balance. This reads in pounds. I have seen the ischial tuberosity bear a push of 20 lb. for months without making the skin sore.

Flexion at the hip can be obtained by bending the splint or by elevating the foot as with a Thomas. I have seen no tendency for scoliosis to persist after the splint is removed. Within a day or two the lumbar vertebrae resume their normal position.

Two of the cases which I have treated with this splint follow. The *x*-ray plates are shown as black and white drawings, since the plates were too thin to make good prints.

CASE I.

Driver S. Bullet wound, September 30th, 1917. Entrance wound in left groin; exit left great trochanter. Operation same day: Wounds excised and cleaned; bipp. Comminuted fracture of femur—upper fragment in abduction. Abduction splint applied. October 20th: Comfortable; no fever; wounds clean. Body covered with boils due to pediculi. Boil over sacrum ruptured. October 25th: Boil over sacrum healed; no bedsore.

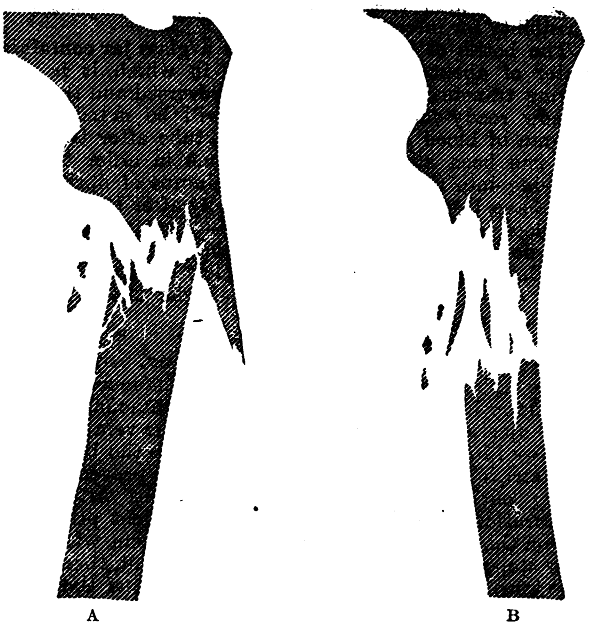
November 16th: *X* ray showed spiral fracture through lesser trochanter with a split running into great trochanter and moderate comminution. Upper and lower fragments in good alignment. Abduction at hip of 35 degrees. Some callus near lesser trochanter.

November 17th: Wounds healed. Bony union—all movements at hip and knee good. December 15th: Up and walking in calliper splint. Both legs are the same length.

CASE II.

Pte. J. Bullet wound, October 22nd, 1917. Fracture of left femur at lesser trochanter. Operation: Foreign body removed; wound cleaned; Thomas splint.

November 10th: *X* ray showed spiral fracture beginning just above the lesser trochanter and following the spiral line,



A B

FIG. 5.—Tracings of *x*-ray plates of Pte. J. A, Fracture while on Thomas splint. Upper fragment in abduction. Angulation at fracture and consequent shortening. B, Fracture while on abduction splint. Fragments in line with slight over-correction and 1 cm. over-extension.

leaving the lesser trochanter intact on the upper fragment. Considerable comminution and loss of some cortex. Upper fragment is turned out in abduction and is flexed at the hip. Lower fragment in poor line. There is marked angulation at the point of fracture. Plate shows some hazy callus, probably not bony.

Operation, November 16th: Fragments forced into position; callus broken up. Nails driven into condyles for extension. Abduction splint applied. On November 18th *x* ray showed marked improvement. There was slight over-correction (Fig. 5). Abduction angle lessened from 45 to 35 degrees. Alignment perfect.

December 12th: Condylar nails loose; removed. Adhesive leg extension. December 25th: Union firm.

Measurements:

	Left.	Right.
Great trochanter to adductor tubercle ...	41 cm.	40 cm.
Anterior iliac spine to adductor tubercle ...	45 cm.	44 cm.
Anterior iliac spine to internal malleolus ...	85.5 cm.	85 cm.

The fractured femur is 1 cm. longer than the sound one.

A METHOD OF CITRATED BLOOD TRANSFUSION.

BY

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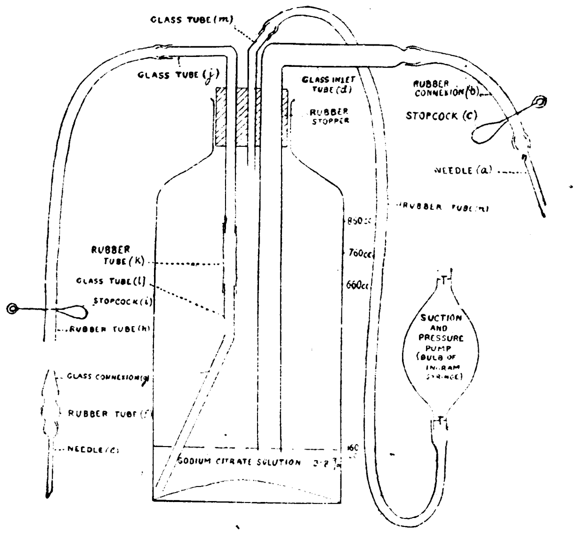
TRANSFUSION with citrated blood has had a fairly wide use in civil practice during the past few years. Reports have varied concerning the satisfaction this method has given. Some workers report excellent results. Others have experienced certain drawbacks, especially the occurrence of reactions after transfusion. Although the method of citrate transfusion is very simple, definite precautions must be observed or the blood will undergo changes, while outside the body, that may render it toxic. The very fact of the apparent simplicity of transfusion with citrated blood has undoubtedly led in many instances to a lack of appreciation of the care necessary in carrying out the technique, with consequent undesirable after-effects; blood is a very delicate tissue, and must be handled accordingly. The chief consideration is to get the blood quickly and cleanly into the citrate solution so that coagulation changes, which always begin the moment the blood leaves its containing vessel, may be stopped as soon as possible. The passage leading from the vein to the citrate must be of large diameter, as short as convenience will permit, and absolutely clean. The blood must be well mixed with the citrate at once. With unsuitable apparatus, clotting will probably occur in the tube system, which, although it may not entirely occlude the lumen, will slow the flow to such an extent that the blood undergoes considerable change before reaching the citrate. This is the kind of blood which tends to produce reactions when transfused. With properly constructed apparatus and careful technique, reactions ought to be of infrequent occurrence.

APPARATUS.

The apparatus shown in the diagram has been found satisfactory. It is simple in use and can easily be made out of material at hand.



Transfusion apparatus.

A. *Transfusion Bottle.*

A wide-mouthed well-cleaned drug bottle with a capacity of 900 to 1,000 c.cm. will serve as the transfusion bottle. It should be short and wide, rather than long and narrow, since this shape diminishes the length of intake tube necessary. Three marks are made on the bottle with a file, one at the 660 c.cm., one at the 760 c.cm., and the other at the 860 c.cm. levels, indicating 500, 600, and 700 c.cm. of blood respectively. It is well to use a glass pencil as well to make the marks more distinct. 160 c.cm. of a 3.8 per cent. solution of sodium citrate (isotonic), made up with freshly distilled water and filtered, is placed in the bottle, which is stoppered with a cotton plug wrapped in gauze. A second piece of gauze is tied on over the stopper and neck of the bottle. It is then autoclaved; half an hour at 105° C. should be the minimum. Where a number of transfusions are being given half a dozen or more of these bottles are prepared at once.

B. *Bleeding System.*

The needle (*a*) should be of a large bore—1.5 to 2 mm. internal diameter was found to work well—and not more than 3.5 cm. long (1.5 in.). It should have a fairly large olive-shaped base. The needle is the most important part of the apparatus, and requires careful attention. Before each bleeding it should be carefully sharpened. The most important consideration in the sharpening is to produce a good spear-point. If the point is well protected when not in use by a metal barrel or piece of rubber tubing, sharpening will require only a moment or so. The needle must be kept scrupulously clean, and after each bleeding should be washed out at once, all fragments of fibrin or clot removed from the base, and small pieces of cotton-wool soaked in liquid paraffin thrust through the lumen with the stilette. The whole needle is well oiled before being put away.

The rubber connexion (*b*) should be flexible, and not more than 8 cm. long (3 in.). The inner surface should be smooth, and the lumen slightly smaller than that of the glass inlet tube (*c*). If the rubber connexion fits snugly over the base of the needle, tying it on is not necessary.

The glass inlet tube (*d*) is made of a large-bore glass tubing about 6 mm. internal diameter. It should extend below the level (A) of the solution in the bottle.

C. *Transfusing System.*

The needle (*e*) employed has a bore about half the size of that used for bleeding. The length is not important. As shown in the illustration, the needle is attached to a short glass tube (*g*) by means of a small piece of rubber tubing (*f*).* The free end of the glass tube is thrust into the end of the long rubber tube (*h*) after the needle is in the vein. The rubber tube (*h*) may be of any convenient length. The glass tube (*l*) is bent so that the end projects into the lowest part of the bottle. In this way almost every drop of blood in the bottle may be given.

D. *Pump.*

The bulb of an Ingram syringe serves as a pump with the valves arranged as in the diagram. Suction or pressure can be made by reversing the ends.

PROCEDURE OF BLEEDING.

The donor's arm is extended at a right angle to the body. The skin of the antecubital space is scrubbed up with soap and water, and the sterilization completed with alcohol. A tourniquet is applied to the arm high up, and a suitable vein chosen, remembering that the needle is to be inserted towards the hand. It is very important to have as large a vein as possible. Opening and closing the fist and flicking the skin below the point chosen for venepuncture aids much in dilating the veins. At the point selected to puncture a small amount of novocain is injected intracutaneously. The tourniquet is then released. The apparatus is assembled as shown in the diagram, great care being taken to keep all the open parts sterile. The stopcock (*i*) is closed and the open end of the rubber tube (*h*) protected with a piece of sterile gauze which is conveniently held on by a pair of Spencer Wells forceps. Sufficient pressure is made with the pump to fill the bleeding system with solution. When the air has been driven out of the needle, the stopcock (*c*) on the connecting tube is closed. The pump bulb is reversed so that suction can be made when needed. The apparatus is now ready for use.

The tourniquet is again tightened sufficiently to make the veins stand out well, but not enough to obliterate the pulse. The cuff of a blood pressure apparatus makes an excellent tourniquet with a pressure kept at 50–60 mm. of Hg. A small nick is then made through the skin with the point of a scalpel. The bottle is placed on a stand close to the patient's arm in such a position that there will be no kinking of the rubber connexion when the needle is in the vein. Slight suction is next made in the bottle. The skin opening is mopped dry with a piece of sterile gauze and the needle inserted for a short distance beneath the skin before entering the vein. The stopcock (*c*) is then opened and the needle is pushed into the vein immediately. The blood follows the column of solution down the tube without leaving an air space. A moderate degree of suction is maintained, and the donor continues to open and close his hand slowly, care being taken that he does not move his arm. It is essential to keep the needle immobile. The operator should hold it throughout the bleeding, steadying his hand against the donor's arm. With the free hand the bottle is given a rotary motion every few seconds in order to ensure thorough mixing of the blood. In doing this care should be taken to avoid pulling on the needle. With these precautions 500 to 700 c.cm. of blood can be easily and quickly obtained.

If clotting occurs for any reason, such as the needle slipping out of the vein or air leakage, and the blood ceases to flow, the tourniquet should be released, the stopcock closed, the needle withdrawn from the vein, and another attempt made with a fresh apparatus (needle, rubber connexion, and glass tube), using the same receiving bottle. It is usually better to take the other arm.

When the blood has reached the desired amount the tourniquet is removed, the stopcock closed, and the needle withdrawn. The bottle is again agitated for a few seconds.

If the donor's veins are small and the needle method fails, the vein can be cut down upon and a cannula used. Inserting a cannula into a vein is more difficult and time-consuming than the needle method, and offers greater possibility for infection.

The bottle of blood is placed in a glass jar containing water of about body temperature, in which it is kept during transfusion. The pump is reversed and the blood is now ready for transfusion. It will be noted that a column of blood is left in the intake tube after the bleeding has been stopped. This is done in order to avoid drawing into the bottle any little clumps of fibrin which may have begun to form immediately after the cessation of blood flow through the tubes. Leaving this blood does no harm. The blood should be given as soon after the bleeding as possible. If it is left standing for some time, changes may occur which make the blood less beneficial or even toxic.

PROCEDURE OF TRANSFUSION.

The recipient's arm is prepared in a manner similar to that described for the donor and a small amount of novocain injected into the site chosen for the vein puncture. It is well to tie the rubber stopper down to the bottle with two strips of adhesive plaster in order to prevent it from flying out when the pressure increases. After these preparations have been completed, sufficient pressure is put on the pump to fill the transfusing system with blood. The stopcock (*i*) is opened to let the air out, then closed. The tourniquet is next tightened. As soon as the needle enters the vein blood flows out through the short glass tube; the tourniquet is immediately released, the apparatus is connected up, the stopcock opened, and the pump started.† This technique is simple, and, if carried out carefully, there is no danger of forcing air into the vein. If the veins are collapsed or constricted, as is the case in certain patients with shock and haemorrhage, it may be necessary to cut down on the vein and use a glass or silver cannula instead of the needle.

By using a needle it is scarcely possible to force the blood in too rapidly. With a cannula care must be taken to go slowly. Ten minutes should be the minimum time for the introduction of 500 c.cm. of blood. Care should also be taken to close the stopcock before the air bubbles begin to pass up the tube.

REMARKS.

The question may be raised whether it is not better to coat the inside of the bottle and tubes with paraffin. Theoretically this would be a good thing, and in "peace" times it can be carried out. In rush periods, however, it

* A needle with a close-fitting metal connexion is more easily handled. The metal connexion is slipped into the open end of the rubber tube (*h*) beforehand.

† The operator should hold the rubber-glass connexion firmly throughout the transfusion.

is quite impractical on account of the time required for the coating. Furthermore, judging by the excellent results obtained without the use of paraffin it seems questionable whether a paraffin coating is necessary.

An isotonic solution of sodium citrate is used instead of the 10 per cent. solution customarily employed, since it is felt that this maintains more nearly normal conditions for the blood. The amount of sodium citrate contained in the 160 c.cm. of "isocitrate" is approximately 6 grams. No harmful effects have ever been observed from the injection of this quantity of citrate, which is very much less than the supposedly toxic dose; 0.5 per cent. citrate has been shown to be sufficient to prevent clotting when well mixed with blood. When 500 c.cm. blood are drawn into 160 c.cm. of a 3.8 per cent. solution the resulting mixture is 0.9 per cent. citrate. With 700 c.cm. blood it is 0.7 per cent. An amount of blood as large as 800 c.cm. may be taken into this amount of citrate with safety if the blood flow is well maintained and the blood and citrate are thoroughly mixed. The sodium citrate in this mixture equals 0.6 per cent. In bleeding quantities over 700 c.cm. the flow through the needle frequently begins to slow up and mixing the blood and citrate becomes more difficult.

RESULTS.

This method was used under rush conditions. Forty-four transfusions were given to 38 patients. The patients transfused were cases of haemorrhage and shock—chiefly the former. Donors were always tested beforehand for compatibility of blood. The amount of blood given in a single transfusion varied from 400 c.cm. to 700 c.cm. The average quantity was between 500 c.cm. and 600 c.cm. In cases of very marked anaemia a second transfusion was occasionally given. Briefly it may be stated that the immediate effect of citrated blood was the same as that seen after the transfusion of blood by the other methods in common use. The blood pressure increased from 20 to 40 points afterwards. On one occasion there was a rise of 50 points, after only 450 c.cm. of blood. The general improvement was maintained and increased. The patients stood operation well, and subsequent progress was fully as satisfactory as seen ordinarily following transfusion. Of the 38 cases transfused 25 were evacuated to the base in good condition, and 13 died—a mortality of 34 per cent.

No reactions of any consequence were observed. In several instances there was slight chilliness during or immediately following transfusion, which soon passed off without further discomfort. It was impossible, under the rush conditions, to keep temperature charts on the majority of the patients, but in a number of instances in which temperatures were taken no rise occurred afterwards.

ADVANTAGES.

Aside from the chief advantage of its being a "one man job," this method has several other considerations in its favour. The apparatus can be made from materials easily obtained. The technique of transfusion is simple and quickly carried out. The bleeding can be done in a conveniently arranged room outside the resuscitation ward. The blood is then carried into the ward and given at the bedside without the necessity of moving the recipient, thus avoiding injury, which is often done to the patient in shock by moving him to the operating theatre, or even on to a table near by.

SUMMARY.

The use of citrated blood for transfusion seems to fill a definite need in that the technique is relatively simple, easily acquired, and can be carried out entirely by one medical officer. Furthermore, this method obviates the necessity of having the donor and recipient together, and the blood can be given at the bedside. Stress is laid on the fact that, although the technique is apparently very simple, certain definite precautions must be observed in the handling of the blood in order to obtain good results. The chief considerations in the technique are to get the blood quickly and cleanly into the citrate, to obtain prompt and thorough mixing of the blood with the citrate, and to transfuse the blood as soon as possible after the bleeding.

An apparatus is described which can easily be constructed, and has been found to work satisfactorily. The blood is received into isotonic sodium citrate—3.8 per cent. The amount of this solution—160 c.cm.—contains 6 grams of sodium citrate, which has no harmful effect. When a good blood flow is maintained through a needle of adequate calibre and the blood and citrate are well mixed, as large a quantity as 800 c.cm. blood may be obtained by this method.

A series of forty-four citrate transfusions were given under rush conditions at a casualty clearing station with good results. The immediate effect of the transfused blood and subsequent progress of the cases were fully as good as that seen following ordinary transfusion. No reactions of any consequence were observed.

DESTRUCTION OF NITS OF THE CLOTHES LOUSE BY SOLUTIONS OF CRESOL-SOAP EMULSION AND LYSOL.

BY

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THESE experiments were carried out with a view to assisting officers in charge of baths and wash-houses where the clothes of infected troops are treated in order to rid them of lice. From conversations with officers in charge of these establishments it appears that a precautionary measure frequently employed is to steep infected garments in a vat containing solutions of cresol-soap emulsion. There exists, however, some uncertainty as to the strength of the solution and period of immersion necessary to destroy the nits of *Pediculus humanus*. In this connexion it may be pointed out that overlapping methods of disinfestation should if possible be avoided in the interests of economy. Hot water or dry heat at 55° C. destroys both nits and active lice within thirty minutes, even when protected by a covering of khaki cloth; while, if the temperature is raised to 60° C., fifteen minutes suffice. If at any period during the process of washing or drying garments they are subjected to the temperatures and periods above given, chemical solutions are unnecessary; if, on the other hand, the garments are steeped in effective chemical solutions, then it is unnecessary to use temperatures so high as those mentioned for washing or drying.

In utilizing the results of the present experiments for practical disinfestation it must be borne in mind that solutions of both cresol-soap emulsion and lysol degenerate in their effectiveness for the destruction of bacteria in relation to the organic matter with which they become charged during use, and it is probable that a somewhat similar fall in their effectiveness for the destruction of nits may occur. It has not been possible, so far, to ascertain if this probable drop in efficiency occurs, owing to our lack of knowledge of the exact condition of use. If samples of solutions actually employed could be forwarded to the Lister Institute, with the necessary data as to strength and the relations of quantity of fluid and period of use, and the number of garments treated, it would be possible to carry out the experiments necessary to obtain information on this point.

METHOD OF TEST.

Pieces of army shirt flannel on which numerous nits had been laid were immersed in the solutions for the periods shown in the accompanying tables; they were then taken out, and the superfluous fluid removed by placing on filter paper for a few minutes. After this they were placed in small entomological boxes lined with a strip of dry flannel, and carried in a thin cotton bag, suspended from the neck between skin and shirt, to incubate.

On examination of the tables it will be noted that the lysol (crude carbolic acid and soft soap emulsion) solutions are decidedly more effective than the cresol-soap emulsion solution at the higher temperature but less so at 32° F. Why this should be the case is not evident. The difference