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PART I.
ORIGINAL COMMUNICATIONS.

ART. X.—*Remarks on the Operation of Transfusion and the Apparatus for its Performance.* By ROBERT M'DONNELL, M.D., F.R.S., one of the Surgeons to Dr. Steevens's Hospital.

IN the May number of this Journal for the present year Dr. Beatty published a case of *post partum* hemorrhage, in which the operation of transfusion had been performed. I may be allowed cordially to thank him for the flattering terms in which he speaks of the individual who had the good fortune to be the operator in this instance. I may be also allowed to return the compliment by saying that I have seldom read anything at once more truthful or more graphic than his description of the near approach of death and the dawn (as one may almost say) of returning life in the patient. It was one of those cases which repay a surgeon for years of anxiety and toil, and which make up for many disappointments.

The operation of transfusion may be rendered so simple and so safe that I am convinced it should be performed in a much larger number of cases than it is at present. The surgeon should be prepared to perform it not only in all cases of impending death from loss of blood, where it has been possible to arrest the actual hemorrhage, or where it has become spontaneously controlled, but in many other instances. When an operation is simple, almost free

from danger in itself, and as regards its performance nearly painless, it is well to try it in cases in which one would shrink from it were it a dangerous or difficult procedure. Acting upon this principle, I once performed it in a case of tetanus, to which I shall presently refer, and I conceive it is well deserving of more extended trial in such cases, as well as in chlorosis, cholera, and other affections.

At present I wish to confine my observations to two points, one physiological as regards the fibrin of the blood, the second practical touching the apparatus and mode of performing the operation.

I conceive that most physiologists at the present time will agree with me in thinking that it is an advantage to get rid of the fibrin of the blood about to be used for transfusion. Few are now found to believe that the fibrin is an all-important nutritive element (plasma) existing in the blood, without which it ceases to exercise its life-supporting functions. Notions upon this subject have undergone a great change since, some twenty years ago, Mr. Simon drew attention to what is now, I fancy, regarded as the true state of the case. In his admirable "*Lectures on General Pathology*" he says:—

"This is a matter of great importance, and you cannot do justice to it without reflecting carefully on the natural functions of fibrin. Many physiologists have regarded fibrin as that ingredient of the blood which, in the ascending scale of development, stands next for appropriation into the living textures of the body: they have regarded it as representing the ripeness, and perfection, and nutritiveness of the blood. On the opposite side, of late years, have been some who inclined to a very different view, thinking that they find cogent reasons for placing fibrin on the same scale as the extractive matters, and for reckoning it among those elements which have arisen in the blood from its own decay, or have reverted to it from the waste of the tissues. I may confess that, to my mind, this appears infinitely the more plausible view, and I will tell you the arguments which induce me to adopt it.

"First, I find that fibrin is undiminished by bleeding, however frequently repeated: nay, that it often, or even usually, increases under this debilitating treatment; its highest figure given in Andral's book (10·2) was at a fourth bleeding; and Scherer found it as high as 12·7 at the third venesection in a case of pneumonia. I find that under many other circumstances of exhaustion, and weakness, and inanition, during the progress of starvation, during diseases essentially anemic, during violent fatigue, and the like, its

proportion has been found at least as high, perhaps higher, than in the inflammatory process. And as in these respects I find its proceeding to be in direct contrast to that of the red-globules (which we know to be potential elements in the blood, and which are at once reduced by bleeding or starvation), so also do I find a similar contrast in another striking particular. Messrs. Andral and Gavarret, in the course of their extensive researches in the comparative physiology of the blood, ascertained that an improvement in the breed of an animal tended always (*cæteris paribus*) to increase the proportion of its coloured blood-corpuscles; they found that the same improvement tended likewise to diminish the proportion of its fibrin. And I find further indications of the same inverse ratio between the fibrinousness and the perfection of the blood, in the facts that there is little or no fibrin in the blood of the fetus, none in the egg, none in the chyme, and less in the blood of the carnivora (who feed on it) than in that of the herbivora.

“Some of these facts, derived from very different sources, appear quite inexplicable on the theory that fibrin is essential to the progressive development of the tissues; and the opposite inference seems unavoidable, that it must be considered an excrementitious product, derived from the waste of the tissues or the oxidation of the blood, and in progress of elimination from the system. This conclusion, carried into the domain of pathology, would lead us to suppose that an augmented proportion of fibrin in the blood (whether occurring in active disease or within the limits of apparent health) can be taken as an indication only of increased labour and waste in certain elements of the body, not of an increased development in the resources and nutrition of the blood. And on the same grounds it would appear that a super-fibrination of the blood, in acute inflammatory diseases, must be regarded as a consequence and effect of those diseases, not as their cause, and not as a primary affection.”

If we add to all this, so well expressed by Mr. Simon, the *fact* observed by Dr. Brown-Sequard and verified by myself, that when defibrinated blood is made artificially to circulate through the limbs, trunk, or head of a recently dead animal, it emanates from the veins charged with fibrin, we find strong corroborative evidence in favour of the view that it is, in truth, a material of an excrementitious nature. The same notion is strongly supported by the further fact that the fibrin is destroyed in the blood passing through the liver and kidneys.

Physiologically, therefore, it appears that blood is rendered more suitable for the purposes of transfusion by being deprived of its fibrin. From a surgical point of view, of course, defibrinated blood has immense advantages. No one who has not made experiments on the subject can fancy the difficulty of transferring blood from one creature to another without its coagulating. To defibrinate the blood previous to its injection disarms the operation of more than half its difficulties and dangers. There is no occasion for undue haste; there is no risk of embolism from clots; the serum, the salts, and the blood discs, all the vivifying elements, in short, are present; nothing is left out save what is physiologically useless, if not injurious and surgically dangerous.

There is but one objection which can reasonably be urged against defibrination, and this is the time lost in doing it. Transfusion is generally an operation of emergency; there is, it is urged, no time for stirring the blood and straining it. To meet this I should propose that every case containing the transfusion apparatus should be provided with a solution of phosphate of soda, so that, according to the plan of Dr. Braxton Hicks,^a it might be added and coagulation prevented if it appeared that the patient's life might be lost during the few minutes lost in defibrinating.

As regards the advantages of omitting the fibrin from the blood, the experiments of Panum are important and indeed conclusive. He showed that, if clots of any size enter the vein, death occurs either during or immediately after the operation from obstruction of the pulmonary artery. If death is not immediate it may supervene later, owing to embolism produced at some point in the circulation.

The researches of Brown-Sequard and Panum have, therefore, a great practical value, inasmuch as they demonstrate that for purposes of transfusion fibrin is not an essential part of the blood. It is, as a matter of fact, reproduced in forty-eight hours, and its

^a Dr. Braxton Hicks (*Guy's Hospital Reports*, Vol. xiv., p. 1) recommends a solution of phosphate of soda of the same specific gravity as the blood. He says:—"I would propose that three ounces of fresh phosphate be dissolved in a pint of water; some of this will crystallize out, but when required for use it will rapidly re-dissolve if immersed in warm water at 100° Fah. The proportion of the solution to the blood employed should be about one-fourth."

Neudörfér recommends the addition of two grammes of bicarbonate of soda dissolved in from thirty to forty-five grammes of a solution of albumen or sugar to every 120 grammes of blood. It is obviously better, unless the circumstances very urgently call for it, to avoid the introduction of such substances.

absence exercises little or no influence on the quantity of urea evacuated.*

The case in which I some years ago performed the operation of transfusion in a patient suffering from tetanus presented some features of interest which make it worth relating. Although I cannot say that it seemed to exercise any beneficial effect upon the complaint, or even to prolong the patient's life, it certainly gave relief from a very distressing symptom. It was quite impossible to induce the patient to swallow anything, so great was the spasm of the gullet; enemata were instantly ejected. It was most piteous to hear her constantly crying through her teeth, clenched upon a piece of cork—"Save my life, save my life if you can; I am dying of hunger and thirst." An hour after the operation the sister in charge observed that she ceased to complain of hunger or thirst. The spasms did not, however, diminish in either frequency or intensity. As the patient was quite conscious during the performance of the operation, she was able to describe accurately her sensations as the blood was thrown into her veins. The following is a statement of her case, as noticed at the time by Dr. W. Dudley White, then residing in Jervis-street Hospital:—

Mary Anne Dooley, aged fourteen years, was admitted to Jervis-street Hospital on March 27th, 1865, with a contused and lacerated wound of the right hand, which had been caught between the rollers of a paper mill. The little finger was completely destroyed, and the rest of the hand severely injured. Up to April 16th the patient made favourable progress, and on that morning was up and about, but complained of weakness, and had no inclination for breakfast. In the course of the forenoon the sister in charge perceived the peculiar expression about the eyes and brow, which she recognized as tetanic. Very active treatment, with belladonna and tobacco stupes to the injured hand and limb, was adopted from the first. The following mixture was administered in increasing doses, until very marked symptoms (great dilatation of the pupil and delirium) were produced:—

℞. Atropiæ valerianatis, gr. i.
Ammoniæ valerianatis, gr. x.
Aquæ, ʒ vi.

M. et solve.

* Panum Experimentelle Untersuchungen über der Transfusion, Transplantation oder Substitution des Blutes, &c. Virchow's Archiv, xxvii., p. 249.

60 minims by measure every two hours until effects on the pupil become marked.

A blister was applied round the arm on the side injured. This, as well as the hand, was stupefied with the infusion of tobacco.

All along nutriment was given as frequently and abundantly as the patient could bear or take.

On the second and third day the pulse rose to 140; opisthotonos became distressing; ice was applied along the spine, and chloroform administered with but very temporary benefit. After each time of its administration, however, it was possible to give beef-tea.

On the 19th the spasms were very frequent, occurring regularly every seven minutes, with a severe one every three hours; patient complained piteously of hunger and thirst; was absolutely unable to take nutriment by the mouth, and instantly rejected enemata.

On the following day she was apparently sinking from inanition, constantly saying that she was dying of hunger and thirst.

With the consent of my colleagues, Drs. Forrest and Tyrrell, I then performed transfusion. The patient was quite calm and collected; all delirium had ceased, the atropia having been suspended in consequence of the total inability to swallow.

Dr. Tyrrell took blood from my left arm to the amount of twelve ounces; this was defibrinated by stirring, strained through muslin, and kept at the proper temperature by allowing the vessel containing it to sit in warm water. It was then thrown into the corresponding vein in the patient's left arm. I had no difficulty in finding the vein and opening it. When I had introduced the nozzle Dr. Tyrrell carefully worked the syringe, which I at that time used, and by steady, gentle strokes, the entire of the blood was injected. Every two or three minutes an interval was given, and the patient asked how she felt. She expressed herself as feeling an agreeable sensation, an undefined sensation of warmth pervading her.

An hour after her sensations of hunger and thirst were quite allayed.

The operation had no effect whatever on the spasms: it did not seem to exercise the slightest control over the course of the complaint. On Friday (21st) the patient died, without pain, and quite conscious to the last.

The apparatus which I now recommend for the injection of defibrinated blood or any other fluid into the veins is very simple. It has the advantage of dispensing with the use of the syringe, an

instrument ill adapted to operations of emergency, as the piston has often ceased to be air-tight just when it is necessary that it should be completely so. In its stead I use a strong glass pipette, which, with the pressure of air from the mouth, is quite sufficient to force in the blood.

The accompanying wood-cut will explain this simple apparatus. A B C represents a glass pipette, D Indian-rubber tube, and E a silver canula or nozzle, near to which a piece of glass tube (F) is inserted and adapted by Indian-rubber tubing.

The orifice (A) of the pipette should be of such a size that it may be closed by the thumb and slightly funnel-shaped, so that the fluid may be readily poured into it from a small jug or ewer. The stem (B) should be about half an inch in diameter. The bulb (C) should be capable of containing about six ounces^a of fluid, and may be graduated.

The lower end of the pipette should taper, so as to be very easily inserted into the Indian-rubber tube (D). The glass tube (F) near the nozzle should also be of a size just adapted to that of the tube which should be tied upon it. The silver nozzle^b (E) should be neatly made, probe-pointed, and at the base the size of No. 6 catheter; there is no opening at the end of it, but an eye or side opening at some little distance from the probe point.

^a Statistics prove that in the majority of the successful cases of transfusion recorded, there has not been more than from four to six ounces of blood injected.

^b These nozzles have been very neatly constructed for me by Messrs. O'Neill and Thompson, surgical instrument makers, 7, Henry-street, and 25, Nassau-street, Dublin, from whom cases containing all the necessary instruments for transfusion as here described may be obtained.

Besides this instrument every transfusion case should contain—1st, Bandage, lint, and lancets; 2nd, Glass stirring rod, and piece of muslin (both perfectly clean) for straining the blood; 3rd, Small sharp-pointed scalpel or tenotomy knife, forceps, scissors, and straight needles; 4th, Thermometer; 5th, A small clip or spring forceps to catch the Indian-rubber tube—this is simpler than a stop-cock, as well as lighter and more manageable; and 6thly, Some fine wire for securing the Indian-rubber tube at different points. This is more convenient for the purpose than ligature silk.

There is no real difficulty in the operation, but there is much nicety, and its success depends upon close attention to a number of apparently trifling details. Besides the things above mentioned nothing is needed but what can be at hand even in the dwelling of an humble patient, viz., some warm water, a basin, some bowls, a small jug or ewer.

The blood to be injected is usually obtained from the husband or some healthy relative or friend. In hospital, students are always found ready generously to offer their's. It should be drawn from a good-sized opening in the vein into a perfectly clean bowl or finger glass, previously rinsed with hot water. It is to be stirred as it flows into the bowl, with a glass rod, also perfectly clean; as soon as the shreds of fibrin are found clinging on the end of the rod (this occurs in five or six minutes) the blood is to be strained through muslin, previously dipt in boiling water, into a second vessel. This second vessel should be kept sitting in a basin of hot water at a temperature, ascertained by the thermometer, of about 105°. The straining of the blood gets rid not only of the clots of fibrin, but of the froth which has come from the stirring, which should be brisk.

The blood is now ready for use, and has only to be maintained for a little time at the due temperature. This is a matter of detail, varying with the heat of the season and apartment.

The pipette is next got ready, that is to say, the blood is sucked up into it until the bulb is filled; the tube and nozzle are adjusted to it, and the spring clip put on the tube so as to prevent the escape of the blood. When filled and ready it may be placed in a jug or any other deep vessel containing water of the proper temperature. If standing erect, with the spring on the tube and the nozzle elevated, no blood can escape, and it remains in such a condition that there is no occasion for any extreme haste in the further steps of the proceeding; there is no fear of its cooling too much in a moderate time, nor of its coagulating.

The next part of the proceeding is to open a vein in the patient. This may be done at the back of the hand or foot, but perhaps best at the bend of the elbow. The skin over the vein is pinched up between the forefinger and thumb of the left hand of the operator. This raises the skin only, and when it is transfixed and divided to a moderate extent the vein is usually seen crossing the cut; if not visible, we must press along the skin from below, so as to squeeze enough of blood into the vein to make it visible. When once seen a needle should be passed across underneath it; this is only as a mark, for if the vein contracts from exposure to cold air it is not easy to find it again. If necessary the vein may be slightly raised from the surrounding adipose tissue before opening it. This is done by taking hold of it in a fine pair of forceps, and making a nick in it with the scalpel. The pipette and tube are then brought, and the probe point of the silver nozzle is introduced into the vein, but not so far as the eyelet hole in the side of the canula. Before pushing it in so far as that, the spring clip is taken from the tube, and the blood allowed to descend and emerge from the eyelet hole, expelling all air before it. The canula is then pushed in, into the vein, and the blood allowed to flow on. The weight of the column, which may be increased by raising the pipette, is usually sufficient, but if not the mouth can make sufficient atmospheric pressure to ensure the passage of the fluid into the vein. When all the blood in the bulb has been thrown in, it can be re-filled by pouring in more without uncoupling it from the tube, but it is also easy, if there is not a ewer of convenient size, to take off the pipette and suck up the blood into it as at first. When the thumb is placed on the upper orifice it is controlled so that it can at once be re-adjusted to the tube. While the injection is going on the operator holds the Indian-rubber tubing between the forefinger and thumb of his right hand, close to the piece of glass tube; if any bubble is seen in the glass tube its passage into the vein can be instantly arrested by pinching the Indian-rubber tubing.

The apparatus just described has the merit of being very simple, and always in order; the use of it and of defibrinated blood makes the operation of such easy performance that I should venture to hope it will now be more frequently had recourse to than formerly. It is obvious that this apparatus is equally applicable for the injection of saline solutions into the blood vessels, a mode of treatment in cholera and other complaints well worthy of a more extended trial than it has as yet received.