the guide for the incision, and it is recommended that "in *cutting down on a wounded artery*, a large probe should be passed to the bottom of the wound, and taking this as a centre, a free incision should be made in such a direction as may best lay open the cavity with the least injury to the muscles and soft parts. After turning out any coagula contained in the wound, and clearing it out as well as possible, the injured vessel must be sought for." Great care should be observed in ligaturing the vessel in consequence of the altered condition of the structures, from inflammation or infiltration.

The operation may be greatly facilitated by the application of Esmarch's bandage. Should the wound in the vessel not be apparent, it is only necessary to loosen the bandage, when the jet of blood will declare its position. The artery, when found, should be tied or twisted both above and below the wound in it. The necessity for tying the lower end is the greater, because it is the more frequent source of secondary hæmorrhage.

When the lower end of the vessel cannot be found, a piece of compressed sponge left in the wound sometimes prevents subsequent hæmorrhage. It is not advisable to apply a single ligature immediately below the origin of a large branch.

Intermediary or **Reactionary Hæmorrhage** may occur some hours after the receipt of a wound, or as soon as the patient becomes warm, and reaction is completely established. If position, cold, and the compression of a bandage does not check it, the wound must be opened out and the bleeding vessel sought for and tied.

Secondary Hæmorrhage is common in gun-shot wounds, due to sloughing of the parts injured, or the re-opening of a wound in which a vessel is temporarily closed. It may occur from the fifth to the twenty-fifth day after the infliction of an injury.

It may be produced by local or constitutional causes, the former being any movement which may disturb the wound or increase the rapidity of the circulation; as, for instance, (*a*) by transporting wounded men too soon, which may be unavoidable; (*b*) by the imperfect application of a ligature; (*c*) by sloughing or ulceration of a large vessel; (*d*) by projecting spicula of bone injuring a vessel; (*e*) by a peculiar *hæmorrhagic diathesis* natural to some persons, but which on service in the field generally presents itself when the men are scorbutic and worn out by fatigue and privation. The most common cause probably is unhealthy

eptic inflammation and suppuration in the neighbourhood of the artery.* Under these influences its coats soften and yield in places to the blood pressure, when some spot may ultimately give way, and hæmorrhage be the result. If the ends of the arteries are embedded in healthy granulation tissue, there will be no secondary hæmorrhage.

Treatment of Secondary Hæmorrhage after Gun-shot Wounds.—When severe the surgeon will have to cut down on the wounded artery and tie or twist both ends, or tie it in its continuity leading to the seat of the bleeding. Some authorities advocate dealing with the main trunk. Stromeyer and MacCormac are opposed to this practice, such operations having been uniformly unfavourable in their experience; they are more in favour of amputation in cases of secondary hæmorrhage. When not severe, it will probably be restrained by pressure and the elevation of the part. Pressure, when selected, should be applied directly on the bleeding point, by graduated compresses and bandages, and it will be of advantage, too, if it be put on the main artery or arteries leading to the aperture.

Nothing can be more disheartening than searching for a bleeding point in a suppurating unhealthy wound. If it is found, in all probability it will not hold a ligature; but it is more than likely that it will not be found. Should, then, the main artery be tied higher up, or should amputation be performed? In the experience of the writer at Suez† in 1884, several severe cases of secondary hæmorrhage, resulting from deep spear wounds, were controlled by ligature of the main artery of the limb. In one case deligation of the superficial femoral failed to check the bleeding, but tying the external iliac controlled it, and the man made a good recovery. It would seem, therefore, advisable in cases of this kind to tie the artery, if practicable, higher up first before proceeding to the graver operation of amputation. The true treatment is such antiseptic management of the wound from the first as will prevent septic inflammation and suppuration.

Hæmorrhage occurring from stumps may be primary, intermediate or reactionary, and secondary. Primary hæmorrhage would be dealt with at the time of operation. Intermediate or reactionary may occur from reaction, or from disease of the arterial coats, which may give a certain amount of warning by general oozing; or, in flap operations, where an oval opening having been made in an artery, the whole lumen of the vessel has not been included in the ligature.

Secondary, at a later period, when it may be from causes interfering with the formation of the coagula, or producing ulceration of the coats of the artery, or from septic causes as described above (*vide* p. 51).

The treatment of hæmorrhage from a stump at an early period must be prompt; the maxim that holds good in primary hæmorrhage, not to interfere with a vessel unless it bleeds, will not answer here. Bleeding having occurred more than once, active measures must be adopted. After having tried elevation of the stump, the application of tourniquet, pressure by means of bandaging the stump so as to press the flaps together, and the application of cold to the wound and the adjoining parts, without

* *Proceedings of Pathological Society*, 4th Dec., 1883.

† *A.M.D. Reports* for 1883. *Vide* Appendix III.

checking the hæmorrhage, it will be necessary to open the wound and make a search for the bleeding vessel.

It frequently occurs that there is some difficulty in isolating a bleeding vessel in a stump. It may then be secured by passing a curved tenaculum through the tissues immediately surrounding the vessel, and placing a strong ligature around the whole. It may also be secured by thrusting a needle armed with a ligature through the tissue in the direction of the bleeding vessel, and endeavouring to seize it along with the surrounding tissue. If the vessels are softened and will not hold the ligature, success sometimes attends the application of the solution of the perchloride of iron or the actual cautery. In bleeding from a stump where the interosseous artery of the leg has been divided high up, hæmorrhage has been suppressed by a long acupressure needle being passed through the stump, so as to press the artery against one of the bones.

Should hæmorrhage occur at a later period, when the stump is irritable and inclined to slough, the surgeon may select one of the five following alternatives:—Apply a tourniquet; open up the stump and tie the vessels; ligature the main artery immediately above the stump; tie the vessel high up in the limb at a distance from the stump; or, lastly, amputate. Mr. Guthrie remarks on this description of hæmorrhage—"In irritable and sloughing state of stump, hæmorrhages frequently take place from the small branches, or from the main trunks of the arteries in consequence of ulceration; and it is not always easy to discover the bleeding vessel, or when discovered to secure it on the face of the stump; for as the ulcerative process has not ceased, and the end of the artery which is to be secured is not sound, no healthy action can take place; the ligature very soon cuts its way through, and the hæmorrhage returns as violently as before, or some other branch gives way. Some surgeons," he says, "have, in such cases, preferred cutting down upon the principal artery of the limb in preference to performing another amputation, even when it is practicable; and they have sometimes succeeded in restraining the hæmorrhage for a sufficient length of time to allow the stump to resume a more healthy action. This operation, although successful in some cases, will generally fail, and particularly if absolute rest cannot be obtained, when amputation will be necessary. The same objection of want of success may be made to amputation; on a due comparison of the whole attending circumstances, the operation of tying the artery in most cases is to be preferred in the first instance, and if that prove unsuccessful, then recourse is to be had to amputation; but this practice is by no means to be followed indiscriminately."

"To obviate all doubt, the parts from which the bleeding comes should be well studied, and the shortest distance from the stump at which compression on the artery commands the bleeding carefully noted; at this spot the ligature should be applied, provided it be not within the sphere of the inflammation of the stump. In case the hæmorrhage should only be restrained by pressure above the origin of the profunda, and repeated attempts to secure the vessel on the surface of the stump have failed, amputation is preferable to tying the artery in the groin, when the strength of the patient will bear it."

Intermittent Hæmorrhage.—A remarkable case of intermittent hæmorrhage, apparently due to malarial influence, occurred to a weakly soldier under Porter's care at Netley. He had suffered in India from severe fever and ague, which culminated in disease of the left knee-joint, for which Porter amputated the leg through the condyles (Carden's method). The case progressed satisfactorily till the eighth day, when hæmorrhage from the stump set in, at intervals preceded by the cold and hot stages of ague. The usual local and constitutional remedies were tried without success, until sulphate of quinine was administered, when the hæmorrhage ceased, as well as the paroxysm of ague, and the man rapidly recovered.

Expedients for Suppressing Hæmorrhage may be divided into temporary and permanent, such operating either indirectly on the trunks conveying the fluid to the point, or directly on the orifice of the bleeding vessel.

In case of severe Hæmorrhage on the Field of Battle, the first impulse on the part of the surgeon or his attendant is to check the bleeding by placing his fingers in the wound, or applying a tourniquet to the main trunk. The latter may not be available; it would, therefore,

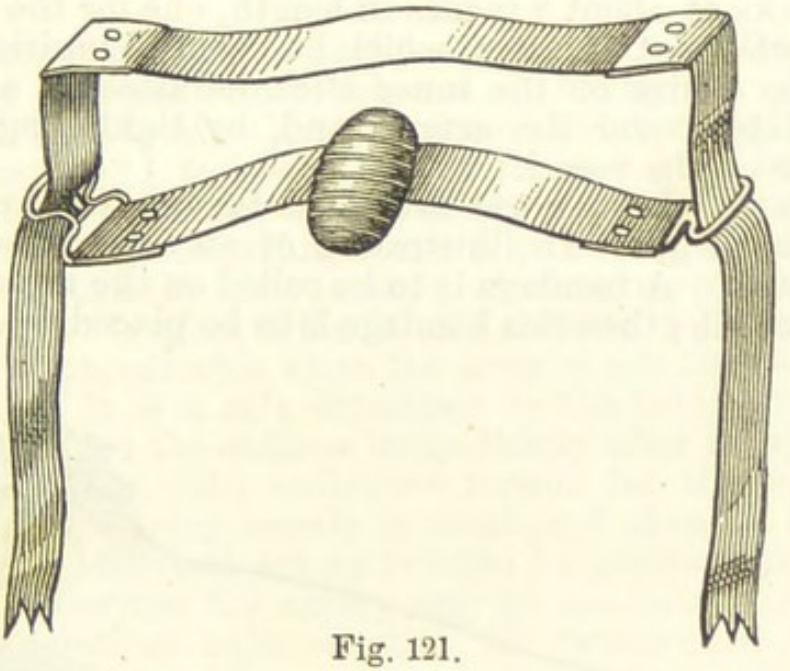

Fig. 121.

be necessary for an attendant to apply pressure with his fingers even during transport, in the event of the bleeding being from a large vessel.

Bleeding can frequently be checked by *plugging* a wound; but this may be followed by grave symptoms, in consequence of the blood becoming diffused, giving rise to an aneurism or to gangrene.

The tourniquet is the chief temporary means, which in its primitive state was simply a band to go round the limb, with a pad placed immediately over the vessel, and the whole tightened by means of a bayonet or piece of stick.

To Petit we are indebted for the screw tourniquet; and since his time there have been many modifications, nearly all with a view to stop

the current of blood through the main artery of the limb, and at the same time to admit of a certain amount of circulation being carried on.

It was found that with wounded men having the old-fashioned twisted strap, or the more modern screw tourniquet, applied to a limb, and transported for any distance without surgical assistance, the tourniquet frequently shifted, or the man *lost the limb from gangrene.* To obviate this, and admit of a wounded man retaining the instrument for a considerable time, either during transport or until the services of a surgeon might be available, Dr. A. B. Mott, U.S.A., invented one with bands or hoops of iron or brass, which Mr. Hamilton describes as "a very ingenious field tourniquet (fig. 121), which is easily applied, and may be considered safe even in the hands of those who know nothing of the danger of ligating limbs too tightly, since the compression is applied at only two points in the circumference of the limb."

Professor Esmarch, in his work on bandaging, describes a tourniquet for the field invented by Volckers, which he considers, on the lower part of the upper arm, can be applied with much less danger than the usual circular tourniquet. Volckers found it was easy to make the pulse above the elbow disappear, by crossing the arm with a stick at the proper angle of the axis of the bone. This apparatus (fig. 122) can be made with two little round sticks of about 8 inches in length, one for the inside, and the other for the outside of the arm, which he keeps in position by means of straps. On the centre of the inner stick he attaches a pad, which is placed immediately over the artery, and, by tightening the straps, is brought to bear on the vessel.

For pressure on the femoral artery in the upper part of the thigh, Professor Esmarch gives an illustration of an apparatus which can be easily constructed. A bandage is to be rolled on the middle of a stick at least a foot in length; then this bandage is to be placed against the artery,

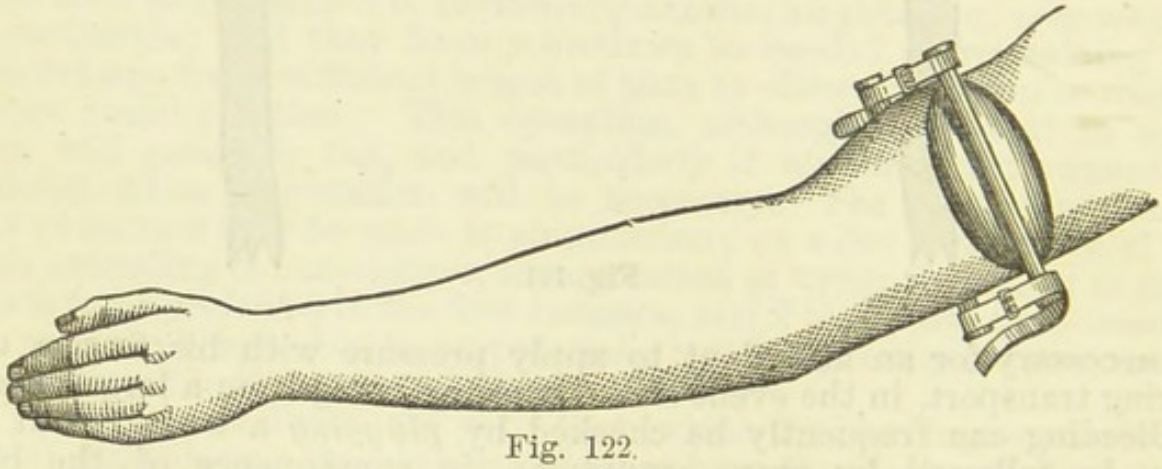

Fig. 122.

and tightened by means of a strap and strong buckle passed behind the limb and over each end of the stick; by this means continued pressure can be maintained (fig. 123).

Several ingenious modifications have been made of the ordinary screw tourniquet, whereby the strap is carried clear of the sides of the limb to allow of venous return. These have been effected by the addition of metal wings, over which the strap is carried.

Dr. John Hunter, of the R.N., has designed three new forms of tourniquets, which have the great advantage of allowing venous return.*

Tourniquets in the hands of surgeons have their undoubted advantages, but, at the same time, they are most dangerous in the hands of uninstructed men, who are exceedingly likely by the indiscriminate and prolonged use of them to cause gangrene of the limb.

The Expedients that may be employed for the permanent arrest of Hæmorrhage are—pressure, ligature, torsion, acupressure, flexion, cauterisation, application of cold, styptics, exposure to air, position, forci-pressure and application of hot water.

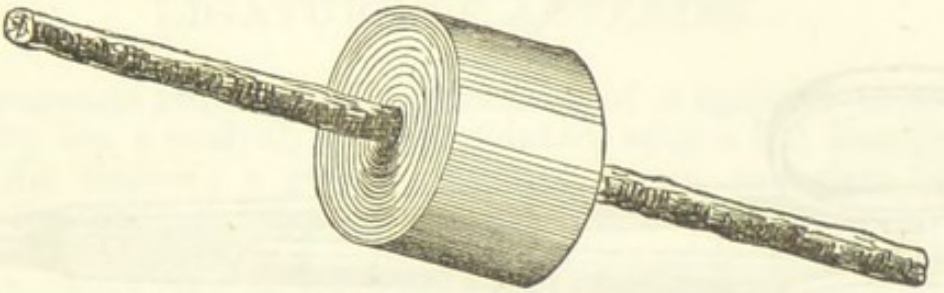

Fig. 123.

Torsion of Arteries, though used in former times, fell into disuse, and was revived by Amussat and Velpeau. During the Franco-German War of 1870-71, Sir W. MacCormac appears to have used it with marked success. He says—"I twisted the vessels in a very large number of cases of amputation for gun-shot wounds. I only remember a single instance of secondary hæmorrhage from a twisted vessel. It was a case of amputation through the knee-joint, in which acute pyæmia supervened. Torsion," he says, "is more difficult and tedious in its application than a ligature. It is inapplicable when the arteries are diseased."

It is doubtful if it is a safe expedient in the field, especially if it be necessary to transport the sufferer immediately after its application.

Sir W. MacCormac used unlimited torsion for the smaller arteries. For the large vessels lying loosely in unaltered sheaths, he considers it better to limit the length of artery twisted by grasping the vessel with a second forceps, otherwise the artery may be needlessly and dangerously disturbed in its relations to its sheath. He twists until he feels the internal coat giving way.

Sir Spencer Wells has introduced a new kind of artery and torsion forceps, which very conveniently replace the old spring artery forceps of Liston, and the bull-dogs used for the temporary stoppage of bleeding vessels during an operation, while they are the most readily applied of any of the varieties of torsion forceps met with.

The grasping and holding extremity is roughened by rather deeply-cut transverse teeth (fig. 124), so that the bleeding vessel is forcibly compressed and its coats almost crushed together. This is alone sufficient to stop the bleeding without any torsion, especially if the instrument be left on the vessel for a minute or more.

* *Lancet*, July 15, 1876.

Acupressure may be applied in several different ways, the object in all being to compress the mouth or bleeding orifice of the artery against tissue or bone.

Flexion may be used for hæmorrhage from the forearm, hand, lower leg, or foot, by placing a piece of lint or handkerchief rolled up in the bend of the elbow or under the knee; then flex the limb and fix it. In the event of a tourniquet not being available, this proceeding might be used with advantage.

Cauterisation is now seldom used; at the same time it may be found of use in hæmorrhage from the surface of irritable and indolent stumps, or in gun-shot wounds of the tongue. It is recommended that the iron

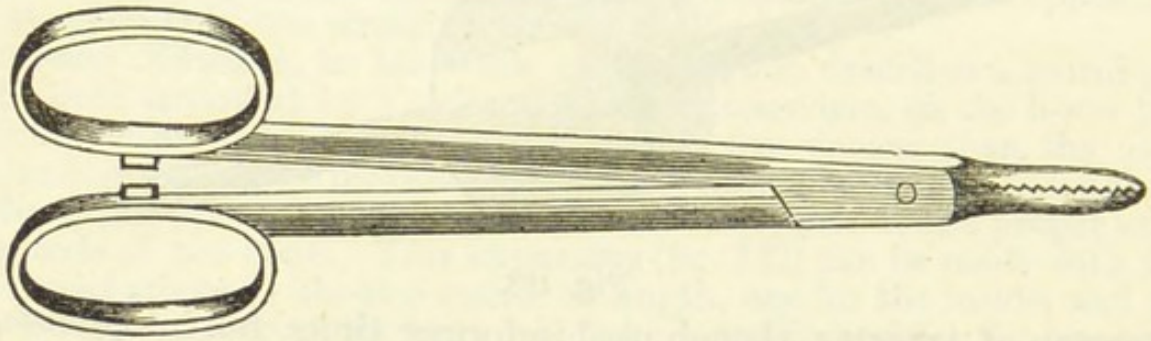

Fig. 124.

which is used for the purpose of cauterisation should be at a black heat, being considered more effectual in that condition than at a red or white heat.

The Application of Ice or Cold is nearly always attended by satisfactory results in wounds of very small vessels, favouring the coagulation of the blood. **Hot Water** will accomplish this end more promptly than cold, and it is especially appropriate when the patient is feeble and exhausted by shock. It should be 150° F., and may be carbolised or iodised.

Styptics were much used in former days. They act by causing the blood to coagulate rapidly and firmly, but should only be used when there is oozing from parts where other applications cannot be conveniently made. Styptics are, as a general rule, most objectionable, as they act injuriously on the tissues to which they are applied, by causing much pain and tendency to extensive sloughing or suppuration, and thus rendering healing by first intention impossible.

The styptics occasionally used are the perchloride of iron, matico, turpentine, gallic acid, alum, nitrate of silver, chloride of zinc, Ruspini's styptic, and mineral acids.

Langenbeck has prescribed a solution of ergot in glycerine, to be used as a hypodermic injection in cases of hæmorrhage and in the treatment of aneurism: proportion—1 grain of ergotine to 6 minims of glycerine; 2 minims for an injection. Porter tried this in two cases of aneurism without any satisfactory result, but saw it successful in cases of epistaxis and hæmorrhage from an intercostal artery.

Wounds of Veins.—Unless from some large and deep-seated trunk, hæmorrhage from wounded veins is seldom dangerous.

If a wound of the chief vein of an extremity is complicated with a wound of its artery, the case must be looked upon as most serious, being generally followed by gangrene of the limb.

If the vein wounded be of such a size that it would be dangerous to tie, the rent or tear in it may be closed by the uninterrupted or Glover's suture. Veins, if they bleed, may be tied as freely as arteries, though in ordinary cases pressure and elevation would be sufficient.

LIGATURE OF ARTERIES.

The instruments required for application of a ligature to an artery in its continuity are a scalpel, not too pointed, with a flat handle for pressing aside the tissues; a good-sized forceps; an aneurism needle; retractors; a ligature; needles and thread. In cutting down on an artery it may be only necessary to follow up a wound, which point should always be observed, the original wound being taken advantage of.

Mr. Erichsen gives such excellent instructions for cutting down on an artery, that they may be repeated here with advantage:—

"In making the first incision, the skin should be put on the stretch by the fingers of the left hand, or by those of an assistant. If the artery be superficial, or if there be parts of importance in its vicinity, the incision should not penetrate deeper than the skin. But if the vessel be deeply seated and no parts of importance intervene it may be carried at once through the subcutaneous areolar tissue, until the fascia covering the artery is exposed. This must then be pinched up with the forceps, and opened by the edge of the scalpel laid horizontally. Through this opening a grooved director may then be passed, and the fascia incised on it, without risk to subjacent parts. The sheath of the vessel is now exposed by a little careful dissection; and the next step of the operation is one of great delicacy. It consists in exposing the artery and separating it from its accompanying vein. This is done by pinching up the sheath with the forceps and applying the knife horizontally. The artery having been exposed, the surgeon seizes one edge of the sheath with the forceps, and putting it on the stretch, gently separates the artery from its accompanying vein by tearing through the areolar connections with the end of the aneurism-needle, or with a director, being careful not to expose it to a greater extent than is absolutely necessary for the passage of the ligature. The ligature should be passed between the vein and the artery, care being taken only to include the latter, and especially not to transfix and include a portion of the vein. The artery should be tied tightly with a reef-knot, which does not slip" (fig. 125).

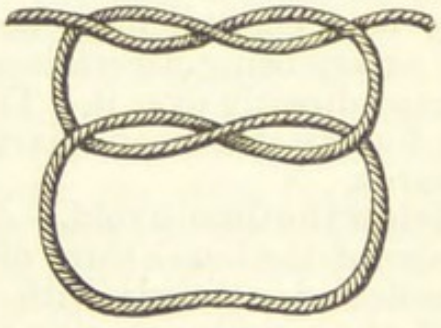

Fig. 125.

Catgut ligatures are now chiefly used, and to enable the catgut to acquire the necessary strength, it is prepared in a mixture of chromic and carbolic acid. After it is prepared for use it should be kept in a 1-5 solution of carbolic oil.

A specially prepared carbolised silk ligature is also used by some surgeons. Others, again, use ligatures of ox aorta and kangaroo tendons. When any of these specially prepared materials are used for tying arteries, after the knot has been securely tied both ends are cut off, and the knot remains in the wound until absorbed.

The following table may assist in showing when the separation of the old ordinary silk or thread ligatures from large arteries may be anticipated, at which period hæmorrhage may occur :—

Common iliac, 18th to 25th day ; external iliac, 15th to 22nd day ; femoral, 14th to 28th day ; subclavian, 17th day ; carotid, 20th day ; brachial, 21st day ; axillary, 22nd day.

The rules for tying the principal arteries have been taken from Mr. Heath's valuable work on *Operative Surgery*.

Ligature of the Common Carotid.—This operation may be performed above or below the omo-hyoid muscle.

Above the Omo-hyoid.—The patient must be placed on his back, with the shoulders supported by a pillow. An incision 2½ to 3 inches in length is to be made exactly on the anterior oblique border of the sterno-mastoid muscle immediately opposite the larynx, so that the middle of the incision may correspond to the level of the cricoid cartilage. The incision should be carried at once through the platysma, superficial cervical nerves, and fascia to expose the muscular fibres of the sterno-mastoid. Should the external jugular cross the line of incision, it should be tied with two ligatures before being cut. The anterior edge of the sterno-mastoid is to be turned back until the angle formed between it and the omo-hyoid is clearly defined. The sterno-mastoid is then to be held back by an assistant while the operator dissects forward the outer edge of the omo-hyoid, which is then to be held with a hook, so as to increase the space between the two muscles. In doing this, a large anterior jugular vein may be seen, and must be carefully preserved. The exact position of the artery being ascertained, the sheath is to be opened with knife and forceps directly over it. The outer side of the sheath being grasped with the forceps, the needle is to be passed close to the artery from without inwards.

Below the Omo-hyoid.—An incision 3 inches in length along the anterior border of the lower third of the sterno-mastoid will allow that muscle to be reflected outwards (with or without division of its sternal attachments) until the muscles passing upwards to the hyoid bone are exposed. The outermost muscle is the omo-hyoid, and this is to be separated from the sterno-hyoid, when the broad sterno-thyroid will be seen beneath them, pushed up by the thyroid gland. The finger carried between the omo-hyoid and sterno-thyroid will distinguish the carotid in its sheath lying against the vertebræ. The sheath is to be opened with knife and forceps, and the artery fully exposed, without injuring the descendens noni nerve, when the needle may be passed from without inwards.

In these two operations the first incision should be exactly upon the margin of the sterno-mastoid, and the sheath of the artery should be opened well on the inner side to keep clear of the internal jugular vein.

The Lingual Artery may be most certainly tied at the apex of the digastric triangle beneath the hyoglossus. A curved incision beginning to the right (or left) of the symphysis menti is to be carried to the level of the hyoid bone, and then nearly up to the angle of the jaw. This should divide the platysma and expose the submaxillary gland without injuring it. The lower border of the gland is then to be turned up and held with a hook, when a little dissection will expose the two bellies and intervening tendon of the digastric, forming two sides of a triangle, of which the 9th or hypoglossal nerve is the base. The nerve will be seen to pass beneath the posterior border of the mylo-hyoid, which should be defined, and is usually accompanied by a branch of lingual vein. Both of these are to be dissected up a little, so as to bring the hyoglossus muscle, on which they lie, fully into view, and the hyoglossus is then to be divided transversely about $\frac{1}{8}$ of an inch above the great cornu of the hyoid bone, when the lingual artery with its venæ comites will be seen. The needle should be passed from above downwards. If the incision is carried up to or beyond the angle of the jaw, the large facial vein may be divided, and will require two ligatures. In dividing the hyoglossus, if the incision is made too deeply it will open the pharynx.

The Facial Artery may be tied immediately in front of the masseter on the margin of the lower jaw, by an incision, 1 inch in length, parallel to the fibres of the masseter. The artery lies upon the bone immediately beneath the platysma, and the vein is to its outer side. The artery is often tortuous.

The Subclavian Artery, in its third part, may be tied. In order to reach the vessel, the arm should be drawn down, and the head turned towards the opposite side. Standing at the shoulder of the patient, the operator draws the skin down upon the clavicle with the left hand, and makes a curved incision upon the bone, reaching from the sterno-mastoid to the trapezius. This incision should divide the skin, platysma, and fascia down to the bone, and with them the descending branches of the superficial cervical plexus, and possibly a vein, which should be tied at once if it bleeds. The skin being now allowed to resume its natural position, the incision will be about half an inch above the clavicle, and must be deepened by cutting carefully through the deep fascia thus exposed. The position of the external jugular vein having been ascertained, if it can be held on one side it should be preserved, but if it is in the middle of the incision it should be tied in two places, and divided between them. The finger introduced into the wound will be able to recognise the edge of the anterior scalenus and the first rib, with its tubercle, and possibly the artery and the cords of the brachial plexus. With the steel director aud forceps, a cautious dissection is to be made in the direction of the artery, guided by the finger, until, by tearing through a process of fascia continuous with the scalenus, the vessel is exposed. The needle may be most conveniently passed from above downwards between the last cord of the plexus and the artery. The

great risk is venous hæmorrhage, which is to be guarded against most carefully. The brachial plexus lies external to and behind the subclavian artery; the subclavian vein in front and below.

The Axillary Artery in its First Stage.—If it is necessary to tie the axillary, as in the case of a punctured wound, the operation recommended by Guthrie is probably the best. It consists in making an incision from the centre of the clavicle directly downwards, in the course of the vessels, to the middle of the anterior fold of the axilla. In this way the skin, superficial fascia, and greater pectoral muscle must be successively divided. The lesser pectoral will then be exposed, and the artery may be ligatured above or below this, without further division of muscular substance, or if it be thought desirable to deligate it under this the muscle must be cautiously cut through. When this is done, a very distinct and firm fascia will come into view; this must be picked up and carefully opened, when the artery and vein will be seen lying parallel to one another, the artery being to the outer side. The vein having been drawn inwards, the aneurism needle must be carried between it and the artery. The advantage of this operation is that the wound is open and free, and that constantly the artery can be more easily reached in any part of its course. The disadvantage is the great division of muscular substance it entails.

In its Third Stage.—The axillary artery may be readily reached when the arm is at right angles to the body. The operator should sit between the arm and the trunk, and an incision 3 to 3½ inches long is to be placed parallel to the anterior border of the axilla, at the junction of the anterior with the middle third of the space—*i.e.*, one third of the whole width of the axilla behind its anterior border. Carried through the deep fascia, this will expose the axillary vein, which is to be drawn down by an assistant. The great cords of the brachial nerves will then be seen, and a little separation of these will expose the axillary artery between them. The needle should be passed from the inner side, or away from the vein, and the ligature must not be applied close to a branch. If the incision is made in the middle of the axilla, the vein will be to its outer side, and in great danger, and it will be difficult to expose the artery. The relation of the artery to the nerves being uncertain, it is easy to miss the vessel, or to mistake one of the cords for it. If the ligature were applied too close to the large subscapsular branch, secondary hæmorrhage would be likely to occur.

Brachial Artery.—This operation may be performed in any part of its course. The middle of the arm is the best point to choose. A line drawn from the middle of the axilla to the inner side of the biceps tendon at the bend of the elbow indicates its course. The arm should be held by an assistant at right angles to the body without resting upon any support, which, if employed, is apt to push up the triceps muscle and displace the vessel. The fibres of the biceps should be exposed without dividing them.

The arm being abducted and rotated outwards, an incision should be made about 2½ inches long on the internal margin of the biceps. "The skin, which is always thin, and the fascia should be carefully divided,

and the deep fascia exposed. This is next to be laid open, but with care, for the basilic vein lies immediately below it, on the inner side of the brachial artery. The ulnar nerve will be found on the inner side of the vein, and the median in front of the artery, but there is no regularity in these relations ; much care is consequently required in finding the vessel."

When in doubt as to the recognition of ulnar or median nerve—the former in the middle of the arm will be found passing downwards and backwards.

The Brachial Artery at the Bend of the Elbow.—The position of the median-basilic vein having been ascertained if possible, a 2-inch incision, beginning at the level of the internal condyle, is to be placed parallel to, and usually above, the vein on the inner side of the tendon of the biceps, which is always to be readily felt, if not seen. The incision may be conveniently made from above downwards on both sides of the body, the operator being between the arm and the trunk on the left side. The bicipital fascia, varying much in thickness, will be exposed by the first incision, and on dividing it with the knife and forceps, or, if preferred, upon a director slipped beneath it, the artery with its two veins will be found between the median nerve and the tendon of the biceps. The needle to be passed from the nerve.

The Ulnar Artery, in the middle of the forearm, corresponds with a line drawn from the tip of the inner condyle to the radial side of the pisiform bone. This line marks the outer edge of the flexor carpi ulnaris. An incision 2½ to 3 inches long in the middle third of this line should be made to expose the deep fascia, through which the white tendinous margin of the flexor carpi ulnaris can be perceived. An incision carried along this will allow the handle of the scalpel to separate the flexor ulnaris from the palmaris longus, or the flexor sublimis digitorum, until the ulnar nerve is exposed at the bottom of the wound. To the radial border of the ulnar nerve, the ulnar artery will be found with its two veins. The needle should be passed from the nerve. If the incision is too much in front, the interval between the palmaris longus and flexor sublimis may be selected in error.

The Ulnar Artery at the Wrist.—An incision 1½ to 2 inches in length is to be made along the radial border of the flexor carpi ulnaris immediately above the annular ligament. The first incision is to go through the fascia of the forearm, and expose the white border of the tendon. This being drawn inwards, another process of fascia will be seen binding down the ulnar artery, veins, and nerve to the flexors of the fingers. This fascia is to be picked up and opened directly over the artery, and, the veins having been separated, the needle is passed from the nerve, which is to the ulnar side of the vessels. The position of the pisiform must be correctly ascertained.

The Radial Artery in the middle of the Forearm corresponds with a line drawn from the middle of the hollow in front of the elbow to the base of the metacarpal bone of the thumb. An incision, 2 to 2½ inches in length, should be made in the middle of the forearm, and should be carried at once through the deep fascia. In thin persons the incision will expose the border of the supinator longus, but in a fleshy arm that muscle

will overlap the artery considerably, and the border must be sought nearer the median line of the arm. The edge of the supinator is to be turned outwards, and the artery with its two veins will be found in the cellular interval between it and the pronator teres. The radial nerve is deeper than, and to the outer side of, the artery, and the needle should therefore be passed from the outer side. If the first incision is not made through the fascia, it is difficult to find the edge of the supinator. In reflecting this muscle, it is easy to miss the artery and expose the nerve to its outer side.

The External Iliac Artery may be tied by a curved incision 4 to 5 inches long. It will be best to begin 1 inch to the outer side of the middle of Poupart's ligament and an inch above its level, and to prolong it to a point an inch above the anterior-superior iliac spine. The first incision should expose the tendon of the external oblique; if the superficial epigastric artery is cut, it should be tied at once. The tendon is then to be divided to the same extent, the blade of the knife being held with its edge perpendicular to the surface in the whole length of the incision, and the muscular fibres of the internal oblique will be exposed. These are to be divided in the same way, the original curve of the incision being carefully preserved, until the transversalis is exposed. The muscular fibres of the transversalis are then to be divided in the original curve and by the same method, or a portion of muscle may be taken up with forceps, and divided, until the fascia transversalis is brought into view, when a director may be slipped beneath the remainder of the muscle, and the knife run along it. The fascia transversalis, which will now be exposed in the whole length of the incision, will be found to vary much in the quantity of fat it contains, being sometimes thin and transparent, and at others thick and well developed. It is to be picked up with forceps and carefully opened with the blade held horizontally, and the director being inserted, it is to be divided. The outside of the peritoneum will now be exposed. It is of a bluish appearance, and the bowels can be indistinctly seen through it. The operator with his forefinger carefully strips up the peritoneum from the iliac fossa towards the median line as far as the inner border of the psoas. The external iliac artery and vein will be found lying parallel to the inner border of the psoas in a distinct sheath of fascia, which must be opened with knife and forceps in order to expose the artery. The vein lies to the inner side of the artery, and the genito-crural nerve to its outer side; the needle should be passed from within outwards. If the incision is too near the middle line, there will be a risk of opening up the external abdominal ring or the sheath of the rectus, and of dividing the epigastric artery. If the incision is too low, it will interfere with the inguinal canal and spermatic cord in front; and behind, the trunk of the circumflexa ilii running between the internal oblique and transversalis will be divided. The curve and length of the incision must be carefully preserved, or it will be difficult to reach the artery, and each muscle should be finished before the deeper one is interfered with. In using the director, great care must be taken not to force it through deeper structures unawares, but, by moving it horizontally, to make it clear its way at the intended level.

The Femoral Artery may be tied at the apex of Scarpa's triangle and in Hunter's canal, the former being the preferable and more usual operation.

To tie the Femoral in Scarpa's triangle, the thigh is to be slightly flexed and abducted, the knee being bent, and in this position of the limb, a line drawn from about the middle of Poupart's ligament to the inner condyle of the femur, will mark the position of the upper part of the artery. An incision begun 2 inches below the groin and in the centre of the thigh, should be prolonged for 3 or 4 inches, and be carried through the fascia lata, so as to expose the sartorius crossing the lower part of the incision. A blunt hook being inserted at the inner edge of the fascia lata, the operator seeks the inner border of the sartorius, and turn the whole muscle outwards with his finger, when it is held aside by an assistant. Any small bleeding branch is now to be secured, when, if the incision has been properly made, and is not pulled out of position, the sheath of the artery will be readily seen at its lower part. The femoral sheath is to be carefully opened with knife and forceps, and especial pains taken to dissect well down to the true arterial coat on both the inner and outer sides of the vessel. The needle should be passed from within outwards. If the limb is not flexed and abducted, the incision will be made too much to the outer side. If the incision is too small, it is very difficult to displace the sartorius sufficiently. No attempt should be made to pass the needle until the artery is thoroughly cleared, or the vein may be perforated. Should such an accident occur, the hæmorrhage being controlled by pressure with the finger below the wound, the needle should be withdrawn, and separation of the vessels effected higher up, when the artery being carefully tied, the hæmorrhage from the vein will not recur.

To tie the Femoral Artery in Hunter's Canal, the thigh is to be flexed and abducted as in the previous operation. An incision 3 to 4 inches in length is to be made in the middle third of the thigh parallel to the inner border of the limb, and about an inch from the margin of the gracilis. This incision may expose the saphenous vein which is to be avoided, and the fascia lata is to be divided so as to expose the sartorius, which will be recognised by the direction of its fibres running obliquely downwards and inwards. The outer edge of the divided fascia being held with a hook, the operator seeks the outer border of the sartorius, and turns the whole muscle inwards with his finger. The tendinous expansion thrown across the vessels from the adductors to the vastus internus must now be opened over the artery, which can generally be seen through it, and the artery carefully isolated, when the needle should be passed from without inwards, avoiding the saphenous vein. If the incision is below the middle third of the thigh, the canal will not be exposed, but the popliteal space will be opened. If the incision is put too far from the inner border of the thigh, the vastus internus will be exposed, and may be mistaken for the sartorius, but its fibres are coarser and run in the opposite direction.

Posterior Tibial Artery in the leg may most certainly be reached when it lies between the superficial and deep muscles. The knee being

flexed and the leg laid on its outer side, an incision 3 or 4 inches long is to be made in the middle third of the leg, parallel to the inner border of the tibia, and half an inch behind it. The edge of the knife should be turned towards the bone in making this incision, and the same direction maintained in the division of the muscle. The gastrocnemius will probably not be seen, but, if so, it should be drawn aside and the tendinous surface of the soleus exposed. This is to be divided for the whole length of the incision, with the muscular fibres beneath it, and a deep tendon which should be recognised and carefully divided on a director if preferred. By drawing the divided soleus outwards with a spatula, the posterior tibial vessels and nerve will be seen bound down to the deep muscles by the deep fascia, which varies much in thickness. The fascia being opened with a knife, the venæ comites should be separated from the artery with a steel director, and the needle passed from without inwards. If the incision is put too far from the tibia, the gastrocnemius will be found, and may be mistaken for the soleus. In dividing the soleus, if the knife is turned away from instead of towards the tibia, a much more extensive division of muscular fibres will result. If the incision be made too close to the border of the tibia, it is difficult to distinguish the soleus, and there is great risk of getting beneath the deep muscles and down to the interosseous membrane.

The Anterior Tibial Artery in the upper third. The limb being supported under the knee, so that the sole of the foot may be flat on the table, an incision begun at a point midway between the external tuberosity of the head of the tibia and the head of the fibula, and an inch below them, is to pass obliquely downwards and inwards from 3 to 3½ inches. The deep fascia of the leg is to be divided to the same extent, without injuring the muscles beneath, and then, with the forefinger and handle of the knife, the cellular interval between the tibialis anticus and extensor longus digitorum is to be sought, and the two muscles carefully separated. This interval can be more easily recognised with the finger than by the eye, but when opened up a muscular branch of the artery will usually be seen between the two muscles. Two broad spatulas must be employed to separate the muscles down to the interosseous membrane. The anterior tibial artery and veins will be seen lying on the interosseous membrane with the nerve to the outer side. The needle should be passed from the nerve. In using the finger to find the intermuscular space, it should be directed towards the tibia rather than the fibula.

In the Lower Third.—The tendon of the tibialis anticus can be readily felt through the skin, lying next to the anterior border of the tibia, immediately above the joint. An incision 2 to 2½ inches long on the outer border of the tendon of the tibialis anticus, and immediately above the anterior annular ligament, is to be carried through the deep fascia, so as to expose the tendon. To its outer side will be seen the tendon of the extensor proprius pollicis, which is drawn outwards with a hook, when in the interval between the two, the anterior vessels and nerve will be seen lying upon the tibia.

MORTIFICATION, OR GANGRENE.

Traumatic Gangrene. — Cheyne thus sums up the pathology of gangrene after operations and injuries*—"First, it may result from direct destruction of the tissue at the time of injury, from injury to large blood-vessels, &c. Second, it may occur as the result of inflammation in a weak part. In this case the inflammation is set up by the growth of micro-organisms in the discharge or tissues of the wound, or by tension in the wound. Third, it occurs as the result of growth of bacteria in the tissues seen in phagedæna and traumatic gangrene."

In traumatic gangrene, or that induced by local causes, the parts may be so injured that they are killed outright, or their vitality may be so weakened that they cannot recover themselves, as in the case of severe bruises, laceration, wound of the main artery or vein of a limb interfering with the circulation, which frequently happens in gun-shot fractures when splinters of bone or the missile wound the artery, or in punctured or incised wounds of a large vessel allowing of extravasation. It has also happened from a bandage being applied too tightly.

The parts killed outright by the force of the injury, or so weakened thereby as to have their vitality seriously impaired, are, if exposed to septic influences, readily preyed upon by micro-organisms of a *saprophytic* or *pathogenic* character; if the parasitic bodies are of the former class, possibly only those parts originally killed outright mortify or undergo putrefactive fermentation; whereas, if the parasites include the latter class, the gangrenous process will show a disposition to spread among the damaged tissues.

Treatment.—In cases of injury the extent of the gangrene can be most materially modified by careful antiseptic treatment from the first. For it should be remembered that the cause of the gangrenous process is a living agency; therefore the treatment should consist of such chemical applications as are known to prevent or limit its growth (*e.g.*, corrosive sublimate lotion, iodoform, &c.), whereas poultices and water-dressing encourage and foster the morbific agency, and so, of course, tend to increase and spread the gangrene. In doubtful cases, or in cases of gangrene resulting from a wound of the main vessels, from compound fracture, or from any local cause, such as obstruction of the artery or vein (*distant gangrene*), the rule laid down by the older surgeons was to wait for the line of separation before the parts were removed by amputation, but whilst acting on this rule we should be doing all in our power to limit the gangrene as much as possible. The result of amputation for traumatic gangrene is, on the whole, unfavourable, the disease frequently recurring in the stump; in those cases where the tissues are already infiltrated or disorganised the prospects from amputation are still more unfavourable. The strength of the patient should be maintained by nutritious diet, wine, tonics of mineral acids, quinine, &c., aided by opium.

* *Antiseptic Treatment of Wounds*, p. 22.

Mr. Cripps writes—"In the treatment of local traumatic gangrene resulting solely from severe injury, the parts should be removed so soon as there are unmistakable signs of its death, the point of operation being selected as near the injured part as sound tissue can be obtained. But where the cause is due to defective power in the general circulation, consequent on a weak or diseased heart, with venous thrombosis, there can be no doubt that an immediate operation can be of no benefit to the patient, in as much as it can neither increase the power of the heart nor clear the obstructed vein, while the shock of the amputation and loss of blood may still further depress the patient's vital powers."

"The question of amputation from spreading traumatic gangrene, the result of inflammation is more complicated. The operation will cut off the supply of the infecting material, and the general experience of surgeons is almost universally in favour of amputation, and if this be performed well above the gangrenous part as soon as the disease is recognised, and the stump protected by every antiseptic precaution against new infection, the patient will have a fair chance of recovery."*

Mr. Guthrie gives two or three examples of the practice in extreme cases :† "A soldier is wounded by a musket-ball at the upper part of the middle third of the thigh, and on the third day the great toe has become of a tallowy colour, and has lost its life: what is to be done? Wait, with the hope that the mortification will not extend."

"Suppose that the approaching mortification has not been observed until it has invaded the instep; what is to be done? Wait, provided there are no constitutional symptoms; but if they should be present, or the discoloration of the skin should appear to spread, amputation should be performed forthwith, for such cases rarely escape with life if it be not done. Where in such a case should the amputation be performed? I formerly recommended that it should be done at the part injured in the thigh. I do not now advise it to be done there at an early period, when the foot only is implicated; but immediately below the knee, at that part where, if mortification ever stops, and the patient survives, it is usually arrested; for the knee is by this means saved, and the great danger attendant on an amputation at the upper third of the thigh is avoided. When from some cause or other amputation has not been performed, and the mortification has stopped below the knee, it is recommended to amputate above the knee after a line of separation has formed between the dead and the living. This should not be done. The amputation should be performed in the dead parts, just below the line of separation, in the most cautious and gentle manner possible; the mortified parts which remain being allowed to separate by the efforts of nature."

Gangrene from Frost-bite and Severe Burns.—Erichsen lays down the principle that there are two exceptions to the rule of amputating in traumatic gangrene before the occurrence of the line of demarcation, viz., gangrene from frost-bite, and that from severe burns. During the severe winter of 1854, when the allied armies were before Sevastopol,

* Holmes' *System of Surgery*, vol. i., Art. "Gangrene."
† Guthrie's *Commentaries*, p. 25.

Porter witnessed several cases of gangrene of the feet from exposure, both in camp and in the trenches. Those who were attacked by the disease in the trenches had their feet first wet by the mud and constant rain, when frost suddenly set in, and in consequence of the impossibility of moving about, the circulation became arrested. Those who were attacked in camp found their feet numb and helpless on rising in the morning, having lain down on damp ground without removing their wet socks or boots, the result frequently being loss of both feet.

The treatment adopted was to control the fever of reaction, support the constitution, and allow the dead portions to separate from the living, assisting them by the means already described in gangrene from laceration or bruises, and subsequently detaching with great care such parts as were disorganised. This gangrene may, to a certain extent, have been brought about by a scorbutic taint, as the ulcers which remained were most difficult to heal.

Acute Spreading Gangrene.*—Cheyne says†—"All the facts point to the spread of micro-organisms in the tissues as the cause of acute spreading gangrene and phagedæna. This is a most acute and fatal form of infective inflammation, following punctured, contused, or lacerated wounds, particularly when complicated with bone or joint injuries, and where there are facilities for the retention of putrid blood and discharge in the recesses of the wound."

The causes are believed to be the presence of micro-organisms which have gained access to the subcutaneous connective tissue through the wound. They spread with great rapidity, producing as they grow ptomaines or tox-albumins, which destroy the tissues by their direct destructive chemical action on the protoplasm of the tissue cells. The symptoms as described by Mr. Marcus Beck, are, at first, those of ordinary septic inflammation, the result of pent-up decomposing discharges. There is febrile disturbance of the septic type, there are pain and swelling in the wound, with a blush of redness extending for some distance on each side of it. The swelling, redness, and tension spread upwards and are speedily followed by a dusky purplish tint, by a soft doughy feeling of the part. This is accompanied by emphysematous crackling due to the presence of gases in the decomposing connective tissue. That portion of the limb which is below the gangrenous part becomes pale, cold, and œdematous. The portion which is above becomes rapidly infiltrated by serous exudation. The process has no tendency to limit itself; the œdema and peculiar discoloration extend higher along the inner side of the limb, where they always first reach the trunk. As the gangrene advances, the parts affected fall into a soft pulpy black mass. It will be observed that the disease extends through the connective tissue, the skin falling secondarily into slough. The constitutional symptoms early assume the character of acute septic poisoning, the patient sinking into a prostrate condition and the temperature falling below normal.

Treatment.—It is of no use to wait for a line of demarcation. Erichsen

* For report of a case see *A. M. D. Report for* 1886, Appendix X., page 352.
† "*Antiseptic Treatment of Wounds.*

says—"Amputation should be performed at once. The only chance of safety lies in operating early, and removing the limb high above the part affected." Cripps writes—"Of course, if the sufferer be obviously dying of general infection of the system, it is too late for any operation to be undertaken; but, if the patient be not in a state of collapse, amputation is imperatively demanded, and the chance of recovery depends upon the promptitude with which the operation is performed after the nature of the disease is recognised."

In any operation that is undertaken in this class of cases, the operator must take great care not to wound his own finger in its performance.

Idiopathic Gangrene, or that induced by constitutional causes, such as disease of the heart or arteries, diabetes or Bright's disease, requires notice. The dead part should be wrapped in some dry absorbent dressing, as iodoform gauze, boric, carbolised or mercurialised wool, &c. Cripps writes "that the best treatment in these cases is, that so soon as the thickness of the limb is clearly dead, and the line of demarcation formed, the offensive member should be removed, not by cutting through the living tissues, but by carefully separating the dead as high as practicable, without interfering with the living parts."

It should be borne in mind that dead portions of tissue, if preserved from septic agency, are not necessarily separated *en masse* from the living body but are gradually absorbed.—*Lister.*

Bed sores (a form of gangrene from pressure which but too frequently comes under the notice of the army surgeon) arise from patients being obliged to lie for lengthened periods in the same position, after having undergone operations; or in the treatment of fractures of the lower extremities, probably without proper bedding, cleanliness, nursing, or fresh air; or in patients already debilitated from exposure and want of proper nourishment; and from injury to the spinal cord and other parts of the nervous system.

These sores generally appear on the sacrum, the trochanters, elbows, shoulders, heels, and back of the head.

The surgeon should ever be on the watch for them, as, in very weak subjects, they give but little warning of their approach or presence.

When there is a probability of long confinement, and the case is likely to be attended with constant decubitus, every precaution should be adopted, such as keeping the parts dry, the bedclothes smooth, and pillows arranged from time to time so as to prevent pressure on any particular spot.

Water and air beds may be used with great advantage, but in warm climates they are heating.

The skin may be hardened by the application of brandy, rectified spirits, solution of alum, tannin, tincture of iodine, collodion, or of bichloride of mercury composed of 2 grains to 1 ounce of spirits of wine.

When bed sores do occur, removal of pressure must be carried out by some means, which, on service in the field, requires ingenuity, as the usual mechanical contrivances found in permanent hospitals may not be present.

A sling for the more convenient treatment of bed sores was designed

by Porter and used with advantage in cases where the sacrum and nates were severely implicated ; it may be applied in camp or in permanent hospitals.

The sling consists of a strip of West of England canvas, 18 by 24 inches. At either end it is stitched on two pieces of strong wood about the diameter of the common office-ruler, which keeps the canvas expanded when under the patient, and forms a means of fastening the stays, which are spliced together and attached to 3-inch blocks. These blocks have ropes passing through them and through blocks of the same size attached to poles or uprights (fig. 126), by which means the sling can be raised or

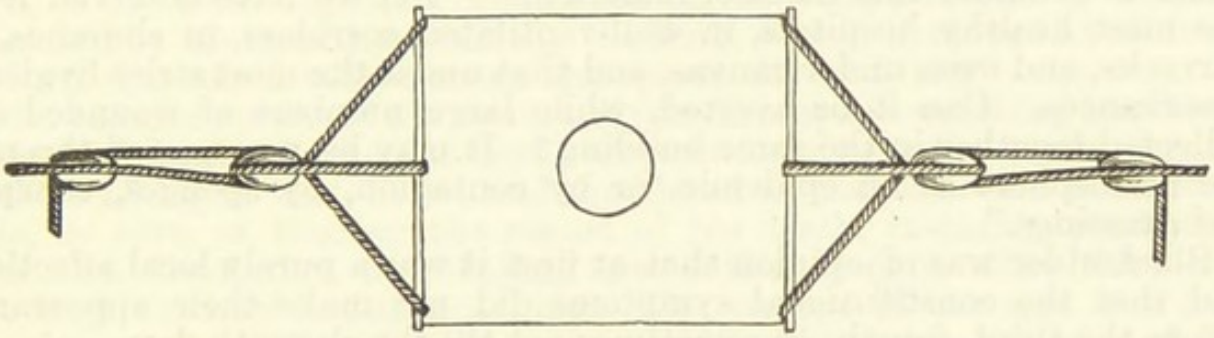

Fig. 126.

lowered. A piece of canvas, round in shape, and 4 inches in diameter, is removed from the centre of the sling, through which the sores can be dressed or cleaned. In applying the sling, it is necessary to place a mattress doubled at one end under the patient's shoulders, the thin end extending to the loins. A pillow should be placed under the knees, and, except for dressing the sores, the patient should not be raised more than 1 inch off the bed.

For local application, numerous remedies have been recommended. Cleanliness should be the first consideration, and the removal of sloughs if any exist.

Equal parts of castor-oil and balsam copaiba may be applied. Balsam of Peru, either pure or diluted with the yolk of egg, spread on lint, or spirits and glycerine, are useful. Salicylic or boric acid ointment have been found useful spread on very thin linen, and warm astringent applications, such as the tincture of catechu, myrrh, iodine, and the resin ointment, have been spoken highly of.

The health of the patient must be carefully attended to, as, without improvement in it, the sores will not heal.

HOSPITAL GANGRENE.

"Putrid Ulcer," "Phagedæna Gangrenosa," "Sloughing Phagedæna," "Pourriture d'Hôpital."

Forms of Hospital Gangrene.—Delpech describes three forms, the ulcerative, the pulpous, and the gangrenous.

It is thus defined by Erichsen—"A rapidly spreading gangrenous inflammation attacking recent or granulating wounds. The gangrene follows closely on the inflammation, the dead tissue forming a pulpy adherent slough. There is febrile disturbance, but no specific infection of the whole system. It is associated with the growth of micrococci, and is intensely contagious."

Hennen* attributed hospital gangrene to bad air, want of cleanliness and ventilation, also to intemperance. Guthrie said "It originates only in badly-ventilated hospitals, crowded with wounded men, among and around whom cleanliness has not been too well observed."

Legouest, after pointing out the usual unsanitary conditions which were liable to promote this disease, remarked—"Yet we have observed it in the most healthy hospitals, in well-ventilated corridors, in churches, in barracks, and even under canvas, and that under the most strict hygienic observances. Can it be averted, while large numbers of wounded are collected together in the same building? It may be propagated through the atmosphere as an epidemic, or by contagion, by sponges, charpie, and dressings."

Blackadder was of opinion that at first it was a purely local affection, and that the constitutional symptoms did not make their appearance before the third, fourth, or sometimes not till the eleventh day.

Hennen described the disease, as it occurred at Bilbao, in the following words*—"Let us suppose that our wounded have all been going on well for several days, when suddenly one of our most promising patients complains of severe pain in the head and eyes, a particular tightness about the forehead, want of sleep, and loss of appetite, and that these feelings are accompanied with quickness of pulse and other symptoms of fever; his wound, which had been healthy and granulating, at once becomes tumid, dry, and painful, losing its florid colour, and assuming a dry and glassy coat. This is a description of the first stage of our Bilbao hospital gangrene; and if a brisk emetic was now exhibited, a surgeon not aware of the disease that was about to form, would be astonished at the amelioration of the sore, and the unusual quantity of bile and indigested matter evacuated by vomiting. If, however, this incipient stage was overlooked, the febrile symptoms very soon became aggravated; the skin around the sore assumed a highly florid colour, which shortly became darker, then bluish, and at last black, with a disposition to vesicate, while the rest of the limb betrayed a tendency to œdema. All these threatening appearances occurred within twenty-four hours; and at this period also the wound, particularly if it was situated on a muscular part of the thigh, buttock, or calf of the leg, whatever might have been its original shape, soon assumed the Circular Form. The sore now acquired hard, prominent, ragged edges, giving it a cup-like appearance, with particular points of the lip of a dirty-yellow hue, while the bottom of the cavity was lined with a flabby blackish slough.

"This rapid progress and circular form of the ulcer were highly characteristic of hospital gangrene, and obtained almost universally, in every wound infected with it, wherever situated.

* *Observations on Military Surgery.*

"The gangrene still advancing, fresh sloughs were rapidly formed, the increasing cup-like cavity was filled up and overtopped by them, and the erysipelatous livor and vesication of the surrounding skin gained ground, while chains of inflamed lymphatics could be traced from the sores to the adjoining glands, these exciting inflammation and suppuration, which often furnished a new nidus for gangrene. The face of the sufferer assumed a ghastly, anxious appearance; his eyes became haggard, and deeply tinged with bile, his tongue loaded with a brown or blackish fur, his appetite entirely failed him, and his pulse was considerably sunk in strength, and proportionally accelerated. In this stage the weakness and irritability of the patient was such, that the slightest change of posture, or the most delicate examination of the sore, put him to torture, increased by his inability to steady the limb, which, if moved at all from the bed, was seized with tremors and spasmodic twitches."

Mr. Hennen speaks of the torture of this disease as something terrible—"Men," he says, "who had borne amputation without a groan, shrunk at the washing of their sores, and shuddered at the sight of a dead comrade, or even on hearing the report of his death, instantly predicting their own dissolution, and sinking into sullen despair. The third and last stage was now fast approaching. The surface of the sore was constantly covered with a bloody oozing, and, on lifting up the edge of the flabby slough, the probe was tinged with dark-coloured grumous blood, with which also its track became immediately filled; repeated and copious venous bleedings now came on, which rapidly sunk the patient; the sloughs, whether falling off spontaneously, or detached by art, were quickly succeeded by others, and discovered on their removal small thickly studded specks of arterial blood. At length an artery sprung, which, in the attempt to secure it, most probably burst under the ligature. Incessant retchings soon came on, and, with coma, involuntary stools, and hiccup, closed the scene. Often, however, the patient survived this acute state of the disease, and sunk under severe irritation, absorption of putrid matter, and extensive loss of substance, without any other symptoms than those of hectic fever, arising from other sources."

The muscles may become extensively exposed or destroyed, leaving a cavity with tendons, vessels, and nerves stretched across from side to side. The bones sometimes become denuded of periosteum, or are attacked with the disease.

Blackadder, who recorded the disease as it appeared in himself, said it commenced with local symptoms. He wounded himself accidentally with a scalpel. In the course of about sixty hours the wound became inflamed, and he was occasionally attracted to it by a smart, stinging sensation, which ultimately extended a considerable way up the arm. On the fourth day the inflammation had increased, and the stinging sensation was almost constant; headache, nausea, and general indisposition followed, with frequent chills, which increased very much towards evening, but which, with other symptoms, were considerably relieved by the use of neutral salts, the pediluvium, and warm diluents. A vesicle, having a depression in its centre, and having a watery fluid of a livid colour, was now forming upon a hard and elevated base; the

surrounding integuments became tumefied, of an anserine appearance, and extremely sensitive to the touch; at about the distance of the fourth of an inch from the base of the tumour, a distinct areola of a bluish-red colour made its appearance, and remained visible for several days. At this period circumstances rendered it necessary for him to be exposed to wet, to undergo considerable fatigue, and immediately afterwards to travel to a considerable distance. The inflammation, however, gradually subsided, but the stinging, accompanied by the burning sensation, still continued; and the sore had no disposition to heal, yet it did not enlarge externally, but was disposed to burrow under the integuments.

Mr. Taylor, late of H. B. M. 29th Regiment, experienced an epidemic at Ferozepore, in India. He remarks—"First, I could tell, by the peculiar dark florid countenance of the patient, that his wound had taken on the gangrenous affection; yet I cannot say that there was in these cases any marked inflammatory fever. In many cases the disease seemed purely local; but in the great majority there was certainly much feverish constitutional disturbance accompanying the local affection, and often preceding it."

The causes of this disease are, then, associated with the growth of micrococci in the wound; consequently, it is highly contagious, and, therefore, aggravated by overcrowding of patients. Experience has shown that when once a building has been contaminated with this disease it will be dangerous to place in it any wounded men; the building ought to be vacated.

There is no doubt as to its highly contagious and infectious character, that it is capable of being transmitted by nurses, clothing, dressings, instruments, sponges, and by atmospheric dust; that it attacks wounds in every stage and condition; that it can be inoculated; that it is generally aggravated by overcrowding of wounded, bad ventilation, want of cleanliness, privation, intemperance, and previous exposure, but that there are occasions when it occurs in the form of an epidemic, notwithstanding the most rigid and careful sanitary regulations; that it appears in all climates, in all seasons and weather, the wet and moist or very cold being most favourable to its production; and, finally, that there may be predisposing causes, such as patients having a scorbutic taint, an enfeebled constitution, or a nervous system depressed by the effects of a severe operation.

The symptoms in every feature of the disease have been so well described by Hennen, Blackadder, and Taylor, in the foregoing remarks, that it is not necessary to repeat them.

With regard to the treatment of this formidable disease, no specific has as yet been laid down for its cure, but each medical officer who has had the misfortune to meet with it has recommended such treatment as he found most successful.

The first consideration of the surgeon will be to try and prevent a further spread of the disease, by removal of the infected patient from among the other wounded, and by prophylactic measures, such as the use of antiseptics, plenty of fresh air, strict sanitary arrangements in and about the hospital buildings, destruction by fire of all dressings, the

total disuse of sponges, cleanliness among the patients, attendants, clothing, and bedding, *evacuation of infected buildings*, and fumigation of them.

The sufferer will have to be considered with respect to local and constitutional symptoms. For the former, the careful and strict use of the most potent antiseptics such as corrosive sublimate lotion, iodoform, &c., is required, but if these should fail then all sloughs should be removed as far as possible, and an anæsthetic having been administered, the parts should be thoroughly swabbed out by a caustic such as nitric acid, acid nitrate of mercury, pure carbolic acid, chloride of zinc, &c.

Professor von Nussbaum, of Munich, testifies as to the great benefit to be derived from practising Lister's antiseptic dressings in the treatment of this affection. He writes—"Hospital gangrene had got the upper hand to such an extent that 80 per cent. of all wounds and ulcers were attacked, and after five years' experience he states that any recent wound treated by this method is guaranteed against pyæmia, hospital gangrene, erysipelas, &c."—*Cheyne.**

Professor Volkmann, of Halle, gives a similar experience, he had an unhealthy hospital, yet upon adopting Listerian dressings, infective diseases which were attacking every patient disappeared at once.—*Cheyne.*

Blackadder recommends the use of Fowler's solution of arsenic as an escharotic; he found that it answered well in arresting the progress of the disease at Passages and at Antwerp.

Constitutional Treatment will consist in giving whatever food and stimulants the patient can take and digest, combined with quinine, opium, ammonia, &c.

ERYSIPELAS.

Erysipelas belongs to the infective class of disease. It frequently attacks sick and wounded in civil and military hospitals, it is undoubtedly contagious. Fehleisen says† it is due to the growth of micro-organisms in the tissues which he named the streptococcus erysipelatosus; the streptococci extend into the lymph spaces and canals of the skin, and he has produced erysipelas in man by the inoculation of the cultivated specimens of streptococci, but has never been able to discover them in the blood-vessels in true erysipelas. He denies that the streptococcus of erysipelas possesses pyogenic properties; but when suppuration takes place, as in phlegmonous erysipelas, it is due to the presence of another pyogenic streptococcus.

Infection most frequently occurs through accidental or intentional wounds, however insignificant they may be. Experiments have shown that the time of incubation is from fifteen to sixty-one hours. Infection may also take place through a mucous surface as well as through the skin.

Erysipelas has generally been arranged in three divisions—"(1) The

* *Antiseptic Surgery.*

† "Micro-Parasites in Disease," *New Sydenham Society*, 1886.

cutaneous; (2) the cellulo-cutaneous, or phlegmonous; and (3) the cellulitis or diffuse inflammation of the connective tissue," which Fehleisen says is not erysipelas.

The first, or **cutaneous**, is known by redness of the skin, which disappears momentarily on pressure, with severe burning or smarting pains, and swelling from effusion into the cellular tissue. The intensity of the redness, which is the characteristic symptom of this disease, will depend very much upon the state of health of the patient, as in debilitated subjects it takes on more of a yellowish tint. In this form miliary vesicles, or large blebs, may appear about the third day, when they break and crust.

The constitutional symptoms of idiopathic erysipelas, caused by the absorption into the blood of ptomaines, are thus described by Fehleisen—"An initial shivering, the characteristic sharply-defined redness, the more or less rapid spreading on the surface (the so-called migration of the rose), the progress of the fever, and finally terminating in resolution, and healing without suppuration or abscess, confirm the diagnosis of true erysipelas." Traumatic erysipelas is of a more serious nature, and if there is a wound or granulating surface, it takes on an unhealthy action; the edges or surface become flabby, and covered with thin serum, instead of healthy pus; granulations become pale and more or less absorbed, or the wound may become dry and the edges swollen; and when there is a tendency in a wound to unite, the adhesions give way. On the other hand, an attack of erysipelas has sometimes a distinct therapeutic effect upon wounds and tumours.

In the second, or **cellulo-cutaneous** or **phlegmonous**, the redness is deeper, sometimes even dusky or purple; inflammation extends deeper into the tissues, and, if neglected, will terminate in diffuse suppuration or sloughing of them, extending even to the intermuscular septa, the sheaths of the vessels and tendons, or the tendons themselves; the swelling is much greater, is hard and brawny, pitting on pressure; the pain is severe and throbbing.

The constitutional symptoms, due also to absorption of ptomaines, as in the cutaneous form, but more intensified, will, however, soon assume a typhoid character if the patient is weak and has been subjected to much privation and exposure; but, if under the influence of proper treatment, and the patient is strong, the inflammation will subside and the disease will gradually disappear.

In the so-called third kind, a **cellulitis** or **diffuse inflammation**, the disease affects the connective tissue primarily, and the skin secondarily. It is characteristic by the same local and constitutional signs and symptoms as phlegmonous erysipelas, but more intense. As the disease advances, the skin becomes mottled, livid in patches, and rapidly runs into blackish sloughs. It may extend to any distance up a limb, and even invade the trunk; it will also affect the sheaths of the vessels and tendons, and the tendons themselves. The joints may also become involved, and bones be denuded of periosteum and become necrosed.

The treatment which should be adopted in the first form must be, to clear out the stomach and bowels by an ipecacuanha emetic and

mercurial purge. Then the condition of the patient as regards constitution, age, and previous habits will be the best guide. Should he be young and robust, spare diet and diaphoretics, with the local application of warm carbolised or mercurial lotions, will be sufficient; but in men who have been exposed to privations, or who may be debilitated from any cause, when the disease assumes a lower type, ammonia, bark, camphor, tincture of the sesquichloride of iron, wine, and nutritious diet should be administered. The tincture of iron and also of quinine have been found most beneficial, acting speedily.

In the milder forms, nothing cold should be applied. The part may be dusted with flour, starch-powder or peat-powder, and then covered up with cotton wool. Often hot fomentations of chamomile or poppy-heads will soothe the irritation that exists. Erichsen says—"At University College Hospital, the treatment recommended by Valette, of Lyons, has been tried in several cases with very good results. A 30 per cent. solution of perchloride of iron is prepared (roughly ʒi of solid perchloride to ʒiv of water), forty minims of this solution may be given internally every two or three hours, and externally the pure solution is applied to the inflamed area. Valette insists that this must be done thoroughly, the solution must not merely be painted on, it must be rubbed in with a piece of lint or cotton wool. The application is repeated twice a day as long as it is necessary."

Dr. Behrend, of Sarga, recommends washing the parts affected with absolute alcohol three times a day. He says the progress of the disease is at once arrested.*

Dr. Ebstein, of Breslau, advocates inunction with a 5 per cent. carbolic vaseline.*

In the cellulo-cutaneous form, the object is to prevent the inflammation running into a state of gangrene; for this purpose purgatives and diaphoretics should be administered in the first instance. If the disease advance to suppuration or gangrene, it will be necessary to support the patient by tonics, stimulants, and generous diet. The parts should be kept at rest and elevated. Fomentations, with chamomile or poppy-head applications, may soothe the disease, but if it become brawny, indurated, and tense, and likely to advance to suppuration and gangrene, incisions should be made to relieve the tension—several small ones being preferable to one long one. The wounds should be dressed antiseptically with warm wet antiseptic lint covered with waterproof. The parts having first been sprinkled with iodoform, the limb should be raised, and a smooth bandage applied firmly but evenly to assist the circulation in the weakened tissues, but iodoform cannot be relied upon alone, carbolic or sublimate lotion should be used in addition.

Burrowing of pus under the skin must be prevented by following up sinuses and dividing unhealthy vascular connections. Tissues in a state of slough or gangrene will have to be gently removed, as their presence may produce most serious consequences by their decomposed condition.

In the treatment of cellulitis, support may be required from the first. The local treatment is the same as in phlegmonous erysipelas.

* *Year Book*, 1890.

The after-consequences of the cellulo-cutaneous form and cellulitis may be most troublesome, if the inflammation has extended to the sheaths of the tendons and the tendons themselves. There may be stiffness of joints and contraction of the fingers, wrist, elbow, and knee, where the tendons become so completely matted together that the motions may be seriously impaired, if not destroyed, or the joints and bones may be so diseased as to require amputation of the limb.

The army surgeon is most likely to meet with diffuse inflammation after shell wounds, or in wounds from splinters of wood. Soldiers doing duty in the supply departments, and employed in the slaughtering of animals, are very liable to the disease.

On the first appearance of erysipelas, the infected individual should be removed from the vicinity of the sick or wounded or, better still, the sick or wounded should be removed from the vicinity of the erysipelas; the latter in most cases being utterly impracticable, all that the surgeon can do is to isolate the sufferer and prevent all communication between him and the other patients, hygienic measures being at the same time enforced.

PHLEBITIS.

Inflammation of the veins may be divided into two kinds—idiopathic and traumatic.

The **idiopathic** form as a primary affection is rare, it is usually connected with thrombosis, and is met with in gouty subjects and after fevers, and is found most frequently in the long saphenous vein, but occasionally in the deeper veins.

"Traumatic phlebitis," Erichsen says, "may be simple and local, or septic and spreading. The coats of a vein in the same way as any other tissue become inflamed, if submitted to any injury of sufficient intensity, whether it be the application of a ligature in a surgical operation, accidental mechanical violence, or the action of caustics. As the result of an injury, a clot forms within the vein, and ultimately may become absorbed, or the vessel may become obliterated. But, if the discharges of a wound are in a septic condition, the thrombus in the plugged vein may become infected with micro-organisms. It then softens and decomposes, and thus excites inflammation in the coats of the vein spreading beyond the part originally injured. Portions of the softened clot are washed on giving rise to dissemination of septic emboli and pyæmia. It is this that has been mistaken for the spreading inflammation of the vein as the primary affection, and led the earlier pathologists to associate phlebitis with pyæmia."

Diffuse septic inflammation in the connective tissue may also involve the coats of the veins in the infected area.

The Symptoms.—An enlargement of the vein, which becomes hard, swollen, painful, and knobbed, having a reddish-purple colour; stiffness, and severe twitches through the limb, with hard, tense feel, and pitting on pressure, from the state of œdema. Much stress has been laid on this latter symptom by some authorities as a diagnostic sign in deep-

seated thrombosis, when the vein cannot be felt, and may be the first symptom noticed. "The œdema may give rise to a hard, white, and tense condition of the limb, which pits on pressure, though in some cases the hardness is too great for this."

These symptoms may be relieved by the clot becoming absorbed under suitable treatment; but should the disease become septic, there will be high fever, shivering, and the usual symptoms denoting that suppuration has taken place, or is about to do so.

The treatment of the idiopathic variety will consist in most perfect rest; warm applications, such as fomentations, &c., and when the patient can bear it, the administration of saline purgatives. Erichsen highly praises the application of extract of belladonna and glycerine in equal parts, covered by a thick layer of cotton wool and a bandage, but care should be taken not to disturb, irritate, or break the thrombosis. If there is depression, it will be necessary to administer ammonia, bark, and stimulants.

In suppurative phlebitis local abscesses may form, which run their course like other abscesses, and are bound and limited by inflammation, so preventing their contents entering the vessels, and mingling with the current of the blood; they should be opened under antiseptic precautions, and the patient will require all the sustaining that is possible by food, wine, and medicine. It is generally pyæmic in character, and commences as an ordinary case of inflammation of the veins, but soon takes on alarming symptoms, characterised by extreme prostration, dry brown tongue, fluttering pulse, sordes on the teeth and mouth, diarrhœa, delirium, and death.

Such a case would require the same line of treatment as that recommended for erysipelas of the worst form, or pyæmia.

SEPTICÆMIA.

True sepsis is looked upon as a general infection from some local source, unattended by any gross pathological changes. Septicæmia is used to express a condition that may arise from two different causes—(1) True progressive septicæmia, caused by the introduction of microbes into the tissues, where they multiply, and later reach the blood. (2) Sapræmia, putrid intoxication, in which few or no microbes are found in the blood, and in which death is due entirely to the presence of ptomaines.*

Septic Intoxication or **Sapræmia** is a condition which may occur whenever the discharges from a wound are allowed to accumulate in sufficient quantity and to decompose. It is now thought that the fever accompanying large recent wounds, in which decomposing matter is in contact with the raw surface, is in great part or entirely due to the absorption of the poisonous chemical products, *tox-albumins*, of the putrefaction, and that this fever continues until the surface becomes covered by healthy granulation tissue, which is believed to prevent further absorption,

* *Surgical Bacteriology*, Senn.

unless the septic fluids are pent up in contact with it at some degree of pressure. The condition necessary for its rapid absorption would be found in all recent wounds, the raw surfaces of which, before they are covered by healthy granulation tissue, form one of the most active absorbing surfaces conceivable. The poison does not multiply in the body, and, according to Koch, no organisms are found in the blood of animals suffering from septic intoxication. "This form of sepsis may be caused by any microbes, otherwise harmless, or only with slight pathogenic properties, as the bacilli of putrefaction, which cause putrefaction in any dead tissue and the symptoms arise as the ptomaines are absorbed, and are *proportionate* to the amount absorbed and subside with the cessation of absorption and their elimination through some of the excretory organs."* The term *septic intoxication* is used to express the condition when a sufficient quantity of the poison has been absorbed within a few days of the injury or operation to endanger life. The milder effects of the same poison are classed as *traumatic fever*, and the continued absorption of small quantities over a long period produces the condition termed *septicæmia*.

Septicæmia is also applied to the condition due to *septic infection*, as distinct from septic poisoning. This is a true infective process, started in the organism by the introduction through a wound of some pathogenic micro-organisms which multiply in the body, and produce effects which are *not* directly proportional to the dose.

Cheyne writes†—"Continued absorption of the poisonous material from wounds will keep up a feverish state, with all the symptoms of septicæmia. In other cases micrococci grow in the tissues of the wounds, and pour their products or ptomaines into the blood. Here micrococci may be found in the blood, but the essential seat of disease is in the tissues. In a third form, micrococci grow in the blood, and multiplying there give rise to the symptoms. In a fourth form, organisms grow in the blood, but they belong to the class bacilli."

"The symptoms of septic poisoning and septic infection are very similar, and difficult, if not impossible, to distinguish clinically, a chill or rigor on the second day, followed by feverishness, headache, loss of appetite, a quick pulse, a dry furred tongue, and delirium at night. On the third day after the injury, some disturbance of the alimentary tract sets in, vomiting is common, but diarrhœa is not frequent. In very acute cases symptoms of collapse quickly set in, the pulse becomes rapid, feeble, and irregular, the tongue dry and brown, and the lips covered with sordes; the temperature falls, consciousness is lost, and the patient may become comatose before death. Dyspnœa is a common symptom during the last day. The skin may assume a yellowish tint and purpuric spots appear, and the body evolve a sickly odour. The urine sometimes contains albumen."

"**Post-mortem Appearances.**—In extremely acute cases the signs of decomposition set in early, and the cutaneous veins mark the surface. Rigor mortis is often fully marked, the blood is often imperfectly coagu-

* *Surgical Bacteriology*, Senn.

† *Antiseptic Treatment of Wounds*, p. 23.

lated, with visceral congestion, subserous petechiæ, early and intense *post-mortem* staining, and usually a swollen and softened spleen. In some cases there is pneumonic consolidation of the lung, and there may be pleurisy, with blood-stained effusion."—*Erichsen.**

Treatment.—Locally thorough antiseptic treatment of the wound, plenty of fresh air, and everything that could sustain and strengthen the flagging powers, as wine, brandy, quinine, &c.

PYÆMIA.

The science of bacteriology has quite demonstrated that pyæmia can no longer be considered a specific disease. It has been shown that in pyæmic products one or more kinds of the pyogenic cocci are always present, thus establishing the direct relationship between a suppurating process in some parts of the body and the development of metastatic or pyæmic abscesses. Pyæmia, then, depends upon an extension of the suppurating process from the primary seat of infection and suppuration in distant organs, by the transportation of emboli infected with pus microbes through the systemic circulation. The distant or metastatic abscesses contain the same microbes as are found in the wound secretions, or the abscess from which the purulent infection took place.

It also has been proved that the introduction of pus microbes into the circulation is not necessarily or even usually followed by pyæmia, if they do gain entrance their pathogenic action is prevented by an adequate resistance on the part of the tissues, and they are effectively disposed of by the leucocytes (*phagocytosis*). If, however, the same number of microbes are present in combination with fragments of a blood-clot or other solid materials which, after they have become impacted in the blood-vessels by embolism, produce such alterations in the tissues surrounding them as to prepare the parts for their pyogenic action. The same happens, if free pus microbes localise in a part the vitality of which has been previously diminished by a trauma, or by antecedent pathological changes which render them weak, and unable to offer sufficient resistance to the growth and development of pathogenic micro-organisms.†

Rosenbach divides the cases of pyæmia into two chief groups. The first is represented by cases which occur in connection with larger or smaller local affections, always, however, of considerable size, such as a suppurating joint or compound fracture, an abscess unopened or imperfectly opened, &c. The main point in these cases is that the general symptoms are maintained by local deposits, which are continuously supplying the body with morbid materials. Here we see the patients pine away and die with hectic fever, and often without any other noteworthy symptom. The second group consist of cases in which there is not necessarily anything worthy the name of a local centre. The infective material often enters through a small puncture, or scratch, or boil, &c. The main point in these cases is that a general pyæmic affection

* Erichsen's *Surgery*. Eighth Edition.
† *Surgical Bacteriology*, Senn.

follows a single, often very transitory infection, without the presence of a permanent local centre.

Surgeon Sandford Moore, 4th Dragoon Guards, who had considerable experience when aiding the sick and wounded during the Franco-German War (1870-71), remarks:—"Pyæmia and hospital gangrene proved as great scourges as ever in the hospitals. It seemed extraordinary how these diseases appeared in some buildings and not in others, although both apparently presented the same conditions for attracting the disease." He also says that the diseases do not occur in hospital buildings until they have been occupied for at least ten days. He has not seen the diseases occur in a room for only one patient unless it was previously occupied by wounded, nor has he seen them occur among patients in the upper stories of a house. A room once poisoned, no disinfection or white-washing seems to be sufficient to drive away the poison immediately, for the remaining patients placed in the room speedily become pyæmic also; and men with slight as well as severe wounds take pyæmia.

"The attack is usually very sudden, coming on generally between the tenth and twentieth days after receipt of injury, and is marked by severe rigor, followed by profuse perspiration, which will in all probability leave the patient apparently well, but will recur in a day or so, producing great depression, the pulse becoming feeble, rapid, or variable, often intermittent, and the temperature high, but is subject to considerable fluctuation. The rigor may be preceded by secondary hæmorrhage, described as parenchymatous hæmorrhage, characterised by general oozing from the surface of the wound or stump.

"The sufferer may be attacked with cough, with or without expectoration, pleurisy, pneumonia, bronchitis, by peritonitis, pericarditis, or effusion in the head; but these complications may be entirely absent, or exist separately. The appetite disappears, the tongue becomes dry and brown, nausea, vomiting, and diarrhœa supervene, the countenance becomes yellow or jaundiced, delirium sets in at night. The temperature is subject to considerable fluctuations of a marked character, and perspirations are still more profuse and exhausting, preceded by severe rigors; abscesses rapidly form in the joints, or among the various tissues of the body; these are of a widely-spread character, and very insidious, as they often occur without any local signs (the pus sometimes infiltrating the cellular tissue and muscles of a trunk to a great extent), and are most frequently met with in the axilla, in the groin, back, iliac fossa, thigh and calf of the leg, giving rise to much suffering and exhaustion, from which the patient rapidly sinks. The disease may be at first mistaken for ague, rheumatism, or typhoid fever, but the continued rigors, followed by profuse perspirations, exhaustion, and suppuration, will soon declare the true nature of the disease."

The prognosis is most unfavourable. The disease is usually fatal, mild cases may recover, but when it is acute, the rigors quickly follow one another: when the pulse is unsteady, the temperature high, and the patient restless, the disease will in all probability prove rapidly fatal.

The treatment consists in giving brandy, wine, ammonia, bark, quinine, and nutritious diet: above all, hygienic measures must be strictly enforced as far as possible, which may be a difficult point to attend to, when the accommodation may be limited, the weather inclement, and no means of preventing overcrowding. The surgeon should keep in view the experience obtained during the war of 1870-71, when it was observed that pyæmia occurred most frequently in permanent buildings; next in frequency in huts, and least of all in tents. Pure air is of the greatest importance, and one must ever remember the remarks of Sir J. Paget, who declares that *the few patients whom he had known to recover from the disease, owed their lives to being kept in a current of fresh air.*

The local treatment will require that free openings of all pus collections under antiseptic precautions must be established and perfect drainage maintained, and every means used by antiseptic applications to destroy and prevent any putrefaction that may have been set up in the wound discharges or the tissues themselves. But the great object must be to prevent this class of disease by such treatment of wounds as has been proved to be able to do so; and at the same time to remember that, in addition to the antiseptic local treatment, the surrounding sanitary conditions are of the first importance.

Operations during Pyæmia.—The opinion given by Sir J. Paget is, that, with acute pyæmia, in which the patient has rigors once or more in a few days, and profuse sweatings with very rapid pulse and breathing, and with delirium, and rapid wasting, or with dry tongue and yellowness of skin, or any considerable number of these symptoms, the probability of good is so small and of harm so great that you should refuse to operate. But if the pyæmia have become chronic, attended with only wasting and sweating and the formation of abscesses here and there, and if the injured part be manifestly useless, or a source of irritation or of exhaustion, the mere existence of pyæmia in the chronic form need not deter the surgeon from the necessary operation.

OSTEO-MYELITIS.

Acute septic inflammation in bone is now considered to be a purulent process due to the presence of some of the pyogenic micro-organisms, and that the rapid diffusion of the process is largely due to the unyielding nature of the tissues: general dissemination and metastatic foci in distant organs, or in other bones, are often observed because the microbes re-enter the circulation again, and by so doing cause thrombosis; and subsequently intravascular growth and general dissemination from such centres of germ growth take place. In some cases, even during the earliest stages, the general symptoms are out of all proportion to the local lesion, presenting a clinical picture characteristic of intense septic intoxication.*

Cheyne says†—"The irritation may be due to organised irritants, such

* *Surgical Bacteriology*, Senn.
† *Antiseptic Surgery.*

as the micrococcus and bacillus, which have the power of growing in the living tissues of the animal body. These organisms having gained access to the wound, may spread until they reach the periosteum or the medulla, and thus set up an acute septic periostitis or osteo-myelitis with acute necrosis, and give rise to pyæmia. The death of the bone may not be confined to the exposed portion, but the suppurative inflammation may extend up beneath the periosteum or in the medulla, giving rise to acute suppurative periostitis or acute osteo-myelitis, in either case leading to the death of large portions of the bone, and very greatly endangering the life of the patient at the time."

It was remarked during the Franco-Prussian War, 1870-71, that gun-shot fractures, owing either to the nature of the missile or to the transport of the patients, were attended in a most remarkable manner by suppurative osteo-myelitis and pyæmia.

The presence of the disease may be suspected when, after an operation or injury, the patient is attacked with shivering, deep-seated pain, and swelling. If it be an amputated bone, the medulla will protrude like a fungus, and the periosteum will be detached from the bone, the soft parts retract, and the bone appear dry and discoloured.

Fayrer says *—"The symptoms in this formidable disease are, in the outset, said to be obscure. The local symptoms, no doubt, may be so when the affected bone is unexposed or undivided. The constitutional symptoms are those of pyæmia, and, at the outset, may be mistaken for a mere access of fever, a rigor such as may follow any surgical operation, or may occur from other causes. But as the local and constitutional symptoms progress, the doubt is soon cleared up. The symptoms, in the acute form, generally make their appearance early (within a week or ten days, or it may be earlier) after the operation, wound, or injury. The stump, wound, or contusion, may have been doing well. It may, perhaps, have sloughed a little, and the sloughs have cleared away, healthy granulations having appeared. The flaps may have united almost by the first intention, or all but at a point or two, whence discharge continues. The pain is not necessarily acute, and the tenderness on pressure of the stump is but slightly increased. The discharge becomes more profuse, but it is not healthy, well-elaborated pus. A probe being introduced, the bone is found dry and denuded, and, if exposed, the medulla will probably be found protruding like a fungus, whilst the periosteum is stripped from the end of the bone. With all this there may have been only a quickened pulse; or a febrile condition at some time of the day, the temperature at others being at, or even below, the natural standard; or rigors, as yet so slight as hardly to have attracted attention, may have occurred. Such are the early stage and symptoms, local and constitutional. These rapidly progress and develop themselves in the most marked manner. And now the critical period has arrived when it is necessary to make a thorough examination, and decide the question whether it be osteo-myelitis or not. Exploration should be made with the finger, the stump, if necessary, being sufficiently reopened to admit of doing so, and the condition of the bone should be

* *Clinical Surgery in India.*

carefully examined and ascertained. In incipient cases the medulla will be found protruding like a fungus, and the bone surrounding it exposed to a greater or lesser extent. At a later period, the end of the medulla is found already blackened and encrusted, but within it is a putrid mass of bone *dèbris* and pus—a probe readily passing down the entire length of the shaft. In the former stage you can wait and watch progress, the mischief may be limited, and a ring of bone be thrown off. But in the latter case immediate interference is necessary, and nothing less than amputation, either at or above the next joint, will suffice. The constitutional symptoms will also have indicated the necessity for interference, and they are the symptoms of *pyœmia* of a marked character."

"The condition of the soft parts must not deceive. It is no uncommon thing to see the dead and putrid bone lying in the midst of perfectly healthy soft parts, and therefore the condition of the bone and the constitutional symptoms must be the guide as to the time and necessity for operation."

M. Jules Roux, in consequence of the fatal results of amputation and resection for this disease, proposed and carried out disarticulation of the injured bone. Of twenty-two cases in which he performed secondary disarticulation of joints for osteo-myelitis, all recovered; whereas every soldier died whose limb was secondarily amputated through the continuity of the injured bone, after the battles of Magenta, Montebello, and Solferino.

Fayrer urges the removal of the limb at the next joint above the affected bone. He says, in the cases of the hip and shoulder, disarticulation, of course, alone is practicable; whereas, in the leg and forearm, the respective advantages of disarticulation at the elbow or knee may fairly be questioned—and he has no hesitation in saying that, except in cases of endemic tendency to osteo-myelitis, section of the humerus or femur, in their lower third, is as good an operation as disarticulation, if not better than the latter. The great point to be attained is the removal of the whole of the suppurating bone. Whenever there is an endemic tendency to osteo-myelitis in a hospital, this disarticulation, though, in itself, inferior as an operation to section of the bone (according to his view in the case of the elbow and knee), should be preferred to amputation through the bone, as the fresh bone-wound might, under the endemic influence, give rise to a fresh attack.

Operative measures should be adopted at an early period, before pyæmic symptoms have commenced to appear, as, once that disease has set in, amputation, disarticulation, or excision are of no avail. It is, however, a difficult point to decide how long amputation may be deferred on the chance of the mischief being limited, and the diseased part thrown off without the constitution being affected.

The constitutional treatment in this disease should be improvement of the system by tonics, wine, nutriment, change of air, and strict attention to hygienic conditions.

ANTHRAX.

"Charbon," "Malignant Pustule," "Contagious Carbuncle," "Wool-sorter's Disease."

A specific contagious disease communicated to man from the disease of horned cattle, horses, sheep and other herbivora, known as splenic fever, and due to the presence in the system of the bacillus anthracis.—*Quain.**

There are three forms of the disease met with in man, the cutaneous, the pulmonary, and the gastro-intestinal.

The *cutaneous* form is caused by direct inoculation on one of the more usually exposed parts of the body, as the face, neck, hand, or arm, and is not uncommon among those who deal with carcases, hair, and hides of animals.

The *pulmonary* and *intestinal* forms are due to infection by means of the atmospheric germ-laden dust which is either breathed, or swallowed in the food and drink by those exposed to its influences. In 1880 there was an outbreak of the disease at Bradford, where it was called "wool-sorter's disease," and the force of the disease fell upon the respiratory organs. In the intestinal form the stress falls upon the gastro-intestinal organs as evidenced by vomiting, pain, colic, and diarrhœa; hence the name "Siberian plague."

The **cutaneous** variety, the charbon or malignant pustule, begins as a small red inflamed and itching spot which in twelve or fifteen hours vesiculates, the skin beneath the vesicle appearing as a dry brown or black slough. In the course of the second day another crop of vesicles appears round the original seat of disease, the parts around become œdematous. In this stage of the disease there is little pain, the slough is always dry *and there is no pus*, the sloughing spreads from the skin down to the subcutaneous tissue instead of as in carbuncle from the latter to the former.†

In cases of charbon the constitutional symptoms may be slight or wanting. But when the general system is involved the symptoms may present great variety, but there is generally great mental depression and physical exhaustion, cold sweats, diarrhœa, followed by delirium and coma.

In **internal anthrax** the symptoms may be general or accompanied by local affections, usually pulmonary or gastro-intestinal, but they are generally such as we connect with extreme prostration, great mental depression and anxiety. The chief *post-mortem* lesions, are scattered hæmorrhages in various organs; diffuse cellular exudations, congestion of lungs, and frequently a swollen and pulpy condition of the spleen.

This disease in all its varieties is due to the presence of the anthrax bacillus in the connective tissue of some part of the body. Koch states that in animals and man the bacillus can enter the organism either

* *Dictionary of Medicine.*

† *The Practice of Surgery*, Bryant.

through the skin, or through the mucous membrane of the gastro-intestinal canal or respiratory passages. This bacillus is destroyed by a temperature of 60° C. and decomposition soon destroys it, but the spores retain their vitality for years and are unaffected by ordinary dangers of climate or temperature.

Treatment.—Charbon, being at its origin local, Bryant says, should be locally treated, and there can be no doubt that excision of the inflamed and vesiculated area is the best practice to adopt even in advanced cases. The bodies of animals which have died from splenic fever should be burnt and not buried, for Pasteur has shown that in cases where infected bodies have been buried, the pasturage over their graves has been directly infected, and thus caused fresh outbreaks of splenic fever owing to the earth worms bringing the bacilli to the surface, and spuming them in their casts over the fresh grass.

M. Pasteur has also proved that sheep can be protected from the ravages of splenic fever (due to anthrax) by the vaccination of them with attenuated tox-albumins caused by the growth of these bacilli in suitable media.

TETANUS.

The infectious nature of tetanus was suspected for a long time, but it is only quite recently that the real microbic cause was discovered almost simultaneously by Nicolaier and Rosenbach. Nicolaier found a bacillus in earth which produced tetanus in animals by inoculation. Rosenbach found a similar bacillus in the pus of a patient suffering from traumatic tetanus. The bacillus has been found in different kinds of soil and in street dust. In man it has been found in tetanic patients in the wound secretions, in the nerves leading from the seat of infection, and in the spinal cord. The question then arises, is the disease of which the bacillus is the specific cause due to the presence of the microbe, or of its products (ptomaines) in the organism? Brieger has demonstrated beyond all doubt that the ptomaines of the bacillus tetani cause tetanic convulsions.*

M. Verneuil traces the infection to horses. This view has received great credit in France. Horse dung seems especially open to suspicion, and thus it is found that ordinary dust, garden earth, and surface soil play an important part in the causation of tetanus.†

There are two varieties of this disease—the idiopathic and traumatic; the former seemingly connected with exposure to cold or damp, particularly if the body has been previously exposed to heat and perspiring; and the latter to some kind of injury, in which exposure to cold may predispose to its attack, as occurred after the battles of Ferozepore and Chillianwallah, when the wounded were exposed during the cold nights, after very hard work during the day in a burning sun. It also occurred in Egypt under the same circumstances, as mentioned by Larrey; and

* *Surgical Bacteriology*, Senn, p. 153.
† *Brit. Med. Jour.*, Oct. 25, 1890, p. 945.

after the battle of Ticondergo, when the wounded were exposed the whole night after the action in open boats upon Lake George.

The symptoms in both are exactly the same, but they may vary in degree.

The experience of army surgeons is, that tetanus may supervene on every description and in every stage of wounds, from the slightest to the most formidable, in the healthy and sloughing, the incised and lacerated, the most simple and the most complicated; in all constitutions; in the strong and robust, and in the feeble and debilitated. It is, however, more apt to occur in debilitated subjects when the nervous system is lowered. It is more common in hot than cold climates. It occurs in all states of the atmosphere, but is most common during sudden changes of the weather.

In temperate climates the disease seldom supervenes before the fourth or fifth day. In hot climates it may appear sooner; but it may take place at any period after the infliction of the injury, even after the wound has cicatrised.

Tetanus may be acute or chronic, the former proving in general rapidly fatal, and the latter continuing for a considerable period. The further the prolongation of the disease, the better are the prospects of recovery.

The disease is generally ushered in by a disturbed state of the digestive organs, with a feeling of *malaise*, a sense of weakness, and general depression; stiffness or soreness about the jaw, face, and neck; inability to swallow food or drink. As the disease advances, there is pain in the pit of the stomach, spasms of the voluntary muscles, the countenance assumes an aged and agonised expression, the angles of the mouth being drawn up (*risus sardonicus*). Cramps and pains will attack the muscles of the legs; difficulty of breathing will set in with a loud sobbing from spasms of the diaphragm. The skin will be hot, the pulse quick, and the perspiration profuse with a pungent odour. The mind in all probability will remain clear, but the sleeplessness will cause much distress.

The muscles of the trunk become affected, the body being sometimes bent back forming an arch (*opisthotonos*), or to one side; or the body may be straight, stiff, and rigid, with the belly drawn in and chest expanded; or the body may be arched forward (*emprosthotonos*). There may be constipation, but the sufferer will have perfect control of the bladder. The voice will be weak from spasmodic contraction of the muscles of the chest and neck.

The temperature generally becomes very high, particularly immediately before death, which occurs from exhaustion.

The sufferer may have short intervals of relief, the spasm being again induced by a slight current of air passing over the body, by taking food or fluids, or by shifting his position or the bed-clothes.

Hennen remarks—"Happy should I be could I afford anything satisfactory on this dreadful complaint; but, in truth, my observations have tended more to show me what I could *not* trust to, than what I could place the smallest reliance on, when the disease was fully formed;" and further on he says—"I have never been fortunate enough to cure a case of Acute Symptomatic Tetanus; in some instances of the Chronic species

I have effected or witnessed relief." Compare these remarks, written fifty-five years ago, with what Mr. Erichsen now says—"Nothing can be more unsatisfactory than the treatment of the acute form of traumatic tetanus. In it all medicines are useless as curative agents; but though medicines are of no avail as means of cure, they may act as palliatives and afford relief to the patient."

The line of treatment must be local, constitutional, and, if we believe in the microbic origin of the disease, thoroughly antiseptic. For this purpose, if there is a wound, it should be most carefully cleansed, and all extraneous substances, such as pieces of clothing, bullets, and splinters of bone, should be removed. If matter is pent up, it must be evacuated; and, if the wound is inflamed, an endeavour should be made to bring it to a healthy state, taking care at the same time to guard against changes of temperature by suitable coverings if the nights are cold.

Section of Nerve.—When tetanic symptoms have been induced by puncture or laceration of a nerve, Larrey recommended that the nerve should be divided, and was successful in the treatment. This expedient has also been adopted by others, and with satisfactory results.

Professor Fayrer, of Calcutta, mentions a case of tetanus caused by a wound of the hand, and relieved by section of the median nerve.

A case of tetanus having occurred, the bowels should first be relieved by a large turpentine enema, after which perfect quietness in a darkened room, free from noise or currents of air, must be insisted upon, as the best means of preventing the approach of spasm. The use of the ice-bag along the spine, as recommended by Todd, has afforded relief in allaying the spinal irritation, but is a great depressant. Chloroform has been extensively used, but without any permanent benefit. Hamilton remarks on this remedy, that "it has been tried very largely during the past few years, and, so far as we can learn, almost universally by our army surgeons, but not with a success which, in our judgment, would warrant its continuance, or, to say the least, its substitution for opium or morphine." After enumerating the various remedies proposed, he goes on to say—"In our opinion, but few of these remedies are entitled to any special confidence; by far the largest mass of testimony having accumulated in favour of nutritious food, tonics, stimulants, and opiates, the latter of which, if employed at all, must be given in the most liberal and persevering manner; in some cases both by the mouth and by the rectum, or by the endermic method."

With regard to sedative and anti-spasmodic agents, Erichsen considers that they are of no use whatever in acute traumatic tetanus. "I have," he says, "seen many drugs of this kind employed without producing any effect in lessening the violence of the convulsions. In most cases, however, the inhalation of chloroform, or the administration of chloral, materially lessens their severity, and gives the patient at least temporary ease."

The Calabar bean has been used of late years with some success, but, like all other medicines, it has failed in many hands. It is a great depressant, and with it large quantities of stimulants as well as beef-tea should be given, so long as the patient can swallow them, if not, by

enemata. The drug should be given frequently until the pupil is completely contracted. Dose, 1 to 3 grains; extract, $\frac{1}{16}$ to $\frac{1}{4}$ grain.

Mr. Wagstaff of St. Thomas's Hospital records a successful case treated by profuse sweating, induced by the hot air-bath persevered in for twenty-three days morning and evening.

The inhalation of nitrate of amyl has been recommended by Dr. W. S. Forbes of Philadelphia; 3 to 5 drops may be inhaled.

Professor Fayrer records two cases of traumatic tetanus treated and cured by opium smoking and internal administration of chloroform and hemp. Both patients were Hindoos. The average quantity of opium-goolie smoked daily by one patient was 84 grains. The chloroform and hemp were administered according to the following prescription:—

℞ Chloroform, ♏ x.
Ext. of hemp, gr. i.
Mucilage, ℥i.
Camphor Mixt. ℥ss. Every six hours.

Stimulants and nourishment appear to give more prospects of success than any other means, and with the use of chloroform to lessen the spasms, perfect rest, quietness, and freedom from currents of air, the sufferer may withstand the exhaustion in the chronic form of the disease. On this line of treatment Sir T. Watson remarks—"In all cases, there being no special indication to the contrary, I should be more disposed to *administer wine in large quantities and nutriment than any particular drug.*"

At the present time, December, 1890, Drs. Behring and Kitasato, of the Berlin Institute of Hygiene, report that they have succeeded in curing animals which have been infected with tetanus or diphtheria. Moreover, by inoculations of an inorganic chemical substance they have succeeded in rendering healthy animals refractory to these diseases. They maintain that the immunity of rabbits and mice from tetanus is due to an alteration in the active property of blood serum, which has the effect of rendering harmless the toxic tetanus-producing substances. They have succeeded in protecting rabbits against living tetanus bacilli, as well as against the tetanus virus. No mouse or rabbit in its natural condition is found refractory to the influence of the tetanus poison.

TUBERCULOSIS.*

At the Berlin International Medical Congress in 1890, Professor Koch, in his address "On Bacteriology and its results," announced that at last he had found "a remedy which is capable of rendering animals experimented on insusceptible to inoculation with the tubercle bacillus, and which arrests the process of tuberculosis in animals already diseased." The remedy does not take effect through the stomach, but must be introduced by subcutaneous injections. Human beings are very much more susceptible to the effects of the remedy than guinea-pigs (the animals

* Translation from the original paper in the *Deutsche Medizinische Wochenschrift.*

experimented upon). Koch thus describes the symptoms felt by himself after the injection of 0·25 cubic centimetre; pains in the limbs, fatigue, inclination to cough, difficulty of breathing, all of which speedily increased; in the fifth hour he was seized with a violent fit of shivering which lasted nearly an hour, at the same time there was sickness, vomiting, and the temperature of the body rose; after twelve hours all these symptoms gradually grew less, the temperature fell, and by next day was again normal. The heaviness in the limbs and the feeling of langour lasted a few days longer, and the spot where the injection had been made continued red and painful for the same length of time.

A healthy human being reacts either not at all or very slightly under the injection of 0·01 cubic centimetre. But it is quite different when the patient is tuberculous, as this same dose will be followed by a strong general as well as local reaction.

The local reaction can best be observed in those patients whose tuberculous affections are visible; for instance in cases of lupus, a tuberculous affection of the skin. Here, a few hours after the injection has been made under the skin at some distant part (generally between the shoulder-blades), the lupus spots begin to swell and grow red, shivering follows; and while the fever lasts, the swelling and redness continue to increase, so that the lupus tissue becomes necrotic and of a reddish-brown colour in places. After the fever has subsided, the swelling of the lupus spots gradually decreases, and after two or three days they have entirely disappeared. The seat of the lupus is then covered with a crust of oozing serum which dries into a scab; this scab ultimately falls off, leaving a smooth red scar. Several injections are required to remove the lupus tissue completely.

The local reactions in tuberculosis of the glands, bones, and joints are less striking, but are attended by swelling, increase of pain, and redness of the superficial parts.

The reaction in the internal organs, especially in the lungs, cannot be observed, but patients with decided tuberculosis of the lungs are far more susceptible to the remedy than those suffering from surgical tubercular affections.

The remedy does not kill the tubercular bacilli, but the tuberculous tissue. In some parts there is an instant destruction of the diseased tissue after one injection, so that it falls off like a dead mass. In other parts there seems to ensue a disappearance or sort of melting away of the tissues, which requires repeated injections of the remedy for the completion of the cure. It is only capable of inflaming living tuberculous tissue; it produces no effect whatever on dead tissue such as, for instance, necrotic cheesy masses, necrotic bones, all of which will need to be removed by surgical operation, to effect which every effort must be made.

Phthisical patients with large cavities, who almost always suffer from other complications (arising, for instance, from the penetration of other pus-forming micro-organisms into the cavities, &c.), will probably, Koch thinks, only in exceptional cases derive any lasting benefit from the use of this remedy, and he raises the question whether it might not be

possible to afford relief to any of these suffering people by a combination of this new therapeutic method with surgical operations, such as are undertaken in cases of empyema, which would permit the possibility of removing the necrotic masses of tissue, together with the secondary suppurative processes.

The most important point in this new treatment, doubtless, consists in the earliest possible application of it. On this account an early diagnosis is all-important, and hence the vital importance to the patient of every effort being taken on the part of the doctor to recognise at the earliest possible date the presence of the tubercle bacilli in the sputum.

SCURVY.

When scurvy presents itself among soldiers in time of war, it appears under different forms, such as swelling of the limbs, ulceration, especially of old cicatrices having a livid colour, and irregular tumid border, with a surface covered with a spongy, dark coloured, strongly-adherent fœtid crust, dysentery, hæmorrhage, nodes, spongy swelling of the gums, and petechiæ, rendering the subjects quite inefficient, and *aggravating wounds or injuries* by preventing their healing.

* "Scurvy may be induced by deficiency of fresh vegetables, deficiency of nitrogenous food, probably also by deficiency of fat and by mere sameness of diet.

"It may be cured by the use of fresh vegetables, salts of vegetable acids, increased nitrogenous food, and by variety of diet.

"Once scurvy is set up in a body of men, dysentery, diarrhœa, typhus, rheumatism, ulcers, &c., are sure to break out, and it besides leaves the system totally unfitted to resist any epidemic poison that may present itself upon the scene, so that cholera and typhoid fever find easy victims."

† "Measures to be adopted in time of war, or in prolonged sojourn on board ship, or at stations where fresh vegetables are scarce, are –

"1. The supply of fresh vegetables and fruits by all the means in our power. Even unripe fruits are better than none, and we must risk a little diarrhœa for the sake of their antiscorbutic properties. In time of war every vegetable should be used, which it is safe to use, and when made into soups, almost all are tolerably pleasant to eat.

"2. The supply of the dried vegetables, especially potato, cabbage, and cauliflowers; turnips, parsnips, &c., are perhaps less useful; dried peas and beans are useless. As a matter of precaution, these dried vegetables should be issued early in a campaign, but should never supersede the fresh vegetables.

"3. Good lemon-juice should be issued daily (1 oz.), and it should be seen that the men take it.

"4. Vinegar (½ oz. to 1 oz. daily) should be issued with the rations, and used in the cooking.

* *Military Hygiène*, Royal United Service Institution, 1870, by Professor F. de Chaumont, F.R.S.

† Parkes' *Manual of Practical Hygiène*, p. 492.

"5. Citrates, tartrates, lactates, and malates of potash should be issued in bulk, and used as drinks, or added to the food. Potash should be selected as the base, as there is seldom any chance of the supply of soda being lessened. The easiest mode of issuing these salts would be to have packets containing enough for one mess of twelve men, and to instruct the men how important it is to place them in the soups or stews. Possibly they might be mixed with the salt, and issued merely as salt."*

"Amchur" consists of peeled mango. The green mangoes are peeled, the stones removed, and the cut pulp is sun-dried. Sixty-seven grains of amchur contain 19 grains of citric and malic acids, and are, therefore, equivalent to ʒi of lime-juice.†

Iron, in the form of the tincture of the perchloride, in doses of 30 drops three times a day, has been recommended by Dr. Hammond for this disease. Attention should be paid to cleanliness, air, and exercise.

FOOTSORENESS.

Professor Parkes remarks—"Footsoreness is generally a great trouble, and frequently arises from faulty boots, undue pressure, chafing, riding of the toes from narrow soles, &c. Rubbing the feet with tallow or oil, or fat of any kind, before marching is a common remedy. A good plan is to dip the feet in very hot water before starting, for a minute or two; wipe them quite dry, then rub them with soap (soft soap is the best) till there is a lather; then put on the stocking. At the end of the day, if the feet are sore, they should be wiped with a wet cloth, and rubbed with tallow and spirits mixed in the palm of the hand (Galton). Pedestrians frequently use hot salt and water at night, and add a little alum. Sometimes the soreness is owing simply to bad stockings; this is easily remedied. Stockings should be frequently washed, then greased. Some of the German troops use no stockings, but rags folded smooth over the feet. This is a very good plan.

"Very often soreness is owing to neglected corns, bunions, or ingrowing nails; and the surgeon must not despise the little surgery necessary to remedy these things; nothing, in fact, can be called little if it conduces to efficiency.

"If blisters form on the feet, the man should be directed not to open them during the march, but at the end of the time to draw a needle and thread through the blister; the fluid then gradually oozes out.

"All footsore men should be ordered to report themselves at once.

Chafing.—"Occasionally men are much annoyed with chafing between the nates or inside of the thighs. Sometimes this is simply owing to the clothes, but sometimes to the actual chafing of the parts. Powders are said to be the best—flour, oxide of zinc, and above all, it is said, Fullers' earth."

* Parkes' *Manual of Practical Hygiène*, p. 492.
† Appendix to *A. M. D. Reports*, 1887, p. 343.

TREATMENT OF THE APPARENTLY DROWNED.

First attempt the restoration of breathing, and secondly, after breathing is restored, the promotion of warmth and circulation.

Remove at once all wet clothing and wipe the body dry, cleanse the mouth and nostrils, and draw the tongue forward.

Place the patient on the ground with the face downward, and one of the arms under the forehead, turn the patient well and instantly on the side, supporting the head, and excite the nostrils with snuff, salts, or tickle the throat with a feather. Rub the chest and face warm, and dash cold water, or cold and hot water alternately, on them. If there be no success, instantly replace the patient on the face, raising and supporting the chest well on a folded coat or other article of dress. Turn the body very gently on the side and a little beyond, and briskly on the face, back again, repeating these measures cautiously, efficiently, and perseveringly about fifteen times in the minute, or once every four or five seconds, occasionally varying the side. On each occasion that the body is replaced on the face, make uniform but efficient pressure with brisk movement on the back between and below the shoulder-blades, or bones on each side, removing the pressure immediately before turning the body on the side. During the whole of the operations, let one person attend solely to the movements of the head and of the arm placed under it.

Should these efforts not prove successful in the course of from two to five minutes, proceed to imitate breathing by Dr. Sylvester's method, as follows:—

Place the patient on the back on a flat surface inclined a little upwards from the feet, and support the head and shoulders on a small firm cushion or folded article of dress placed under the shoulder-blades. Draw the tongue forward, and keep it projecting beyond the lips; an elastic band over the tongue and under the chin will answer this purpose, or a piece of string or tape may be tied round them, or by raising the lower jaw, the teeth may be made to retain the tongue in that position. Remove all tight clothing from about the neck and chest, especially the braces. Standing at the patient's head, grasp the arms just above the elbows, and draw the arms gently and steadily upwards for two seconds. Then turn down the patient's arms, and press them gently and firmly for two seconds against the sides.

Repeat these measures alternately, deliberately, and perseveringly, about fifteen times in a minute, until a spontaneous effort to respire is perceived, immediately upon which cease to imitate the movements of breathing, and proceed to induce circulation and warmth by commencing to rub the limbs upwards with pressure and energy. The friction should be continued under the blanket or over dry clothing; promote warmth of the body by the application of hot-flannels, bottles of hot water, heated bricks to the pit of the stomach, the armpits, between the thighs, and to the soles of the feet.

On the restoration of life, a teaspoonful of warm water should be given,

and then, if the power of swallowing have returned, small quantities of wine, warm brandy and water, or coffee should be administered. The patient should be kept in bed and a disposition to sleep encouraged.

COOKING-PLACES.

"The simplest kitchen consists of a trench dug in the direction that the wind is blowing, of such width that the kettle, when placed on it, should not rest above an inch on each side. When the width is 9 inches, its depth should be 12 at the end from which the wind is blowing, and continue that depth for 4 feet, decreasing then gradually to 3 inches at the opposite end, where a space must be left equal to the breadth of the trench, to serve for a chimney. The fire is lit at the end where the trench is deep; it should not extend beyond 3 or 4 feet up the trench. The kettles are placed touching one another along this trench; dry sods should be used to stop up the chinks made by the roundness of the kettles, so that the space under them may form a flue. It is advisable to pile up sods, or, with stones and earth, to erect a chimney of at least 1 foot in height at the end away from the fire. All grass round the fire-places should be cut to prevent accidents from fire.

"These kitchens are susceptible of great improvement. The chimney can be made of mud, or wattle and daub, and the draught may be increased by using short pieces of hoop-iron, as bars stretched across the trench to support a filling-in of clay round each kettle, or in other words, to make a regular place for the kettle, into which it will fit exactly, so that its position may be frequently changed, to prevent the contents of one being cooked before the other. As the day following the wind may change to an exactly opposite direction, a similar trench must be dug in continuation of the former one, the same chimney being used. In this manner the same chimney will serve for trenches cut to suit the wind blowing from all four quarters. The openings from these trenches into the chimney must all be closed with a sod, except the one to be used when the fire is lit. In some places, where bricks or stones suitable to the purpose are to be had, it is better to construct these kitchens on the ground instead of below its surface.

"In well-wooded countries, like America, two logs rolled together in the direction of the wind, the fire being kindled between them, make a good kitchen. In such places fuel is no object, so the construction of chimneys can be dispensed with, and the kettles hung from a stick resting at each end on a forked upright.

Field Ovens.—"The simplest method of making them is as follows:—Take any barrel (the more iron hoops on it the better), the head being out; lay it on its side, having scraped away the ground a little in the centre to make a bed for it; or, if there is a bank near, excavate a place for it, taking care that the end of the barrel does not reach within 6 inches of the edge of the bank; cover it over with a coating of about 6 or 8 inches of wet earth or thick mud, except at the open end, which is to be the mouth of the oven. Pile up some sand or earth to a thick-

ness of about 6 inches over the mud, arranging for an opening 3 inches in diameter being left as a flue (to increase the draught) to lead from the upper side of the barrel, at the far end, through the mud and earth. This flue is only left open when the fire for heating is burning. When bread is put in, it should be covered over. Form an even surface of well-kneaded mud at the bottom within the barrel, to form a flooring to place the bread on. Light a fire within the barrel, and keep it up until the staves are burnt. You will then have a good oven of tough, burnt clay, tied together by the iron barrell-hoops. When required for use, heat it as if it was an ordinary oven. When the ashes are drawn out, and the bread put in, close the mouth with some boards, or a piece of tin or iron."*

LATRINES.

A latrine should be made as soon as the hospital arrives on the ground. A small shallow trench will suffice for one night.

In standing camps, latrines may be with seats, as shown in fig. 127. The seat being a simple pole, additional comfort may be given by adding a top pole to form a back ; but this is quite needless, except for hospitals. The trench should be made as narrow as possible, and from 3 to 4 feet deep. Too much care cannot be bestowed in selecting the site of the latrine, and placing it so that no filtration from it may reach the water

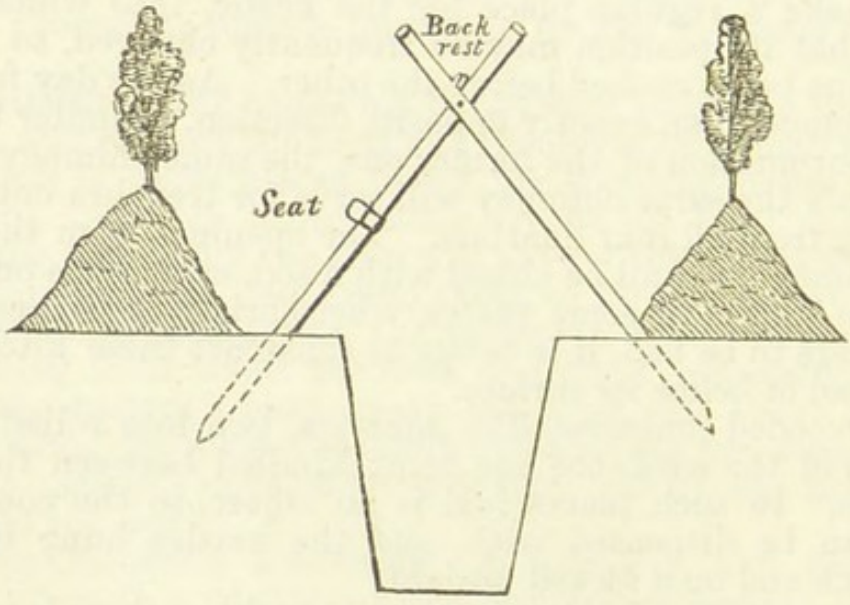

Fig. 127.†

supply. A small piece of canvas may be carried to give some shelter to the latrine. If trees or brush are in the neighbourhood, it can be enclosed by a screen about 4 feet high. Twice a day, about 10 A.M. and

* *The Soldier's Pocket-Book*, by Col. Sir Garnet Wolsley, p. 152.

† Fig. 127 is taken from Regulations and Instructions for Encampments, Horse Guards, 1st August, 1889, plate xxvi.

6 P.M., the bottom of the pit should be covered with a 3-inch layer of dry earth. The wood ashes from the cooking-places should be spread about in the vicinity. Lime, if it is to be had, should be used in large quantities.

The health and comfort of every one in hospital depends very much upon the manner in which these duties are conducted.

WATER.

Pure water being so essential, the following instructions may be given here:—"When the halting-ground is reached, it may be necessary to filter the water. A common plan is to carry a cask, charred inside, and pierced with small holes at the bottom; it is sunk in a small stream, and the water rises through the holes. A better plan still is to have two casks, one inside the other; the outer pierced with holes at the bottom, and the inner near the top; the space between is filled with sand, gravel, or charcoal if procurable; the water rises through the gravel between the barrels, and flows into the inner barrel (fig. 128). It is advisable to heat sand or gravel to redness before use; the same applies to charcoal if there be any question of its purity. *All* these media must be changed frequently.

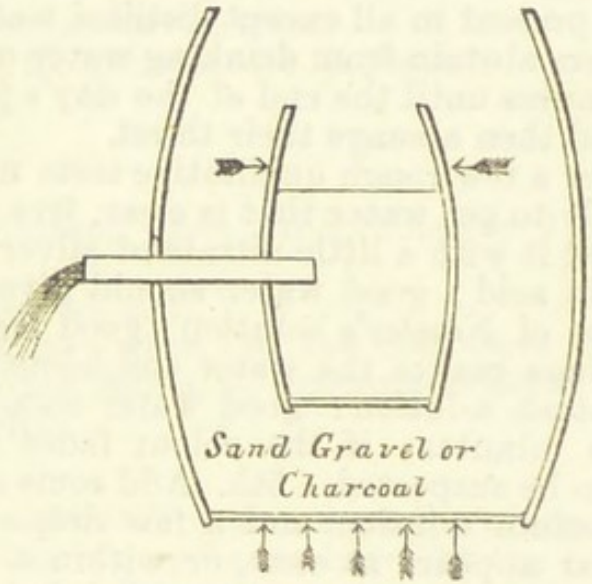

Fig. 128.

"Medical officers should make arrangements for the different places of supply. Men and cattle should be watered at different points; places should be assigned for washing; and, if removal of excreta by water be attempted, the excreta should flow in far below any possible spring. In case of a spring, several reservoirs of wood should be made, and the water allowed to flow from one to another—the highest for men, the second for cattle. If it is a running stream, localities should be fixed for the special purpose; that for the men's drinking-water should be highest up the

stream, for animals below, washing lowest; sentries should be placed as soon as possible.

"The distribution of water should be regulated; streams are soon dried up, made turbid, and the water becomes undrinkable for want, perhaps, of simple management."

In India, especially on board river steamers, where drinking-water is taken direct from the river, which is generally very muddy, a lump of alum is moved rapidly through it with satisfactory results, in proportion of 6 grs. to a gallon.

In the Ashanti campaign of 1873, the water was purified by Surgeon-Major Gouldsbury's direction in the following way, in the absence of proper filters:—Alum was added to precipitate suspended matter—the water was passed through a rough filter, consisting of (1) sponge, (2) sand, (3) charcoal in pieces; it was then boiled, and a few drops of solution of potassium permanganate added. Water, even taken from a hole in a marsh, was innocuous after this treatment.*

Maignen's filter was used by the troops in Egypt.

As it is unlikely that any organic poison will resist the temperature of boiling, it is of the greatest importance that all suspicious water should be boiled before use. During epidemics, such as cholera, this is essential; it may even be advisable to try and supply the men with distilled water at such times: any sort of rough still would answer. One great advantage would be that impure water could not be substituted for it, as a few drops of solution of nitrate of silver would at once detect the presence of chlorides, which are present in all except distilled water.

The Russian soldiers abstain from drinking water on the line of march in their Turkestan routes until the end of the day's journey, when they at once make tea, and then assuage their thirst.

In judging of water a few rough qualitative tests may be useful. 1st. Try as far as possible to get water that is clear, free from sediment, and colourless. 2nd. Test it with a little nitrate of silver solution and a few drops of dilute nitric acid; good water should give only a faint haze. 3rd. Add a few drops of Nessler's solution: good water should give no colour. A yellow tinge makes the water suspicious. 4th. Add a little permanganate of potash solution: good water should remain pink for about ten or fifteen minutes; if the colour fades rapidly or becomes brown the water is to be suspected. 5th. Add some solution of starch, a little iodide of potassium solution, and a few drops of dilute sulphuric acid; if a blue colour appears at once, or within a minute or two, the water is suspicious. Other tests may be added, but these are generally sufficient for practical purposes, while they entail the use of no special apparatus.

* *Manual of Practical Hygiène*, 7th edition, p. 31. Edited by Professor de Chaumont.

Water Required Daily for One Man, &c.

For cooking and drinking,	. . .	6 pints, or 8 in the tropics.
Ablutions, including baths,	. . .	5 gallons.
For personal and domestic use, without baths,		12 ,,
,, ,, with baths,		16 ,,

If the supply is running short, 4 gallons a-head per diem for all purposes is the least amount that ought to be given.

Elephants require	. . .	25 gallons daily.
Camels ,,	. . .	10 ,,
Horses ,,	. . .	6 ,,
Oxen ,,	. . .	6 ,,
Mules and ponies require,	. .	5 ,,

RATIONS.

Two bullocks, roughly speaking, will feed 1,000 men for one day.

In case of active operations in the field, a special scale will be fixed according to the climate and the circumstances of the expedition, but the following scale will, as far as possible, be adopted as a guide :—

1 lb. fresh, salt, or preserved meat.
1¼ lb. bread, or 1 lb. biscuits or 1 lb. flour.
$\frac{1}{8}$ oz. tea.
$\frac{1}{3}$ oz. coffee.
$\frac{1}{36}$ oz. pepper.
$\frac{1}{2}$ lb. fresh vegetables, when procurable, or 1 oz. compressed vegetables.
$\frac{1}{320}$ gal. lime juice ($\frac{1}{10}$ gill), with ¼ oz. sugar on days when fresh vegetables are not issued. } at the discretion of the G.O.C. on the recommendation of the M.O.
$\frac{1}{64}$ gal. rum ($\frac{1}{2}$ gill).

When the supply of cattle is abundant the ration of 1 lb. of fresh meat during active operations may be increased by the G.O.C. to 1¼ lbs.*

Vinegar is of great value as an antiscorbutic, and its use should be encouraged. Condiments are also most important. Fat has about two and a-half times the potential energy of the carbo-hydrates, but will not replace them, hence the value of bacon in the above scale. Bacon was issued for the first time as a ration in the late expedition up the Nile (1884-85), when it was greatly appreciated. For a scale of rations used on that occasion, see Appendix IV.

The late Professor de Chaumont wrote—"In cases of extreme fatigue,

* Para. 20, Allowance Regulations, 1890.

nothing so rapidly recruits the exhausted frame as Liebig's extractum carnis, and strongly recommends its issue to men before going on trench or picket duty in cold, wet weather, or to men on coming off heavy duty, cold and weary, often too fatigued to sleep. It can be prepared in no longer time than is necessary to get water heated, or it may be taken, less advantageously, cold."

* Daily Amounts of Water-Free Solids Required to Maintain Health for an Adult Man.

	In Rest.	In Ordinary Work.	In Laborious Work.
	Ozs.	Ozs.	Ozs.
Albuminates, . . .	4·5	4·5	6 to 7
Fats, ...	1·0	3·5	3·5 to 4·5
Carbo-hydrates, . .	12·0	12·0	16· to 18·
Salts, ...	0·5	1·7	1·2 to 1·5
	16·0	21·7	26·7 to 31·0

On service, in the field hospitals, the sick and wounded are supplied with their usual daily rations, which should be supplemented by medical comforts, or by such articles as the Supply Department may be able to provide.

Work† or energy is expressed as so many tons raised 1 foot in height, 300 foot-tons may be taken as ordinary work, 350 as hard work, 400 as laborious work. The simplest mode in which the force of man can be employed is in transporting the weight of his body along a level road. This, at the rate of three miles an hour, is equivalent (*Haughton*) to raising $\frac{1}{20}$ of his weight through the distance walked. Hence

$$\frac{(W + W^1) \times D}{20 + 2{,}240} = \text{foot-tons of work done.}$$

W = weight of body.
W^1 = weight of clothing, &c.
D = distance in feet.
20 = co-efficient of resistance.
2,240 = lbs. in a ton.
One mile = 5,280 feet.

* *Manual of Practical Hygiène*, de Chaumont.
† Lecture on "The Food of the Soldier," by Surgeon A. M. Davies, M.S., Assistant Professor of Hygiene.

By this means of calculation, a ten-mile march with a 60-lb. load is a fair day's work, being altogether equal to 300 foot-tons.

SPACE AND VENTILATION.

Army Regulations on the Space Allowed for Each Man.

In Temperate Climates.

	Cubic Space.	Superficial Area.
In Barracks, ...	600 cubic feet.	50 square feet.
In Hospitals, ...	1,200 ,, ,,	90-100 ,, ,,
In India.		
In Barracks—		
Plains, ...	1,800 cubic feet.	90 square feet.
Hill Stations, ...	600 ,, ,,	60 ,, ,,
In Hospitals—		
Plains, ...	2,400 ,, ,,	100-120 ,, ,,
Hill Stations, ...	1,632-1,836 ,, ,,	102 ,, ,,

A bell tent is issued on service to every fifteen men; it measures in area of base (diameter, 12·5 feet) 123 square feet, and yields 427 cubic feet.—*Lord Wolseley.*

The hospital marquee covers 396 square feet, and contains 3,366 cubic feet. It can accommodate ten men without cots and eight men with cots comfortably. By regulation it is intended to hold eighteen sick.

Parkes and de Chaumont give ·6 per 1,000 volumes of carbonic acid in the air as the limit of impurity allowable—of this, ·2 is derived from respiration, and the remainder is the normal quantity in the air.

To maintain the air at this standard, an ordinary man who inspires and expires 30 cubic inches at every respiration sixteen times in a minute, requires to be supplied with 3,000 cubic feet of air per hour. In order to get this without draughts, sufficient cubic space and superficial area must be allowed for each patient, so that the air would maintain this if changed three or four times in an hour.

The surface area per tent for different densities of population per square mile is as follows :—

No. of Square Yards per Tent.	No. of Tents per Square Mile.	No. of Troops per Square Mile.
50	61,952	929,280
100	30,976	464,640
500	6,195	92,928
1,000	3,097	46,464

The density of population is in

	Per Square Mile.
London,	35,840
Liverpool,	72,832
Manchester,	56,236
Philadelphia,	45,000

To compare the density of population in a camp with the above, we must, as he points out, in our calculation divide the superficies of the Regimental Camp by the strength, and not the actual space occupied by a company, as towns and cities have every street, alley, and square included in their superficies.

For example, a Regiment of Infantry in open column of companies, when encamped, has a front of 320 yards and a depth of 266 yards, which gives 85,120 square yards ; divide this by the strength, 1,096 men, and we have 77·6 square yards per man—or, taking a more compressed form, in double companies, with only 15 yards between the companies instead of 40, we have a front of 120 yards and a depth of 150 yards.

$120 \times 150 = 18{,}000$ square yards$\div 1{,}096$, gives 16·4 square yards per man, equivalent to 188,175 men per square mile.

But after all, the compression is not in the regimental but in the company lines, where fifteen men are packed into one badly-ventilated bell tent. Under these conditions, the regulations of 1871 should be strictly observed. Company tents should never be arranged in double lines—short single lines are best. The tents in line should be separated from each other by a space at the very least equal to a diameter and a half of a tent. Whenever the troops remain in camp more than three days, tents should be struck every two days, all arms, straw, and blankets should be removed from the ground, and the ground should be swept clean and left exposed to the sun and wind. Whenever troops remain more than one night in camp, the tent flys should be rolled up the first thing every morning. In rainy weather the fly may be rolled up on the leeward side of the tent. Remember a camp is a temporary town without paving or proper drainage, hence the great care requisite to ensure a proper surface cleansing, &c.

The space between corps should be 25 yards or 30 paces—distances in Infantry Camps are usually reckoned by yards. 5 yards = 6 paces.

A square mile = 640 acres = 3,097,600 square yards.

REGULATIONS AS TO DEFECTS OF VISION FOR CANDIDATES FOR COMMISSIONS IN THE ARMY.*

The following will be substituted for paragraph 1013*b*, added to the Regulations for the Army Medical Department by Clause 53, Army Circulars, 1887 :—

Letters and numbers corresponding to Snellen's Metrical Test-Types (Edition 1885) will be used for testing the standard of vision.

If a candidate's vision, measured by Snellen's test-types, be such that he can read the types numbered D. = 6 at 6 metres or 20 English feet, and the types numbered D. = 0·6 at any distance selected by himself, with each eye separately and without glasses, he will be considered fit.

If a candidate cannot read with each eye separately, without glasses, Snellen's types marked D. = 36 at a distance of 6 metres or 20 English feet, *i.e.*, if he do not possess one-sixth of Snellen's standard of normal acuteness of vision, although he may be able to read the types D. = 0·6 at some distance with each eye, he will be considered unfit.

If a candidate can read with each eye separately Snellen's types numbered D. = 36 at a distance of 6 metres or 20 English feet, without glasses, but cannot read them beyond that distance, *i.e.*, if he just possesses one-sixth of normal acuteness of vision, and his visual deficiency is due to faulty refraction, he may be passed as fit, provided that, with the aid of correcting glasses, he can read Snellen's type D. = 6 at 6 metres or 20 English feet, with one eye, and at least Snellen's types D. = 12 at 6 metres or 20 English feet, with the other eye ; and, at the same time, can read Snellen's type marked D. = 0·8 with one or both eyes, without the aid of glasses, at any distance the candidate may select.

Squint, inability to distinguish the principal colours, or any morbid condition, subject to the risk of aggravation or recurrence in either eye, will cause the rejection of a candidate.

ROYAL NAVY AND INDIAN PILOT SERVICE.†

1. A candidate is disqualified unless both eyes are emmetropic. The candidate's acuteness of vision and range of accommodation must be perfect.

2. A candidate is disqualified by any imperfection of his colour sense.

3. Strabismus, or any defective action of the exterior muscles of the eyeball, disqualifies a candidate for the Royal Navy.

* Para. 779, Part i., *Regulations for Medical Services*, 1890.

† "Regulations as to Defects of Vision for the Civil and Military Services of the Government of India," by Sir J. Fayrer, K.C.G.I., F.R.S.

N.B.—Candidates as guards, engine-drivers, signal and pointsmen on the Indian railways, come under the rules prescribed for the Pilot Service and Royal Navy.

THE INDIAN CIVIL SERVICE.

(*Covenanted and Uncovenanted*).

1. A candidate may be admitted into the Civil Service of the Government of India, if ametropic in one or both eyes, provided that with correcting lenses the acuteness of vision be not less than $\frac{6}{9}$ in one eye and $\frac{6}{6}$ in the other; there being no morbid changes in the fundus of either eye.

2. Cases of myopia, however, with a posterior staphyloma, may be admitted into the service, provided the ametropia in either eye do not exceed 2·5 D., and no active morbid changes of choroid or retina be present.

3. A candidate who has a defect of vision arising from nebula of the cornea is disqualified, if the sight of either eye be less than $\frac{6}{12}$; and in such a case the acuteness of vision in the better eye must equal $\frac{6}{6}$, with or without glasses.

4. Paralysis of one or more of the exterior muscles of the eyeball disqualifies a candidate for the Indian Civil Service. In the case of a candidate said to have been cured of strabismus by operation, but without restoration of binocular vision, if with correcting glasses the vision reach the above standard (1), and if the movement of each eye be good, the candidate may be passed. The same rule applies to the case of unequal ametropia without binocular vision, both eyes having full acuteness of vision with glasses and good movement.

Candidates for admission into the following Departments come under the rules laid down for the Civil Service :—Ecclesiastical, Education, Salt, and Opium.

Candidates for the Departments of Public Works, Forest, Survey, Telegraph, Railway, Factories, as well as Police, and various artificers, may be admitted into the service under the following rules :—

1. If myopia in one or both eyes exist, a candidate may be passed, provided the ametropia do not exceed 2·5 D., and if with correcting glasses, not exceeding 2·5 D., the acuteness of vision in one eye equal $\frac{6}{9}$, and the other $\frac{6}{6}$, there being normal range of accommodation with the glasses.

2. Myopic astigmatism does not disqualify a candidate for the service, provided the combined spherical and cylindrical glasses required to correct the error of refraction do not exceed −2·5 D. ; the acuteness of vision in one eye, when corrected, being equal to $\frac{6}{6}$, and in the other eye $\frac{6}{9}$ together with normal range of accommodation with the correcting glasses there being no evidence of progressive disease in the choroid or retina.

3. A candidate having total hypermetropia not exceeding 4 D. is not

disqualified, provided the sight in one eye (when under the influence of atropine) equal $\frac{6}{9}$, and in the other eye equal $\frac{6}{6}$, with +4 D., or any lower power.

4. Hypermetropic astigmatism does not disqualify a candidate for the service, provided the combined lens required to cover the error of refraction do not exceed 4 D., and that the sight of one eye equal $\frac{6}{9}$, and the other $\frac{6}{6}$, with or without such a lens.

5. A candidate having a defect of vision arising from nebula of the cornea, is disqualified if the sight of one eye be less than $\frac{6}{12}$. In such a case the better eye must be emmetropic and possess normal vision. Defects of vision arising from pathological or other changes in the deeper structures of either eye, which are not referred to in the above rules, may exclude a candidate from admission into the service.

6. A candidate is disqualified if he is unable to distinguish the principal colours (Achromatopsia).

7. Paralysis of one or more of the exterior muscles of the eyeball disqualifies a candidate for the service.

THE INDIAN MARINE SERVICE.

(Including Engineers and Firemen).

1. A candidate is disqualified if he have an error of refraction in one or both eyes which is not neutralised by a concave, or by a convex 1 D. lens, or some lower power.

2. A candidate is disqualified if he cannot distinguish the primary colours and their various shades, red, green, violet or blue, and yellow.

3. Strabismus, or any defective action of the exterior muscles of the eyeball, disqualifies a candidate for the Marine Service.

APPENDIX I.

FORMULARY.

Alkaline Bath.

Take of—

Carbonate of soda,	4 oz.
Water,	30 C.

Mix.

Iodine Bath.

Take of—

Iodine,	¼ oz.
Solution of potash,	2 fl. oz.
Water,	30 C.

Mix.

Linseed Meal Poultice.

Take of—

Linseed meal,	4 oz.
Olive oil,	½ fl. oz.
Boiling Water,	10 fl. oz.

Mix the linseed meal with the oil, then add the water gradually, constantly stirring.

Mustard Poultice.

Take of—

Mustard, in powder,	2⅓ oz.
Linseed Meal,	2⅓ oz.
Boiling water,	10 fl. oz.

Mix gradually the linseed meal with the water, and add the mustard, constantly stirring.

Freezing Mixtures.

Take of— No. 1.

Sal-ammoniac,	5 parts,	Thermometer sinks from 50° to 10° Fahr.
Nitre,	5 „	
Water,	16 „	

Mix.

Take of— No. 2.

Snow,	Thermometer sinks from 32° to 0° Fahr.
Common salt,	

Mix.

Liniment of Sulphuret of Lime.

Take of—

Quicklime,	1 part.
Sublimed sulphur,	2 parts.
Water,	10 parts.

Mix.

Boil, constantly stirring with a piece of wood, until the lime and sulphur are *perfectly combined*. Decant, and keep in a well-stoppered bottle.

Wash the body well with warm water, and then rub the liquid into the skin for half an hour. For itch.

Carbolic Acid Solution.

Take of—

Carbolic acid,	1 part.
Water,	20 parts

1-20—dilute with equal parts of water, it equals 1-40.

Boracic Acid Solution.

Take of—

Boracic acid.

Distilled cold water (60° Fahr.).

Dissolve as much as the water will take up.

Salicylic Acid Solution.

Same directions as for the boracic acid.

Mercurial Solution.

Solution of the perchloride of mercury (B.P.) = 1 in 870.

One grain of sublimate in 8 ozs. of water roughly = 1 in 4,000—a good working strength.

The mercurial solution is coloured blue by Sir Joseph Lister, by means of an aniline dye.

The 1-500 solution is simply one part of corrosive sublimate dissolved in 500 parts of water.

It is only to be used of this strength for cleansing the skin, washing out the wound before stitching up in the case of an operation, or for purifying in the first instance an accidental wound.

Chloride of Zinc Solution.

Take of—

Chloride of zinc,	40 grs.
Water,	1 oz.

Mix.

Sir W. Burnett's solution of chloride of zinc contains 300 grains in one ounce, therefore if diluted with 6½ parts of water it will equal 40 grains in one ounce. To purify sick-rooms, night-chairs, cesspools, privies, add 1 part of Burnett's solution to 100 parts of water.

Chlorinated Soda Solution.

Take of—

Liq. Sodæ Chloratæ,	1 part.
Water,	9 parts.

Useful as an application to unhealthy wounds.

Eucalyptus Oil.

Take of

Eucalyptus oil,	1 part.
Olive oil,	10 parts.

Boracic Acid Ointment.

Take of—

Boracic acid,	1 part.
White wax,	1 part.
Paraffin,	2 parts.
Almond oil,	2 parts.

First mix the wax and paraffin by heating them together, then add the oil. Mix the crystals with this in a warm mortar, and continue the process of mixing till the liquid solidifies. The half strength contains half the quantity of boracic acid.

BORACIC LINT is ordinary surgical lint soaked in a hot saturated solution of boracic acid and then hung up to dry.

The expression of so many parts in a 1000, in exact measurement, is 1 gramme in a litre.

1 gramme = 15·43 grains (or 1 c.c.).

1 litre (1000 c.c.) = 1·76 pints. For rough calculation 1 grain may be taken to equal 1 minim.

To Bleach Sponges.—After they have been washed out in luke-warm water, they are put into a 1 per cent. solution of hyposulphite of soda, to which is added $\frac{1}{5}$th as much of an 8 per cent. solution of concentrated hydrochloric acid in water. They are stirred about in this with a wooden stick until they have lost their brown colour. If they are left too long in this solution they tear easily. For twenty-five large sponges about 175 fl. ozs. of the hyposulphite solution and 35 fl. ozs. of the hydrochloric acid solution will be required.

APPENDIX II.

ANTISEPTICS CONTAINED IN

	Quantities.	Where placed.
Field Medical Companion.		
Vaseline, antiseptic,	1 box.	
Bandages, first dressing (Esmarch),	No. 2.	
Boric wool,	2 oz.	
Sulphuro-chromic catgut ligatures, in leather case,		
Surgical Haversack.		
Lint, antiseptic, carbolised,	4 oz.	
Loose wove bandages, antiseptic,	No. 4.	
First dressing bandages, antiseptic,	3	
Boric wool,	2 oz.	
Medical Field Panniers.		
No. 1.—Medicine Pannier.		
Acid, boracic,	2 oz.	In body of pannier.
,, carbolic cryst,	4 oz.	
,, ,, liq.,	4 oz.	
Iodoform,	2½ oz.	
Paraffinum molle, antiseptic,	1¼ lb.	Drawer No. 3.
Zinci chlor.,	1 oz.	
No. 2.—Material Pannier.		
Lint, antiseptic,	8 oz.	Basket A.
Cotton wool, antiseptic,	1 lb.	Basket B.
Antiseptic gauze,	6 yds.	Wrapper.
Silk, protective,	2 yds.	
Tenax,	1 lb.	Tin C
Carbolised catgut,	6 hanks.	,,
Drainage tubing,	6 yards.	,,
Field Fracture Box.		
Cotton wool, antiseptic,	½ lb.	
Tow, carbolised,	½ lb.	
Flannel serge, antiseptic,	2 yards.	
Surgery Wagon.		
Acid, carbolic,	8 oz.	Basket A.
,, ,, liq.,	12 oz.	
Hydrarg. perchlor.,	2 oz.	
Iodoform,	6 oz.	
T. benzoin co.,	12 oz.	

Surgery Wagon—continued.	Quantities.	Where placed.
Paraffinum molle, antiseptic,	2½ lbs.	Basket A.
Zinci chlor.,	4 oz.	,,
Carbolised catgut,		
Wire, silver,	1 oz.	,,
Bandages of kinds,	101	Basket B.
Boric wool,	8 oz.	,,
Carbolised gauze,	6 yards	,,
,, tow,	1 lb.	,,
Lint, antiseptic,	2 lbs.	,,
Protective,	2 yards.	,,
Macintosh,	3 yards.	,,
Bandages,	76	Basket C.
,, first dressing,	20	,,
,,	15	Partition under bskts. 1 & 2.
Boric wool,	5 oz.	,,
Carbolic gauze,	6 yards.	,,
,, tow,	1 lb.	,,
Lint, antiseptic,	2 lbs.	,,
Protective,	2 yards.	,,
Macintosh,	3 yards.	,,
Boric wool,	1½ lbs.	Basket D.
Bandages,	200	,,
Carbolised tow,	3 lbs.	,,
Boric wool,	½ lb.	Basket F.
Lint, antiseptic,	16 lbs.	,,
Special Surgical Panniers.		
No. 1 Pannier.		
All appliances are antiseptic.		
Acid, carbolic,	8 oz.	Tin A.
Iodoform,	1 lb.	
Drainage tubing,	12 yds.	Tin B.
I. R. bottles for washing wounds,	4 yds.	
Gauze,	12 yds.	In lower division.
No. 2 Pannier.		
Boric wool,	1 lb.	
Reserve Medical Field Panniers.		
No. 1.—Reserve Medical Pannier.		
Acid, boracic,	4 oz.	In body of pannier.
,, carbolic cryst,	4 oz.	
,, ,, liq.,	4 oz.	
Iodoform,	5 oz	
Paraffinum molle, antiseptic,	2 lbs.	
Zinci chlor.,	2 oz.	
Iodoform, in 2 stoppered bottles,		Drawer No. 2.
Drainage tubing,	12 yards.	Drawer No. 3.
Bandages, first dressing,	No. 10	Drawer No. 4.
Lint, antiseptic,	1 lb.	
No. 2.—Reserve Material Pannier.		
Gauze, antiseptic,	12 yds.	Tin A.
Silk, antiseptic, protective,	4 yds.	
Tenax,	1 lb.	
Wool, antiseptic,	½ lb.	Tins C and E.
Lint, antiseptic,	1 lb.	

Pharmacy Wagon.	Quantities.	Where placed.
Acid, boracic,	8 oz.	D compartment, slide 2.
,, carbolic,	8 oz.	D ,, ,, 2.
,, ,, liq.,	2 lbs.	D ,, ,, 6.
Collodion,	4 oz.	D ,, ,, 2.
Hydrarg. perchlor.,	6 oz.	D ,, ,, 6.
Iodum,	8 oz.	D ,, ,, 2.
Iodoform,	3 lbs.	D ,, ,, 3.
Liq. Sodæ chlor.,	2 lbs.	D ,, ,, 1.
Zinci chlor.,	8 oz.	D ,, ,, 2.
Bandages, antiseptic,	No. 524.	A ,, drawers 1, 2, 3.
Ligature, catgut,	6 hanks.	A ,, slide 3.
Lint, antiseptic,	70 lbs.	B ,,
,, marine,	36 lbs.	B ,,
Silk, protective,	4 yards.	D ,, ,, 4.
Tow, carbolised,	28 lbs.	B ,,
Wool, salicylic,	6 lbs.	E ,,
Drainage tubing,	12 yards.	D ,, ,, 4.
Irrigators,	1 set.	D ,,
Sulphuro-chromic catgut,		D ,, leather case.
Large Fracture Box.		
Tow, carbolised,	2 lbs.	
Cotton wool, antiseptic,	1 lb.	
Flannel serge, antiseptic,	2 yards.	
Medicine Chest.		
Acid, carbolic liq.,	4 oz.	
,, ,, crystal,	2 oz.	
Hydrarg. perchlor.,	3 oz.	
Iodoform,	2 oz.	
Iodum,	3 oz.	
Liq. sodæ chlor.,	8 oz.	
Zinci chlor.,	12 oz.	
Vaseline, antiseptic,	2 lbs. 8 oz.	
Zinci chlor.,	2 oz.	
Sp. rectif.,	8 oz.	
Bandages, various,	34	(12)
Gauze, antiseptic,	6 yards.	(10)
Ligature, chromic catgut,		Leather case.
Lint, antiseptic,	2 lbs.	(10)
Wool, antiseptic,	1 lb.	(7)

Note.—When dressings are said to be antiseptic without further explanation, no information is given in the Regulations.

Note.—The First Field Dressing.*—The first field dressing is not authorised at present. The antiseptic in it will be the sublimate of mercury; it will not contain a triangular bandage.

*Par. 201, *Regulations for Medical Services*, part ii., 1890.

APPENDIX III.

The following Orders have recently been issued to the Medical Department of the German Army:—*

Instructions for Preparing and Applying Antiseptic Bandaging Material (Sublimate Bandages).

A. *Preparation.*

1. The preparing of the antiseptic bandaging material, which the Sanitary Detachments for the field have to carry with them ready impregnated, is done after the order of mobilisation, but before leaving the locality from where they are mobilised, and this has to be done by the field apothecary. *N.B.*—The same rule extends to the roller bandages covered with powder of plaster of Paris.

2. *Sublimate Gauze.*—The antiseptic fluid used for preparing the gauze is composed according to the following formula:—

Bichloride of mercury,	50	parts or grammes.
Spirits of wine,	5000	,,
Distilled water,	7500	,,
Glycerine,	2500	,,
Fuchsin,	0·5	,,

This quantity in grammes suffices for the saturation of 400 metres of gauze.

By the addition of fuchsin it is intended merely to give a red colour to the gauze in order to distinguish it from non-prepared material.

3. The gauze should be dipped into the antiseptic fluid and well kneaded. After fifteen minutes it should be removed and well squeezed, and then hung up on a line to dry. The drying must be done without exposure to the sun, otherwise the fuchsin gets bleached. The drying takes about twelve hours in a room not heated, or nine hours in a room heated to 65° F.

4. Should circumstances require a more rapid preparation, then the water in the formula may be substituted by spirits of wine.

5. After the drying (the gauze will still feel somewhat moist owing to the glycerine), the pieces of gauze (40 metres) should be folded up smooth and submitted to a screwpress in order to obtain cubes of 11·5 centimetres (4 3-5″), and then they should be well tied up with string.

6. These cubes of pressed gauze should be wrapped in red packing-paper and labelled "Sublimate Gauze." The same wrapping up and labelling must be given to sublimate gauze even when prepared in the field.

7. The above given formula for the antiseptic fluid may, in certain cases, be modified according to directions from the surgeon. For use in the field ordinary water may be substituted for distilled water.

8. *Sublimate Cotton Wool for Wounds.*—The directions for preparing antiseptic cotton wool are the same as given in paragraphs 2, 3, 4, and 7, but the cotton wool takes up more fluid than an equal weight of gauze.

9. During the drying process attention has to be given to ensure the wool dries loose and not in a lump.

* *Krieg's-Sanitaets-Ordnung*, Appendix V., § 63, dated 13th May, 1886.

10. Quantities of 1 kilo. (35 ozs. of the antiseptic cotton wool, after drying, are to be pressed into packets of 11·5 centimetres, tied with string, wrapped in red paper, and labelled "1 Kilo. Sublimate Cotton Wool." In the medical chest carried with the troops smaller pressed packages of sublimate cotton wool weighing 100 grammes 3 ozs.) will be found.

11. *Sublimate Catgut.*—Catgut should be placed in a 5 per cent. watery solution of sublimate for from 8 to 10 or 12 hours, and afterwards preserved in spirits of wine for use.

12. *Sublimate Silk.*—Silk should be well boiled, and then placed for several hours in a 5 per cent. watery solution of sublimate, to which 20 per cent. of glycerine has been added. It should then be dried and wrapped up in a piece of waterproof cloth. Immediately before use the silk should be placed in a 3 per cent. carbolic solution, or a 1 per cent. sublimate solution.

13. *Antiseptic Drainage Tubes.*—Drainage Tubes are to be disinfected by placing them in a 5 per cent. solution of carbolic acid from six to twelve hours, and then preserving them in a fresh solution of the same strength. Should there be only one vessel for holding antiseptic drainage tubes and catgut, then the drainage tubes should be preserved dry, wrapped up in a waterproof material, and only immediately before use, placed in a 3 per cent. carbolic solution or in a 1 per cent. sublimate solution.

14. *Disinfecting Sponges for use with Wounds.*—Sponges should be freed from all adherent matter, repeatedly put under a stream of boiling water, well squeezed, and then placed for twelve hours in a 1 per cent. sublimate solution. The disinfected sponges are to be preserved dry in linen bags.

B. *Application.*

The antiseptic dressing at the bandaging place.

(*a*) The dressing of a wound of the lower leg, as an example.

The application of the antiseptic dressing, after any previous needful manipulation as checking hæmorrhage, may be divided into 3 parts:—

1. *First Part—Preparing the Wound.*—Disinfection of the surrounding parts of the wound by rubbing them with a 1 per cent. sublimate solution or a 3 per cent. carbolic solution; irrigation of the wound by means of one of these solutions.

2. *Second Part—The Dressing.*—The wound should be covered with pieces of sublimate gauze, and then the whole leg should be wrapped in layers of sublimate gauze, of at least eight in number. Before doing so, however, a piece of sublimate cotton wool should be placed above and below the wound underneath the gauze in order to confine the margins of the deeper dressing. Over the layers of sublimate gauze a layer of waterproof cloth is to be placed and the whole maintained in position by a gauze bandage which has been freshly dipped in a carbolic solution.

For a permanent dressing in the hospital the larger waterproof cloth is not required, but the folds of gauze should be more numerous.

The sublime gauze may in every case be replaced by sublimate cotton wool in a corresponding quantity. If the injury of the leg is complicated by fracture of the bone, then, of course, follows—

3. *The Third Part—The Immobilisation.*—Immobilisation may be done in two ways—

(*a.*) By placing the limb in a moulded iron splint (Volkmann); or

(*b.*) By making a plaster of Paris bandage over the antiseptic dressing.

If it is intended to apply a plaster of Paris bandage, then the sublimated cotton wool should be used underneath because it furnishes an eminently soft and elastic substratum for the plaster of Paris. Of course, in these cases the dressing must cover the knee and ankle-joints, in accordance with the principles which guide the application of immobilising dressings. *N.B.*—For immobilising limbs in the absence of open wounds, the *common* cotton wool is to be employed as a padding.

C. *The First Dressing Packet.*

The first dressing packet consists of two compresses of antiseptic gauze, 40 centimetres (16″) long and 20 cm. (8″) broad; of a cambric bandage, 3 metres long

and 5 cm. (2″) broad; a safety-pin and a wrapper of waterproof material, 28 cm. (11″) long and 18 cm. (7″) broad.

In applying a first dressing by means of this packet, the wound is to be covered with the two compresses (gauze in an 8-fold layer), over this the waterproof cloth is placed, and the whole fixed with the cambric bandage and secured by means of the safety-pin.

In case of a simple gun-shot injury with entrance and exit, both openings should be covered each with a compress of gauze and half the waterproof material. Should there not be a sufficiency of first dressing packets at the dressing station, then suitable pieces of waterproof material, about 12 cms. ($4\frac{3}{4}$″) square, ought to be kept ready, in appropriate numbers, to be used in addition to gauze compresses, cambric bandages, and safety-pins, in store in the same manner as the contents of the first dressing packets were intended.

Iodoform Dressings.

Simple, not too extensive, injuries may receive a covering dressing of iodoform. The wound is to be dusted over with a thin layer of iodoform, then covered with a gauze compress or some prepared cotton wool, over this a piece of waterproof material, and the whole fixed by means of a roller bandage and safety-pin or by a triangular sling.

APPENDIX IV.

LIST OF SUPPLIES SENT IN EACH BOAT PROCEEDING UP THE NILE, CALCULATED FOR TWELVE MEN IN A BOAT, AND TO LAST 100 DAYS—1884-85.

Net Total for Each Boat.	ARTICLE.	Proposed Daily Issue per Man.
799 lbs.	Preserved corned beef, .	1 lb. four days out of six.
192 ,,	,, fresh meat, . .	1 lb. one day out of six.
168 ,,	Bacon, ...	1 lb. one day out of six.
48 ,,	Boiled mutton, ...	
66 ,,	Cheese, ...	$\frac{3}{4}$ oz.
770 ,,	Biscuit, Navy, ...	1 lb. five days out of six.
240 ,,	,, cabin, ...	
200 ,,	Flour, ...	1 lb. one day out of six.
52½ pint bottles.	Pickles, ...	$\frac{1}{2}$ oz. four days out of six.
17 tins.	Jam, ...	$1\frac{1}{3}$ oz. two days out of six.
17 ,,	Marmalade, ...	
80 lbs.	Tea, ...	1 oz.
240 ,,	Sugar, ...	3 oz.
19 ,,	Salt, ...	$\frac{1}{4}$ oz.
80 ,,	Preserved vegetables, . .	1 oz.
7½ gals	Lime juice, ...	$\frac{1}{320}$ gal.
432 rations	Erbswurst, ...	1 ration every third day.
40 lbs.	Cocoa and milk, ...	For occasional use.
2 gals.	Vinegar, ...	$\frac{1}{1280}$ gal.
40 lbs.	Rice, ...	
40 ,,	Oatmeal, ...	
10 ,,	Baking powder, . . .	
2 ,,	Pepper, ...	
40 ,,	Tobacco, ...	On repayment.
27 ,,	Soap, common, ...	,,
9 ,,	,, carbolic, ...	,,
192 boxes.	Matches, ...	
1	Field Hospital Supply Case.*	

DIRECTIONS.

The column for the daily issue shows the data upon which the supplies of each article have been calculated; but, provided the total ration is not exceeded, the various articles may be issued in such proportion as may be considered advisable by Officer Commanding.

* FIELD HOSPITAL SUPPLY CASE CONTAINED

3 bottles brandy.
3 bottles port wine.
12 4-oz. tins Liebig's extract carnis.
½ lb. mustard.
1 lb. soap, yellow.
1 lb. candles.
1 tin alum.
2½ lbs. arrowroot.
¼ lb. salt.
4 tins condensed milk.
6 tins cocoa and milk.
2 boxes safety matches.
½ lb. compressed tea.
1 corkscrew.
1 opening knife.
1 bottle permanganate of potass.

APPENDIX V.

KIT OF OFFICERS IN THE FIELD.*

The following List is published as a guide to Officers as to the Articles of Kit, &c., which they should take into the Field.

(1.)

Worn, or Carried on the Person.

	Approximate weight.			Approximate weight.	
	lb.	oz.		lb.	oz.
Full dress head-dress ...	...		Drinking cup and water-bottle	0	15
Tunic, or patrol jacket ...	3	0	Pocket book	3	4
Trousers	2	8	Field glass (and compass), with strap...	...	
Boots (shooting)	4	0	Watch	0	6
Socks (woollen)	0	3	Waterproof coat (Regulation pattern)	2	8
Drawers	0	5	Haversack	0	15½
Flannel shirt	0	10	1 map of the country ...	...	
Flannel belt	...		Sword	...	
Silk pocket handkerchief..	0	1	Pistol	...	
Leggings	0	9			
Clasp knife	0	9½			
Pouch belt and pouch for instruments	...				

* *Manual for Field Service*, par. 580.

(2.)

CARRIED IN A BED VALISE, OR OTHERWISE.

	Approximate weight.			Approximate weight.	
	lb.	oz.		lb.	oz.
1 waterproof sheet with eyelet holes	3	7	1 housewife	0	4
1 greatcoat	5	0	6 spare boot laces	0	2
1 blanket	5	0	1 tin of dubbing	0	2
1 pair of trousers	2	8	1 portfolio, containing pen, ink, and paper	0	4
1 pair shooting boots ...	4	0	1 journal book	0	15
2 pairs of socks	0	6	1 flannel belt	0	5
1 pair of drawers	0	5	1 field dressing (carried on person when in presence of the enemy)	0	4
1 flannel shirt	0	10			
1 silk pocket handkerchief	0	1			
1 woollen nightcap ...	0	2			
2 towels	0	12	1 candle lamp, and a few candles inside it... ...	3	12
1 holdall, containing 1 comb, 1 small hair brush, 1 tooth brush 1 small clothes brush, 1 pair of scissors, and 1 metal soap box and soap	1	2	1 tin match box	0	1
			2 tin plates	1	5
			1 cup, containing knife, fork, spoon, pepper, and salt pots	1	8
			1 indiarubber basin ...	0	8
1 small sponge in bag ...	0	8			
	23	13		9	6
Total in valise ...	... ... 33 lb. 3 oz.				

NOTES.—The total weight to be carried in the regimental wagons must not exceed for Commanding Officer 80 lb., for Field and other Mounted Officers 50 lb., and for all others 40 lbs. This does not include canteens.

In addition to the above, which is to be looked upon as the light equipment of Officers, a bullock trunk will be allowed to every Officer, to carry about 100 lb. weight of personal baggage. This trunk will be embarked with Officers, but will be left at the Base of Operations during active movements in the field, and it will be brought up only when it may be deemed convenient to the service by the General Officer in chief command.

Officers to cook by companies or squadrons, and to provide their own cooking utensils; 20 lb. allowed for each company, and for every three Officers of Regimental Staff, &c.

With a view of allowing Mounted Officers to carry any extra articles of kit that they may require, a saddle bag (in addition to the wallets) has been authorised, and pattern can be seen in the Pattern Room, Horse Guards, War Office.

The Officer drawing the camp equipment for the Staff should include picketing gear (as under) for all the Officers' horses, public or private, and one waterproof sheet (Cavalry pattern) for each Mounted Officer. Previous to a campaign, all Mounted Officers should make sure that this provision has been made for their own horses.

Picketing gear to be carried on the horse:—

1 length of built up rope.
Headrope.
Peg.
Heelrope and peg.
1 mallet for every 3 horses.

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BELL AND BAIN, PRINTERS, GLASGOW