TRANSFUSION OF BLOOD IN WAR SURGERY:

SOME INDICATIONS AND RESULTS, AND DESCRIPTION OF NEW MODIFIED DIRECT METHOD.

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THE indications for transfusion of blood in war surgery are: (1) anæmia, caused by (*a*) loss of blood, (*b*) prolonged sepsis; (2) retarded healing of wounds, including compound fractures.

Anæmia.

Severe loss of blood may occur at the time a soldier is wounded or within a day or two afterwards, and then due to the return of blood pressure removing blood clot, &c. Transfusion of these primary hæmorrhage cases is beneficial immediately and permanently, so long as the blood of the donor is suitable and the "wound" shock not too great. Some transfusion enthusiasts claim a great deal for it in surgical shock; still, when we consider what we know of the pathology of shock, we must not expect too much of transfused blood in these cases. Often the accompanying manipulation and exposure of these cases do more harm than the transfusion does good, if any, unless the anæmia is extreme.

Hæmorrhage may occur after sepsis is well established in a wound, usually six to eight days after receipt of wound, or after an amputation for sepsis. These cases were very common at the "Base" in the early part of the war, and are liable to occur even now. These men cannot stand the loss of blood, not even a few ounces. Transfusion, either after they have had a secondary hæmorrhage or before severe operations, such as amputation, has been instrumental in saving many lives. It replaces the blood that has been, or is going to be, lost, and I am sure prevents "shock" in some degree. Also it often makes a necessary operation possible in an otherwise hopeless case.

Prolonged sepsis.—There is another large class of case in which transfusion is becoming more popular every day, and that is in prolonged sepsis. In nearly all cases of severe septic wounds there comes a time when the patient's resistance becomes exhausted. His wounds have an "indolent" appearance, and healing is slow or absent; he has loss of appetite, and has no "kick" left in him. These cases are always profoundly anæmic. The coagulability of the blood is diminished, there is œdema of the back and legs, and often pus in the urine.

There are many types of this picture I have tried to describe, from the case of a slowly healing stump to the case of pyæmia. From my own observation over many months I find that they are all improved by a suitable transfusion, the severe cases temporarily, the mild cases permanently. Until lately transfusion has only been used in almost hopeless cases, or rather not employed until they were almost hopeless. I believe that the injected blood is directly stimulating to the tissues, so that I advise it to be used early in the case, before the body has lost its power of reaction.

There are now being recorded many cases of "prolonged sepsis" which clinically appear to be septicæmic, and which become well either with or without transfusion. My own observation goes to show that all these cases improve by transfusion so long as the donor's blood is properly examined in conjunction with that of the recipient. It is therefore probable that the donor's blood contains antibodies which may affect the life of the micro-organism probably present in the recipient's blood. It is conceivable that this process might be carried out more effectively by a preliminary vaccination of the donor with autogenous vaccine prepared from the recipient, if the organism can be recovered and the septicæmic recipient does not succumb in the interval necessary for such antibodies to be produced in the donor.

In primary hæmorrhage the most satisfactory amount of blood to use appears to be from 750 to 800 c.cm. given at one transfusion. In septic cases smaller amounts are indicated, 300 to 500 c.cm. repeated in 7 to 10 days, using a fresh donor each time. Donors under the age of 25 seem to stand the withdrawal of blood very well, and after a few hours feel quite fit again.

Retarded Healing of Wounds.

"*Indolent*" *wounds.*—These so-called "indolent" wounds have usually large raw surfaces, with no, or very anæmic, granulations upon them, and they show no sign of healing, the skin edges often being blue and lustreless. In the early part of the case there has been much discharge, and there has of necessity been a heavy drain upon the patient's fluid blood. There is no reaction in the wound. There may be no increase of temperature, but as a rule the pulse-rate is still rather high. Stimulating dressings do no good; some, such as saline, often cause troublesome hæmorrhagic oozing, which has a deleterious effect upon the patient. Non-healing stumps may be mentioned as one of the most common types in this category. Repeated blood transfusion of, say, 400 c.cm. at ten-day intervals, is most beneficial.

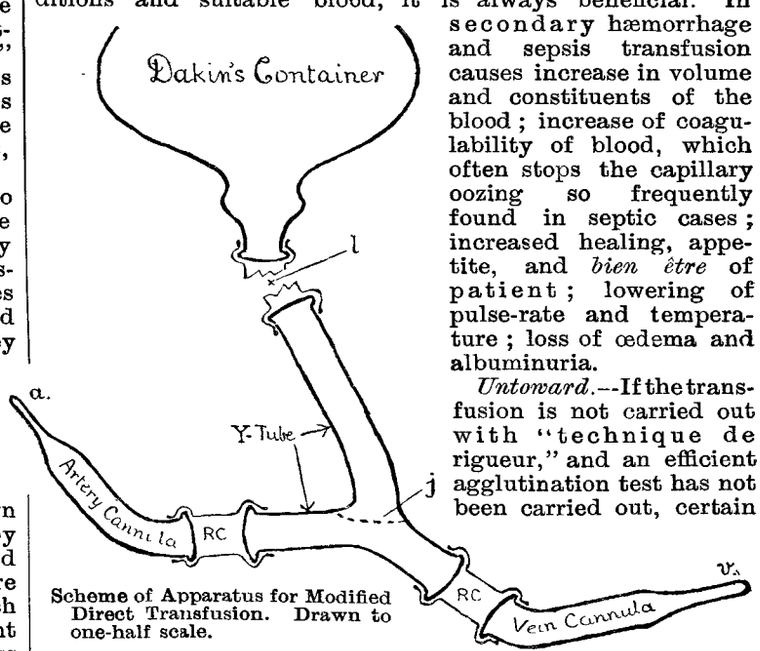
Compound fractures.—The same remarks as have been made about "indolent" wounds are applicable to septic compound fractures, especially those of the femur. There is no doubt that in long-standing cases, where the suppurative process continues in a "watery" manner and there is persistent non-union and no attempt on the part of the patient to react to the infection or throw out new bone, repeated small transfusions increase the production of osteoblasts and alter the appearance of fragments under the X ray which previously may have been considered "dead."

Bed-sores.—Although it is not nice to mention bed-sores in the best regulated institutions, they undoubtedly occur, and their treatment is a bugbear to both young and old members of the profession, to doctors and nurses alike. I find that transfusion, although it may have been done for some other condition in the soldier patient, is invariably most beneficial to a concurrent bed-sore. The appearance of a bed-sore often alters the prognosis very materially.

Results.

Until lately it has been difficult to dogmatise on the results of transfusion in war surgery. It has been used for so many purposes, some quite unsuitable, as in cases which were hopeless from the beginning; also, in numberless "shock" cases, so that it has deserved its reputation among the people who say that "it is something to do" and leave it at that.

Good results.—In primary hæmorrhage, with suitable conditions and suitable blood, it is always beneficial. In secondary hæmorrhage and sepsis transfusion causes increase in volume and constituents of the blood; increase of coagulability of blood, which often stops the capillary oozing so frequently found in septic cases; increased healing, appetite, and *bien être* of patient; lowering of pulse-rate and temperature; loss of œdema and albuminuria.



Scheme of Apparatus for Modified Direct Transfusion. Drawn to one-half scale.

Untoward.—If the transfusion is not carried out with "technique de rigueur," and an efficient agglutination test has not been carried out, certain alarming or even fatal results may take place. Immediate: hæmolysis, agglutination, possibly causing sudden death; cyanosis, with feeble pulse, possibly caused by giving too large a volume of blood when the heart muscle is degenerated from sepsis. Later: sweating, rigors, pyrexia, apparently found more frequently after giving citrated blood; hæmaturia.

Modified Direct Method.

The rationale of this method is to convey blood from an artery of the donor to a vein of the recipient and allow the operator to observe the flow, so that he knows immediately if the flow should cease or if any clotting is taking place.

The apparatus is very simply "home made." It consists of a Y-tube (see figure), two limbs of which are shortened, and two glass cannulæ. These cannulæ are connected to the short limbs of the Y-tube by sterilised rubber tubing (R C); the third limb is connected (*l*) with a reservoir of saline 0·8 per cent. or sodium citrate 3·8 per cent. by tubing about 5 feet long, which has a clip on it. All rubber connexions are conveniently tied with silk. The length of the instrument—that is, the distance the blood must flow through the tube, is about 6 inches. The diameters are: of tip of artery cannula (*a*) 1 mm. internal and 2 mm. external; of vein cannula (*v*) 2 mm. internal and 3 mm. external; of Y-tube cannula 6 mm.

The Y-tube and cannulæ are waxed after sterilisation and joined up in position with rubber tubing which has been duly sterilised. The long limb of the Y-tube is now connected to the reservoir of sodium citrate solution and the apparatus is ready for use.

The operation is as follows:—

The donor's left radial artery is usually taken (unless he is left-handed), the distance between artery and the selected vein in recipient is roughly measured off with instrument, and the two arms secured in position with adhesive. Two operators are necessary: one to prepare the artery and one to prepare the vein.

The skin over the proposed wound is sterilised with 1–20 carbolic, which also acts as an anæsthetic. The radial artery 1½ inches above wrist is dissected out through an inch incision, tied off distally with fine silk, a second loop of which is passed under the artery and used later to tie in the cannula. The artery is now opened with a Graefe's knife from above downwards and outwards, leaving a V-shaped tongue. Pressure in the meantime is applied above the wound to prevent loss of blood.

The vein is prepared in the same way. The clip on the tubing leading to the reservoir is now opened, and the apparatus filled with citrate. The artery cannula is now tied into artery and blood allowed to flow until it reaches the tip of vein cannula, when pressure is again applied to artery. The vein cannula is then tied into vein and all pressure taken off artery. The blood can now easily be seen flowing through the Y-tube at the junction of the short and long limbs where the clean solution of citrate comes in contact with the blood (*j* in figure). This can be more easily demonstrated by occasionally opening the clip on the tube to reservoir, which is suspended about 3 feet above the patient, when the clear solution is seen passing quickly into the vein cannula. This is even more pronounced if pressure is applied to the artery.

At the termination of the operation the cannulæ are withdrawn after pressure has been applied above each wound, both vessels ligated, and skin sutured.

I have not seen any untoward results from tying off the radial artery, although some members of the profession appear to consider the procedure unjustifiable. The anastomosis round the wrist has never been embarrassed in my experience. Care must be taken not to cut branches of the radial nerve. I made a rough calculation as to the amount of blood which passes through the apparatus by running the blood from the radial into a dish containing citrate, the mixture being subsequently transfused. In six men, with average arteries and blood pressure, the amount worked out at 750 c.cm. of blood in five minutes.

Although the method is quick and requires little apparatus and I have never known clotting to take place, yet I do not consider it has many advantages over some of the indirect methods for general use.

Conclusion.

Since the early part of 1916, when I first used this method, there has been such an extensive literature upon blood transfusion in war surgery that it is unnecessary to touch upon the relative advantages of the various methods advocated. I consider that transfusion has a large field of usefulness in war surgery; that whenever possible "whole" blood should be used, as all the constituents of the blood are necessary, especially in septic and septicæmic cases; that a preliminary agglutination test should always be carried out, except when the groups of donor and recipient are known; and that the "Dakin container" indirect method is the most simple and efficient method for general use, as the apparatus is easily made or obtainable, the required amount of blood can be given at one filling, and little assistance is required, also whole warm, unadulterated blood, with little chance of infection, is quickly transferred from one patient to another. Of course, the method selected must necessarily vary according to circumstances of location and available apparatus.

Reference.—O. H. Robertson, Captain, M.O.R.C., U.S.A., British Medical Journal, June 22nd, 1918.

ABNORMAL CONDITIONS OF ENAMEL IN CASES OF MALNUTRITION.

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APART from caries there are many abnormalities to be found in the enamel of the teeth in cases of malnutrition. If 100 good-class children are compared with 100 poorly-fed, ill-nourished children, even a casual inspection will show that the teeth of the poorly-fed children are much more defective than those of the better-fed ones.

The study of defects in the enamel is a matter of much interest and importance, for there is, as it were, a permanent record in many cases of the state of the child's nutrition at various periods of life. The calcification of the enamel begins about the fifth month of intra-uterine life, and the following diagrams give the rate of progress of calcification at various periods for both the temporary and the permanent sets.

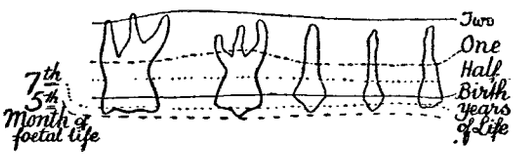

FIG. 1.

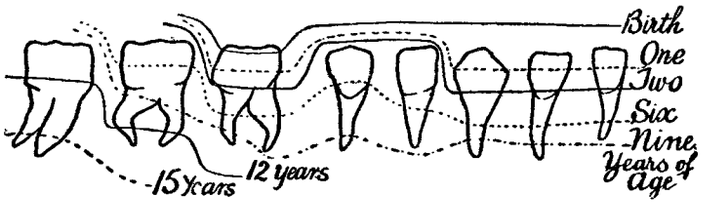

FIG. 2.

It is extremely rare to find the cutting edge of the incisors and canines of the milk teeth with imperfect enamel, and it will be seen that this enamel is laid down or calcified during the last four months of intra-uterine life. On the other hand, it is quite common to find the enamel of the cutting edge of the same teeth of the permanent set markedly defective. This enamel is laid down in the first year of extra-uterine life. In other words, in almost all cases during intra-uterine life the calcification of the enamel proceeds normally, but immediately after birth factors step in which interfere with the proper growth of the enamel, producing defects which are permanent and which are likely to weaken the defences of the teeth and to lead to decay. The agents which determine the tendency to decay are those which affect the soft enamel organ in the earliest history of the tooth and not those which affect the enamel after the tooth has been erupted.

Results of Investigation.

403 children of 11 years of age and over were taken from the ordinary London County Council schools, but of these 281 were children in schools where the nutrition was distinctly below the average. No attempt was made to select children of poor nutrition beyond that they belonged to a poor school and lived under slum conditions in the East-End of London in a poor and overcrowded neighbourhood. As a control 122 children were taken from good-class schools in North London, where the social conditions were fairly good and where the general state of nutrition was good. The following were the figures:—

(A) 403 children. (B) 281 where nutrition was decidedly poor.
(C) 122 children of good nutrition.

	(A)	(B)	(C)
Enamel normal ...	273 cases = 67·5%	... 167 = 60%	... 106 = 87%
,, defective ...	130 ,, = 32·5%	... 114 = 40%	... 16 = 13%

Carious conditions have not been dealt with in these figures. The conditions of the enamel met with in these cases may be summarised as follows:—

1. *Typical hypoplasia.*—As already noted,[1] in these cases the enamel of the teeth is markedly defective, so that the

[1] The Teeth in Rickets, Proceedings Royal Soc. Medicine, 1916, ix., 83–89.