SECONDARY WOUND SHOCK: ITS CAUSATION, PREVENTION AND TREATMENT.

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(Continued from p. 13.)

PREVENTION AND TREATMENT OF SECONDARY SHOCK.

Every effort should be made to prevent the occurrence of secondary shock, and where it has already developed to prevent its further aggravation.

It is proposed to deal with this part of the subject in three sections, viz.:

(a) Discussion of the various measures employed in the prevention and treatment of this condition.
(b) Discussion of the treatment of definite clinical types of shock.
(c) Discussion of the application of the foregoing measures to military surgery in time of war.

(a) Discussion of the Various Measures employed in Prevention and Treatment.

(1) Warmth.—It has already been pointed out that cold is one of the most important factors in the production of shock. It is, therefore, of the utmost importance that all patients who have developed or are likely to develop shock should be thoroughly warmed and that every effort be made to prevent their subsequent chilling. At the same time care must be taken that patients are not overwarmed to such an extent as to cause sweating and discomfort which may produce exhaustion. The body heat may be raised by the various methods of rechauffement described later, by hot drinks, and by infusions given at a temperature above the normal body temperature [34].

(2) Relief of Pain.—As pain tends to produce and aggravate shock, everything that is possible should be done to prevent and relieve it. Wounds should be carefully dressed and fractures splinted as soon as possible after injuries have been received. Morphia in moderate doses is beneficial and should be given when required. Large doses of morphia are harmful and the drug should never be given to patients who are cyanosed.

(3) Prevention and Relief of Mental Anxiety.—It has been shown that emotional stimuli tend to produce shock. Patients should therefore be kept quiet and subjected to as little disturbance as is consistent with proper treatment.

(4) Arrest of Haemorrhage.—The relation of haemorrhage to shock has already been discussed.
Secondary Wound Shock

(5) Prevention of the absorption of Disintegrated Tissue Products.—This is done by the efficient splinting of compound fractures, by the careful transport of injured individuals, by the excision of crushed tissue and by the early amputation of hopelessly smashed limbs. The question of operations will be fully discussed later.

(6) Relief of Thirst.—This can be done by the administration of fluid by the mouth or rectum. It may also be given subcutaneously or intravenously, but the former methods are preferable, where the condition of the patient admits of their being carried out. Fluid given by the mouth should be hot and some have advised the addition of a little potassium citrate or sodium bicarbonate, with a view to keeping the acidosis within bounds.

(7) Prevention of Vomiting.—Persistent vomiting does harm by depleting the body of fluid and must therefore be prevented as far as possible. In some cases the administration of hot drinks will produce or aggravate vomiting. With a view to preventing this Gray [32] has recommended that hot drinks be given in small quantities at a time, after the patient has been warmed and when all disturbances, such as the dressing of wounds, have ceased. Where vomiting is severe and persistent, such as is seen in abdominal cases, it may be necessary to pass a tube and wash out the stomach.

(8) The question of Stimulants.—The majority of stimulants are looked upon as being harmful. Alcohol in small doses is recommended by Doyen (France) [32], but it is not usually employed in this country.

Strychnine has been experimentally shown to be harmful and produces in a normal animal cell changes similar to those found in shock (Crile) [8]. Vasoconstrictors such as adrenalin are bad. They act by producing arterial constriction, which causes a temporary rise in blood-pressure or delays its fall, but which at the same time tends to cut off the blood in the capillaries from what driving force the already depleted heart can supply.

Pituitary extract is probably useless, unless in cases where intestinal paresis is present, when it is thought by some to do good.

Camphor in olive oil given hypodermically appears to be useful at times.

Digitalin is useful when the heart becomes embarrassed.

(9) Administration of Intravenous Infusions.—These are given with a view to increasing the blood volume and raising the blood-pressure. Various solutions have been used, but in all of them, with the exception of gum solution, the effect is only transient, as the fluid quickly escapes from the blood-vessels into the tissues.

The following solutions have been used:

(a) Normal Saline (0·9 per cent sodium chloride) has a definite but small and transient effect. It is practically useless as a method of raising and maintaining blood-pressure. It is better when given by the rectum as it is then retained longer in the system and utilized to a much greater extent and does not tend to produce water-logging of the tissues.
(b) **Ringer's solution**, which contains sodium chloride 0.9 per cent, potassium chloride 0.03 per cent, calcium chloride 0.02 per cent, and a trace of sodium carbonate, has been used and gives results which are much the same as normal saline.

(c) **Hypertonic saline solution**, which contains sodium chloride, 2 grammes; potassium chloride, 0.05 grammes; calcium chloride, 0.05 grammes, and water, 100 cubic centimetres, has been used, and gives slightly better results. The benefit, however, is only temporary, and the resulting rise of blood-pressure is not maintained more than two hours at the most, and usually much less. It is useful at times to tide a patient through an operation. The use of this solution is based on an effort to increase the salt content of the blood, and thereby prevent a loss of fluid from the blood-vessels by osmosis. The salts rapidly diffuse through the vessel walls, and in a short time the salt content of the blood becomes reduced, so that the effect becomes the same as if an infusion of saline had been given.

(d) **Gum acacia solution of Bayliss** [33].—This contains 6 per cent gum acacia and 0.9 per cent sodium chloride. Originally 1.5 per cent sodium bicarbonate was used instead of sodium chloride. The solution is prepared by adding hot boiled tap water to the gum and salt, in small quantities at a time. A precipitate forms, which is got rid of by filtration. If the solution is now sterilized in well stoppered bottles (the stopper being loose during sterilization) it will keep for long periods. This solution gives much better results than any of the others. It raises and maintains the blood-pressure. The rationale of its use is that it is a colloid solution which has a viscosity approximately the same as the blood, and an osmotic pressure the same as the plasma, and therefore when introduced into the circulation in sufficient quantity, not only raises but will maintain the blood volume and blood-pressure by preventing a loss of fluid from the blood-vessels to the tissues. To the casual observer it does not produce the same immediate dramatic effect, which is frequently observed when blood is transfused. McNee, Sladden and others [34] have reported that they have seen no case respond to blood transfusion that failed to do so to gum solution. When shock is complicated by severe haemorrhage the results got from gum are not so good as from blood transfusion, and undoubtedly in dealing with cases of profound shock, the latter treatment is the one to be adopted. Bayliss has pointed out that whereas the first infusion of gum solution has sometimes little effect, if it is repeated in half an hour or so marked improvement often results. It is also of great importance that the infusion should be given as early as possible after the onset of shock.

(e) **Gelatine solution** in a strength of six per cent has a viscosity equal to that of the blood, and an osmotic pressure equal to that of the blood colloids if it is not heated above 40°C., and will raise and maintain the blood-pressure in the same manner as gum acacia solution [33]. On the other hand, if it is heated above 40°C., it loses the greater part of its viscosity (Bayliss). It is not suitable as an intravenous infusion, as it is
necessary to heat it for some time to 100°C to deprive it of the power of setting on cooling, and moreover it is also necessary to sterilize it thoroughly on account of the presence in it of tetanus spores [33].

(f) Dextrin solutions, in strengths varying from two and a half per cent to eight per cent have been used, but do not maintain the blood-pressure for long [33].

(g) Four per cent solution of sodium bicarbonate has been recommended on account of the acidosis which is usually present. It has now been given up in accordance with the more recent views on the effects of acidosis, and moreover acidosis disappears when the blood-pressure is raised to normal [35].

These solutions are given at body temperature. The usual amount to administer is one pint, and this should take twenty minutes to run into the vein. Bayliss recommends that the amount of gum solution given should be 750 cubic centimetres [33].

To recapitulate, both isotonic and hypertonic saline infusions are almost useless, as the rise in blood-pressure and increase in blood volume, which they cause, are only transitory. Of the two the hypertonic solution is the better, and may be of use in the milder forms of shock, or in cases where nothing else is available. Gum solution is the only solution other than blood which is of real use in raising and maintaining the blood-pressure. When given it must be given early, and should be repeated in half an hour or so, if marked improvement has not taken place. In profound degrees of shock, and especially those complicated by severe haemorrhage, it cannot really be looked upon as being as good as blood transfusion, although its beneficial effects are beyond all doubt.

(10) Blood Transfusion.—The enormous value of this method of treatment lies in the fact that it is the only means available of increasing the oxygen-carrying power of the blood and thereby supplying oxygen to the starved tissue cells. The most striking results have been obtained in those cases of profound shock where haemorrhage has played some part. Where transfusion is carried out in this type of case the following changes are usually observed within a very short time:

(i) Marked improvement in the patient’s general condition.

(ii) Strengthening of the pulse and slowing of its rate.

(iii) Marked rise in the blood-pressure. This may become apparent before the transfusion is finished.

(iv) Increase in the haemoglobin and red cell counts.

The immediate effect of blood transfusion is at times little short of miraculous. Cases were often seen during the late war which without a preliminary transfusion would have been inoperable, and again after operation many cases would undoubtedly have died had it not been for a timely blood transfusion. It is a form of treatment to be recommended for cases of very severe shock, but more especially for those in which there has been haemorrhage.
The drawback to blood transfusion, where large numbers of cases have to be dealt with, as in time of war, is the difficulty of obtaining a sufficient supply of blood donors belonging to the right blood groups. A blood donor must be healthy and free from syphilis and malaria, and a preliminary test must be carried out to make certain that his corpuscles are not haemolysed or agglutinated by the patient's serum.

The amount of blood usually given is 500 cubic centimetres.

The dangers of transfusion and the technique of the various methods which may be employed, are fully described in the Vol. I, "Surgery," History of the War, Medical Services. It will here be sufficient to state that from the point of view of military surgery, by far the best and safest method is that which is known by the name of "The Citrate Method." The best apparatus to use is that recommended by Robertson. The principle of the method is that 500 cubic centimetres of blood from a suitable donor are drawn into a bottle containing 160 cubic centimetres of a 3.8 per cent solution of sodium citrate, which has been previously sterilized. The blood and the citrate solution are thoroughly mixed to prevent clotting of the former. A transfusion needle, which is connected by a tube to the bottle, is inserted into the recipient's vein and through this the citrated blood is slowly forced by producing a slight positive pressure in the bottle by means of the bulb of an Ingram's syringe.

Another method which has given satisfactory results is "The Preserved Corpuscles Method." Five hundred cubic centimetres of blood from a universal donor are drawn into a bottle containing a solution of glucose and sodium citrate and placed in an ice-chest for four or five days. The supernatant fluid is then syphoned off and the corpuscles stored on ice till required. They will keep for about three weeks and when required for use are made up to 1,000 cubic centimetres with saline and filtered through layers of gauze. The advantage of this latter method is that the blood can be collected and prepared beforehand, when it is anticipated that there will be a large number of cases to deal with such as was seen at casualty clearing stations during the late war.

(11) The Question of Anaesthetics.—Chloroform is dangerous. Ether is also bad. Ether does not affect the blood-pressure during the operation, but afterwards a fall becomes apparent. This is thought to be due to a toxic action on the endothelial lining of the blood-vessels which renders it permeable to the blood fluids [36].

Nitrous oxide and oxygen is the best anaesthetic to use, as it does not cause a post-operative fall of blood-pressure [37]. Cannon [38] has pointed out that the reserve alkalinity of the blood is kept up better under this than under ether. Spinal anaesthesia is said to be bad on account of it causing a fall in blood-pressure. This however is not very noticeable if it is combined with very light ether anaesthesia. Deplas (France) [32] strongly urges the use of spinal anaesthesia in dealing with injuries of the lower extremities. He recommends that it should be preceded by an injection
Secondary Wound Shock

of morphia and combined with oxygen inhalations. Local anaesthesia is good but it is not always possible to use it.

(12) The Question of Operations.—It has been observed that operative interference has a bad effect on patients suffering from or on the borderline of shock. It is probable that many of the bad effects are attributable to the anesthetic.

Often the symptoms of shock, which have not developed when the operation is commenced, become apparent in the course of the operation or after it is over. It is also well known that certain types of operations tend to produce secondary shock in individuals who have not met with any injury before the operation. Cannon [38] has shown that the following post-operative changes take place: (1) A fall of blood-pressure; (2) a reduction of the reserve alkali of the blood; and (3) an increase in the concentration of the blood. Apart from the original injury, there are certain factors which appear to influence the production of post-operative shock. These are: (1) The effect of the anesthetic; (2) the previous condition of the patient—a patient who has been the subject of hemorrhage or sepsis is more apt to develop shock; (3) the length of the operation—a long operation is more likely to be followed by shock; (4) the nature of the operation—those during which the tissues are traumatized, where there is much loss of blood, where large masses of muscle are cut across such as in amputations, and where there is much handling of intestines and dragging upon peritoneum, are liable to be followed by shock. Where possible, it is advisable to postpone operation in cases with a low blood-pressure and other signs of impending shock until such time as some recovery has taken place. In dealing with a severely wounded man with a low blood-pressure, the surgeon is often called upon to choose the lesser of two evils—an operation where the risk is serious on account of the aggravation of the shock already present, and a delay during which serious or even fatal toxæmia may develop. No hard and fast rules can be laid down and each case must be decided on its merits. The question of the absorption of the toxic products of damaged muscle and the increase of sepsis must always be borne in mind in postponing an operation on a wounded man. In this connexion, experience has shown that the early amputation of a hopelessly smashed limb is distinctly beneficial to the patient, as it is followed by a lessening of shock. In deciding when to operate, Gray [32] considers that the systolic blood-pressure is an important indication of the patient’s condition. He believes that if it is not below eighty-five millimetres Hg an operation may be proceeded with, provided that the right anesthetic is chosen and the operation rapidly performed. If it is decided that an operation is imperative, there are certain prophylactic measures which ought to be carried out—viz:—

(i) If the blood-pressure is low, it should be raised by the infusion of gum acacia solution or the transfusion of blood.

(ii) The patient should be thoroughly warmed and kept as warm as possible during the operation.
D. McKelvey

(iii) The anesthetic, if possible, should be nitrous oxide and oxygen.

(iv) The operation should be carried out as quickly as is consistent with thoroughness. Traumatization of tissues should be reduced to a minimum and any separation or severance should be performed with a sharp knife. Intestines when exposed should be carefully covered with sterile towels wrung out of hot saline, and should be handled as little as possible. Bleeding points should be carefully secured and any unnecessary loss of blood avoided. Crile recommends that in amputations, nerves should be blocked with novocain before being divided. He also recommends that the skin and tissues in the line of all incisions, and the peritoneum in abdominal operations, should be infiltrated with 4 per cent novocain solution. The idea is that painful stimuli, caused by the operation, are thereby prevented from reaching the sensory cells of the brain and producing or aggravating shock. Strong evidence against this theory of shock production has already been quoted. Nevertheless the procedure is mentioned as there is still a number of surgeons who carry it out, in the belief that it considerably lessens post-operative shock. In cases where there is no infection, Crile advises the use of the bihydrochloride of quinine and urea (1/2 per cent to 1/4 per cent solution), which is injected some distance from the line of the incision, instead of novocain. The anesthetic effect of this drug lasts several days and considerably lessens post-operative pain.

When the operation has been finished, treatment should be carried out along the lines indicated in the earlier part of this section. Warmth should be maintained, fluids given by the mouth and rectum, pain relieved and sleep encouraged by the use of morphia. After intestinal operations it is well when giving morphia to combine with it atropine sulphate 1/30 grain, as this helps to prevent painful distension. If much blood has been lost and if the general condition is bad and the blood-pressure falling, an infusion of gum solution should be given or blood transfusion carried out. The use of stimulants should be avoided except where the heart is embarrassed, and then digitalin 1/30 grain may be given hypodermically.

(b) Discussion of the Treatment of Definite Clinical Types of Shock.

There are three main phenomena of shock towards the relief of which treatment should be directed. These are:

(1) Loss of body heat.
(2) Fall of blood-pressure.
(3) Diminution of blood volume.

As has already been pointed out, the last two are dependent on one another.

An individual's power of recovery from shock depends to a great extent on the power of his circulation to take up fluid from the tissues and thereby increase the volume of his blood and diminish its concentration, or to retain fluid which is added for this purpose [36].
Secondary Wound Shock

It has been shown experimentally that when the circulation of the blood is restored to normal, toxins of the "histamine type" are quickly got rid of from the system.

It has been found that cases of shock may be divided, clinically, into three groups [39], viz.:

Group I: Compensated Cases.—In this group the patient has the power to take up fluid from the tissues and dilute his blood. The general condition of the patient is good. The pulse is 90 to 110. The systolic blood-pressure is above 100 millimetres Hg, and the blood volume is never below 80 per cent. The plasma volume does not show so great a reduction and is usually 85 to 90 per cent of normal.

Warmth and rest are usually sufficient for this type of case. Should the symptoms get worse after an operation, gum solution should be given intravenously and saline administered per rectum.

Group II: Partially Compensated Cases.—In this group the power to take up fluid from the tissues is feeble, but there is power to retain fluid introduced into the circulation. The general condition is poor and the extremities are cold. The pulse is 120 to 140.

The systolic blood-pressure is below 90 millimetres Hg and is usually 70 to 80 millimetres. The blood volume is 65 to 75 per cent, and the plasma volume 70 to 80 per cent of normal.

The treatment in the first place should be warmth and rectal salines. If there is no improvement after an hour, an intravenous infusion of gum solution should be given. If improvement, as indicated by the condition of the pulse and blood-pressure, is maintained for two or three hours, an operation may be undertaken if it is considered necessary. If, however, improvement is only transient, a second infusion of gum solution should be given. If there is no effect from this, blood transfusion should be carried out. Should the patient collapse during or after an operation, prior to which two infusions of gum solution have been given, blood transfusion should be carried out.

A good indication of the rate at which the blood is being diluted is the rate at which the haemoglobin percentage falls. It is advisable to estimate the haemoglobin before the first infusion is given and afterwards to carry out repeated estimations. Where fluid is not being retained in the circulation the haemoglobin percentage does not fall to any appreciable extent.

Group III: Uncompensated Cases.—In these cases both the power of taking fluid from the tissues and the power of retaining it in the circulation are absent. The pulse is imperceptible. The systolic blood-pressure is below 60 millimetres Hg. The blood volume is below 65 per cent, and the plasma volume as low as 62 per cent of normal. In these cases treatment is, as a rule, of no avail. The treatment of this type of case should be warmth and early blood transfusion.
(c) Discussion of the application of the Foregoing Measures to Military Surgery in Time of War.

It will be readily understood that the varied conditions met with in warfare render it difficult to be able to maintain at all times a uniformly high standard of efficiency as far as the prevention and treatment of secondary shock are concerned.

Difficulties arise when there are large numbers of wounded to deal with, such as are seen when there is a big advance or retreat; when the weather is unfavourable and when the routes of evacuation are bad. Much has been written about what ought to be done for the wounded man at the regimental aid post, but the writers always seem to overlook the fact that during active operations the R.A.P. is often situated in a shell hole or by the side of a sunken road or in some similar place, where there is little opportunity of carrying out anything much in the way of treatment, and where detention of the patient will only serve to increase his bodily and mental discomfort. It must therefore be understood that the procedure about to be recommended cannot always be carried out in the forward area. An effort should, however, be made to do as much as circumstances will permit and what may have to be left undone at one post it may be possible to do at the next post further back along the line of evacuation. Since such factors as cold, pain, haemorrhage, and toxins play such an important part in the production of secondary shock, efforts must constantly be directed towards reducing these to a minimum.

The enormous value of the lessons taught by the late war of the benefit derived from the warming of wounded men, from the establishment of advanced operating centres, "resuscitation rooms" and "shock-teams," can hardly be overestimated.

It is proposed to indicate the lines on which prevention and treatment of shock should be carried out at the various stages through which a man passes during evacuation from the front line.

(1) Treatment by the Regimental Stretcher Bearers.—All stretchers supplied to these bearers should have fastened to them a blanket, wrapped in a waterproof sheet, which serves to keep it dry. In addition to the ordinary equipment of dressings and tincture of iodine, each bearer should be supplied with a strong pair of scissors, which enables him to get at a wound by the shortest possible route. The necessity of keeping the patient warm and of applying the dressing quickly and efficiently, with as little exposure as possible, should be thoroughly impressed upon them. They should be carefully instructed how to control haemorrhage, and how to improvise tourniquets. Personally, I found it inadvisable to encourage them to apply splints, as they usually wasted a lot of time putting them on, and they invariably had to be reapplied at the R.A.P. The only exception I made to this was the application of a rifle splint to a fractured lower limb. Needless to say, the necessity of getting patients back to the R.A.P. as quickly as possible should also be impressed upon them.
Secondary Wound Shock

It is of great importance that wounded men should not be allowed to exert themselves any more than can be avoided. Where it is necessary for them to walk back to the R.A.P. they should be divested of all unnecessary equipment, so as to enable them to perform the journey with the least possible exertion.

(2) Treatment at the Regimental Aid Post.—A supply of dry blankets, stretchers, and hot water for the preparation of hot drinks should always be at hand. Where circumstances permit, an oil stove and a pair of trestles should form part of the equipment of the R.A.P.

When a severely wounded case arrives, he is transferred to a dry stretcher, on which have been placed two blankets folded lengthwise in such a way that a double thickness of each blanket, comprising two-thirds of its width, is underneath the patient, and the remaining third of each blanket hangs as a flap over either side of the stretcher. A third blanket is folded and placed on top of the patient, and the side flaps are turned over this. In this manner the maximum warmth can be obtained from three blankets. Wet clothes should not be removed unless they can be replaced by sufficient blankets to keep the patient warm. If an oil stove is available, it should be placed under the stretcher, which rests on trestles, and the side flaps turned down so as to form a hot-air chamber beneath the patient, which soon warms him. The dressing of the wounds should now be attended to and haemorrhage controlled. Fractures should be carefully splinted and everything done to prevent aggravation of the wound during transport. Hot drinks of sweetened tea, coffee or cocoa should be given. Morphia, ¼ grain, should be administered if the patient is suffering any pain, and the fact noted on the medical card.

No operations should be undertaken anywhere in front of the casualty clearing station, except those necessary for the arrest of dangerous haemorrhage, or perhaps for the removal of a hopelessly smashed limb, which by dragging on exposed nerves is causing pain and aggravating shock.

When a severely wounded man, exhibiting the early signs of shock, arrives at the R.A.P., the treatment of his general condition and not his wounds should be the primary consideration. Having made him warm and comfortable, the aim should be to get him evacuated as quickly as possible.

(3) Treatment at the Advanced Dressing Station.—The same treatment should be continued. Unless there is any special indication, the dressing should not be touched, but splints should be readjusted if necessary. As the next stage of the journey is usually by ambulance cars, care should be taken that the cars are properly warmed and in addition, hot water bottles, if available, should be used.

(4) Treatment at the Main Dressing Station.—The warming process should be continued and hot drinks given. Splints should be readjusted if necessary. The dressing, if comfortable and not soaked with blood, should not be touched, unless it is anticipated that there will be some delay
before the case can be got back to the casualty clearing station, in which case the wound can be cleaned up and a sterile dressing applied. Antitetanic serum should be given and morphia repeated if necessary, and the fact noted on the medical card. No operation other than those referred to should be undertaken.

The importance of good organization at the main dressing station whereby serious cases are singled out and dealt with without undue waste of time cannot be exaggerated. Having carried out the foregoing treatment, the main object should be to get the patient back to the casualty clearing station as quickly as possible.

Often, however, during active operations cases have to be kept for some time at the main dressing station owing to the difficulties which may be experienced by the motor ambulance convoys in coping with large numbers of wounded. In event of this happening, it would be well to administer intravenously 750 cubic centimetres of gum acacia solution to those patients who are suffering from severe degrees of shock. Conditions will not, of course, always permit of this being carried out, but often it will be possible to give at least a rectal saline.

Where possible each main dressing station should have a resuscitation room, where patients can be thoroughly warmed. The following are a few of the types of warming apparatus which can easily be improvised beforehand:

(a) The type already referred to for use at a regimental aid post. The advantage of this form is that the warming process can be carried on whilst the patient is being examined and the dressings attended to.

(b) A type for use with the primus stove. This consists of an oil drum which is placed on the floor in the upright position. A window is cut in the side near the lower end, through which the stove can be introduced. A metal pipe fixed to the top of the drum conducts the hot air into a cradle which rests on the stretcher and is covered with blankets.

(c) A type for use with the tall pattern oil stove. This consists of an empty petrol tin which is laid with its broad surface flat on top of the oil stove. A hole is cut in the tin where it is in contact with the stove, and a pipe let into one end of it conducts the hot air into a cradle on the stretcher.

As already mentioned, care must be taken that the patient is not over-heated.

If piping is not available it can be improvised from the sides of biscuit tins.

Cradles can be improvised from strips of aluminium splinting or by using several suspension bars, such as are employed with the Thomas splint.

(5) Treatment at the Casualty Clearing Station.—At the casualty clearing station it is essential that the whole staff be so organized that there is no unnecessary waste of time in singling out those patients who urgently require treatment.
Secondary Wound Shock

Each casualty clearing station should have a resuscitation ward, fitted up with various forms of hot air, and where possible electric warming apparatus. There should be "shock teams" whose duty it is to look after the more severe cases and to attend to the administration of infusions and transfusions. A list of blood donors, whose groups have been ascertained and recorded, should be kept; needless to say this list should contain as many universal donors as possible. A supply of bottles containing citrate solution and the other parts of the Robertson apparatus should be kept sterilized and ready for use. It would also be well to have at hand quantities of preserved corpuscles for use when large numbers of wounded are expected. Quantities of gum solution, sterilized and ready for administration, should also be at hand. When a severely wounded man is admitted, the warming process should be begun as soon as possible and carried on concurrently with the removal of his clothes and the examination of his wounds.

It is at the casualty clearing station that all the methods of treatment discussed in the previous sections can usually be fully put into practice, and every possible effort should be made to deal with cases along these lines as far as time and circumstances will permit.

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