MÉMOIRE SUR LA TRANSFUSION DU SANG - NOUVEL APPAREIL TRANSFUSOIRE

By: Dr. SOTTEAU

A TRANSLATION BY PHIL LEAROYD

A copy of the paper 'Memoir on Blood Transfusion', which has the sub-heading 'new transfusor device', published in the journal *Annales de la Société de Médecine de Gand* in 1847 (reference volume 19, pages 50-98) can be viewed or downloaded from the following site:

https://books.google.be/books?vid=GENT900000014319&printsec=frontcover#v=onepage&q&f=false

The author starts with a number of comments regarding the 'elixir' beliefs surrounding blood and the early blood transfusion attempts – especially that of lengthening life – together with some ancient mythical examples. He states that it is believed that the origins of blood transfusion reside in 'transfusory surgery', i.e. the direct injection of medicinal substances into a vein. He goes on to mention the work of a number of experimenters and their work both in the mid 17th century and then later in the early part of the 19th century, where he especially provides extensive quotes relating to the work of Charles Waller and Edward Doubleday. Dr. Sotteau then collates together some additional points made in subsequent publications relating to transfusion in uterine haemorrhage cases.

The author then takes a retrospective view to see if the causes which condemned transfusion two centuries previously still exist – relating specifically to widespread prejudices and unsubstantiated beliefs that started in Roman times. He identifies the recent discoveries regarding the need to transfuse only red cells of the same species and the dangers of air entering into the circulation. He also identifies that transfusion should be used for any abundant haemorrhagic situation, e.g. external traumatic as well as uterine.

He provides a detailed description of the treatment of an 11-year-old (haemophiliac) boy by Mr. Lane at Guy's Hospital, London – though identifying uncertainty as to how the whole blood transfusion effected the observed changes, arguing that the infusion of red cells accounts for more than just volume replacement, a consequence of which he states that transfusion should be recommended in diseases associated with blood loss and/or anaemia. He then comments on the potential problems associated with the introduction of air into the patient's circulation and the partial clotting of the donor blood prior to transfusion.

Finally, Sotteau describes his own transfusion device, which is somewhat contradictory to his earlier comments regarding the donor blood clotting in that it is made from tin, rubber and cork. It is a somewhat complex device that includes a vessel held within a water jacket in which to collect the donor blood. Sotteau however identifies that his device has never been used for a human blood transfusion.

I have produced a translation of this paper from the original French into English to hopefully enable its content to be appreciated by a wider audience. Whilst I am obviously aware that instantaneous computer generated translation is available, this process however struggles with accurately reading the original text and interpreting specialist terminology, as well as producing a 'colloquial style' not always representative of the original text. In addition, an 'automatic translation' may either purposely or inadvertently alter the wording to 'make it read better' but in doing so there has to be an element of interpretation involving something on the lines of 'I believe that this is what the author is actually trying to say'. I want to avoid that as much as possible and try to present what the author actually wrote and

as a result the reader may find that the English text does not ‘flow’ as well as it could. Although I have taken great care in accurately identifying the original text and producing a true representative translation of the author’s original wording I cannot guarantee that this work does not contain ‘translational errors’ and the reader is recommended to check specific details against the original text.

I have reproduced the original paragraph settings and general layout as accurately as possible and maintained within the translation the words that are originally printed in italics and capital letters. I have also maintained the spelling of the names of people as originally printed. The original references to the text are included at the bottom of each separate page; I have sequentially re-numbered these and reproduced them as originally written at the end of the translated text. The illustration of Sotteau’s transfusion device is printed before the article (on page 50) whilst the explanation to the figures is printed after the article (on page 98). I have placed these together at the end of the translated text.

This publication is somewhat unique in that immediately after the paper by Sotteau, within the same journal (pages 99-105) is published a ‘report of the preceding work’, which provides a critical appraisal of his paper on behalf of members of the *Annals of the Society*. I have produced a translation of this article as well as it provides a number of interesting comments and placed it immediately after the translation of the article.

NOTE: An additional review of this paper also appears in the *Gazette médicale de Paris*, 17, 2, 40, 787-788, which can be read or downloaded from the following site:

https://books.google.co.uk/books?id=cg5AAAAAcAAJ&pg=PA836-IA2&source=gbs_selected_pages&cad=1#v=onepage&q&f=false

MEMOIR ON BLOOD TRANSFUSION; NEW TRANSFUSOR DEVICE

DOCTOR SOTTEAU

Presenting this work on one of the important inventions of medicine far be it from me to wish to restore to the question of blood transfusion the exaggerated proportions that were given to it at its origin. Moreover, about two centuries have passed since this last epoch, and this lapse of time has sufficed to form the opinion of doctors on the value of this therapeutic means, and to strip it of all the prestige with which its authors had at first surrounded it. It will therefore be easy for me to present it here in all its simplicity and without all the wonder that was formerly attached to it.

The transfusion of blood has for twenty-five years seriously occupied the whole of Europe. At the time of its discovery, it was believed that the problem of immortality had been solved and that the secret of curing all diseases had been wrested from nature; at last, thought it had found the fountain of youth.

It is conceivable that such a method must have found many supporters. The old man in full decrepitude and the sick man on the edge of the grave demanded it with equal eagerness. The old man especially saw his wrinkles erased, his flabby flesh firmed, in short, his vigour of twenty-five years of age revived with all the charms which distinguish this age of illusions. In the presence of so marvellous a means of rejuvenation and prolongation of life, he did not hesitate to despise all those who had hitherto been imagined for the same purpose. From the elixirs, balms, and teas of long life, to the panacea of immortality, advocated by PARACELSUS, and the elixir of life of the famous CAGLIOSTRO, everything incurred its disdain. Since, he said, old age is like a disease which alters our tissues and undermines us, why should we not, by introducing into our veins a young and restorative blood, regenerate our organs and impart to the constitution a movement similar to that which takes place in convalescence, where new blood, elaborated by healthy organs, is sufficient to repair the forces and restore equilibrium in the whole human machine?

Of the thousand means proposed to restore to the deteriorated man the vigour of youth, only one, and unfortunately the most fatal of all, escaped this general proscription, and that was that followed by King David, who had become obsolete with age, and which consisted in warming himself in the arms of a young Sunamid. BOERHAAVE also had recourse to it, with success, it is alleged, to revive an old mayor of Amsterdam; but, let it be said here in passing, similar practices have contributed rather to shorten the course of a voluptuous old age than to prolong its duration.

However ridiculous the pretence of wanting to make oneself immortal, or at least that of wanting to prolong life beyond its ordinary limits, it nevertheless has its origin in facts, some of which have never been disputed, and others, although very inauthentic, are none the less very stirring.

In the time of Adam, human life was incomparably longer than today, it is said to be nearly a thousand years. The early times after the flood also furnished examples of extraordinary longevity: Asphaxal lived three hundred years, and Hebert, whom the Hebrews considered the father of their nation, did not die until he was four hundred and eighty-seven years old. The Greeks, on the point of succumbing, were rescued by the old man Nestor, who, according to Homer, was about three hundred years old. And then, who does not know the remarkable story of the famous Galdo, who claimed to have discovered universal medicine? He passed through Venice about two centuries ago, at the age of four hundred years.

It was above all a certain quotation from VALESCUS that excited the pretensions of decrepitude. "He saw," he says, "in Spain, an abbess, already decrepit and smelling of fir, whose teeth suddenly returned, her hair blackened, the wrinkles disappeared, and the throat reappeared as at fifteen years of age; in short, that we saw life renewed, a young and beautiful girl" (1). But the selfish abbess had the barbarity not to bequeath to posterity the means which had saved her from the sad infirmities of old age; she carried her secret to the

grave!... The prophet Isaiah and St. Augustine pretend that the eagle has the power of rejuvenating itself by clipping its beak, and finally Philostratus maintains that the lion enjoys the same faculty when it succeeds in feasting on the flesh of a certain ape of the Caucasian ape. It is to be presumed that it was these popular beliefs that led to the admission of the possibility of eternal life in this world. It is not for us to examine their orthodoxy here.

It would be difficult to indicate precisely the origin of the blood transfusion; but it is very probable that it was inspired by the so-called transfusory surgery, which consisted of the direct injection of medicinal substances into the veins, in order to obtain a more rapid effect. Already for a long time the ancients had attributed marvelous properties to human blood introduced into the digestive tract, and transfusory surgery, proceeding by analogy, must necessarily have conceived the idea of its direct introduction into the veins. It was, however, towards the middle of the seventeenth century that blood transfusion was seriously considered. As soon as the idea was put forward, a crowd of doctors demanded the priority of this invention. Then, as now, it seems, a discovery must never belong to its true author. Terrible quarrels marked the early days of this discovery. LOWER, J. DENIS, CL. FARDY, J. VEHR, and M. HOFFMANN particularly contended, about the year 1665, for the honour of priority. It is easy to imagine how these doctors, who exaggerated the advantages of transfusion, spoke of it in pompous terms. On the other hand, CANTWELL, LAMARTINIÈRE, PERRAULT, etc., sought, as far as it was in their power, to depreciate it by showing it surrounded by the most eminent dangers to life. In any case, the first experiments date from this period. It was in Oxford that RICHARD LOWER instituted the first transfusions on dogs. It was then tried in Paris by EMMERETS, assisted by DENIS. Later, similar experiments were made with success in Italy, a man, in whose veins lamb's blood had been injected, felt so well after that, four days later, he requested the operation again.

In spite of all these apparent successes, which promised it such a brilliant future, transfusion fell into disrepute, and it was scarcely until after a proscription of more than a century and a half that it emerged from nothing; but this time, we dare to hope so, to render real services to humanity.

As we have just said above, EMMERETS practiced transfusion in Paris in 1668 under the eyes of DENIS. They tried it in particular on a man suffering from mental alienation, and, it appears, the first two attempts produced advantageous results. A third was brought to crown the work, but alas!, it was the tomb of the patient and of transfusion itself. They were beginning the last injection, when the patient cried out: *Stop! I'm dying! I'm suffocating!* And indeed, he died instantly. It is easy to imagine that this misadventure dealt a severe blow to the popularity of transfusion, and, shortly afterwards, a decree of the Châtelet, dated 17 April 1668, forbade the operation of transfusion until it was approved by the Faculty of Medicine.

But unfortunately the scientific body, charged with examining the question, did not concern itself with it and in this way deprived humanity of the benefits it had a right to expect from the transfusion of blood.

This fact is a new proof that unlimited freedom is an indispensable condition of the prosperity of the sciences. When laws or brute force come to impose a check on them under the very pretext of protecting them, they never fail to degenerate and deceive the hopes they had at first conceived. Blood transfusion is a striking example of this, a decree of the Châtelet in France prohibiting its practice, and for more than a hundred and fifty years it has remained in complete oblivion. If the judgment of this curative method had been left to the public, it would perhaps have been equally unfavorable to it; but a reprobation of this nature would not have prevented scientists and philanthropists from pursuing the researches they could undertake on this subject, from appreciating it at its true value, and from making it reappear with all the brilliance it deserved.

Moreover, certain doctrines, such as those of HOFFMANN, STHAL, CULLEN, etc., which were in opposition to the humoral theories of that period; and later, those of PINEL and BROUSSAIS, which were the height of solidism, adding to the discredit that various circumstances had brought to light, were very likely to make people lose sight of the transfusion of blood.

It was not until the year 1821 that the experiments of Messrs. J. L. PRÉVOST and J. A. DUMAS on blood again aroused the attention of doctors to transfusion. These physiologists have observed that (2), when an animal is bled to the point of syncope, that all muscular movement is abolished, and that the action of the heart and respiration are suspended, that it is almost certain that life is forever extinguished; if any liquid is then injected, either pure water or blood serum at 38°C., death is none the less the consequence of the haemorrhage that the animal has suffered; but if the blood of an animal of the same species is injected, each portion injected substantially revives this kind of corpse, and it is not without astonishment that, after having restored to it a portion of blood equal to that which it has lost, it is seen to breathe freely, to move with ease, to take food, and finally to recover completely, if the operation was well conducted. The same experimenters have also demonstrated that, if the blood is taken and injected into an animal of a different species, but whose globules are of the same shape, though not of the same dimensions, the animal is only imperfectly raised, and can seldom be preserved for more than six days. In those who are subjected to these tests, we observe some phenomena which must not be omitted: the pulse becomes more and more accelerated, the respiration retains its normal state, but the heat is lowered with remarkable rapidity when it is not artificially maintained. From the moment of the operation, the excreta become mucous and bloody; they retain this character until death. The instinctive powers are not altered. That if blood with circular globules is injected into the veins of a bird, the animal usually dies in the midst of very violent nervous accidents, comparable in their rapidity to those obtained by means of the most intense poisons; that if cow or sheep blood is transfused into cats and rabbits, either the operation was performed immediately after the extraction of the blood, or the blood was left to rest in a cool place for twelve or even twenty-four hours, the animal has been restored, for a few days, in a large number of cases. The blood was kept fluid by removing a certain amount of fibrin or by adding 0.001 of caustic soda. Finally, it has been proved that sheep's blood, injected into the circulatory organs of ducks, excites rapid and very strong convulsions, followed by death, etc., etc.

In spite of all that these observations present in favour of the transfusion of blood, their authors have nevertheless concluded nothing advantageous from them, and they conclude their work on this subject by saying that, if they have mentioned it, it is in order to prove that transfusion on man must be condemned as absurd and dangerous, as long as we are not more advanced in the intimate knowledge of the active principle of blood.

However, the experiments of Dr. BLUNDELL (3) leave no doubt as to the advantages which may be derived from the injection of the blood of an animal into the veins of an individual of the same species, in preventing death in cases of abundant haemorrhage. He also succeeded, by means of the same operation, in keeping animals living for a long time when they were entirely deprived of food.

Encouraged by the experiments of Dr. BLUNDELL, Dr. H. M. EDWARDS, contrary to the opinion of Messrs. PREVOST and DUMAS, in a thesis which he defended in Paris in 1823, that is to say, two years later, before the Faculty of Medicine, expressed the opinion that recourse might be had to transfusion in certain cases of serious haemorrhage. This thesis had no echo in France and it was again in England that experiments on the transfusion of blood were continued, with the aim of endowing human medicine with it. It was an English doctor, named WREN, who first proposed to institute this operation on man, and who gave the idea to DENIS and EMMERETS of then performing it in France.

Messrs. WALLER and DOUBLEDAY have fully justified the opinion of Dr. MILNE EDWARDS, by making a happy application of the operation which the latter sought to recommend. They resorted to transfusion in cases of uterine loss which followed childbirth and compromised the lives of the patients. The observations relating to these experiments have already been published, and I could therefore have dispensed with quoting them in this memoir; however, as they seem generally little known and, moreover, are very conclusive, I think it essential to mention them.

1st OBSERVATION (4): "The woman who is the subject of this observation, it is Mr. WALLER who speaks, was of a very delicate constitution, and of a lymphatic temperament. I went to her house about ten o'clock in the evening. A few moments before my arrival, the amnion waters had flowed. On proceeding to the touch, I found that the head had not yet crossed the superior strait, that the cervix was completely dilated, and that it was very dilatable, as well as the external parts. However, the pains had diminished in strength and frequency; I left the patient, recommending her to send for me when they reappeared, which happened about three hours later. I was asked for on behalf of Mr. JESSE, who usually gave his care to this woman and who had received the child. The delivery had been promptly terminated. On entering the patient's room, I found her lying on her back, her face pale as the sheet that covered her, her whole body discoloured and offering, in a word, all the apparent signs of death, etc. However, by carefully feeling the pulse, I managed to feel the pulsations of the artery, which presented long intermittencies. I was informed that the expulsion of the placenta, which had taken place naturally, had been followed by a most abundant haemorrhage, which had brought about, almost immediately, this state of general collapse. We had recourse to ordinary means such as the application of cold, etc. The patient was administered brandy and ammonia in large doses for an hour and a half, without any success. Seeing that the patient was still in the same situation, I resolved to consult Dr. BLUNDELL to find out whether it would not be advisable to perform the transfusion. This practitioner being of the opinion that transfusion was indicated, the necessary preparations were made. However, as the pulse seemed at that moment to be about to rise, it was agreed to wait; but this hope having completely vanished after three hours of waiting, and death having become imminent, we ourselves were definitely in a position to transfuse blood into the veins of the dying woman.

"After exposing one of the veins of the arm, we made an opening large enough to admit the end of the syringe. A small blunt needle, passed under the vein, easily stopped the little haemorrhage caused by the puncture of the vessel. I will observe here that, in cases of this nature, as the patient cannot without danger lose the slightest quantity of blood, it would be useful to use this means even before opening the vein.

"The syringe used by Dr. BLUNDELL did not differ from those usually used for injection, and contained about two ounces of liquid. After having expelled the air from it, in order to avoid the serious accidents which its introduction into the veins gives rise to, he fills it with the blood drawn from the husband's arm and received in a glass; then, after having inserted the end of the instrument into the opening of the patient's vein, he pushed the liquid into it with great precaution. This first injection of two ounces did not seem to produce any effect; but, towards the end of the second, the symptoms which announce syncope appeared; the pulse dropped a little. The patient sighed deeply and made an effort to vomit, without, however, rejecting anything. These accidents, quite similar to those which often follow a somewhat strong bleeding, ceased spontaneously after one or two minutes.

"I should have said that the patient had rejected the contents of her stomach some time before the operation, so that only subsequent observations can tell us whether the symptoms we have just spoken of were due to the injection of blood, or to a spontaneous return of nausea.

"Be that as it may, as in an operation of this nature it is essential to act with the greatest precautions because of the little knowledge we have of its effects on the body, and that moreover the patient said she felt much better, we did not think it appropriate to go further. The pulse, which before the injection was at 120, now gave only 110 beats per minute; but it still retained all its weakness.

"At our next visit, about six hours later, it was with great satisfaction that we saw that our patient had risen considerably. Her pulse was then 100 beats and much stronger. She complained of a violent hunger and was allowed some nourishing but soft food.

"It might be objected that the patient could have recovered without the transfusion having been performed, and it is quite impossible to deny that this could not have taken place. But it will be noted that we had the greatest reason to think that the patient could not escape death, which we already regarded as inevitable, and I think that anyone who had seen her

would have shared this opinion. Besides, the same could be said of all the remedies that are use daily. We do not yet know how far the power of nature may extend in cases of this kind, as in many others, and it is impossible to prove, incontestably, that the favourable change is due to the efforts of nature rather than to the effect of the means employed. From the fact that death did not immediately follow the shedding of blood, it does not necessarily follow that the patient could have survived; for, even after six hours, there was still no improvement. In the only case of fatal uterine haemorrhage which I have had occasion to observe, the patient lived three hours after the flow of blood had ceased, and although during all this time most of the means indicated in such cases had been used.

"It might also be objected that it is hardly probable that four ounces of blood could have sufficed to save the life of a woman dying of haemorrhage. To this I will reply that I am intimately convinced that this quantity of blood, small as it was, was sufficient to turn the luck in favour of the patient. Let it be remembered that in performing this operation we did not pretend to restore the patient to her former vigour, but that we only wished to increase the quantity of blood fluid in circulation, in such a way as would be sufficient to maintain the contractions of the heart until such time as digestion and blood formation could repair the losses of the economy. I will also ask those who have been able to see many uterine haemorrhages, whether they have not met with cases in which the patients were reduced to such a degree of weakness, that the discharge of a very small quantity of blood, even if it were only four ounces, would necessarily have resulted in death. It is for this consideration that I think I can maintain that, although the quantity of blood was only very small, it was nevertheless sufficient to tip the balance in favour of our patient.

"Be that as it may, this observation proves, as far as an isolated fact is capable of:

1° That the transfusion operation is extremely simple and easy to execute.

2° That four ounces of blood may be injected into the veins of a woman who is about to succumb to haemorrhage, without causing any untoward accidents; or at least without giving rise to more serious symptoms than those which usually follow ordinary bloodletting.

3° Finally, that it is very probable that the blood thus injected will be immediately used for the general needs of the circulation."

2nd OBSERVATION (5): "Mrs. Cochlin, says Mr. DOUBLEDAY, twenty-nine years of age, of a strong constitution, gave birth to a daughter on 28 November last. The delivery was not accompanied by any accident, only the placenta adhered strongly to the walls of the uterus, and Mr. G. FRANCKS, to whose care the patient was entrusted, vainly employed all the ordinary means to obtain deliverance. At the end of two hours, a most serious haemorrhage having occurred, he introduced his hand into the womb to detach the placenta, which was still very adherent to the bottom of this organ. Mr. FRANCKS sent for me, and, on my arrival, I found the womb contracted on the placenta which was beginning to be expelled; but before and during her discharge, the patient lost such a great quantity of blood that she fell into syncope. Her appearance was such that, when I entered the sick woman's room, I thought she was moribund. The pulse was no longer felt on the wrist, the face was bloodless, the lips discoloured, the nostrils pinched, the sight obscure, the agitation extreme, the breathing accelerated and interspersed with frequent sighs, and finally, the whole body was covered with a cold and sticky sweat.

"I immediately made the patient take about six ounces of brandy. This liquor raised the strength a little, and made the pulse perceptible. It was continued to be used at short intervals, with the addition of a certain quantity of carbonate of ammonia and laudanum. We persisted in the use of these means for half an hour, without almost any advantage. The pulse was sometimes sensitive and very accelerated, and sometimes quite imperceptible. Seeing that we gained nothing by the use of these means, I saw no other chance of salvation for the patient than in the operation of transfusion.

"Mr. BLUNDELL, of whom I was deputy, was fully of my opinion. This method was therefore proposed to the husband, who not only accepted it, but also offered to supply the blood that would be needed.

"Mr. BLUNDELL then set about performing the transfusion, discovering the median-cephalic vein; but the patient refused so obstinately that he was obliged to give it up, without any other hope of preserving her life. However, I requested Mr. BLUNDELL to leave me the syringe, determined to renew the attempts at an operation when the patient was at the point of death.

"I then entrusted it to the care of Mr. FRANCKS, recommending him to continue the use of stimulants and other similar means.

"At half-past two in the afternoon, that is to say more than six hours after the cessation of the haemorrhage, this surgeon sent me word that the patient was rapidly losing her strength and that I would probably no longer find her alive. I hurried there and found her in the worst condition. She had already been given twenty ounces of brandy, a hundred and sixty drops of laudanum, a large quantity of carbonate of ammonia, and three egg yolks mixed with brandy, broth, and oatmeal.

"As any delay could be fatal, I immediately passed a blunt needle under the vein that Mr. BLUNDELL had already exposed, and I made an opening large enough to easily insert the cannula of the syringe; during this time Mr. FRANCKS slightly compressed the vessel on the needle in order to avoid any loss of blood. Immediately the vein of the arm of the patient's husband was opened wide and the blood was received in a conical glass. I filled the syringe at once, and, after taking all the usual precautions to prevent the entry of air, I adapted the cannula to the opening of the vein, and pushed the blood into it gently and cautiously. Scarcely had it been injected, when the pulse rose sensibly and became wider, and the appearance of the lips and face greatly improved in consequence of a second injection, which was followed by a third, which made a total of six ounces of blood. The patient's condition at that moment was so satisfactory and she felt so well that she cried out that she was as strong as an ox. During a fourth injection of two ounces of blood, she said that she felt this liquid flowing through her veins, the pulse was then quite raised, and the patient was perfectly recovered. Three more injections of two ounces were made, which brought the total quantity of the liquid injected to fourteen ounces. The pulse continued to gain strength, but after the seventh injection the patient complained of a slight pain above the left eye. I then stopped, and closed the opening of the vein in the usual manner. The pulse, which, before the operation, gave 140 scarcely perceptible pulsations, offered only 104 immediately afterwards, a quarter of an hour later 98, and after half an hour 90. It was generally strong, full, a little soft and a little irregular. At the end of the first hour after the operation, the patient sat up and, with the help of her guard, cleaned and dressed herself as after an ordinary childbirth.

"A few hours later, I observed febrile symptoms and slight uterine pains which could be attributed to the effect of the brandy and other stimulants that had been administered to the patient. They were combated by diluents and light laxatives. The day after the operation, towards the evening, it was noticed that a slight inflammation had manifested itself in the path of the vein and that it was spreading to the armpit. Twelve leeches were immediately applied to the arm and covered with emollient fomentations. The next day six more leeches were placed towards the upper end of the vein. These means were sufficient to remove the inflammatory symptoms. The secretion of milk was very abundant and the breasts painful. Finally, on the seventh day after the operation, the patient was perfectly recovered; only the wound on the arm was not healed until a few days later.

3rd OBSERVATION: This third observation also belongs to Mr. WALLER (6). The woman who is the subject of it had been in bed for three weeks, and was so exhausted by continual vomiting and nausea that she had no longer the strength to turn over alone in her bed. She was seized with the pains of childbirth on 29 April, about three o'clock in the morning. Mr. WALLER went there about ten o'clock. For five hours she had been experiencing a violent haemorrhage, which was only increasing. The pulse was scarcely sensitive at the wrist, and the general weakness was extreme. The child presented the shoulder; Mr. WALLER hastened to make the version and to finish the delivery. Far from diminishing, the collapse increased considerably, a small quantity of brandy, administered internally, produced no

effect. The pulse was imperceptible, the breathing laboured and deep; in a word, her state of exhaustion was such that it was impossible to be nearer death; "and I must confess," said Mr. WALLER, "that I did not believe in the attempt I was about to make."

The preparations for the operation lasted nearly an hour. The patient was at her lowest. Assisted by Mr. DOUBLEDAY, Mr. WALLER opened a vein in the arm, and injected, in the usual manner, thirteen large of blood taken from a robust man. The patient, as she has since confirmed, was so weak that she could no longer see or hear, that she could not speak, and that she did not even feel the instrument that opened her vein; in short, she had not the slightest idea of what was being done to her. This first attempt did not seem to produce any marked effect; from that moment, however, the pulse became more sensitive, and the extreme agitation which had existed before ceased completely: five minutes later thirteen more large of blood were injected. The pulse became still more sensitive, but it continued to be very weak. After another five minutes, another ounce and a half of blood was introduced into the vein, resulting in a great improvement in the pulse, which gave 140 beats per minute. From that moment, the patient was able to answer all the questions. Half an hour later, fifteen large of blood were again injected from Mr. WALLER's nephew, a young man of fourteen years of age and in good health. The results of this last injection were still more manifest. The patient's condition was considerably improved. The pulse was tolerably strong, and since then gave 130 beats per minute; the general appearance was satisfactory, the heat good, etc. At eight o'clock in the evening, Mr. WALLER, who had been obliged to be absent, found the patient in a very satisfactory condition. The pulse was at 140, regular though small, the face calm, the tongue clear and moist; only the irritation of the stomach persisted and the patient immediately rejected everything she took. At last, on the seventh day after this operation, she was able to remain up for half an hour, and on the twelfth she was in full convalescence.

Mr. WALLER concludes this important observation thus: "It should be noted that in this case the introduction of the blood into the vein did not produce any symptoms of momentary discomfort, and I presume that this is due to the extreme slowness with which I injected the blood; for, from certain experiments which I have helped to make very recently, I must conclude. that the prompt and forced injection of blood into the veins produces in animals several unfortunate symptoms, and that, when the animal is in a state of extreme exhaustion, the action of the heart is destroyed by forcefully pushing too much blood into the veins."

The publication of the various foregoing observations seemed to awaken the fortunate results that can be expected from the transfusion of blood, when this operation is conducted with prudence and instituted with expediency. Since then, the medical journals of England and Germany have announced new successes, especially in cases of uterine hemorrhage following childbirth. Here are some observations on this subject collected in these periodical writings. I will here briefly relate them, since the three preceding observations, which I have transcribed in full, contain almost all the same details.

In a case of uterine haemorrhage following childbirth, Dr. SCHUEEMANN, of Hanover, transfused, in 1833, with complete success, seven or eight ounces of blood. Half an hour later, the happy effects of this practice had already been felt, and three hours later the cure was complete. In this circumstance some fortifiers were used to aid the action of the transfusion (7).

Dr. KLETT also reports two cases of blood transfusion (8) on women exhausted by uterine discharge during childbirth. One of these operations was performed by the surgeon SCHRAËGLE. The condition of these two women left no doubt as to their approaching end; they presented extreme weakness. Dizziness, obscuration of vision, coldness of the extremities, cold sweats, hiccups, deathly pallor, alteration of the face, repeated syncope, such were the frightful signs of imminent death, and which determined the doctors to help the patients by an injection of blood into their veins. In one of them, only two ounces were injected. The effect was surprising, says Mr. KLETT, the patient opened her eyes almost instantly. The pulse became sensitive again and rose, the hiccups diminished and then ceased entirely, the face resumed its natural appearance, and the heat seemed to succeed

suddenly to the coldness of the body. The haemorrhage ceased and the patient regained her senses. The administration of ratanhia, cinchona and iron completed the cure (9).

The second woman was injected with about two or three ounces of blood, and the death that threatened her was also averted.

The *Medicinisch Correspondenz-blatt*, 1837, contains another observation by BERG, which is almost similar to the two preceding ones. It differs, however, in that the patient was not revived until a few minutes after the injection. The recovery of the rest was complete after a month. Finally, the last observation of this kind which I have to record here is reported by Dr. JACKSON (10). If the operation was not crowned with success this time, it is nevertheless a case worthy of being recorded, since it proves that the death of the patient was determined by circumstances unrelated to the transfusion. And in fact, the vicious implantation of the placenta having necessitated the child's version, the result was a haemorrhage which soon exhausted the patient's strength. It is even probable that, if art had not intervened, death would have been much more prompt. Dr. TWELIE injected seven ounces of blood into the basilica vein of this woman, in the presence of Messrs. JACKSON and ASHWEL. The pulse rose instantly and the woman seemed to live again as if by a miracle; she opened her eyes and uttered a few words: an hour later she fainted again. Mr. ASHWEL performed a new transfusion using the blood of the patient's husband; she was fortunate enough to raise her life for a moment, but this success was only temporary: the patient expired an hour later.

Thus, out of eight cases of transfusion that I have just cited, seven have been successful; only one was unfortunate because of circumstances totally unrelated to this therapeutic method.

Before continuing, it is important that I remark that, in each of the transfusion operations of which I am here accounting, two capital precautions have been taken: first, that of injecting only the blood of an individual of the same species, and secondly, that of preventing, by all possible means, the air from entering into the blood vessels at the same time as the blood.

The author of the article Transfusion in the *Dictionary of Medical Dictionaries* (1842), expresses himself as follows with regard to this operation: "Transfusion is a means that it is no longer permissible to neglect in extreme cases; but before resorting to this serious means, it is necessary to be certain that there is no other resource left to save the lives of the sick. The cases of metrorrhagia are almost the only ones in which it has been successfully applied. The analogy could make it possible to extend its use to all haemorrhages immediately threatening life; but the unsuccessful attempts made in other circumstances, such as that of Mr. BLUNDELL in a case of consumption by a scirrhus of the pylorus, must make one circumspect in this regard. Until further data are available, therefore, we must adhere to the precept of SCHOENLEIN, a professor in Berlin, and have recourse to transfusion only in desperate cases of metrorrhagia."

I fully share the opinion of the author I have just quoted, as to the circumspection that must be put into the use of blood transfusion, and I agree with him that it should only be resorted to when it is well proven that there are no other resources to save the patient; but I am far from believing with Professor SCHOENLEIN that it should be resorted to only in desperate cases of metrorrhagia. I will later cite facts which prove that it would be a fatal error to restrict this therapeutic method within such narrow limits. But, before approaching these facts, let us take a retrospective look at transfusion, and examine whether the causes which caused it to be condemned two centuries ago still exist today.

At the origin of transfusion, it was believed that it was sufficient, in order to modify the constitution, to inject any blood into the veins, provided that it presented the conditions in harmony with the goal that was intended to be achieved. Thus, the aim of the old man being to rejuvenate himself, he needed a blood suitable to restore to him all the attributes of youth; while the patient, guided by the desire to cure himself, sought the blood of an individual who was perfectly healthy and above all possessed of the qualities that were supposed to neutralize the vices of the one which circulated in his veins. Finally, on the strength of the humoral theories, which were very much accredited in those times, it was soon deduced that

the absurd consequence that one could by means of transfusion, turn a wolf into a sheep, and a coward into a man of heart.

It would be difficult to determine here the causes which gave rise to this unqualified confidence in the transfusion of blood. One could perhaps consider as such, old prejudices, then generally widespread, about the marvelous properties of the fluid blood. Thus, it was formerly believed that bull's blood was a poison, and it is said that Themistocles committed suicide by this means. The Romans looked upon the blood of man as a remedy for epilepsy, and when a gladiator succumbed in combat, the unfortunate people who were afflicted with the obsolete disease hastened to collect and drink his still steaming blood, in order to cure themselves of this cruel affection (11). It is also said that Louis XI, in the hope of correcting the acrid nature of his blood, drank that of a child who was thus sacrificed to the health of the monarch. It was only according to the advice and reprimands of St. Francis de Paul that he resolved to seek his healing in religious practices, etc.

But the progress of science has dispelled all these gross errors, and since it has been discovered that there exist in the blood globules of different shape and size in each species of animal, it has been understood that the vascular system, considered in each individual of a different species, is so arranged as to be able to give passage only to globules proportioned in volume and shape to the calibre of the conduits through which they are to pass. Too large, the blood globules, introduced by means of the transfusion, must obstruct the capillary ramifications and produce a kind of asphyxia; too tenuous, they circulate too quickly and have, so to speak, no time to assimilate. In both cases, the good effects of the transfusion are only temporary; sometimes this operation is then even followed by sudden death (12).

The progress of medical science has therefore proved the necessity of using, for transfusion, blood taken from an individual of the same species. They have, moreover, demonstrated how fatal are the accidents which accompany the entry of air into the organs of circulation.

The masters of surgery, such as BEAUCHENE, DUPUYTREN, DELPECH, DE CARTRARA, ROUX, PUTEGNAT etc., had already remarked that in some operations performed on the neck or on the upper part of the chest, air could enter the open vessels and cause sudden death. The recent experiments undertaken on this subject by Professor AMUSSAT have justified the result of the observations of these practitioners, by demonstrating that whenever air penetrates the veins of a living animal, either by means of insufflation, or by the sole effect of respiration, when it is a question of a vein of the neck or of the upper part of the chest accidentally opened, death is almost always instantaneous. It would be useless, however, to dwell any longer on these experiments, which this scientist has been kind enough to repeat before most of us, and which are scrupulously reported in the memoir which he has published on the subject (13).

Thus, knowing perfectly well today the precautions that must be rigorously observed when resorting to transfusion, it will now be possible to transfuse in complete safety. It is only a question of establishing the cases in which this operation can have salutary effects.

Hitherto transfusion has scarcely been practiced except on women exhausted by uterine discharge after childbirth, and, as I have already said, Professor SCHOENLEIN also advises that it should be used only in desperate cases of metrorrhagia. Be that as it may, I know facts as peremptory as those I have already cited, which prove that there are other conditions under which this operation can also be used successfully. I think it should be used whenever an individual's life is in danger because of abundant blood loss; and, if we are obliged to admit some exceptions to this general indication, the fact remains that they are still very rare.

Here is an observation of transfusion in a case of traumatic haemorrhage; it was communicated to me by Professor AMUSSAT, of Paris. Since then, Dr. DE MUYNCK, who was present at the operation in question here, has confirmed its complete accuracy to me.

Sir ASTLEY COOPER extirpated one day in London, in the presence of Messrs. DUPUYTREN and DUBOIS, an enormous tumour that a Negro had on his back. The operation was laborious and had already been going on for a long time; the individual had lost a great quantity of blood, and was at last on the point of succumbing, when ASTLEY COOPER, addressing DUPUYTREN, asked him what he would do in such a circumstance. The famous surgeon of Paris hesitating to answer, ASTLEY COOPER resumed: "Eh! good! I'm going to try to inject blood into his veins." A nurse present was bled and his blood transfused into the veins of the Negro who immediately regained his strength, to the point that the operation could be continued and after a short convalescence, he was fully recovered.

This observation demonstrates incontestably that blood transfusion is also applicable when abundant haemorrhages, caused by external causes, endanger the life of the individual. For why, in such cases, could not the loss of this fluid be compensated by an introduction of blood into the vessels, just as well as if it had been made through the uterine surface? I see no serious objections to this question, and, until they are made, I particularly recommend the observation of Mr. AMUSSAT to the attention of practitioners.

The second observation of this kind which I have to mention, although presenting some analogy with the preceding one, nevertheless contains data which seem to me to be of great importance, in establishing the extent which this operation can acquire as a therapeutic method. This motive has induced me to reproduce it here literally.

Strabismus, tenotomy, frightening haemorrhage, transfusion, healing; by SAMUEL LANE, Professor of Anatomy and Surgery (14).

"Georges Firmin, aged eleven, was taken by his father to Mr. LANE to be cured of a strabismus, according to the procedure of Mr. STROMEYER. The operation offered nothing special, except that the child felt ill and that his eye bled more than usual. The blood, however, finally stopped, and the child was able to walk about almost immediately afterwards. In the evening, however, the haemorrhage reappeared and lasted several hours. Mr. LANE was warned and stopped it after half an hour of compression. Then the parents informed him that the child had been in danger several times by haemorrhages occurring on the occasion of the most insignificant wounds. Four years ago, he had been admitted to Guy's Hospital for a haemorrhage which, occurring after evulsion of a tooth, had lasted four days. Six months later he was admitted to the same hospital for another haemorrhage, which could not be stopped for a fortnight, and shortly afterwards he suffered a similar accident caused by a small cut in the finger, which was cured by compression. In September 1839, he had entered the St. George's Hospital for a knee ailment. An application of leeches gave rise to a disturbing haemorrhage, which could only be stopped by bringing the edges of each puncture together with a needle and thread.

"The operation performed on the eye of the young patient also gave rise to haemorrhages which, however, offered intermissions. When the patient got up and fell into syncope, the blood ceased to flow; but scarcely had he revived when the haemorrhage reappeared, although the pulse remained almost insensible to the wrist. The blood was not very coagulable and as liquid as if it were diluted in water.

"On the third day the haemorrhage was stopped for several hours with the help of applications of gum tragacanth powder and compression, which the child helped with his hand. The gum mixed with the blood formed a kind of paste more or less hard, which, placed in front of the orbit, momentarily stopped the haemorrhage, which, however, the slightest movement was sufficient to renew.

"On the fourth day, the child vomited everything he took and was in a state of extreme prostration. The blood flow nevertheless continued and the patient appeared to be expiring.

"On the fifth day, continuous syncope and convulsive movements. The matter contained in the stomach rose into the mouth and the patient did not have the necessary strength to expel it from this cavity; so he was at every moment threatened with suffocation.

"It was in this state of affairs that Mr. LANE proposed transfusion. He performed it on the sixth day after the strabismus operation. Until then, the blood had not ceased to flow; the skin was cold and pale, and almost like that of a corpse. For the rest, the pulse was imperceptible in the wrist; the arms and head, which were no longer held in respect by sufficiently strong muscles, obeyed only the action of their gravity.

"*Operation*. It was seven o'clock in the evening, and Messrs. PHILP and WIRKER were present at the operation. The device consisted of a syringe with a very tapered spout and furnished with a funnel, the stem of which was fixed perpendicular to the axis of the syringe and towards the base of the nozzle of this instrument. The funnel is intended to receive blood and pour it into the body of the syringe. A very simple mechanism makes it possible to stop at will the flow of blood contained in the funnel.

"The operator opened a vein in the arm that he had previously dissected as if for an anatomical preparation. An ANEL stylus, passed under the vessel at the place of its opening, was intended to lift it and thus oppose the flow of blood. Then, after immersing the instrument in hot water, and after making sure that its beak was suitably adapted to the opening of the vein, he fills it with the blood instantly supplied to him by a young woman of a strong and robust constitution. The instrument thus arranged, and having first been carefully rid of the air it could contain, he prepared to introduce the spout into the opening of the vein; but the blood was already beginning to coagulate, and he was obliged to remove the apparatus and wash it again in hot water. Then, and this time taking the precaution of operating while the blood flowed from the young woman's arm into the funnel and into the syringe, he pushed a certain quantity into the veins of the young patient. During the operation he carefully monitored, and with each stroke of the piston, the state of the respiration and the functions of the brain, according to the movements of the ribs, the colouring of the skin, the injection of the eyes, the lips, etc. He thus injected up to five and a half ounces of blood, putting a certain interval between each stroke of the piston. Four times the apparatus had to be removed and washed because of the tendency of the blood to coagulate. At last, when the woman had already lost ten or twelve ounces of blood, and her vein was scarcely giving any more, Mr. LANE stopped.

"The benefits of the operation were slow to manifest themselves; but the pulse immediately reappeared at the radial. About two hours later, the child was much better; he rose on his bed and drank a glass of water mixed with wine, which he had the strength to bring to his mouth. It was hard to believe in this almost miraculous return from life to death, and in so few hours. Finally, the blood no longer reappeared at the wound of the eye, his appetite returned, and he was completely cured at the end of three weeks. After spending some time in the country, he returned in good health and completely free of his strabismus."

This observation of blood transfusion seems to me remarkable in several respects. First, it demonstrates, as in the case of Mr. AMUSSAT, that transfusion can repair accidents resulting from traumatic haemorrhages as well as those produced by uterine discharge after childbirth. Secondly, it seems to prove that the transfused blood can be used, not only to replace that which has been lost, but also to modify the humoral constitution of the operation. In fact, the person who is the subject of the observation has not since been subjected to haemorrhages as a result of slight solutions of continuity: which obliges us to admit that the transfusion has imprinted on the blood a character of plasticity which it formerly lacked, and the absence of which was the real cause of the frequent loss of blood with which the individual had been affected.

Mr. KLETT, of whom I have already spoken, in seeking to explain the physiological action of the blood introduced into the veins, expresses the opinion that its action, in cases of haemorrhage, cannot be entirely attributed to the material compensation which results from it. He seems disposed to believe that it is due to a momentary excitation of the vital properties, an excitation which must be supported by medicines.

Although I think, contrary to the opinion of Mr. KLETT, that material compensation alone has sufficed in the cases he has observed to rescue his patients from death, I cannot help granting to the blood introduced into the veins a certain vital action which, in the event of a

deterioration of this fluid coinciding with a fatal haemorrhage, can not only replace the lost blood, but also modify the constitution to the point of curing the primary disease at the same time as the accidents of haemorrhage.

It seems to me that the observation collected by Mr. LANE militates strongly in favour of this opinion; and, without wishing to establish here that it will henceforth be sufficient to inject rich and perfectly healthy blood into the veins of an anaemic person, to cure him, even after having previously rid him of a part of his vitiated blood, I feel that this method may have particular applications other than those I have just indicated. I cannot recommend enough to those who will now defect to make sure of the effects of this operation on diseases that could coincide with blood loss. This, it seems to me, is the only way to determine the limits that are appropriate to the therapeutic method that I recommend.

I have just said that Dr. KLETT has tried to explain physiologically the advantageous effects of transfusion which, he says, cannot depend on the material compensation of the blood lost by the introduced blood, but are caused by the dynamic action of this fluid, an action which is sufficient to excite the contractions of the paralyzed heart and thus restore the course of circulation. He concludes that the blood that should be preferred is that of a young and vigorous individual. He bases his view on the fact that the quantity of blood (four ounces) injected in some cases was too small to be able, by its mass alone, to restore life to the individual on the point of succumbing to haemorrhage. I also said that I did not entirely share this opinion, and that in the cases we have described, with the exception of the last from a certain point of view, it seemed to us that the material compensation for the losses had been sufficient to prevent death.

In every haemorrhage which ends unfortunately, there are, between its beginning and its end, a host of degrees in which it can be stopped. It would be impossible for us to determine the last degree in which haemostatic means can still be of assistance. All we have to do is to see their usefulness through results. But what was the quantity of blood that still remained to be lost by the dying patient, at the time they were used? This is a question which it would be impossible to resolve positively; only we can say that, in cases where transfusion has been successfully used, the injection of this or that quantity of blood having sufficed to obtain the desired effect, it is more than probable that, if the haemorrhage had been stopped at the moment when there was still in the veins of the dying person a quantity of this fluid equal to that which had to be injected into him to keep him alive, he would have survived without the help of art. It could thus be concluded that the mass of blood transfused, however small, may, by materially compensating for the loss experienced, be sufficient to sustain life at least momentarily. I am far from denying the vital influence of blood on the body in transfusion; but I do not think that it possesses as great a power as Dr. KLETT thinks, especially when it is only a question of reawakening life in an individual endowed with a good constitution: for Messrs. DUMAS and PRÉVOST have restored bloodless cats and rabbits, by injecting into their veins blood drawn from a cow or a sheep, twelve or twenty-four hours previously (15), a time which had certainly sufficed for the complete exhaustion of the vital force of this fluid.

It would result from my way of seeing that, if we injected into the veins of an individual exhausted by loss of blood, a certain quantity of a liquid which was somewhat similar in its composition, we could, at least under certain circumstances, to sustain the contractions of the heart for some time and to artificially maintain life until an injection of blood had become practicable. (I am assuming here the case where it would have been impossible to obtain human blood.)

However, if I were called upon to demonstrate how so small a quantity of blood (four ounces) injected into the veins can maintain life in an individual who is bled dry and ready to expire, I would, I confess, be greatly embarrassed; I would, however, hazard the following explanation. The injected blood being sufficient to temporarily supply the contractions of the heart, it is probable that the blood vessels, which must necessarily contain a certain quantity of blood, react against the emptiness which a haemorrhage tends to make them experience. It is especially then at the expense of the parenchyma and membranes which still contains blood that this void must be filled. The venous radicles redouble their energy, and the

absorption is not long in spreading into the exhausted vascular system the elements necessary for the maintenance of the circulation. I know that it is the serous part of the blood that predominates in this case and that it is hardly suitable for nutrition, but the blood insensibly recovers its original qualities by means of a good diet to which one is sometimes obliged to add the use of certain therapeutic means.

I have said above that, in the event of a lack of human blood for the transfusion, it might perhaps be possible to replace it with a liquid of a more or less similar composition. I am pleased to see that this opinion is also expressed in the journal l'*Abeille* (16) by Dr. LEWINS, a member of the Royal College of Physicians of Edinburgh. Here is how this doctor expresses himself on the subject:

"I have recently learned of the unfortunate outcome of several cases of uterine haemorrhage occurring after childbirth and in which no attempt has been made to save the unfortunate patients by transfusion.

"Circumstances lead me to think that this omission, serious in our opinion, arises from the supposed difficulty and danger of the operation. However, they are generally exaggerated. I can do no better, to destroy this false idea, and at the same time to urge midwives to have recourse to transfusion in urgent cases, than to give a few extracts from a communication made to the Central Committee on Cholera in 1832.

"Dr. LATTA, of Leith, has advised, in cholera asphyxia, to inject into the veins a large quantity of an alkaline solution, from five to ten pounds for example, for an adult, and to repeat these injections at more or less long intervals, according to the state of the pulse and the indication of other symptoms. Whenever the pulse weakens, the injection must be repeated without regard to its quantity. In one case, one hundred and twenty ounces were injected at once, and increased to three hundred and thirty ounces, in twelve hours. In another, three hundred and seventy-six ounces were injected into the vein, from Sunday at eleven o'clock in the morning until Tuesday at four o'clock in the morning; which makes more than thirty-one pounds in the space of fifty-three hours.

"The solution was composed of 2 gross of muriate and 2 scruples of carbonate of soda in 60 ounces of water. It was injected at 106°F. (41° centigrade)."

The author of this note thinks, like Mr. BLUNDELL, that transfusion is a very useful remedy in the treatment of uterine haemorrhages, when they are serious enough to endanger life. He is, moreover, convinced that the heart is momentarily stimulated in a manner sufficient to sustain life, by a saline solution similar to that used in the treatment of cholera, a solution which can be obtained at any time, and which can be injected more easily than the blood itself; for the latter is subject to coagulation, which constitutes a serious accident which has led MAGENDIE to say that, if the blood is received in a vase or in a syringe, and then injected, it coagulates more or less and thus becomes, by obliterating the pulmonary arteries, a cause of death.

The proportions of the ingredients of the solution used in cholera have varied: thus, in one case, 4 grams of muriate of soda, 50 centigrams of carbonate of soda, and 1,500 grams of water at 105° Fahrenheit were used. The solution must be filtered.

In more than a hundred cases of transfusion, both at Leith and at Edinburgh, there has been no accident from the introduction of air.

The assertions of Dr. LEWINS therefore confirm my predictions and prove that it is possible to maintain life momentarily by means of saline injections. They also teach us that transfusion can be successfully applied in cholera after the period of asphyxia. It is easy to understand the usefulness of the practice he recommends in the latter case. The loss of the aqueous part of the blood, which results from the innumerable vomiting and stools, characteristic signs of this disease, must naturally produce the thickening of this liquid, which ends by infatuating the capillaries and preventing its course in the vessels of a certain calibre, hence cyanosis, asphyxiation, and death, which is the almost inevitable consequence. To restore to the blood its ordinary fluidity and warmth, is it not to prevent these formidable accidents and to put the patient in a position to endure the other phenomena of the disease, until art or nature has triumphed over them? If this scourge were to reappear, would it still be permissible to neglect this method of treatment?

It follows from all that has been said above:

1° That only the blood of an individual of the same species as the one who is to receive it should be used in transfusion.

2° That the transfusion of blood has been of undeniable advantage in the cases of uterine discharge which I have mentioned and which have occurred following childbirth; and that, by analogy, it should be used in all similar circumstances.

3° That the practice of this operation has also been successful in cases of traumatic haemorrhage, and that, consequently, it is indicated whenever a loss of blood is caused by external causes.

4° That, if there is an extreme emergency, a saline solution of muriate and soda ash could be used, until it could be obtained, in the proportion of 4 grams of the first salt and 50 centigrams of the second to 1,500 grams of water at 105° Fahrenheit (40° cent.).

5° That the transfusion of a saline solution has already been successfully attempted in cholera asphyxia.

6° That the transfusion of blood in man seems to have failed only by the introduction of air into the veins during the operation, or because the blood used for the operation was already partly fixed by the cooling, or finally, because of the injection of blood of a foreign species.

As this last proposal has already been examined, I will not return to it here. I will confine myself to saying a word about the non-success of the operation which concerns us, either because of the accidental introduction of air into the veins, at the same time as that of the blood, or because of the partial clotting of this liquid at the time of transfusion.

Up to this day, only the ordinary syringe has been used to transfuse. This instrument is so disadvantageous for so delicate an operation, that I cannot help attributing the successes obtained only to the extraordinary dexterity and prudence of those who had the courage to use it.

From the observations recorded in this memoir, we can be convinced that the transfusion of blood, instituted by means of the ordinary syringe, consists of several stages. First of all, the blood, while waiting for it to be used, must be received in a vase which is immersed in hot water; it must be transferred into the syringe previously purged of air, and finally, the siphon of the instrument must be carried into the opening made in the vein. What slowness, what causes of cooling, what difficulties above all in eliminating this pernicious air.

In the last transfusion observation that I have related, there is mention of a rudiment of a special device for this operation.

It consisted of a syringe, to the lower part of which a funnel had been adapted, which served to receive the blood and carry it into the body of the device. But this innovation does not seem to have been a happy one, since during the operation the device had to be removed and washed four times on account of the coagulation of the blood, and yet only five and a half ounces of this liquid had been injected into the veins of the patient.

I have endeavoured to remove the disadvantages attached to the instruments used up to this day, and I hope to have succeeded by the invention of the device of which I am here giving the description. The main aims that I had in mind in making it are: 1° to prevent the coagulation of the blood after it has left the vein; 2° to prevent the penetration of air into the instrument. I have also tried to make it accessible to those who are not even used to surgical operations.

This device consists of two essential parts: a reservoir for collecting the blood, and a pump body fixed in the middle of the reservoir and intended to inject this liquid into the veins.

The reservoir is composed of two tin vases, of different sizes, and arranged in such a way that the smaller one, being introduced into the larger one, leaves between it and the first a space sufficient to contain hot water. The vases are held in their respective positions by a strip of the same metal which unites them by their upper edge in which an opening has been made for the introduction of water. The arrangement of this vase represents a kind of bain-marie.

The blood is introduced into the inner vessel, by means of a conduit which is inserted into the lower part of the device. This conduit on the outside is formed of a rubber pipe, five to

six inches long and the end of which is arranged in the shape of a funnel, in order to be able to be applied directly to the bleed and thus protect the blood from contact with the air.

To avoid as much as possible the unfortunate effects that the action of the air can have on the blood, I have added to my apparatus a cork disc which has the dimensions of the inner vase and which is pierced in its center by a circular opening intended to give passage to the body of the pump in question. This cork disc, introduced into the reservoir, floats as soon as it comes into contact with the blood, which in this way, is protected from the action of the atmosphere.

As it is important to transfuse the blood as soon as possible after it leaves the vein, I also thought it essential to accumulate in the reservoir only the quantity necessary to charge the pump. For this purpose, a line drawn on the body of the pump indicates, when it is reached by the line float, that there is a sufficient quantity of blood in the reservoir to operate.

The pump body is fixed vertically in the center of this part; it crosses the lower part and is continued on the outside by an elastic pipe about twelve inches long. This pipe ends with a slightly conical shaped metal tip.

The pump body is pierced at its lower part, and before it passes through the reservoir, with an opening provided with a valve so arranged as to allow the introduction of blood into the same pump body during the suction movements, and to prevent the return of this liquid when the piston descends.

Immediately after leaving the vessel, the pump is equipped with a valve that prevents the introduction of air and allows the blood to escape at the time of injection.

In addition to these essential parts, the device also consists of an accessory part that must also be mentioned here. It is a small metal cannula, cone-shaped, and about two inches long, one end of which is very thin and terminated in the shape of an olive, while the other has roughly a diameter of about three lines. The channel, with which this cannula is pierced lengthwise, is very narrow and arranged in such a way as to receive the nozzle which terminates the pump pipe. I have given it this conical shape because, introduced into the open vein as in an ordinary bleeding, it can be pushed into it until it forms a plug, and thus prevent the return of the blood that is injected; and as for the narrowness of the canal which passes through the cannula, it is intended to force the inexperienced operator to inject into the veins of his patient only a small quantity of blood at a time.

OPERATIVE PROCEDURE. – The operative procedures used in the observations I have related above, being of great simplicity and having been crowned with success, I can do no better than to propose them as a model. I will therefore confine myself, more or less, to indicating here the manual of my device.

All veins seem to me to be suitable for transfusion; yet I consider those closest to the heart as the most suitable. I would, however, urge the surgeon to avoid operating on those which are in the dangerous space, a space circumscribed by two semi-elliptical lines running from one armpit to the other, one above the clavicles, the other below (17). In case of emergency, however, I would not hesitate to inject through the external jugular vein that I would open at the place of choice for phlebotomy, redoubling my precautions to prevent the introduction of air. The embarrassment of discovering the veins in some fat people, and especially in those who are in a bloodless state, induces me to give this advice. In a moment as serious as that which requires transfusion, we must not hesitate. The patient's life is in decline and we cannot help him too soon.

The veins of the arm are the most convenient for the operation, especially the median cephalic vein.

When the veins are sufficiently visible, it is sufficient to open them with the lancet, using the usual precautions for bleeding. The ligature is immediately loosened and placed below the opening, as it is essential to prevent the slightest loss of blood. The cannula is then inserted into the vein, either directly or after having ascertained by means of a stylet the direction to be followed; it is pushed into it until it forms a plug. It is recommended that an assistant hold the cannula in this position and apply moderate compression to the wound

with the thumb to prevent blood loss. The end of the pump pipe being inserted into the cannula, the operation is immediately carried out.

Here are the precautions that must be taken before the operation.

To eliminate the air that naturally exists in the conduit of the cannula intended to be introduced into the vein, it must be immersed in hot water, and while it is under this liquid, close hermetically, by means of a small cork stopper, its large end which will only be unblocked to adapt the nozzle of the pump pipe, at the time of transfusion.

Water, heated to about +25° centigrade, is then poured into the space between the two vessels. The reservoir is also filled with it to heat the pump, which is then used so that the pipe is also brought to a suitable temperature. As one does not always have a thermometer at one's disposal, one can ascertain the degree of heat that the water should have, by plunging the hand into it, which should feel neither heat nor cold. The water in the reservoir is then carefully removed, while the water that forms the bain-marie is retained.

The blood is received directly into the reservoir by adapting the flared end of the elastic rubber pipe, which I mentioned above, to the bleeding point. As soon as the float has reached the level of the line marked on the pump body, it is necessary to start injecting; it is important, however, before operating, to let blood penetrate the pipe in order to expel the air; we realize that we have reached this goal, when the play of the piston begins to make the blood flow through its end. We then adapt the metal end of the tube to the cannula that has been previously introduced into the vein and from which the small plug is then removed. The little water it contains is driven into the veins with the blood, without causing the slightest inconvenience. It is essential to transfuse slowly.

Immediately after the operation, the cannula is removed from the vein. It is obvious that the precautions indicated above would be taken if it were necessary to introduce it again. When one or more other injections are immediately deemed necessary, it is necessary, each time, and before returning to it, to give several strokes of the plunger, in order to expel all the coagulated blood that may have remained in the conduits and to eliminate from the reservoir any that may have remained there of this liquid. It would even be prudent to wash it with lukewarm water.

Although it is essential that the transfused blood passes slowly through the veins of the patient, I cannot recommend enough that we act with the greatest rapidity in all the manoeuvres that the operation of transfusion requires. It is for this reason that I particularly recommend charging the pump as soon as the reservoir contains a sufficient quantity of blood. This is the best way to prevent clotting.

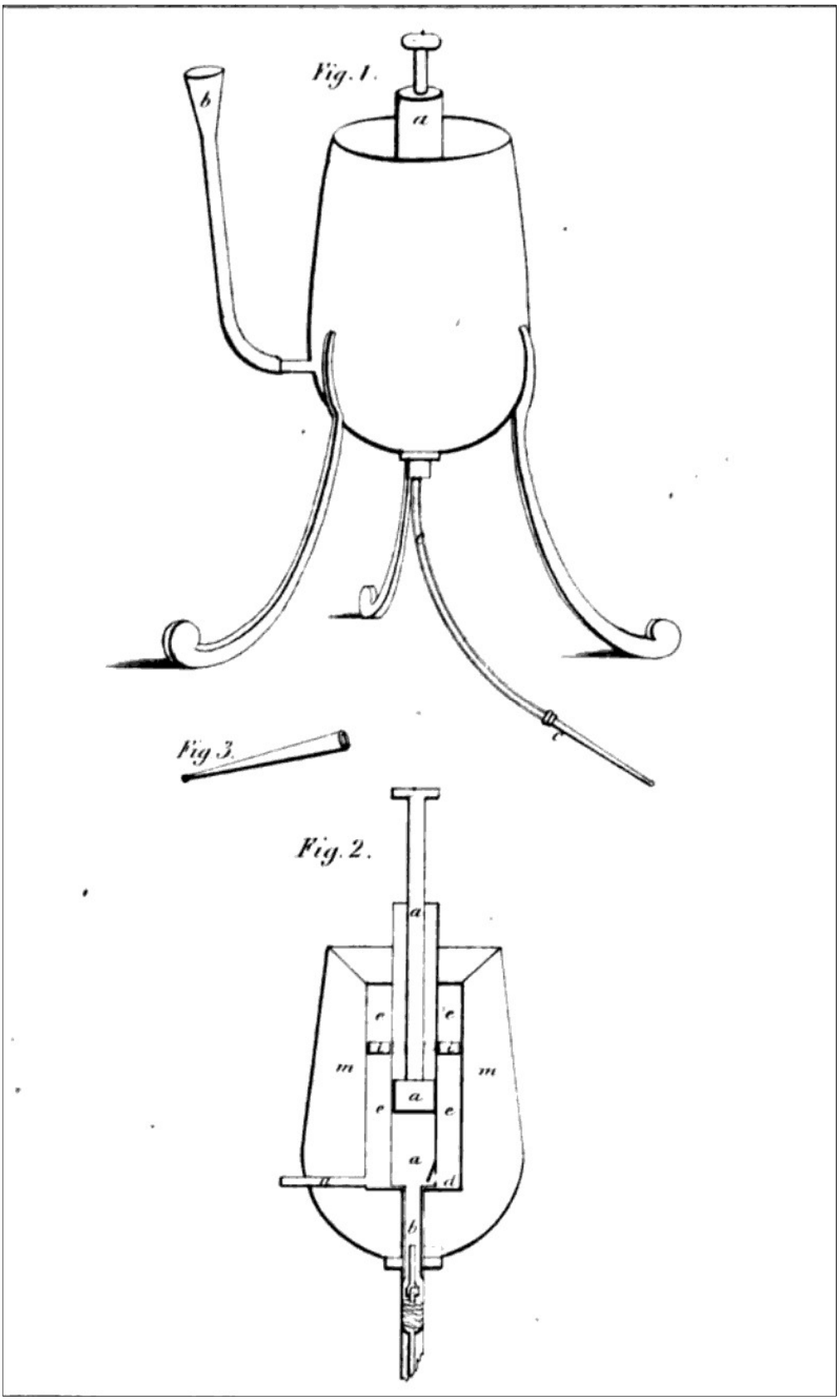
It would be impossible to indicate here, by a general rule, the quantity of blood that should be injected. We have seen, in the examples I have reported, that it varied from two to fourteen ounces. During the transfusion, the phenomena that occur must be carefully observed and the remaining course of action must be based on them. It is important to say here, in passing, for the operator's information, that the pump of my apparatus contains two ounces of blood.

I must confess to the truth that my instrument has never been used on a living subject. I am inclined, however, to believe, from the tests I have made of it on the corpse, that it meets all the necessary conditions to institute the operation of transfusion successfully.

For those who, like myself, do not fear the momentary action of air on the blood, it would be possible to simplify my apparatus and reduce it to a simple vessel intended to receive warm water, and in the middle of which would be the pump provided with a single lower valve, to prevent any flow. The blood would be directed directly into the body of the pump which would be applied against the bleeding. To do this, we would only have to remove the plunger and replace it when the pump was filled with blood. After the operation, the plunger would be removed and reinserted several times, to expel any blood that may have remained in the pipe. It is needless to add that the precepts which we have given in the description of the first device should also be observed in the most rigorous manner.

All the transfusion operations which have been successfully performed in England have been carried out by means of devices which in no way removed the blood from contact with the air. Why should we not hope for the same results here, and try the use of my apparatus,

modified as I have just indicated? This simplification would greatly facilitate its handling and would contribute to its widespread use.



EXPLANATION OF THE PLATE.

Fig. 1: shows the entire device. This is double the size of the drawing.
a. Pump body.
b. Conduit used to introduce blood into the reservoir.
c. c. Pipe used to conduct blood into the vein.

Fig. 2: shows the cross-section of the device.
a. a. a. Pump body.
b. Conduit through which the blood must escape.
c. Valve which prevents the introduction of air into the pump and the premature flow of blood.
d. Opening with a valve that allows blood to enter the pump body.
e. e. e. e. Reservoir intended to receive blood.
i. i. Floating cork.
m. m. Space intended to hold warm water.
n. Conduit in which the blood enters the reservoir.

Fig. 3: Cannula intended to be introduced into the vein on which the operation is performed.

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REPORT ON THE PRECEDING WORK.

Commissioners: Messrs BURGGRAEVB, DUMONT, HEYMAN, rapporteur.

GENTLEMEN,

Of all the therapeutic means hitherto employed in medicine, the transfusion of blood is perhaps the one which has had the most varied fortune. After having been the object of the enthusiasm of some and the disapproval of others, after having provoked, something unheard of in the annals of medicine!! the intervention of laws and religion, it was no longer taken care of for almost a century and a half, and it now seemed abandoned without return as a means of treatment.

However, the last word was far from having been said on transfusion. HUPELAND in 1815 and GRAEFE in 1818 made new attempts to revive the infusion of medicines and the transfusion of blood into the veins. Their experiments moved the learned world; transfusion was put back on the agenda and several medical luminaries, among whom we distinguish WALLER, DOUBLEDAY, DIEFFENBACH, PRÉVOST and DUMAS, took part in the new debate.

This debate, as you know, gentlemen, is far from over. And although it has established itself on a footing of reciprocal convenience and moderation, it nevertheless bears on the most opposite and exclusive opinions. As in 1665, some pretend that transfusion is a remedy of marvelous effect in a great number of diseases; others, on the contrary, consider it always useless, sometimes dangerous and even fatal.

Such is the state of doubt and uncertainty of science as to the therapeutic value of the introduction of foreign blood into the veins of man. It is obviously the laudable desire to dispel it that has led our honourable collaborator, Dr. SOTTEAU, to communicate to you the work you have asked us to examine. As an organ of your Commission, I have the honour to present to you the reflections which the appreciation of the opinions of this honourable member has suggested to it.

In summary, Mr. SOTTEAU's doctrine is one of those which is most favourable to transfusion. Explaining the reverses of the first transfusions by the neglect of the most indispensable precautions, that of using blood taken from an individual of the same species, that of preventing its coagulation and, finally, that of preventing the entry of air into the vessels, he is of the opinion that transfusion, instituted in a suitable manner, is a means which it is no longer permissible to neglect. He considers the transfusion of blood to be indicated in the most formal manner whenever in a traumatic or uterine haemorrhage (which for us is also traumatic, in the sense that in the latter affection the vessels are in the condition of being accidentally opened), the mass of the blood is so diminished to the point of putting the life of the patient in danger. Then, based on an observation by SAMUEL LANE, professor of anatomy and surgery, he is not far from believing that, in some circumstances, transfused blood can fulfill a second purpose, that of modifying the qualities of this fluid in the person who receives it. He recommends this last point to the attention of practitioners. Moreover, his convictions are not based on any observation of his own; he drew them from the experiences of DUMAS, PRÉVOST, BLUNDEL, EDWARDS, WALLER, DOUBLEDAY, as well as a large number of practitioners, both German and English.

Before proceeding to the appreciation of the proposals contained in the work of the Honourable Mr. Sotteau, we have one regret to express. It is that of not seeing them supported by any experience that is personal to their author. It seems to us, however, that, in order to establish definitively the value of transfusion as a curative means, new facts and facts almost passed before our eyes, were indispensable. Their absence obliges us to carry the question to the uncertain ground of physiology, or at least to that of the observation of authors, who have not always been immune from all reproach of partiality.

Be that as it may, your Commission is fully of the opinion of Mr. SOTTEAU when it considers the transfusion of blood to be useful in the event that, by any cause, the mass of blood is reduced to the point of immediately compromising existence. We say by some cause, because we also believe that cases of metrorrhagia are not the only ones in which it can be applied successfully. Its suitability extends to all great haemorrhages, provided that they are not caused or maintained by any morbid principle or by any alteration of the apparatus. Reduced to these cases, transfusion has nothing contrary to the principles of the healthiest and most rigorous physiology. What could be simpler, in fact, than to introduce into the living economy the double agent of stimulation and repair, the absence of which threatens the body with death!!

Mr. SOTTEAU, in seeking to explain the physiological action of the blood introduced into the veins, thinks that it is much more the material compensation of the mass that heals, than the vital and dynamic action of the blood. Here, Gentlemen, we will not try to hide it, a great difference of opinion arises between the author of the memoir and your Commission. We cannot accept an opinion which tends to assimilate the circulatory apparatus to a hydraulic machine which would cease to function because its various pipes would no longer be in a sufficient state of repletion, and we believe that we can invoke against such a hypothesis various considerations as much physiological as pathological and therapeutic. Here are these considerations: the mass of the blood, according to the most recommendable authors, seems to vary between 25 and 30 pounds; it is often only after a loss of 6, 8, 12 pounds and even more, that one is obliged to have recourse to transfusion; and finally, in most known observations, the introduction of four ounces was sufficient to cure. For us, circulation, like all phenomena of life, takes place above all under the influence of vital reactions. Physical forces, it is true, have a certain degree of co-operation in the exercise of this function, but the fact remains that the effectiveness of their intervention is subordinated to the integrity of the vital conditions of its apparatus. Thus the blood, in its progress through the vessels, observes certain laws of hydraulics, but the first and essential cause of its movement lies in the impression which the inner membrane of the heart and the circulatory tubes receives from this fluid. We therefore believe, gentlemen, contrary to the opinion of Mr. SOTTEAU, that, if transfusion cures, it is by stimulating the heart and the vessels, it is in a word, by awakening their paralyzed action, as Dr. KLETT thinks.

We would perhaps not have taken pains to combat the opinion of our colleague concerning the physiological action of the blood introduced into the veins, if he had not based a special indication on it. In his conviction that the transfused blood acts almost exclusively by its mass, he is not far from believing that it could, in case of emergency, be replaced by a liquid somewhat similar in its composition. He even proposes a solution composed of two gross of muriate and two scruples of soda ash dissolved in sixty ounces of water. We say frankly, we would shrink from such a medication which, by introducing a foreign liquid into the body, undoubtedly subjects the organs to an irritation to which they are not accustomed, and which, consequently, is capable of causing a thousand disorders in their action. Moreover, Mr. Sotteau himself condemns this argument when he says that "*only the blood of an individual of the same species as the one who is to receive it should be used*." And, as you have already understood, Gentlemen, if the blood of any animal cannot be suitable for man, much more must any other liquid be fatal to him. For the best understood chemistry cannot compose one as comparable to human blood as is the blood of an animal, even the least perfect.

As we have already said, several passages of the work in question here show a tendency to grant to transfusion the power of modifying the qualities of the blood of the individual who undergoes it. However, as the author's ideas, in relation to this point, are expressed only in a rather doubtful manner; as, on the other hand, we have reason to believe that he did not intend to group them together in a formal proposition we will not endeavour to make them the subject of a serious refutation here. And if one day, Gentlemen, such were our mission, we reckon that we could, without presuming too much on the validity of our arguments, demonstrate how inadmissible it is to attribute to a certain quantity of blood instilled in the veins of a patient, the faculty of modifying the total mass of the humors, so as to bring it back

to its normal state. Then we would especially call your attention to the following considerations: first, the blood, being almost never diseased in a primitive way, except in cases of virulent diseases, it is quite impossible that transfusion can replenish it, since it allows the organic alterations or disorders to persist, which are the causes of the vitiation of the humors; secondly, it is not very rational to suppose that so insignificant a quantity of blood as that which is injected in the transfusion, that is to say, three or four ounces, is capable of changing the composition of twenty-five or thirty pounds of the same liquid. As for cases of contagious diseases, the blood and the humors in general are, it is true, altered before the lesions of the organs, but, let it be remembered, is it really logical to admit that four ounces of healthy blood, for example, could purify the whole mass of this liquid, when an atom of virus, elusive of which the present state of the physical sciences, was enough to infect the entire economy?

To complete our task, we must also talk to you about the instrument that the Honourable Mr. SOTTEAU presented to you at your last meeting. Like all his other mechanical productions, the new transfusion pump reveals in its author an undeniable specialty of genius. This device, which has just received a final improvement, eliminates the disadvantages of the old transfuser syringes, namely the possibility of injecting air, the rapidity with which the blood coagulated in them and finally, the danger of an injection too prompt and too rapid. Moreover, the use of this device alone can tell us whether it really possesses in practice the qualities which it seems to possess, when considered from the point of view of theory.

For too long, Gentlemen, you have been traversing the obscure maze of medical sciences for you to be unaware of how difficult it is to find oneself there. Therefore the dissent of opinion which exists between the author of the memoir and your Commission can in no way diminish the merit of Mr. SOTTEAU's communication. You will recognize him above all for having awakened the attention of practitioners to a curative method too exclusively proscribed in our country and destined perhaps to render the greatest services to humanity.

We therefore propose the insertion of this work in the Annals of our Society.