

SOME REMARKS

ON THE

OPERATION OF TRANSFUSION.

It is said that Andreas Libavius, in 1615, first proposed the operation of transfusion, and that about 1658, in consequence of the acknowledgment of Harvey's doctrines respecting the circulation of the blood, the first attempts were made to transfuse blood into the veins of diseased persons, their tainted blood being previously removed. Marvellous are the effects said to have been produced by transfusing the blood of healthy young animals into the veins of old or diseased ones. Hence the prevalence of the opinion, that this was the mode of curing all diseases, and even of immortalising man. Denys, a physician, and Emene, a surgeon, of Paris, ventured to transfuse the blood of a calf into the veins of an idiot; but the mixture induced furious madness, and the consequence of this and other unsuccessful results, transfusion was forbidden. Since this period it has been neglected, having been considered either useless or dangerous.

In common with many of my most intelligent friends, I have long entertained an opinion, that notwithstanding the improvements which have been already made in surgery, there are still many operations of importance which may be added to the science. Among these operations, transfusion may, I think, fairly rank as one; and it is with a view of keeping this valuable operation before the profession, and in the hope of adding somewhat to the body of facts by which it may be still further illustrated, that I am induced again to make it the subject of a memoir.

Without pretending to give an enumeration of all the cases in which transfusion may be tried, with a fair prospect of advantage, I may observe, that there are some cases, in which the practical utility of it is both great and obvious.

1. I remember being called once to a poor woman in my neighbourhood, who had lost a large quantity of blood after her placenta had been taken away. When I saw her, the hemorrhagy was stopped, but she was evidently sinking; and, notwithstanding the assiduous use of all the ordinary remedies, she died in the course of two hours after the first eruption of the blood.

2. By a friend of mine on the other side of the water, I was requested some two or three years ago, to give advice in a case very similar to this. The blood came away from the womb, during, and after the birth of the placenta; and the patient died in the course of three or four hours afterwards, throughout the greater part of which time she was obviously sinking, notwithstanding the ordinary remedies were actively tried.

3. A poor fellow, in one of our hospitals, lost a great quantity of blood in consequence of an injury of the leg; but, although it was pretty evident that death must ensue, he continued to breathe afterwards for two or three hours.

Now, in cases of this kind (and I might enumerate others which have fallen under my personal notice), when the patient is gradually sinking, and the bleeding is suspended, there is a fit opportunity for trying the operation of transfusion; and, unless we are prepared, in the face of opposing facts, to deny the utility of the operation altogether, it must, I think, be admitted that it would be used in such emergencies, with the fairest prospect of preserving the patient's life.

It is not, however, in conjunctures of this kind only that the operation deserves consideration: there are other cases in which transfusion should not be lost sight of, although its utility in them is certainly much more dubious.

We know that in hanging or submersion, death, at first, is apparent only, and not real; for a certain period after respiration stops, resuscitation is still possible. Now, that death from bleeding may also for a time be apparent, is by no means

unlikely ; and it is not impossible, therefore, that transfusion may be of service, if performed within a given period, even after the breathing has been stopped. Under this impression it was that I instituted the following experiments ; and although the results have not corresponded with my wishes ; and although too they do not by any means form a complete body of information on the point, with a view of making an opening in the subject, I am induced to record them.

Their results, the experiments we shall not transcribe, afford a variety of inferences which, although they do not lead us to expect much from transfusion, when the asphyxia of hemorrhagy has been produced, are sufficient, I think, to bear as out in the assertion, that in cases of this kind, in which there is no other hope, the operation may deserve consideration ; and we may infer,

1st. That the time which intervenes between the opening of an artery, and the attack of apparent death, varies exceedingly in different individuals, even when the artery remains unclosed, and the bleeding therefore is not obstructed. In some of these dogs it was about two minutes, (8) and in one twenty (9).

2dly. That after the cessation of respiration, and the relaxation of the abdominal muscles in the dog, the animal very speedily becomes irrecoverable by the process of transfusion ; for it will be observed, that when the dog was suffered to be in a state of apparent death for sixty-four, (4) thirty-four, (5) twenty, (7) nay, even ten minutes, (6), it could not be resuscitated ; and this, too, although in experiments 7, 8, the operation of transfusion was assisted by the stimulus of the hot bath, and an artificial respiration very diligently executed. Whether this principle may or may not be transferred to the human body, admits a doubt ; but the affirmative is probable.

3dly. That one impediment to the resuscitation of the animal in these cases, arises, perhaps, from the coagulation of the blood in the heart, for concretions were found there on inspection in Experiment 7 ; it should be added, however, that this was ascertained to be the case, by inspection, in one of the dogs only, for the others were not examined ; and that in other animals, as, for example, the ox, the blood has been found by an excellent experimental observer, Mr. Thackrah, to be fluid in the

heart, half an hour after the animal has been knocked down : nor must it be forgotten, that the blood of the dog has a much stronger tendency to speedy coagulation than the human blood. We must not, therefore, lightly make this inference general, nor transfer it without consideration to the human body.

4thly. That although the dog cannot, perhaps, in general, be resuscitated, even a few minutes after the carotid artery has been fairly laid open, and distended by the introduction of a pipe ; and although resuscitation be improbable, if respiration has been suspended in consequence of bleeding, yet, now and then, recovery is possible ; since, in Experiment 9, a complete resuscitation was accomplished, about twenty-five minutes after the artery had been opened, and four or five minutes after the animal had lain to appearance dead. And here it may be observed, transiently, how necessary it is not to draw conclusions hastily from a few experiments, but, on the contrary, to multiply them as much as may be, since it is by performing the same experiments repeatedly that important exceptions are sometimes ascertained.

5thly. It follows from the preceding inferences, that if we are called to a patient fifteen or twenty minutes after the carotid artery has been laid open, the patient may be still respiring ; and therefore, that resuscitation, by means of transfusion, may not perhaps be found in every instance impracticable. If the eighth pair of nerves were divided only, the recovery might be permanent ; and if it were cut through on both sides, the patient might be expected to live afterwards for a few hours.

6thly. In some of these experiments, in which the carotid was laid wide open, the blood, towards the close of the operation, came away sluggishly, and in small quantities ; so that the discharge might have been arrested by the mere pressure of the finger. When persons cut their throat, I strongly suspect, that by the pressure of the finger, or, by putting a fold or two of a handkerchief into the wound, the flow of the blood might sometimes be so obstructed as to prolong the patient's life till further assistance could be obtained. If this assertion be true, it cannot be made too generally known.

7thly. The preceding experiments do not enable me to decide whether, in apparent death from bleeding, a preference should be given to the injection of blood into the jugular vein or the carotid artery ; but, I think, on the whole, the blood ought to be injected into the carotid artery, toward the heart, in order, if possible, to renew the circulation through the coronary vessels, on which, I suspect, the irritability of the heart depends. But to proceed. The formation of blood is the principal end of the chylopoietic viscera, and of their auxiliaries ; and it seems, therefore, not improbable, in those cases in which the action of these viscera is interrupted by a scirrhus of the pylorus, or other causes, that their operations might be superseded by the injection of blood into the veins, so as to supply the vessels in a direct manner with that blood, which in health is the result of sanguification. As, however, opinions derived from reasonings of this kind are exceedingly uncertain, until they are brought to the test of experience, I have been induced to institute an experiment, not unattended with labour, with a view of demonstrating that dogs certainly may be supported for a length of time by the transfusion of blood only, without the aid of food taken into the alimentary tube ; and that the following is a brief statement of the results :

1st. That the dog may be nourished a length of time, without the help of food, by transfusing into the veins the blood of another individual of the same species, either by the tube or the syringe.

2dly. That the blood which is supplied to the vessels in this manner does not support the body so effectually as an equal quantity would do, if derived from sanguification.

3dly. That the health is liable to be much impaired, by operations of this sort ; and that enlargement of the heart, the spleen, and the liver, may be produced by them in the course of three weeks.

4thly. That these effects, it is probable, in the present state of our knowledge, are not inevitable, nor of equal degree in all cases ; but are rather to be attributed to the circumstances of the operation than the nature of the operation itself.

5thly. Whether these principles may be transferred from the dog to our own species, is at present uncertain ; but till we

have proof to the contrary, they furnish a strong presumption, that the human body may be nourished by the injection of blood.

In the progress of knowledge and the decay of prejudice, should the method of nourishing by transfusion be practised hereafter on the human subject, I suspect it will be found, that small quantities of blood are sufficient to support the body in a state of languid life ; and that ill health is not inseparable from the operation, provided it be performed in a dexterous and judicious manner, and provided, especially, the blood be injected frequently, in small quantities at once.

But to conclude this part of my paper. There are perhaps various cases, in which blood may be transfused with advantage, but three more especially deserve consideration :—those, I mean, in which the patient is dying for want of nourishment ; those in which the patient is already dead, to appearance, in consequence of copious bleeding ; and those cases, lastly, in which the breathing still continues, although it is pretty evident, from the course of symptoms, that death must ensue in consequence of the loss of blood which has been sustained. These cases, under the present modes of management, are all of them desperate.

OF THE KINDS OF BLOOD PROPER FOR THE OPERATION OF TRANSFUSION WHEN PERFORMED ON THE HUMAN BODY.

When the blood of one genus of animals is added, in small quantities, to that of another genus by transfusion, we have reason to believe (in the present state of our knowledge), that no dangerous consequences will ensue ; and I have heard Dr. Haighton assert, that after taking a few ounces of blood from the dog, he has afterwards transfused that of the sheep in its place, without producing dangerous symptoms. Now, if further experiments, multiplied and varied, should thoroughly confirm this principle, we may hope to find hereafter, that the blood of animals may be safely thrown into the human vessels

in small quantities daily, for the purposes of nourishment, instead of the human blood, which it must be more difficult to procure.

Although, however, the blood of one genus of animals may, perhaps, without fatal consequences, be sparingly mixed with large quantities of the blood of another genus, all the facts, which have hitherto come to my knowledge, go to prove, that if an animal be drained of the blood in its larger vessels, and replenished with large quantities of blood derived indifferently from another genus, great danger, and in general death itself will ensue.

The experiments performed, with a view to establish the point, acquire additional strength, when associated with others instituted by Dr. Leacock, of Barbadoes, a few months before; experiments to which I am wholly indebted for my first notions on this point. From these it appears, that if a dog be drained of its blood until apparent death be produced, it may, indeed, be revived for a time, and very completely too, by replenishing it from the sheep, but it generally dies in a few days afterwards.

Connected with my own, these experiments of Dr. Leacock possess a peculiar interest, for though they harmonize with them in the general result, they differ from them materially in the circumstances. It was arterial and not venous blood; the blood of the sheep and not the human, that was substituted; and it deserves particular remark, that in Leacock's experiments, the transfusion was not performed by the syringe, a method of operating with which he was unacquainted, but simply by the tube.

From these facts it appears clearly that the human blood cannot be safely substituted in large quantities for that of the dog. It is certain that death was not produced accidentally, from the hurry of injection, or from plethora; from suffering the blood to accumulate in the cup of the syringe, or the dog to remain too long in a state of asphyxia, for in some of the experiments, these accidents were carefully obviated, particularly in the last.

16. The only experiments that I know of, in which the human blood was substituted for that of the dog, by an opera-

tion similar to those described above, without destroying the animal, are those performed, six or seven years ago, by Mr. Goodridge, of Barbadoes, a gentleman who was at that time finishing his medical studies, at the united hospitals. In these experiments, probably in consequence of the natural vigour of its constitution, and, perhaps, from the smaller quantity in which blood was injected, the animal was enabled to struggle through the consequences of the operation; but even in these cases, for some hours after the transfusion, a variety of unfavourable symptoms occurred.

As it is clear, from the preceding experiments, that the blood of one sort of animals cannot, with impunity, be substituted indifferently, and in large quantities, for that of another sort of animals; it follows, of course, that in performing the operation of transfusion on the human body, the human blood should alone be employed, at least until we have discovered some other kind of blood as well suited to the vessels as that which they naturally contain.

Provided the blood transfused be derived from an animal of the same species with that which receives, it seems to matter but little whether that blood be arterial or venous. In most of those experiments in which, after draining the dog of its own blood, I resuscitated the animal, and preserved its life, by supplying it with blood taken from the vessels of another dog, arterial blood was injected, in preference to the venous, because a full supply of this kind of blood might be more easily obtained. To satisfy myself, however, that venous blood possesses the resuscitating power, as well as the arterial, I performed some experiments, and from them we may, I think venture to presume, until we have proof to the contrary,

1st. That, in transfusion, venous blood may be successfully used, although, perhaps, arterial blood is preferable.

2dly. That an animal may be saved from the death of hemorrhagy, by the transfusion of a much smaller quantity of blood than that which it has lost.

3dly. That the blood of one genus of animals cannot be indifferently substituted, in large quantities, with impunity, for that of another genus; and, therefore, that if an operation

be performed upon the human body, human blood only should be employed, until some other blood be found which is equally congenial to the vessels.

To these inferences may be added the following remarks. It seems not improbable that animals of one genus possess the power of assimilating to their own the blood of another genus, provided they live for days after it has been infused into their veins; as it is not easy to conceive how life can continue for a length of time afterwards, (Experiment 16,) unless such assimilation be accomplished.

Although the blood of one genus of animals cannot be injected largely into the vessels of another genus, without danger to life, it is not unlikely that small injections of this kind may be safely tried. The importance of this principle, in the operation of nourishment by transfusion, is obvious.

Although an animal may be resuscitated by the transfusion of venous blood, I suspect that, of the two varieties, the arterial blood is the most efficacious; but into this enquiry I forbear to enter further at present.

It is clear, from these facts and inferences, that although the blood of the mammalia may be essentially the same in all the genera, the different kinds of blood differ very importantly from each other. It is an interesting, and, perhaps, a difficult enquiry, Whether any genus of animals be furnished with a kind of blood congenial to the human veins? That of the horse is the most promising.

Blood may be received into a cup, and passed through a syringe, without being thereby rendered unfit for the purposes of life.

In performing transfusion there can, I conceive, be no doubt that blood ought to be transmitted by the tubule merely when this method is practicable; but as we should probably meet with obstructions in operating in this way on the human body, I have been led to make experiments with a view of ascertaining whether blood may not be absorbed and propelled by means of a syringe, without becoming unfit for the purposes of life; for transfusion may easily be performed in this manner:—

The following are the inferences drawn.

1st. That blood, although it have passed through the syringe, and repeatedly, is still capable of supporting the life and health of the body. With one exception, all the dogs on which these operations were performed, eleven in number, recovered, and some of them got completely well within two or three days afterwards.

2dly. That although blood which has passed the syringe retain its fitness for the animal purpose, it probably becomes deteriorated by this operation, especially if it lie for a few seconds out of the vessels, and be slightly inspissated in consequence. In exp. 22, 23, 24, 25, 28, 29, the dogs suffered but little, but in exp. 20, 21, 26, 27, dangerous symptoms were produced. How long the blood may lie out of the vessels without becoming wholly unfit for the vital purposes, has not been ascertained, though the principle is well worth investigation.

3dly. That the deteriorated blood, after it has been thrown into the vessels, undergoes a sanative process, by which it again becomes thoroughly congenial to the functions of the animal; for it will be observed, that most of the dogs, though languid for some two or three days subsequently to the operation, became very lively and well a few days afterwards.

4thly. And probably that dogs of tender constitution suffer more from operations of this kind than those which are more hardy; other circumstances being the same. This plain, but important principle, must be borne in mind when we think of transferring these conclusions from the dog to the human subject. The preceding principles certainly hold good in the pathology of the dog, but whether they hold true also in human pathology must be ascertained by future observation; the affirmative is in a high degree probable.

OF TRANSFUSION FROM THE ARTERIES OF ONE MAN TO THE VEINS OF ANOTHER.

In general, there must, I am aware, be considerable difficulty in obtaining arterial blood from the human body for the purposes of transfusion; but persons may be induced occa-

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sionally, sometimes from motives of affection and sometimes for hire, to submit to the opening of an artery.

If blood is to be transferred from the arteries of one man into the veins of another, it would be necessary, in the first place, to lay bare a vein on the fore-arm of the patient to the extent of an inch or more, and then to bind a ligature between the hand and the intended opening, in order to prevent the escape of the blood when the circulation is renewed; after which an opening should be made with a lancet longitudinally, (in the course of the vein I mean) so as to allow the ready entrance of the small venous tube, which should be slipped into the vessel towards the heart, and retained there by pressure of the finger.* The patient who is to receive the blood being prepared in this manner, the operator should next prepare the person who is to supply it. Of the different arteries which may be fixed on as adapted to an operation of this sort, perhaps the radial, ulnar, or anterior tibial are the principal, and of these three I think the radial is decidedly to be preferred, for its conveniency in other particulars as well as on account of its easy access. The artery elected, a tourniquet should be put on the limb, between the intended opening and the heart, in readiness to be constricted, should emergency require, and then, to the extent of an inch or two, the artery should be laid bare with the scalpel, extensively enough to secure the aperture against the obstructions arising from a deficiency of room. This done the artery should be detached a little, say to the extent of half an inch, and a ligature should be put on the vessel below, close against the part where it remains connected with the cellular web and the vasa vasorum; and about an inch from this ligature, a pair of spring forceps should be applied, which, closing of themselves, may press the sides of the artery together, so as

* Should the small quantity of air lodging in this tubule be found to produce injurious effects, the tubule may be inserted first into the flexible tube, and then, after the whole tubular apparatus has been filled with blood, as hereafter explained, the tubule may be slid into the vein; but unless the operator become dextrous and prompt, the blood will become deteriorated, and even clotted, by lying in the inanimate apparatus.

to close it completely. The artery should then be laid open with a lancet to the extent of a line, (one-eighth of an inch) so as to allow the ready entrance of a small tube, and this opening should be made in the course of the vessel, as the artery, I find, when divided across, contracts more in its calibre, and, if the incision be a little too deep, in danger of breaking completely through. A small tubule, about the size of a crow-quill, in connexion with a flexible tube about as large as a goose-quill, should then be introduced into the artery with its extremity towards the heart, and should be secured there by means of a ligature; the ridge, or shoulder, near its orifice, will give it a bearing line, and prevent its slipping out. The operation being brought to this point, the small arterial forceps are opened by pressing the handles together, so as to give passage to the blood and expel the air from the tubes; after which the forceps are suffered again to close, and the tubular apparatus being full of blood, the flexible tube is firmly connected with the tubule in the vein. With a moderate share of dexterity, the junction may be easily accomplished in a few seconds, and before the human blood, of slow coagulation, has time to become clotted; provided the venous tubule be made to unite with the flexible tube in the way of a plug. By pressing the tubule home into the flexible tube, and giving it at the same time a semi-rotatory movement, the junction may be made sure. The apparatus being thus prepared, the blood should be admitted to it by opening the spring forceps, and by means of the same instrument: the rapidity of the flow, as well as the moment of its cessation, may be regulated with great nicety. After the operation has been concluded, the wounds and the injured vessels must of course be managed on the general principles of surgery; and it may not be amiss to remark, that if, with a view of facilitating the operation, the artery of the person who emits the blood have been detached a little from its bed, when ligatures are afterwards applied, those ligatures ought to be applied close to that part where the vessel still remains in connexion with the cellular web, in order that the adhesion of the sides of the artery may not be interrupted, for want of connexion with the vasa vasorum.

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The instruments required for this operation should, I think, be shut up in the same case with the impellor hereafter described. Those which I would recommend, are the following:—a tourniquet, a scalpel, a lancet, an eyed probe, a blunted needle and ligatures, a pair of spring forceps, venous tubules, a smaller and a larger, and two flexible tubes, each about six inches long, one connected with a smaller and one with a larger arterial tubule to meet the varying calibre of uniting, in the way of plug, with either of the venous tubules.

OF THE TRANSFUSION OF VENOUS BLOOD BY MEANS OF
THE IMPELLOR.

When, in consequence of the want of arterial blood, it becomes necessary to transfuse the venous, a different method of operating must be adopted; and, in the present state of our knowledge, I would recommend in such cases the employment of the impellor.

In operating with this instrument, a chair is to be procured, and by means of a gimlet an aperture is to be worked into the outside at the back of it, at a convenient elevation, and into this aperture the vice of the apparatus is to be very firmly screwed. By means of the solid stem which projects from its apex, the cup is to be fixed erect in the gripe of the vice, and the large outer cup, containing the impelling part of the instrument, is to be filled with tepid (96°) water, if this can be procured, so that the whole of this part of the apparatus, inclusive of the syringe, may be covered in completely by the water, in such manner that the entrance of *air* into the instrument by leakage, whether of the joints or of the syringe, may be effectually precluded. The apparatus being thus far prepared, the inner cup is to be put on, care being taken to fit the tube which projects below from the apex of this inner cup, to the corresponding tube which springs up from the cylinder with which the syringe is connected, and which lies in the bottom of the larger cup; because, if the exact apposition of one tube to the other be neglected, a difficulty may needlessly arise in putting the inner cup into

its place, in consequence of the two tubes interfering in an obstructive manner with each other. Half a pint, or a pint of water is then to be poured into the inner cup and pumped briskly through the instrument, so that the air may be expelled thoroughly, the water taking its place; and the extremity of the flexible tube which springs from the instrument is towards the end of the operation to be bent down into water contained in a tumbler, the pumping being continued, and this with a view of ascertaining, by the appearance of bubbles, whether there be any fissure at which air enters. The exact temperature of the instrument is not of importance, but the water should, in preference, be milk warm. The apparatus being thus prepared, the operator with his lancet may lay bare, as before, a vein on the fore-arm of the patient, to the extent of an inch at least, taking care to cut down completely through the cellular web, and then, by means of the same instrument, he may, as in the former operation, make a longitudinal incision at least a line in length, and large enough to allow of the ready entrance of the venous tubule to be introduced to the extent of two or three lines thoroughly, but with the utmost gentleness, with its extremity towards the heart. A ligature should not be used. The tubule should be retained in its place by the finger of the assistant who holds the arm. The orifice of the tubule should not have a cutting edge.

After the tubule has been introduced, the chair should be brought close to the edge of the bed; an ounce or two of water should be poured into the cup if void, the syringe should be thrown into action, so as to fill with water the flexible tube which may have drained itself empty, and then the venous tubule, previously inserted into the vein, should, by means of pressure combined with a slight semi-rotatory movement, be plugged pretty firmly into the flexible tube, in order to prevent the juncture from bursting open when the blood is impelled. After the apparatus has been fitted together in this manner, the person who is to supply the blood takes his seat on the chair; his arm is opened by the lancet as in ordinary venesection; any superfluous matter lying in the cup is removed by a piece of sponge; and the blood, instead of being received into a basin in the usual manuer,

is directed into the cup of the transfusing instrument, and by the play of the syringe, impelled direct into the vein of the patient, without being suffered at any time to accumulate largely in the apex of the cup. As the object of the syringe is merely to give impulse, it ought not to be worked by long strokes, but by short and sharp movement, care being taken that the plug be every time pushed home, so as to bear down upon the nozzle plate and prevent any accumulation in the barrel of the instrument. If the syringe be worked in this manner, the blood will be a little more exposed when transmitted through the impellor, than it is when passing direct from artery to vein by means of a tube; since, in order that the impulse may be given, it is enough that the blood be admitted but a little way into the barrel of the syringe. Those who are acquainted with the principles of hydrostatics, must be aware that the entrance of a few minims would be amply sufficient for this purpose.

For supplying blood, men are preferable to women, as they bleed more freely and are less liable to faint. If blood can be procured from the arms of two persons at once, it would sometimes perhaps be desirable. Spirit sufficient to exhilarate and rouse the circulation, may be advantageously given to those who are to furnish the blood before the operation is begun. If the blood, flowing slowly from the arm, show a disposition to clot in the cup, or if the supply of blood fail, the person who furnishes should remove his arm, and a little water poured into the cup of the instrument may be pumped through the syringe so as to displace the blood; thus the apparatus being cleared of blood, will be secured against clot, and kept in a condition to proceed with the operation. If a large bubble of air be absorbed into the syringe, the operation should be suspended, the instrument should be separated from the venous tubule, and the blood and air should be cleared out of the apparatus by immediately pumping through it a few ounces of water, which should be at hand in a small jug furnished with a spout. It would be easy to contrive an instrument which would measure the quantity of the blood injected, but I think it better to avoid complexities of this kind. Of the quantity of blood thrown in, an opinion

may be formed from the feelings of the person who emits it, or by the size of the stream of blood which flows from the arm, and the continuance of the flow; or by putting water into the cup after the operation, and working the instrument with the same measured movement, and with the same degree of rapidity, and for the same time as during the operation. The measure of the water passed through the instrument in this manner, will give nearly the measure of the blood transfused. The time during which the operation is continued, should be ascertained by the watch.

It is of great importance, in using this instrument, that the outer cup be filled thoroughly, so as to cover in the head or upper end of the barrel of the syringe, to the depth of an inch, or an inch and a half at least; and it is this complete submersion of the impelling portion of the apparatus, with all its joints and vents, which is the only security against the entrance of air.

Till it be ascertained (and the affirmative is probable) that human blood may lie out of the vessels for one or two minutes, without material injury, we ought, in operating, to prevent the blood from accumulating in the cup of the instrument. Should it, however, be found hereafter, that the blood may be suffered to gather in the cup, without thereby becoming materially unfitted for its offices in the vessels, then, if this instrument is used at all, it may be proper, during the operation, to suffer an ounce or more of blood to accumulate, in order to prevent more certainly the cup from becoming empty, and thus to preclude the absorption of air.

The minute dexterity required in managing this instrument may be easily acquired by any person who will accustom himself to pump blood, or even water, through it; and those who are frequently performing the operation of venesection must have many opportunities of doing this. When the operation is completed, a pint of water ought to be immediately worked through the apparatus, in order to clear out the blood, and prevent it from lying in the tubes and becoming clotted there; and, as soon as occasion serves, the whole should be unscrewed and cleaned out more completely. If the wire-springs which raise the valves are injured, others may be

very easily made by giving a piece of wire a spiral form, like that of the spring which has been destroyed. If the leather valves are spoiled, others may be made of a piece of soft alum-leather. Both the wire and the leather should be stored in the case for this purpose. The owner of the impellor 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. Laundry of St. Thomas's Street, Southwark, now manufactures these instruments.

OF TRANSFUSION BY THE SYRINGE.

Should it be found hereafter, by numerous pointed, and therefore decisive experiments and observations, that human blood may lie out of the vessels in the cup for several seconds, without becoming thereby unfit for the vital purposes, there is yet another mode in which transfusion may be accomplished, by the syringe alone, I mean, and this method of operating, if feasible, may be adopted in preference to the preceding, on account of its greater simplicity. In this method of operating a good syringe is required, capable of containing two or three ounces of blood, and furnished with a pipe for the vein, (like that used in the former instrument), about two inches long, and made to fit by plugging, and a semi-rotatory movement, into the nozzle of the syringe.

The blood is to be drawn into a conical vessel, for example a tumbler, and while flowing into this vessel, held by an assistant, it is to be absorbed into the syringe. When charged, the syringe is to be held with its tubular nozzle upwards, and the piston is to be pushed slowly onward till the blood begins to issue, in order that the air, which from its greater specific levity, will rise to the upper part of the instrument, may be thoroughly expelled. The syringe, together with the tubule springing from it, now charged with blood only, is to be slid into the vein of the patient, properly laid open for the purpose, and without delay or hurry the blood is to be injected in an equable stream; the operation being repeated as often as the quantity of the blood to be injected may require:—the syringe being of a known capacity will measure the blood.

This, with some little improvement, was the method of

operating adopted in Brazier's case, p. 139. In this method also Mr. Goodridge operated on his dogs, as before described. The simplicity of the operation, and the portability of the instrument, are its great recommendation. A common syringe, if a good one, might be used in this manner if the emergency were pressing. When the syringe is observed for the first time, air may be previously expelled from the instrument by charging it with water. The vein must be laid thoroughly bare, as the cellular web, if not divided completely, will slip over the orifice in the vein, and obstruct the introduction of the instrument; and the opening must be made sufficiently large and free to allow of the ready entrance of the tube. Perhaps a probe might be passed under the vein with advantage.

MISCELLANEOUS REMARKS ON TRANSFUSION.

It may be objected to transfusion in every shape, that the tube may excite inflammation of the vein. In weighing this and similar objections, however, it should not be forgotten, that in the present state of our knowledge, it is proposed to perform the operation in the most desperate cases only, when it seems to be the sole remaining mean of saving the patient's life. There is much good sense in the familiar maxim of Celsus, and in the present case it is peculiarly applicable; for, surely, it is better to incur the uncertain risk of venous inflammation, than to leave the patient to his fate. Besides, the pipe should not be secured in the vein by ligature, but by the pressure of the finger merely, or the blood may be injected by an artery. In the latter case the risk of venous inflammation will be completely obviated, and in the former, probably, it is small.

It will, perhaps, be further objected to transfusion, that the operation is likely to be obstructed by the coagulation of the blood; but this objection is unfounded. In the preceding experiments the operation, though performed on the blood of the dog, was not impeded by concretion; yet the canine blood coagulates in one-sixth of the time which is necessary for the coagulation of human blood, as the following experiments

prove; and it is clear, therefore, that in transfusing human blood, coagulation can furnish no insuperable impediment.

31. I drew off, into a conical wine-glass, about three drachms of blood from the femoral artery of a dog; it began to coagulate in about ten seconds, and was completely solid in about eighty. In a second experiment which I made, the blood began to coagulate in about ten seconds, as before, and was completely solid in about sixty.

32. A patient being seized with an arterial epistaxis, I collected some of the blood of a bright florid tint. A full minute elapsed before even minute coagula made their appearance, and the blood did not become wholly solid till four or five.

33. A few drachms of venous blood were taken from the arm of a girl liable to attacks of epilepsy. It was full sixty seconds before even minute coagula began to make their appearance about the sides of the vessels, and six or seven minutes elapsed before a general coagulation of it took place.

34. I filled a syringe with blood taken from the same patient as the preceding. When retained there for one minute only, it was found, on expulsion, to be thoroughly fluid, and it was but slightly inspissated after remaining there for two minutes.

That air may enter in conjunction with the blood, may also be objected to this operation; and I have been induced, therefore, to make the following experiments and observations, with a view of ascertaining how far this observation is just.

35. Into the femoral vein of a dog (scarcely larger in the body than a full-sized cat) I threw about five drachms of atmospherical air in the direction of the heart, in quantities of about a drachm at a time; the whole operation occupying about five minutes. The quantity of the air was measured by means of the syringe. In consequence of this operation, dyspnæa was produced, together with irregular action of the heart; the dyspnæa, however, not coming on as soon as the air might be supposed to have entered the heart, but a minute or two afterwards.

During this operation the dog sighed deeply, and a slight dyspnæa was produced; the pulse too became unequal, and

the muscular system tremulous. As soon, however, as the animal was liberated, it leaped from the table, licked its wound, and seemed pleased with caresses. On the following day it was languid and restless, and the muscular tremour continued; the pulse intermitted occasionally, and the dog vomited once. In other respects it appeared tolerably well, took food greedily, and revived completely by the third day. This dog was very delicate; and, the small size of the animal considered, the quantity of the air injected was large; yet all the symptoms may be imputed, in part, at least, to the alarm which the operation excited.

36. About three drachms of air were blown from my lungs towards the heart, into the femoral vein of the dog, which had been made the subject of the preceding experiment; the greater part of the air being introduced at once. The respiration, circulation, and general health of the animal, seemed to be but little deranged by the experiment, even at the time; and the dog suffered so little subsequent inconvenience, that a day or two afterwards it was led into the country; nor did any urgent symptoms ultimately occur.

37. Mr. Coleby, well known at St. Thomas's Hospital, procured a large dog, laid bare the femoral vessels, introduced pipes, with their extremities towards the heart, and by means of the *impeller*, transmitted blood from artery to vein, for several minutes together without ceasing. The syringe used in this operation, of faulty construction, was not air-tight, and in consequence a considerable quantity of air was, by little and little worked into the vessels along with the blood. Before, too, the instrument was put into action, the air was not expelled by charging it with water, so that when the syringe began to play, all the air contained in the tubes, the cylinder, and the barrel of the syringe below the plug, was injected into the animal's veins.

In consequence of this operation, the dog suffered a great deal of distress, with frequent and irregular pulse for six or seven days afterwards, at the end of which it was killed and examined, when, as I am informed, a considerable quantity of air was found in the cavities of the heart, mixed up with the blood.

These facts considered, then, it seems probable that the entrance of a few drachms of air into the vessels, would be attended with considerable distress and even danger; but it must be recollected, that if the operation be carefully performed by a competent person, with a proper instrument, there can be no risk, lest air should enter the vessels in large quantities; and the *probability* is, that a bubble or two of air only would occasion little if any inconvenience. It is not objected to the capital operations in surgery, that an unskilful operator may lay open an artery, or that this or other accidents may happen in a moment of negligence even to the most dextrous.

In making these experiments on the dog I did not warm the instrument unless the weather was unusually cold; and though, in the present state of my information, I have recommended tepid water in operating on the human subject, I have a suspicion that heat tends to exhaust the irritability, and destroy what may be called the life of the blood.

Whether large quantities of water may or may not be safely injected into the human vessels, is, I think, uncertain; but there is reason to believe, at present, that small quantities will occasion no inconvenience, and the injection of small portions only is necessary in performing this operation. Both water, and wine and water, were injected into my dogs without fatal, or even serious consequences; but into this question I forbear to enter.

In pointing to the advantages which belong to transfusion by the syringe, in preference to transfusion by the tubule, I shall not enter into details. I refrain, therefore, from enlarging on the facility of the operation, or its uses in physiological research, and shall content myself with touching on those advantages which appear to be the most important. This operation may be performed with promptitude, for the human blood is always at hand; and the instrument may, in many cases, be procured in readiness, as the danger of uterine bleeding, at least, may frequently be foreseen. Promptitude of operating is an advantage of capital importance; for there is reason to *surmise*, from the preceding experiments (4, 5, 6, 7, 8,) that the apparent death of bleeding soon becomes irremediable. Another advantage arising out of this method of

operating, is the abundance in which the blood may be procured. A dog, below the middle size, and this variety, perhaps, is principally found about our houses, generally dies after it has given off from ten to twelve ounces of blood; but much larger quantities of human blood might be obtained on an emergency from the friends of the patient, or for hire.

But of all the advantages derived from transfusion by the syringe, by far the most important is, the opportunity it offers of throwing human blood into human veins. There seems reason for presuming, from facts already related, that the blood of one class of animals cannot be substituted in large quantities for that of another, with impunity; and hence it becomes of the utmost importance that we should be able to supply the human vessels with human blood,—an excellence, which transfusion by the syringe eminently secures.

SOME ACCOUNT OF SIX CASES, IN WHICH INJECTION INTO THE HUMAN VEINS WAS ATTEMPTED.

38. By two gentlemen in my neighbourhood I was called to a case in which a woman was dying, in consequence, as was supposed, of a loss of blood, which occurred during the birth of the placenta. As I entered the room, thirty or forty minutes after the messenger had been dispatched from the house to request my attendance, the patient ceased to respire; and *five or six* minutes afterwards, about sixteen ounces of blood, procured with ease by venesection, from two men (relatives of the patient) were thrown, by means of a syringe, into the bleeding vein of the arm. No signs of resuscitation were observed. The vein was laid bare with a lancet. The blood was infused without difficulty. The operation was performed with the syringe simply, in the mode recommended (p 536).

39. A young man, of somewhat muscular make, a patient in Guy's Hospital, lost a large quantity of blood, from the bursting of an artery, and appeared afterwards, for *two or three* hours together, to be evidently sinking from inanition. This patient I was requested to see; but in consequence of

my being from home, on professional business, time was lost, and I could not perform the operation till the man had ceased to respire for three or four minutes. Assisted, however, by a surgeon of talent and enterprise, Mr. Key, I injected sixteen ounces of blood, by means of the impellor, into the bleeding vein, exposed by the lancet; but, with the exception of one single sigh, no signs of returning life were perceptible. An esteemed and intelligent pupil of mine, Mr. Lord, furnished the blood; and there was no difficulty whatever in obtaining it by venesection as fast as the operation required.

In the first of these cases, it will be observed, the syringe was used; in the second, the impellor; and they prove, that in either mode, the operation is of easy performance: both, though indecisive, render it doubtful whether a man can be resuscitated by an injection into the veins, performed three or four minutes after the last respiration. Artificial breathing was not tried.

40. By a friend of mine, on the other side of the water, I was called to a patient, evidently sinking from a hæmorrhage, which had made its attack during the birth of the placenta, though two or three hours elapsed before death actually occurred. In this case, three or four ounces of blood were injected by the *syringe*, before the respiration ceased, without, of course, producing any obvious effect, the quantity being small; but as a full supply could not be obtained from the lady who offered to furnish the blood, the operation was necessarily abandoned. Women, it has been observed already (p. 534), are not so capable of supplying a sufficient quantity of blood as men are.

41. A lady, bled largely for puerperal fever, sank into that state of collapse, which, as men of observation know, is the precursor of certain dissolution. At the request of friends, who were anxious that a remedy, which promised little, should have a trial, about six ounces of blood, taken from her father by venesection, were infused into the bleeding vein, by means of the syringe. Mr. Williams, of St. Thomas's Street, laid the vein bare with a lancet, and the tubular nozzle of the syringe was repeatedly introduced into the vein without any difficulty. No decisive effect of any kind was produced by

the operation, and the lady died of the fever, without suffering any extraordinary symptoms.

42. A poor fellow in Guy's Hospital (his name was Brazier), between thirty and forty years of age, lay at the point of death, in consequence of the extenuation produced by obstinate vomiting, arising, as afterwards appeared, from schirrosity of the pylorus. At the request of Dr. Cholmley, and the expressed wish of the patient, the late Mr. Henry Cline and myself injected, by means of the syringe, twelve or thirteen ounces of blood into the vein usually laid open in venesection, when no ill symptoms, fairly referrible to the operation, were produced. During the first thirty hours afterwards, there was an increase of the strength, and the man appeared mending; but at the end of this period, he began again to sink into a state of collapse, similar to that which had preceded the operation, and died about fifty-six hours after the injection. Not a single bad symptom occurred when the blood was introduced. Could the operation have been repeated, it is not improbable that his life would have been prolonged.

43. A young man of short stature, but rather broad and muscular, came into Guy's Hospital, under an attack of hydrophobia, then verging towards its close. By the medical officers of the Institution, I was requested, in this case, to lend my assistance in performing the operation of Majendie, which consists in the abstraction of some twenty or thirty ounces of blood, and the injection of two or three half pints of tepid water into the veins, from one to several hours after the bleeding.

From this man I directed, that thirty ounces of blood should be drawn; but, I understand, from the very respectable surgeon who operated, that after the prescribed measure had been abstracted, a further quantity, of uncertain amount, was lost during the pause enjoined by Majendie, between the bleeding and the injection of the water, in consequence of the restlessness of the patient, and the resulting difficulty in securing the orifice of the vein.

Thirty or forty minutes after the bleeding, preparation was made for the injection of the water. A surgeon of the Hospital prepared the vein, and introduced the tubule; but it appeared at this time so evident that the poor fellow was dying,

that those whose office it was to decide, deemed it most prudent that the water should not be injected, and in this opinion I thoroughly concurred.

Several other successful instances of the operation of transfusion might be adduced, and were it not that the book has already extended beyond its intended limits, they would be fully detailed. They may, however, be consulted in the various medical periodicals of the day.

Whether it be possible to save a patient, when sinking from hæmorrhage, by injecting blood before respiration is stopped, these cases do not enable us to judge; but we may, I think, infer from them,

1st. That transfusion, especially that variety of it, in which the syringe alone is employed (p. 536), may be performed with facility.

2dly. And in the present state of our knowledge, that the operation is not attended with any obviously dangerous symptom, provided the blood be promptly transmitted, and the injection of air be precluded.

3dly. And till we have proof to the contrary, that when a patient has ceased to respire for a few minutes, much is not to be expected from injection of blood into the *veins*. What effects might be produced by the injection of venous blood into the common carotid of the right side, towards the coronary arteries, remains to be ascertained.

But, to conclude. The preceding paper contains all the facts, favourable and unfavourable, which are come to my knowledge, and which seem calculated to help the mind in judging, respecting the operation of transfusion. On perusing them, every one, who is in the habit of reflecting, will, of course, form an opinion for himself: having, however, thought a little on the subject, I may be permitted to state my own persuasion to be, that transfusion by the syringe is a very feasible and useful operation; and that, after undergoing the usual ordeal of neglect, opposition, and ridicule, it will, hereafter, be admitted into general practice. Whether mankind are to receive the first benefit of it, in this or any future age, from British surgery, or that of foreign countries, Time, the discoverer, of truth and falsehood must determine.