ON IMMEDIATE TRANSFUSION.

By J. H. Aveling, M.D.,

SENIOR MEDICAL OFFICER TO THE SHEFFIELD HOSPITAL FOR WOMEN.

As for the last forty years immediate transfusion has almost entirely been lost sight of, it perhaps may not be out of place to premise that by it is meant the transmission, without exposure to air, of blood out of one vessel into another, by the aid of an intercommunicating tube. And as this mode of operating has attached to it a considerable amount of interest, and was for one hundred and sixty years the only one known and practised, it is proposed now briefly to examine the various forms of apparatus which were employed during that period, and to consider generally the advantages and disadvantages of the immediate method. 1865 will be the bicentenary of transfusion, for then two hundred years will have elapsed since the operation was first performed by Dr. Lower, at Oxford. At that distant day, the idea of transfusing blood was not, however, a new one. As far back as the time of Ovid it had been alluded to, and in 1615 a most remarkable foreshadowing of the operation had been given by Libavius, who described it in the following words:—"Let there be a robust youth, healthy, and full of vigorous blood; let there stand by him one exhausted of strength, thin, lean, and scarce drawing breath; let the master of the art have silver tubes fitting into one another; let him open an artery of the robust person, insert one tube and secure it; let him immediately open an artery of the sick man and insert the other tube; then let him fit the two tubes together, and let the blood of the healthy person leap, hot and vigorous, into the sick man, and bring the fountain of life, and drive away all weakness."

It is quite evident that the operation thus described could never have been successfully performed. Both tubes are directed to be inserted into arteries, and, thus placed, the blood would not flow through them. In fact, when Libavius wrote upon the subject, he did so only to ridicule it. He

had not the slightest idea how nearly he was giving an accurate description of an operation which, half a century afterwards, was destined to be found, not only practicable, but popular. During the fifty years now spoken of the circulation of the blood was discovered, and, as a result, operators were supplied with the knowledge necessary for the proper performance of transfusion. By the aid of this new and powerful light they were enabled to take a clearer view of the operation, and its practicability at once became evident.

Dr. Lower transfused blood from one animal to another, for the first time, in the month of February, 1665. He operated thus:—The carotid artery of a dog having been opened, a quill was tied into it, and stopped with a stick. The jugular vein of another dog was then opened, and two quills tied into it, which also were stopped with sticks. The dogs were then fastened together, the sticks removed, and the quill in the artery united to one of the quills in the vein by the help of two or three other quills fitted into each other. The object of the second quill in the vein was to allow the blood of the recipient dog to escape at about the same rate as the fresh supply from the emittent dog was received —this rate being anything but slow, if we may trust to the evidence of Boyle, who, describing the operation, says— "The blood runs through the quills as through an artery, very impetuously." One dog having been bled to death, the surviving one is to have its jugular vein cut across and tied, and the quills removed; and the operator is then directed to "sew up the skin and dismiss him, and the dog will leap from the table and shake himself, and run away as if nothing ailed him."

Boyle suggested an alteration in Lower's apparatus. He says— "Instead of a quill, a small crooked thin pipe of silver or brass, so slender that the one end may enter into a quill, and having at the other that is to enter the vein or artery a small knob, for the better fastening them to it with a thread, will be much fitter than a straight pipe or quill for this operation, for so they are much more easier to be managed."

Sir Edmund King, who, with Dr. Lower, was the first to transfer blood into the human veins, operated in the following way. The carotid artery of a sheep having been opened, he inserted a silver tube, and tied it in. He then opened the vein in the man's arm "with as much ease as in the common way of venesection," and placed in it another silver tube, having in it a blunt stopper, which facilitated its introduction into the vein. When in, it and the skin were held close together by the finger and thumb, the stopper was then withdrawn, the two tubes united by quills inserted between them, and the blood allowed to flow.

Dr. Denis, who was the first to transfuse blood into the human veins in Paris, used for the purpose two slender latten tubes, curved at one end, and furnished with a shoulder, that they might be more readily fastened into the vessels, and at the opposite end fitting into each other. Emmerez, who often assisted Denis, undertook to perform transfusion without tying the tubes in the vessels, and simply by puncture, like that which is used in bloodletting.

Regner de Graaf also used two silver pipes, but, instead of fitting them into one another, or uniting them by means of quills, he inserted between them a piece of an artery to which there was a side branch, the use of which was partly to allow the escape of air and partly to note the constant stream of the outflowing blood.

Heister says — "Where tubes of metal or bone were found inconvenient, flexible ones were adopted, such as part of the carotid artery, or the ureter from an ox, calf, or lamb, or the windpipe of a capon, duck, &c."

It will be observed that the apparatus already described does nothing more than connect one vessel with another. It has no propelling power; the blood is caused to flow through it simply by the force of the circulation. And this force was quite sufficient when the emittent vessel was an artery; but as transfusion had sometimes to be performed from one human being to another, and as the opening of an artery in this case is rather a serious matter, and, moreover, as venous blood was thought more appropriate than

arterial for transfusion, the plan of transmitting blood from *vein to vein* came into general use, and was much insisted upon by Tardy and by Dr. Harwood, Professor of Anatomy in the University of Cambridge, in 1785.

Owing to this change in the mode of operating a serious difficulty arose. It was found that the force of the venous circulation was not sufficiently strong to ensure the continuous passage of the blood through a simple tube, more especially at the end of the operation, when the blood flowed feebly, and, consequently, stagnation and coagulation frequently occurred, interrupting, and sometimes altogether stopping, the operation. To remedy this, various new forms of apparatus were invented.

Graefe, imagining the coagulation of the blood to be due to the cooling process to which it was subjected in passing from one vessel to the other, had an apparatus constructed consisting of a glass cylinder, which could be filled with warm water, through which a glass tube passed for carrying the blood. At either end of this elastic pipes were attached, which had at their free extremities small tubes of silver or gold to enter the vessels.

Purmann, also believing in the fallacy of keeping the blood warm to prevent its coagulating, describes an apparatus consisting of "a tube surrounded with a linen cover, in which warm water is held, to hinder the blood from coagulating which passes through the tube; this must have on each side a fine silver pipe, one of which must be put into the vein of the man, and the other into the vein of the beast."

The idea of preventing coagulation by keeping the blood warm was held as far back as the time of Denis. He advised that the chamber in which transfusion was to be performed should be heated. And if we might judge from the hot-water chambers, &c., which complicate some of the transfusion instruments still sold, we might conclude that the notion is not yet discarded. But practical men soon discovered that the cooling of the blood was not the only cause of coagulation, for, in spite of the surrounding hot water, it still took place.

Stagnation in consequence of the feebleness of the venous circulation was, as has been before stated, looked upon as a frequent source of coagulation, and, having this theory in view, other forms of apparatus were invented.

Boehm, after he had inserted the two tubes into the vessels, united them by a piece of duck's intestine, by stroking the fingers along which the transmission of the blood might be encouraged.

Coluszi used two tubes of glass which he connected in the middle by a small bladder holding about an ounce. In operating he allowed this bag to fill with blood, and, then compressing it, forced the blood forward at any rate he pleased. But, ingenious as these instruments were, they still were very imperfect, and the operation of transfusion languished and was little used for many years.

Blundell, however, at length revived the subject and worked at it with marvellous energy. Instead of overcoming the remaining difficulties of the immediate method, he began to make experiments "with a view of ascertaining whether blood might not be absorbed and propelled by means of a syringe without becoming unfit for the purposes of life;" and, having invented a syringe for this purpose and shown that it could be effectually used, the new or *mediate* mode of transfusing blood was fairly inaugurated. But Blundell's inventive spirit was not long content with the simple syringe. His first modification of it was the addition of a funnel by which the blood might be collected from the arm of the person supplying it and conveyed to the syringe; his next apparatus was that wonderfully complicated piece of machinery which he called an "impeller." This instrument was packed up in a case together with fourteen other requisites, among which were a vice, a gimblet, leather to form valves, and wire to make springs. Well might the inventor say, "The owner of the impeller ought by all means to make himself master of its structure, and to acquire the little skill which may enable him to set it to rights for himself." But Blundell's next instrument was a most interesting and ingenious one. He called it a "gravitator," and drawings with a description of

it may be found in the 'Lancet' for June 13th, 1829. It seems to be almost identical in its construction and mode of action with a transfusion apparatus lately invented by Dr. Hamilton, of Falkirk.

Although Blundell was the author and strenuous upholder of the mediate way of transfusing blood, he did not discard the immediate method without speaking strongly in its favour. He says, "In performing transfusion, there can, I conceive, be no doubt but that the blood ought to be transmitted by tubule merely, when this method is practicable." It is strange, holding this opinion, that he did not endeavour to bring to perfection that mode of operating which, this sentence shows us, he believed to be the best.

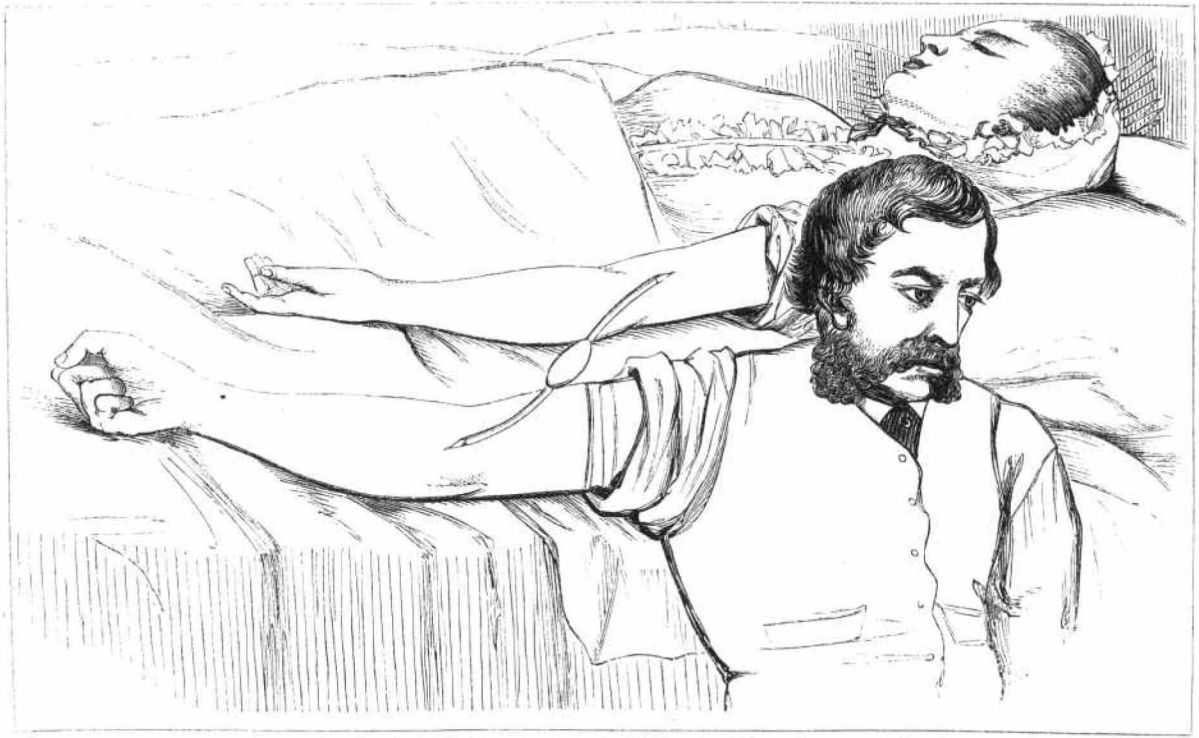
Mr. Scott, of Newington Causeway, invented, during the time Blundell was busy with his syringe experiments, an immediate apparatus, which has, perhaps, been scarcely sufficiently appreciated. It is thus described in the 'Lancet' of May 12th, 1826:—"The peculiarity of Mr. Scott's apparatus consists chiefly in its capability of transmitting blood from the vein of one person into that of another without the usual intermedium of a basin or other vessel. The instrument subservient to the operation is Read's syringe, into the extremity of which slides a hollow flexible tube fourteen or fifteen inches long, armed with a silver pipe for entering the vein of the emitter. A similar tube is screwed to the lateral branch of the syringe, and has a silver pipe which is inserted into the vein of the receiver or patient. The two pipes being inserted, and the syringe put in action, the blood is made to pass freely from one person to another, the velocity and the power of the current being regulated by the action of the syringe at the discretion of the operator." In the next number of the 'Lancet,' published on May 17th, a successful case of transfusion is recorded by Jos. Ralph, of Leicester Square, in which Scott's apparatus was used, and the account given of it is most favorable. He says, "However formidable and difficult the operation may have hitherto seemed, it may be performed by this instrument with the greatest ease." By this invention of Scott's the operation of immediate trans-

fusion was greatly advanced. Two important difficulties were overcome by it. Stagnation in the tube was prevented, and the amount of blood transmitted could be measured. In fact, except in the way of simplification, little else seemed to be required to render the apparatus perfect.

Allow me now to submit to your notice a little contrivance for transfusing blood by the immediate method, which, it will at once be seen, is simply an attempt to combine the excellencies and discard the faults of those forms of apparatus which have already been described. It consists of two small silver tubes to enter the vessels, and of an indian-rubber pipe by which they are united, and which has in its centre an elastic receptacle, holding about two drachms. It is without valves, and is simply a continuous pipe with an expanded portion in the middle. By its means the vessels are, as it were, extended from one to the other, and a supplementary heart is added to regulate the circulation. No opportunity has presented itself of trying the apparatus upon the human subject, but some experiments made with it upon the horse have been perfectly satisfactory.[1] In operating with it upon man the following plan is suggested:

While an assistant is preparing the arm of the person who is to supply the blood, lay bare the vein of the patient, and make an opening in it sufficiently large to admit one of the tubes. Then open the emittent vein, if possible, as in blood-letting, and insert the round-pointed tube downwards. If the apparatus be now held slanting upwards, the blood will flow into it and expel the air. Lastly, insert the bevel-pointed tube into the recipient vein, and the blood may then be made to circulate through the pipe at any rate the operator may think proper. This is accomplished in the following manner:—If the pipe on the emittent side and the receptacle be compressed, the blood will be thrown forward into the recipient vein. If, on the contrary, the pipe be compressed on the recipient side, and the receptacle allowed

[1] In making these experiments I have been ably assisted by my friend Mr. B. Cartledge, a member of the Court of Examiners of the Royal College of Veterinary Surgeons.



POSITION OF THE PATIENT AND OF THE PERSON SUPPLYING THE BLOOD.

to expand, the blood will be drawn into it from the emittent vein. This part of the operation should be performed slowly. Each silver tube should be held in its place between the finger and thumb of an assistant. All other points should be managed as in the ordinary operation.

In conclusion, allow me to describe what appear to be the advantages of the immediate method of transfusing blood.

1st. The chances of coagulation are small.

a. Because the blood glides through the pipe and comes in contact only with a thin coating of coagulated blood.[1]

b. Because the blood is removed from the action of the living vessels for only a few seconds.

c. Because the blood is not exposed to the air.

2nd. The apparatus is effective, simple, portable, and inexpensive.

3rd. The operation is safe, easy, uninterrupted, and a close imitation of Nature.

Dr. CLEVELAND said there appeared to him to be some practical objections to the apparatus exhibited. He did not think that blood could be drawn easily from the vein of the supplier through so narrow a tube; and he felt there would be great risk of injecting air into the vein of the patient, inasmuch as it would be impossible to know with accuracy how the blood was flowing into and from the reservoir or injector. In an operation of this kind, where the exclusion of air was all important, he considered it most essential for the operator not to work, as it were, in the dark.

Dr. GRAILY HEWITT said the subject brought before the Society by Dr. Aveling was one of great importance, and one, moreover, in which he was individually much interested. In the course of last year he (Dr. Graily Hewitt) had brought the subject of transfusion before the profession in a paper read at the annual meeting of the British Medical Association, held at Bristol, and he had exhibited at that meeting the apparatus for the performance of transfusion, which he now begged to lay before the Obstetrical Society. He would remark that the great desideratum in an apparatus for transfusion adapted for use in obstetric emergencies was a simple, certain, and ready means of conveying the blood. The instrument which he had contrived fulfilled, he

[1] See Prof. Lister's 'Croonian Lecture,' read June 11th, 1863.

believed, these indications; and he had had an opportunity of using this instrument a short time since in the case of a poor woman dying from loss of blood connected with placenta prævia. The instrument acted admirably, and by its means he was enabled to transfuse two successive portions of blood. The operation was unfortunately delayed, as it proved, a little too long, and the patient failed to derive benefit from the operation; but the experience afforded by the case was such as to justify him in expecting the best possible results from its use in similar emergencies. The apparatus devised by Dr. Aveling, which in principle, he believed, resembled one that had been recommended by Dr. Richardson, was, he considered, objectionable for a variety of reasons. The want of transparency prevented the observer ascertaining what was going on in the tube; it was not easy to connect, off-hand, the tube with the vein of the individual supplying the blood; and, further, it would be found very objectionable to bring the individual supplying the blood into close proximity with the individual dying from loss of blood. The person supplying the blood was often, in obstetric practice, the husband of the patient; and, unless under very exceptional circumstances, the nerve and fortitude of the individual in question would be likely so to break down as to interfere with the carrying on of the operation. For these reasons, therefore, he believed that, however ingeniously contrived, the "immediate" method could not become a practical operation. [See description of Dr. Graily Hewitt's apparatus, at page 137.]

Dr. EASTLAKE, in speaking of the apparatus for *immediate* transfusion just exhibited by Dr. Aveling, in comparison with Dr. Hewitt's, stated that he had once seen the latter employed in a case where he and Dr. Hewitt were in attendance, and could speak highly of its practical nature, and of the facility with which it was used. Dr. Eastlake entirely concurred with Dr. Hewitt, in believing it to be a great *desideratum* that the person about to part with the blood, and who is generally the husband or some near relative, should not be brought to the bedside of the patient, whose alarming appearance at such a moment would inevitably produce the deepest anguish and agitation to the relative. In the case alluded to Dr. Eastlake said that he opened a vein in the husband's arm, and, notwithstanding his being some distance from the bed, the scene was so distressing, and the poor man so much overcome, that it was with the greatest difficulty he was kept from becoming unconscious by the free administration of brandy.

Dr. BRAXTON HICKS hoped he should be able some day to bring before the Society a plan which he had employed with success in the lower animals, and also in a case of hæmorrhage in a lady. The principle of its action was to prevent fibrillation,

thereby doing away with the greatest difficulty attending the operation.

Dr. AVELING, in reply, would remind the Society that the operation of transfusion had been successfully performed by the simplest means—such as quills; and he differed from Dr. Graily Hewitt in his estimate of the difficulties of the operation.

APPARATUS FOR THE PERFORMANCE OF TRANSFUSION.

By GRAILY HEWITT, M.D.,

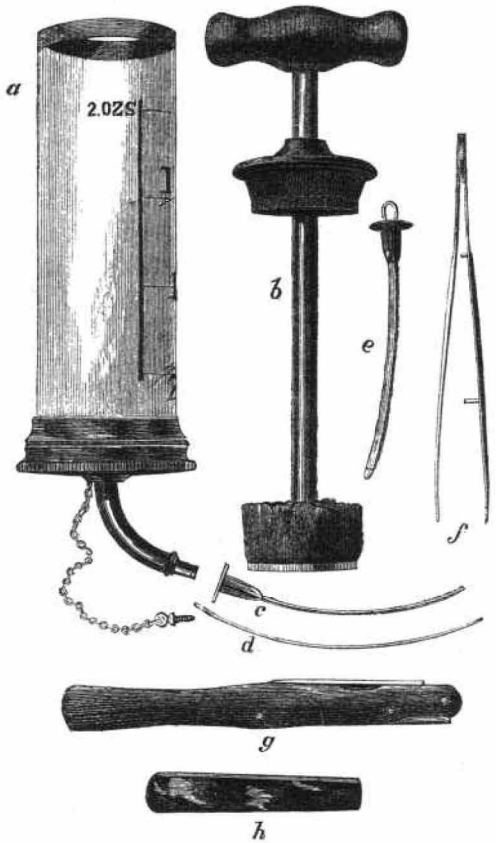
PHYSICIAN TO THE BRITISH LYING-IN HOSPITAL; ASSISTANT-PHYSICIAN-ACCOUCHEUR AND LECTURER ON MIDWIFERY AT ST. MARY'S HOSPITAL.

THE apparatus is constructed to carry out the operation of transfusion in the following manner:

The blood to be transfused is received into a glass syringe, and by means of this thrown into the vein of the patient requiring the blood. The method adopted allows of the almost instantaneous transference of the blood from one individual to another, and the exposure of the blood, which, as is well known, tends to produce rapid coagulation, is reduced to a minimum. This is effected by making the syringe itself the vessel into which the blood is received. For this purpose the piston of the syringe is removed, and the barrel of the syringe is held in an inverted position over the orifice of the vein, in close apposition with the surface of the skin, but not pressed too firmly, otherwise the blood will not flow. The blood then flows into the syringe, and when a sufficient quantity is collected therein the syringe is suddenly removed and the piston inserted, the blood being prevented from escaping by inserting the little plug into the escape-pipe. The syringe is constructed to hold two ounces.

Prior to filling the syringe with blood the arm of the receiving patient must be prepared. For this purpose the arm is to be uncovered, the vein selected which is

largest—usually the median-basilic or the median-cephalic —and a longitudinal incision, one and a half inch long, made through the skin, immediately over the course of



The contents of the "Transfusion Case" are here represented; half the actual size. The syringe (*a*) holds two ounces; *b*, the piston; *c*, canula, and *d*, its plug; *e*, reserve canula; *f*, pair of forceps; *g*, scalpel; *h*, lancet.

the vein. The vein itself is then to be dissected out, and completely bared for nearly one inch of its course. The vein is then to be seized with the forceps, and a slight

incision made in it by means of the scalpel. This incision should be made obliquely, and just enough to admit the canula with its plug. The canula, at the extremity of which the rounded plug projects, is slightly curved. The next step is to introduce this canula, with its plug, into the vein; the plug is then withdrawn, and the escape of a minute quantity of blood shows that the canula is properly inserted. The arm is then to be carefully and steadily held by an assistant, with directions to prevent the escape of the canula from the vein. The operator next procures the supply of blood in the manner previously described, being careful not to proceed to this stage of the operation until everything is perfectly ready for the injection of the blood. Experience has shown that the operation will most frequently break down from want of attention to this rule. The actual injection of the blood is performed as follows:—Taking the syringe with its contents to the bedside as rapidly as possible, the operator removes the little plug from the canula, and adjusts the syringe to the latter. This adjustment can, owing to the construction of the apparatus, be effected instantaneously, and by gently depressing the piston the blood flows into the receiving vein. The quantity thrown in at once should not exceed about one ounce or one ounce and a half, and the injection of this quantity should occupy about one minute. It may be necessary to throw in two or more such quantities, according to circumstances. If more than one syringe-full is required, the second or following supplies must be procured and injected in a manner similar to the first.

The glass syringe, with its adjuncts, admits of being very rapidly and easily cleansed. The "Transfusion Case" made by Messrs. Savigny, of St. James's Street, contains, together with the syringe, two canulas with plugs, a small pair of dissecting-forceps, a sharp-cutting scalpel, and a common lancet. The bulk of the whole is very inconsiderable, and the case, containing, as it does, everything possibly required for the performance of the operation, can be carried in the ordinary "obstetric bag," being thus always at hand in case of emergency.

For the performance of the operation it will be found necessary to have the assistance of two individuals—one to hold the arm of the recipient, the other to manage the arm of the person supplying the blood. The incision into the vein, in order to procure blood, should be a tolerably large one, to ensure a rapid flow of blood into the syringe. It is not necessary, as was formerly supposed, to heat the syringe, or to take steps for maintaining the blood at a high temperature; the syringe should, however, be placed in a basin of clean water slightly warmed, in order to render the motion of the piston easy.

In the accompanying illustration the apparatus for transfusion is depicted half the actual size.

The object kept in view in the construction of this apparatus is the rapid transference of blood from one person to another. Experience has shown that, while the rapidity with which coagulation occurs varies in different persons and at different times, two or three minutes may be always calculated on before coagulation will occur. The various steps of the operation must be carefully considered before undertaking it, in order to allow of the transference being effected within this interval of time. The tendency to coagulate is materially diminished by the method here adopted of receiving the blood, whereby the exposure to air and contact with foreign bodies is reduced to a minimum.