RECHERCHES ET EXPÉRIENCES SUR LA TRANSFUSION DU SANG

BY: DR GIOVANNI POLLI

A TRANSLATION BY PHIL LEAROYD

This paper, titled 'Research and Experiments on Blood Transfusion' by Dr. Giovanni Polli, was published in the journal *Archives générales de medicine* in 1852 in two parts. The first part (Vol. 4, No. 30, pp. 203-214) can be read or downloaded from the following site:

https://archive.org/details/BIUSante_90165x1852x30/page/202/mode/2up

The second part (Vol. 4, No. 30, pp. 332-349) can be read or downloaded from the following site:

https://archive.org/details/BIUSante_90165x1852x30/page/332/mode/1up

Both parts of this paper can also be read or downloaded from:

https://books.google.co.uk/books?id=ygVLAQAAMAAJ&printsec=frontcover&source=gbs_atb&redir_esc=y#v=onepage&q&f=false

NOTE: Much of the research work and discussions presented within this two part paper are included within a monograph by Giovanni Polli, that is also titled 'Research and Experiments on Blood Transfusion', published Milan in 1882 in the journal *Annali Universali di Medicina* [Vol. 4, No. 3, pp. 449-504], a copy of which can be read or downloaded from the following site:

http://emeroteca.braidense.it/eva/sfoglia_articolo.php?IDTestata=24&CodScheda=111&Alph=All&OB=spoglio&OM=&SearchString=&SearchField=&PageRec=50&PageSel=16&PB=2&CodVolume=950&CodFascicolo=4916&CodArticolo=70171

NOTE: This paper can also be accessed via the following website addresses but the scanned document is missing the first part of the text:

https://catalog.hathitrust.org/Record/002072542

https://books.google.co.uk/books/about/Ricerche_ed_esperienze_sulla_trasfusione.html?id=R8U0AQAAMAAJ&redir_esc=y

The translation provided below includes both parts of this paper. The first part initially includes a 'translator's comment', which is essentially a disclaimer by the translator of the 'originality' of the work (which was originally published in the journal *Annali Universali de Medicina* as identified above) that also includes the journal's publisher essentially distancing themselves from the content of the work, which presumably illustrates the 'sensitivity' that blood transfusion still elicited at that time.

In the first part of his paper, Polli identifies that the reasons for his experimentation is to determine clarity with regard to the operating conditions, safety and indications for the use of blood transfusion, which he does describe, but also includes for example a comment about

not being bothered about the ‘introduction of a few air bubbles’ when injecting the blood! The author then identifies and discusses the role of fibrin in coagulation and as a result, that clots may therefore be transferred during an indirect blood transfusion procedure. He identifies that his ‘animal experiments’ (of which he provides no details) have led him to therefore recommend the use of defibrinated blood for transfusion. Note: The filter used after the defibrination of the blood (by beating) is translated as ‘shoe’ (i.e. une chausse) – this word has been placed in square brackets within the translation – it possibly should be ‘translated’ to be sieve or strainer.

The second part of his paper includes a summary of a number of published reports by other authors of the transfusion to humans using both animal and human blood. He includes three of his own transfusion cases, using human donor blood, though two of these are transfusions to the same patient – the two patients that he transfused suffered from (somewhat vaguely described) medical conditions and not blood loss. He uses the details within these examples (27 in all) in his ‘defence of transfusion’.

Although he concludes his paper by giving the primary reasons for the use of blood transfusion should be to treat severe blood loss occurring during and after childbirth or following accidental wounds especially to an artery that involve extensive blood loss, he also then includes the roles of transfusion in treating other medical conditions that involve transfusion’s role in ‘nourishment’, arguments used originally by Denis in the 17th century.

I have produced a translation of this paper into English to enable its content to be appreciated by a wider audience. Whilst I am aware that instantaneous computer generated translation is available, this process 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 maintained the general layout of the text including the author’s use of italics. The references and names included within the text are as originally printed. Some text is printed in a smaller font in original paper – this has not been reproduced in the translation.

RESEARCH AND EXPERIMENTS ON BLOOD TRANSFUSION (1) *

Dr. Giovanni POLLI

* Extract from the *Annali universali de medicina*, n° of March 1852. - By inserting Mr Polli's memoir, we in no way accept responsibility for the results to which he has been led by his experiments, and even less for the practical conclusions which he thought he could deduce from them; but it seemed to us that the publication of a work, so rich in facts and personal experiences of the author, would be of some weight for the solution of a question, which recent facts have in somehow put on the agenda. (Translator's note)

The aim of this memoir is to determine: 1. Within what limits and under what conditions the transfusion of blood may be regarded as an innocent operation, and consequently to establish a safe and easy method of injecting blood into living humans; 2. What are the precise indications of this operation, and what successes may be expected from it, in the present state of physiology. These are questions that can, it is understood, only be examined by means of experiments. Without doubt there are many of them and very good ones, in the midst of this jumble of observations and memoirs, which saw the birth of blood transfusion at its dawn. However, I have thought it necessary to repeat these experiments, both to fill in the gaps which may have been left by our predecessors, and to acquire for myself the certainty of the existence of certain phenomena which, in transfusion, appear either incredible or very strange. I have taken care that these experiments, as well as those which I have borrowed from others, should always be precise questions made by nature on the question for which I was seeking the solution. It is by proceeding in this way that I am confident of having shed some light and some precision on a subject hitherto regarded more curious than as useful in practice.

FIRST PART

1st experiment – A straw dog, of medium size, was rendered bloodless by opening the crural artery: livid lips, dull eye, breathing so frequent that it was impossible to count it. The animal no longer made any movement with its extremities, it lay on the ground like an inert mass, it was obviously at the very end; the arterial blood drawn from this dog had been collected almost entirely in a vase. It was beaten with a bundle of rods, until the fibrin was coagulated; it was passed through a [shoe], and inserted with a small syringe into the jugular vein. As the outside temperature was very high, the blood during the whole of its procession had scarcely cooled more than 5 or 6 degrees. During the injection, not much care was taken to avoid the introduction of a few air bubbles into the veins; nevertheless, the dog tolerated this injection very well. He rose quickly; the breathing became calmer, then natural; the eye revived, and within minutes after the injection, the animal was walking around the room.

2nd experiment – A dog of the English breed, robust and well fed, was bled from the right crural artery. All the blood was allowed to flow, which escaped spontaneously. The animal seemed to be on the verge of death: almost imperceptible breathing, purplish labial mucosa, white and cold gums. The blood, defibrinated and passed through a [shoe] as in the previous experiment, was injected into the jugular vein. In a few minutes the dog seemed to come out of this serious condition; he remained dejected and lay down for another quarter of an hour; then he began to perform a few movements. At the end of an hour he seemed to be perfectly restored to his former state. This dog, as well as the one in the first experiment, appeared to be perfectly well a few days after this operation. He was sacrificed for other experiments.

3rd experiment – The good success of the two preceding experiments encouraged me to push further the loss of blood in this one, and to act only when death in the exanguinated animal seemed complete. For this purpose, when the arterial blood had ceased to flow from the crural artery, that on the other side was opened in its turn, and the flow of arterial blood continued until the dog no longer showed a heartbeat or respiration; but at this point the injection of blood into the jugular could not be made; the immobile heart seemed to be the main obstacle to the injection. The dog could not be brought back to life.

4th experiment – In an eight-year-old mare, of the Hungarian breed, of rather small stature, who had lost a hoof due to trauma, the left jugular was carefully isolated from the neighbouring tissues in an area of several inches, then the jugular on the opposite side was opened through a wide opening, and all the blood that could was allowed to flow. The mare, after losing 10 kilograms of blood, began to stagger and be agitated, and sank down onto the straw which had been prepared under her feet. The labial and gingival mucosa was discoloured, the eye immobile, the limbs completely relaxed. The blood, which had been collected in a wooden bucket, beaten with rods to separate the fibrin, which in its turn had been squeezed, to separate all the serum and adhering red blood cells, had been kept at a temperature of 40° centigrade in a water-bath. Twenty minutes had elapsed since the mare had been on the ground, when the injection began into the jugular vein, which had been exposed, with a drill syringe, favouring the flow of the blood to the heart, by gentle pressure in the direction of the vessel. In half an hour, by proceeding slowly, we managed to introduce into the circulatory stream approximately 5 kilograms of blood. We stopped there because the animal was very agitated; a quarter of an hour later she began to move her extremities, and to make some effort to get up. By helping her, she was able to get to her feet and stay there for twenty minutes; then she fell back again, and in increasing agitation; from time to time she inclined her head towards her stomach, which suggests some intestinal complication. She died seven hours after the experiment, in the midst of convulsions. An enormous quantity of food was found in the large intestine, and an effusion of a gelatine-like fluid was found in the stomach.

5th experiment – A 14-year-old horse, of Hungarian breed, thin and blind; 2½ kilograms of blood was removed from the jugular; its temperature was 35°C, its density 1.026; that of the serum at 1.011.5. Before bleeding, the pulse beat 43 times and breathing took place 6 times per minute; after blood loss, 48 pulses and 15 breaths. The animal having fallen to the ground, the right jugular was exposed, and we began to inject into it the already defibrinated and filtered blood which had been removed half an hour before from another chronically affected horse. This blood had a density of 1.023.5 at 35°C, and the serum weighed 1.010.5. In the space of twenty minutes, 1.35 kilograms of this blood was injected; then, as usual, the jugular was tied above and below the wound, the external incision was joined, and the animal was left at liberty. After the operation, the horse appeared very agitated; 44 breaths per minute, 48 to 58 beats, with intermittencies and double beats; quite exaggerated and harsh respiratory murmur, deep and somewhat irregular heartbeat. An hour later, the breathing and pulse had calmed down considerably and had partially resumed their regularity. For a few hours the animal remained on the ground; then it got up, ate, and drank rapidly. The next day he appeared cheerful and with a good appetite, his breathing had returned to 8 a minute, but the pulse had increased in frequency; it beat 72 times per minute. This change in the rapidity of the circulation did not appear to disturb the normal state in any way.

6th experiment – The same horse, after a week of rest, during which he had recovered perfectly, was bled; 2 kilograms of blood were taken from him, which was defibrinated as usual. This blood was left until the next day in a tinned copper vessel in the open air at a temperature of 9° centigrade. The next day, 1.35 kilograms of this blood was injected into the jugular of this same horse, after having stirred this blood, the red cells having been allowed to settle at the bottom of the vessel, and having heated it to 35°C in a water-bath.

The operation was completed in about twenty minutes, the syringe was emptied 5 times, and little care was taken to avoid the introduction of a few air bubbles. There was a little restlessness after the injection, but little by little the animal returned to its normal state, and for fifteen days we kept it well, after which it was sacrificed to experiments on ether.

From these preliminary experiments it seems to me that the following conclusions may be deduced:

The first and second experiments demonstrate that an animal reduced to extremity by a loss of arterial blood which has taken place through a wound made in a large artery, and from which the blood has been allowed to flow freely, is in a short time recalled to life and restored to its functions by the injection this same arterial blood, previously defibrinated, into its veins.

The second experiment proves that if the arterial haemorrhage has been carried by the successive opening of several arteries, until producing the complete death of the animal, it is not revived by the injection of its defibrinated arterial blood, for the probable reason that the heart, having become immobile, does not allow the stream of blood to pass by.

The third experiment demonstrates that if an animal has been deprived of a large enough quantity of venous blood, to cause it to fall bloodless on the ground, and a good part of this same defibrinated blood is injected into the same animal, it is revived to the point that it gets back on its feet.

The fourth experiment shows that an animal can receive in its veins, without danger, or only with a few temporary accidents, the blood of another individual of its species *previously defibrinated*, though of a much lower density.

The fifth experiment finally demonstrates that, in an animal, a considerable quantity of its own blood may be *injected with impunity, although it has been extracted from its body twenty-four hours before, and has been beaten, defibrinated, passed through a [shoe], and left in the open air, in a metal vessel, at the temperature of 9°C, and finally that it was beaten again and brought to a temperature of 40°C, before loading the syringe*.

Let us now examine each of these conclusions in particular:

1. *The blood does not lose its reviving power, although it has been stripped of its fibrin*; this is demonstrated by experiments 1, 2 and 4.

I will not conceal, however, that Bischoff and Magendie say that they have arrived at different results. But the experiments they rely on are quite imperfect. In fact, Mr. Magendie only observed untoward results from defibrination when he continued to extract a new quantity of blood from the animal, and then injected it defibrinated. When, on the contrary, the experiment was conducted in moderation, the injection of defibrinated blood resulted in increasing the quantity of fibrin (*Leçons sur le sang*, p. 184). But, on the other hand, Messrs. Dumas and Prévost (*Bibliothèque universelle de Genève*, vol. XVII) demonstrated, as early as the year 1821, that blood is very well tolerated, and brings back to life, for a few days, an animal dying of loss of blood, even when the liquid is defibrinated or kept liquid by the addition of 0.001 caustic soda. Muller and Dieffenbach also, through similar experiments, demonstrated that, in reality, fibrin is of no use in reviving bloodless animals.

It is certainly because of having given too much importance to blood fibrin that blood transfusion has encountered the greatest obstacles to date! To transfuse whole blood, all kinds of devices were imagined, no less ingenious than embarrassing, in order to direct the blood from one animal to another. But as soon as, by some circumstance, the circulation of the blood slowed down in the transfusion channels, a portion of the fibrin coagulated, and carried a clot into the veins of the animal, which stopped at the vascular bifurcations, suspended the penetration of the blood, and could even become the cause of the most serious accidents.

The proof that fibrin is of much less importance than might at first suppose, at least from the point of view of transfusion, and that it can therefore be safely left aside, is: 1. that it is found only in a very small quantity in the blood mass, from 2 to 3 thousandths, in the physiological state; according to Messrs. Andral and Gavarret; 2. that it is easily reproduced,

either by the metamorphosis of albumin, or by the transmutation of globules, or by any other cause; which means that its proportion may vary rapidly, and by pathological circumstances from 1 hundredth to 1 thousandth. Whatever may be the importance of fibrin (an importance it owes to its coagulability because, in this state, it traps the globules, and contains a great deal of serum in its meshes), that it appears as a predominant element in nutrition; this is not a reason why it should be regarded as summarising in itself the properties of blood, nor as its most elaborate element. The most recent physiological research on the contrary tends to consider it as a second-order substance, destined for elimination.

2. *Blood is not only not injurious, but is also well tolerated, and produces, in all probability, reviving effects, little different from those of fresh blood, although it has been defibrinated by beating; and it retains this property even when it has been kept in a metal container, exposed to air for several hours before being injected*.

This fact, which has been partly verified by Messrs. Dumas and Prévost and by Dieffenbach, renders the injection of blood even more convenient and easier, since it is no longer necessary in all cases to inject blood extracted at the same time, in order to obtain transfusion its favourable effects. In many cases, in which it may presume to need this assistance, we will thus avoid one of those dangerous losses of time which often compromise the success of the operation, as it may be drawn from the source which appears more suitable. This circumstance, that the injection of blood may be made at a temperature lower than that of the animal, further aids the transfusion, by removing from the operator the fear of not being placed in the exact and necessary conditions of temperature.

3. *The mixture of the blood with atmospheric air, which results from the operation of beating in the act of defibrination, and as a result of which the blood-fluid always acquires a more ruddy colour, this mixture, we say, far from being harmful, must be regarded as very useful, since it is recognized that arterial blood, by the very fact that it is richer in oxygen, is a better revitaliser than venous blood, and that the latter, impregnated with air, approaches in its properties arterial blood.*

To calm the conscience of those who consider the introduction of an air bubble into the veins with the blood as fatal, I will recall that, both in my experiments on dogs and in those on horses, I have purposely and on several occasions, by injecting the blood fluid, allowed some bubbles of air to penetrate, which I felt pass whilst producing a gurgling sound, and that the operated animal has never shown the slightest sign of suffering. Messrs. Restelli, Strambio, Quaglino, and Manzolini, arrived at the same result in the experiments which they made a few years ago on dogs (*Annali universali di medicina*, vol. CXXVIII, p. 338).

If we will remember the above, it becomes evident that the greatest difficulties of blood transfusion have disappeared. If, indeed, it is possible to use defibrinated blood, which does not offer the disadvantages of coagulation, blood which has been taken away for several hours from a living animal, which has also been exposed to the air for several hours, and which has been widely agitated with it, a blood which is not precisely at the temperature of the animal; if it can be injected into the veins, with an ordinary syringe, and without fear of contact with the metal walls of the containers and the instrument; if one can rest easy about the possible introduction of a few air bubbles with the blood, this operation is reduced to its greatest simplicity. The transfusion of blood, or rather its injection into the living animal, is no more difficult than any other anatomical injection.

Let us now see in which cases it can be practiced in humans, and what therapeutic advantages we can expect from it.

SECOND PART

Before tracing the most useful and precise therapeutic indications for the transfusion of blood, it is necessary to do justice to a great prejudice, which, in the minds of doctors themselves and of those who are not, weighs on this operation. Demonstrate by the facts of

favourable results of transfusion in bloodless animals, the ease with which it can be practiced in all cases, by means of a very simple preparation of the blood, the perfect harmlessness of this preparation, and of the other circumstances peculiar to this artificial blood-injection, would perhaps not suffice to make this powerful aid accepted without question. Transfusion is generally regarded as an operation, either very dangerous or useless; and the general opinion of doctors is reduced to this: that transfusion, after having at first been received with enthusiasm, has today now fallen, with good reason, into oblivion.

Could it be therefore be true, as the opponents of transfusion maintain, and Mr. Giacomini in particular, that the blood of animals of various species not only does not prevent death by haemorrhage, but produces the most serious accidents, and death in animals that have lost little or no blood; and that the blood of an animal of the same species, put back in place of a similar or slightly different quantity of blood taken from that animal, *kills* it or causes the most serious accidents, and that it is only in cases where there has been considerable haemorrhage, and in which recent blood from an animal of the same species has been injected, and in small quantities, that the animal has recovered, and even then in a small number of cases?

Regarding the transfusion of blood between animals of the same species, we do not believe it necessary to return to it; the foregoing facts sufficiently answer this objection. But we will go further and we will say that the second objection, that which relates to transfusion between animals of different species, is no more well-founded than the first. Indeed, if we read the very remarkable experiments made by Mr. Rosa, and recorded by him in his *Lettere sopra alcune curiosita philosofiche* (Milan, 1782), and we will find three experiments there, which leave no doubt: experiment 118, in which a lamb, rendered completely bloodless by an opening in the jugular, was revived by the introduction into this vein of blood from the carotid artery of a calf; and after a few minutes, got up and began to play, recovered perfectly, and acquired all its growth like lambs of the same litter; - experiment 128, in which a sheep, weighing 90.6 pounds, and having lost, in fifteen minutes, about 60 ounces of blood, and regarded as dead by the butcher, was treated by transfusion of blood from the carotid artery of a calf, gradually regained its heat, and finally revived; he weighed 92 pounds at the time; - finally, experiment 119, in which we see a lamb weighing 50 pounds, which remained for five minutes as if dead, following a haemorrhage, and in which the transfusion of the blood of a calf had the same result (after the operation, the animal weighed 50 pounds 8 ounces). It is therefore with good reason that Rosa concluded: 1. that the mixing of blood is possible from species to species, without endangering the lives of animals; 2. that it is possible and almost certain, to revive a bloodless and apparently dead animal, by the mere infusion of arterial blood, although supplied by an animal of a different species.

As for the failures and dangers of transfusion which we talk about so much, we may first cite Denis, who had tried, in 1667, to perform transfusion in dogs, in several ways, from the artery to the vein, from the vein to the vein, from the carotid to the crural, in weak dogs and in strong dogs, in small and large dogs, some of which had already received and communicated the blood in previous transfusions, and which, out of 19 dogs subjected to his experiments, not only had not lost any, but had always been struck with some favourable circumstances in those who had received the new blood. Nearer to us, finally, Messrs. Prévost and Dumas, after having tried without success to inject pure water or serum at 38 degrees centigrade into animals which they had bled until all muscular movement was abolished, until the action of the heart and respiration was suspended for a few minutes, until the point at which life seemed extinct, were struck to see the injection of the slightest quantity of blood coming from an animal of the same species appreciably reviving this kind of corpse; and if a quantity of blood equal to that lost was injected, the animal breathed freely, moved with ease, took food, and made a full recovery when the operation was well conducted.

It is therefore with good reason that Rosa summing up the results of his own experiments and those made by others, expressed himself thus: "I understand well that many people will find it difficult admitting these facts, which are nevertheless certain and authentic, which

were accomplished before the eyes of a great number of people, which were not done at will, and about which it was very difficult to be deceived; but such is the effect of great and unforeseen truths, which are repugnant to received ideas. Fortunately, these facts are among those whose verification is very easy for those who have the desire." (*Op. cit*., p. 168)

Until now we have been concerned only with transfusion in animals; it remains for us to see whether, in humans, this operation proves to be as innocent and as useful as it seems to be among brutes.

(*Continued in a next issue*.)

RESEARCH AND EXPERIMENTS ON BLOOD TRANSFUSION

By Dr. Giovanni POLLI
(Continuation and end)*

* See the October issue.

Science today has a sufficient number of facts to judge the question of the safety and advantages of blood transfusion in humans. I will briefly report all these facts, or at least those which I have been able to gather, and I will draw some conclusions from them. These facts are not, however, very numerous, and the greater part, especially the modern ones, are scattered here and there in newspapers, where it is not difficult to find them; but I thought that, from their careful consideration, we might bring forth the truth about so obscure a question. I shall distinguish these facts into two series: 1. those which relate to the transfusion of the blood of animals into the veins of man, and 2. the facts of transfusion itself, that is to say, with the blood of man.

FIRST SERIES

OBSERVATION I. – From a healthy and robust 45-year-old butcher, Denis removed 10 ounces of blood by bleeding his arm, and injected him through the same opening with 20 ounces of arterial blood from a lamb. The subject assured that he had not suffered in any way, and felt very well; he would not even rest or take any drink, because he thought it useless; then he began to bleed the lamb that had provided the blood, and to blow it and cut it up. He then went to the inn to spend the tip he had received, tired himself all the rest of the day, and the next day, met by Denis, he assured him that he felt more vigorous than usual, and begged him, if he wished to repeat his operation, not to choose any other subject than himself, and that the second time, he would be even more docile than the first. (Denis, *Lettres sur la transfusion*; Paris, 1667.)

OBS. II. – From a young man of 16 years of age, who, in consequence of a fever which had lasted two months, and during which he had been bled twenty times, had remained in a state of stupor and drowsiness, Denis drew 3 ounces of blood, and transfused to him 9 ounces of arterial blood from a lamb. The young boy lost 3 or 4 drops of blood through his nose, and then he became calm again; his sleep ceased to be restless, he acquired more strength and agility in his limbs, gained weight, and always got better and better until complete recovery.

OBS. III. - A man, insane for eight years, in whom the alienation showed itself in bouts lasting eight or ten months, and during which time he slept neither night nor day, and ran through the streets like a madman. The last attack was in its fourth month, when Denis

withdrew 10 ounces of blood from him by bleeding his arm, and infused his veins with 6 ounces of arterial blood from a calf. The operation was followed by great relief. New transfusion with one pound of blood; as a result, the patient experienced vomiting, diarrhoea, sweating, and a deep sleep for ten hours, and entered a period of ever-increasing improvement until complete recovery.

OBS. IV. - A patient who had been suffering for three weeks from vomiting and a hepatic flow had been purged, bled, and treated with various remedies in vain; his condition seemed hopeless, when it was resolved, as an extreme attempt, to perform a transfusion of blood. Denis performed this operation while the patient was lethargic, had convulsions, and a tight and quivering pulse. After the first injection with 8 ounces of blood, the convulsions ceased, the pulse recovered, consciousness returned, so that the patient was able to recognize the attendants and talk to them, was able to take broth without vomiting, and maintain himself in this favourable state for twenty-four hours. There was a relapse, for which a new transfusion of blood was performed, which brought about a momentary return of strength; but, as the diarrhoea did not subside, the patient succumbed to exhaustion eleven hours after the last transfusion. At autopsy a very extensive volvulus of the small intestine was found, and the intestines livid and ulcerated.

OBS. V. - Manfred, of Lucca, relates having successfully performed a transfusion with the blood of a lamb and through an intermediate cannula into the veins of the arm of a man. (*de Nova et inaudita medico-chirurgica operatione*, etc.; Romæ, 1668)

OBS. VI. - R. Lower and E. King removed from a man 6 or 7 ounces of blood from a man and transfused him with 9 or 10 ounces of the arterial blood of a lamb. The patient felt so well that four days later he begged to be brought back again. (*Gazette médicale de Paris*, 1848, p. 65)

These are the facts which I have been able to gather about transfusions carried out with the blood of animals. We see that not only has the blood transfusion with the arterial blood of a lamb in a living man been well tolerated, but that it has been followed by very marked advantages, except in one case, where it was only tolerated, and in another, in which, although it has been borne without difficulty, it was followed by death due to the fact of serious alterations existing at the time of the operation. The most rigorous conclusion to be drawn from these facts, therefore, is that the injection of lamb's blood into the veins of the living man is *well tolerated*; that in most cases it has been useful, and followed either by an *amelioration* or by the cure of the disease against which it was directed, and that, in the single case where it has been followed by death, it is evidently to *causes foreign and pre-existing to the transfusion* that the fatal termination must be attributed.

SECOND SERIES

OBSERVATION I. – In a 30-year-old man, afflicted with a pyloric stenosis, and reduced by continual vomiting to such emaciation that he had the appearance of a skeleton, Blundell, after having resisted the patient’s entreaties for a long time, ended by performing a blood trransfusion. He introduced through the cephalic vein, and in an interval of forty minutes, 12 or 14 ounces of blood. A few hours afterwards the patient regained a better colour, was able to move his limbs, and said that he felt much better and less weak. The next day the prostration had reappeared, the vomiting and evacuations recurred, and death occurred fifty-six hours after the operation. The pylorus and upper part of the duodenum were squirrhous, the small intestine indurated. (*Med.-chir. trans*., t. X; 1819)

OBS. II. – A woman found herself exhausted by a puerperal uterine haemorrhage. For six hours the haemorrhage had stopped, and, in spite of the most violent stimulants, the

patient did not revive. Blundell injected 14 ounces of blood supplied by the assistants in ten minutes. The pulse, the eye, the warmth, and the colour of the skin immediately revived, and the patient said that she already felt strong. Complete healing in a very short time. (*The Lancet*, t. IX, p. 34)

OBS. III. – A middle-aged lady was seized, following childbirth, with such a haemorrhage that she was pale, cold, and without strength; pulse at 130, 140, small and concentrated; in a word, in the greatest danger. Blundell injected her with 6 ounces of blood supplied by his pupil Wright; the face immediately became calm, and strength reappeared a little; a relapse having occurred two hours later, he injected 6 ounces of blood supplied by his other pupil Uwins; the pulse dropped to 110, strength returned, and soon a complete recovery, in spite of an inflammation of the injured vein, which required the application of a few leeches. (*The Lancet*, t. IX, p. 205)

OBS. IV. – In a woman who was dying of haemorrhage, almost cold and as if dead, Doubledey transfused the blood, but too late; precious time had elapsed in the use of other remedies and in indecision. (*The Lancet*, t. IX, p. 782)

OBS. V. – A 25-year-old lady, after a rapid delivery, was seized with a very severe haemorrhage, the result of the inertia of the uterus; she was in a very great peril, her pulse small and almost imperceptible, her face and lips as pale and cold as a corpse, when Waller and Blundell were called. They delayed the transfusion for another hour; but, seeing vomiting, violent agitation, and an intermittent and formicating pulse, they immediately injected into the right cephalic 2 ounces of blood, which they took from the woman's husband, a strong and robust man; a little agitation, a more intermittent pulse, a short syncope, then the patient's condition gradually improved. (*The Lancet*, t. IX, p. 342)

OBS. VI. – A 32-year-ols lady, of a weak constitution, already emaciated by vomiting which had lasted for three weeks, was seized with the pains of childbirth, and subsequently by a uterine haemorrhage so severe that she was reduced to every extremity: pulse at 140, intermittent; cold face and hands; cadaverous appearance. The fetus was presented at the shoulder. Waller made the version, and took it outside; she was given some alcoholic beverages, but the patient vomited them out; neither the pulse nor the heat increased. The convulsive agitation continued; Waller and Doubledey decided on the transfusion, but it took them another hour to find someone who would give blood. The husband made up his mind, but already the wife gave almost no sign of life: she made no movement when the skin was incised. The first injection was 13 drams of blood, and so on every minute until 8 and a half ounces had been injected. Little by little the patient began to revive, and things worked out so favourably that a week later the patient was already able to sit up on her bed. (*Froriep's Notizen*, B. XIV, p. 318)

OBS. VII. – A 20-year-old lady, extremely exhausted by abundant uterine discharge following childbirth. She had not spoken for six hours, when Brigham injected into a vein in her arm first two ounces of blood, and then, every ten minutes, 10 or 12 ounces in all. After the second dose, the pulse rose, the face revived; the patient came back to life, as if by a miracle, following the injection; speech came back to her, and a few hours after the operation she slept soundly for several hours, after which she awoke in good condition, and from then on progressed rapidly towards a full recovery. (*Edinb. journal et Froriep's Notizen*, B. XV)

OBS. VIII. – A lady of small stature, as a result of a laborious delivery which had brought a dead foetus, was seized with an abundant haemorrhage: a very small pulse, cold extremities; almost imminent death. After employing various means, the cold of the extremities continued with sweating, an unfortunate omen. Jevel, who was assisting her, decided on the transfusion; the veins of the arm being too small, he opened the jugular, and

in twenty minutes he injected in small portions 4 ounces of blood, using a syringe which contained not more than three drachms. The operation did not change the state of affairs, and death took place a quarter of an hour later. At the autopsy, carried out three hours after death, it was investigated whether air had not been injected into the circulatory stream; about 1 drachma of air contained in the heart was collected under water, along with a little coagulated blood.

OBS. IX. – A 28-year-old lady, as a result of repeated metrorrhagia, which could not be stopped with ice, laudanum, ergot rye, alum and tamponade, found herself reduced to a state of extreme weakness, a pulse scarcely perceptible from time to time; breathing very slowly, almost imperceptible; eyes glassy, half-closed; involuntary loss of urine; hiccups from time to time. Dr. Banner injected blood borrowed from the patient's husband. The anxiety of breathing and the disorder of the pulse increased for some time; for three hours the body remained cold and covered with a viscous sweat. From that moment on, the pulse developed, breathing became more natural; the patient was able to take a few spoonfuls of wine and brandy. Little by little she recovered completely, and twenty-one days after the operation she set out, cured, for the country. (*London med. and surg. journal*, 1832)

OBS. X. – A 37-year-old woman, for a long time in the grip of epilepsy, experienced a profuse haemorrhage following childbirth: cold sweats, a small pulse, difficulty breathing. Brown injected her through the basilica of her right arm 4 ounces of blood; immediately the patient experienced a sensation of warmth from the arm to the heart: better colouring, more natural vision. In short, without any very remarkable symptoms, she recovered. (*Oesterr. med. Wochenschrift*, 1837)

OBS. XI. – A 39-year-old lady; very severe haemorrhage ten days after her ninth delivery. In five hours she was reduced to an extreme pallor; exhausted strength, anxious breathing; pulse small, frequent; dilated pupils; voice hushed; nausea and vomiting. The haemorrhage had stopped; but the repeated fainting, the bitter cold of the extremities, the difficulty of breathing, the smallness of the pulse, gave rise to fears of imminent death. Dr. Berg injected into the basilica vein of the left arm two and a half ounces of blood borrowed from a healthy man. For a few minutes more the patient remained deprived of feeling; but soon after the breathing became deeper and less interrupted, and the pulse rose. A few minutes later she was able to answer questions, and after four weeks she was perfectly cured.

OBS. XII. – A young man, afflicted with a congenial tendency to haemorrhages (haemophilia), was reduced, by continual losses of blood which had lasted for five days, following an operation on the strabismus, and by the wound of the latter, to a state of anxiety which placed him in extreme danger. Lane gave him a transfusion with five and a half ounces of blood borrowed from a young girl, and this injection, which was made several times through the median vein, not only remedied the most pressing accidents, but also put an end to the patient's disposition to haemorrhage, which appeared to be the slightest breaks in continuity. (*Bulletin de thérapeutique*, t. XX, p. 65)

OBS. XIII. – A 30-year-old woman, who had been suffering for four years from continual haemorrhages from the eyes, nose, mouth, stomach, bronchial tubes, genitals, ear canal and breasts, who had even had a kind of blood sweat, and which had been treated without success by an infinite number of means and by an extremely considerable number of doctors, was subjected to blood transfusion by Messrs. Uyterrhoeven and Bougard. They first injected 2 ounces of blood into the cephalic, which produced a sensation of heat from the arm to the chest, caused the pulse to fall from 108 to 88, and brought great relief. New injection of 2 ounces of blood: gradual improvement. Finally, a third injection with a larger quantity of blood was obtained. (*Journal de méd. de Bruxelles*, 1848)

OBS. XIV. – In 26-year-old woman, who, following haemoptysis treated by abundant blood emissions, had been seized with metrorrhagia, and subsequently from chloro-anaemia, accompanied by extreme weakness, Bougard injected 2 and a half ounces of blood borrowed from a very robust woman; the pulse rose immediately after the transfusion, strength gradually returned, the skin regained its colour, the vomiting ceased as well as the haemorrhages. Eight days later, at the patient's request, a second transfusion with 3 ounces of blood, which was followed by the most satisfactory result. The patient was getting up, and was already on the point of leaving the hospital, when she was seized with severe metrorrhagia, and subsequently from peritoneal suppuration, to which she succumbed about four months after the transfusion. (*Gaz. med. de Paris*, 1850.)

OBS. XV. – A lady who had reached the end of her pregnancy was seized, following a vicious insertion of the placenta, with such an abundant haemorrhage that it was necessary to terminate the delivery by puncturing the membranes and administering ergot rye. The haemorrhage stopped; but the woman, exhausted, scarcely gave any sign of life. After hesitating for an hour, the danger always increasing, Mr. Nélaton decided to have recourse to transfusion; he slowly injected into the cephalic vein, in three stages, about 350 grams of blood borrowed from a healthy man. There was no agitation or pain. At the time of the injection, the pulse was imperceptible, the heartbeat tumultuous. The precordial anxiety ceased immediately, the next day the heat had returned, the pulse developed, the intelligence clear; the patient only showed great weakness and a lot of cold. Things progressed steadily and always getting better and better, when, seven days later, abdominal pains announced the appearance of metroperitonitis, which was then epidemic and to which the patient succumbed. (*Bull. de thérapeutique*, 1850)

OBS. XVI. - A 30-year-old woman, in whom art had to intervene to complete the delivery, following a very pronounced anteversion, was seized with a profuse haemorrhage, which did not cease until after the syncope; a second haemorrhage, which occurred a few hours later, and which resisted all the means employed, plunged the patient into extreme weakness: cadaverous pallor, cold extremities, pulse almost insensible and soft, with disturbance of vision, repeated syncope, all announced an imminent and inevitable death, when Mr. Marmonier thought of blood transfusion. With no other instrument than a small child's syringe, which could hold 70 grams of liquid, he injected 90 grams of blood borrowed from a woman into the basilic vein of her right arm. Immediately after the transfusion, breathing became more regular, the pulse stronger; the syncope ceased, and the blurring of sight dissipated. We continued the hot rubbing and the use of ratanhia and ergot rye. Two hours after the operation, the patient was so well that she fell asleep, and this sleep gave place to a rapid and unexpected improvement. From that moment on convalescence was rapid, milk secretion was restored, and a month later the patient, perfectly cured, resumed her usual activities.

OBS. XVII. – A 28-year-old woman, subject since her childhood to frequent and abundant haemorrhages, entered the Saint-Antoine Hospital with uterine haemorrhage which alternated with petechiae: excessive discoloration of the skin and mucous membranes, dissipated bruising, etc., the most extensive occupying the limbs; extreme muscle weakness, syncope at the slightest movement; below-normal skin temperature; precipitous pulse at 112, very weak radially, while the carotids were sharply raised at each diastole; weak heartbeat, and systolic murmur sound; intense thirst, constipation, meteorism, pale urine. Despite tonic treatment, the general and local condition worsened: syncope, repeated vomiting, agitation, suffocation, insensitive pulse; meteorism, incessant thirst..., etc. The patient looked like a corpse when Mr. Monneret injected her with 120 grams of blood into a vein in her arm, from which the fibrin had been separated by beating: complete calm during the injection; the pulse regained a little strength, and the patient was able to take some broth. But two hours later the hands and feet grew cold: agitation, groaning, burning thirst, and a hard pulse. Little by little, the patient grew weaker and did not take long to die. No

other alteration was found other than that of anaemia, and especially none that could be attributed to the transfusion. (*Bull. de l'Académie de méd*., 1851)

OBS. XVIII. – In a pregnant woman, who had been reduced almost to extremity by a profuse haemorrhage, following a rupture of the saphenous vein, Dr. Sarristan injected 6 ounces of blood into the median vein. This operation somehow brought her back to life. Twelve hours later, she had an abortion that did not prevent her from recovering. (*La Union*, 1851)

OBS. XIX. – In a case of very serious haemorrhage, following an abortion which had reduced the patient to excessive weakness, Dr. Masfen injected, on three different occasions, 6 ounces of blood, and the patient did not take long to recover. (*Gaz. med. de Milan*, 1852).

OBS. XX. – A 40-year-old man, reduced to a most serious condition by a most abundant haemorrhage, the result of fistulous ulcers ending in gangrene, was subjected to transfusion by Mr. Simon, who injected into his veins 16 ounces of blood from a medical student. The injection was so successful that Simon was able to amputate the diseased limb; but fourteen years after the operation, his strength weakened, and, in spite of a new transfusion, the patient succumbed. At autopsy, the lungs were found to be inflamed and softened. (*The Lancet*, 1852)

OBS. XXI. – A 27-year-old woman, who had experienced a very profuse haemorrhage following a very natural delivery, found herself in a state of excessive weakness, bordering on lethargy: the skin and mucous membranes were discoloured; cold skin; barely perceptible pulsations of the heart; extremely weak pulse, 130 per minute. By the next day, the symptoms had worsened. Mr. Devay thought it advisable to bring in Mr. Desgranges, who performed the operation on the 26 October last, and who injected in two and a half minutes, without the slightest accident, the blood which had just been drawn from a student of the hospital. Immediately the pulse rose to 138; on the other hand, it became stronger and more resilient again; the contractions of the heart resumed their energy; the patient opened her eyes and began to pay attention to her surroundings. The excitement caused by the transfusion increased still further throughout the day, and during the two successive nights there was, with a little delirium, a great deal of prostration; but the improvement proceeded no less rapidly. Two days after the transfusion, the pulse was at 90; free and easy speech; the lips had regained their colour, and the eyes were revived. Despite the appearance of canker sores on the tongue and *phlegmatia alba dolens* of the right lower limb, the patient was cured forty-three days after the operation. (*Bull. de l'Académie de médecine*, 1851)

We see from these 21 facts, which are the only ones I have been able to collect, of transfusion in humans with human blood:

1° That in only 5 cases (obs. 1, 4, 8, 17, 20) death followed the transfusion, or rather, the transfusion was useless, since it could not save patients reduced to extremity. In observations 14 and 15, the transfusion itself had the happiest result, and the accidents to which the patients succumbed cannot be related either to the transfusion or to the condition which seemed to indicate it.

2° That in 16 out of 21 cases, the transfusion was wonderfully useful, since it recalled dying individuals to life and health;

3° That transfusion was very useful in three cases (obs. 12, 13, 14) to radically overcome the repeated haemorrhagic accidents of haemophilia, which had until then resisted all therapeutic means.

If we now consider the 27 cases of these two series, which are more or less all that science possesses, it will be seen that transfusion, by itself, has never caused death, since in two cases of the first series and in the four of the second, which had a fatal ending, either the organic lesions were too serious to be relieved by this means, or the operation was

performed too late. On the contrary, we see that the transfusion was poorly tolerated in no case, has not caused any sign of suffering, instantaneous or consequent, and that in the great majority of cases it has been promptly useful and was followed by healing.

To the preceding facts I may add some of my observations which speak the same language.

OBS. XXII. – On the 17 October 1851, a young girl of 16 years of age, who had been suffering from madness for six years, as a result of the deep grief caused to her by the loss of her mother, and in whom epileptic attacks had also appeared, was subjected by me to transfusion in the following manner: an hour previously, I bled a forty year old woman, robust, affected by the beginnings of rheumatism; the plethoric, fibrin-rich blood was defibrinated by beating and held ready for injection without heating it. I then made a longitudinal incision along the path of the median vein of the left arm; I incised this vein in an area of about 5 or 6 millimetres, I let a few ounces of blood flow out, and, after removing the laces which encircled the arm, I loaded a small tin syringe, with a straight and thin cannula, with defibrinated blood, which I introduced into the opening of the vein, and commenced the injection. I returned to this operation three times, putting four minutes between each injection. A good part of the blood flowed back, because of the excessive extent of the wound and the smallness of the cannula; so that by these three injections I did not introduce into the circulatory torrent more than a third of the blood contained in the syringe, that is to say, 7 to 8 grams of blood. Some of it also leaked into the surrounding cellular tissue, as shown by the formation of a thrombus and the purplish yellow colour around the wound; for the rest, the patient gave no sign of very sharp pain; she only complained of a burning sensation, which went up along the vein to an extent of a few centimetres, and which lasted for some hours, a sensation which must certainly have been related to the introduction of the cannula and the formation of the thrombus. The wound was treated as an ordinary bleeding, and in two days the patient was completely recovered from the local lesion.

OBS. XXIII. – On the 19 October, I made an incision of 3 millimetres in the same young girl to uncover the cephalic vein of the left arm; I opened it, and let out 4 ounces of blood; this was beaten with a bundle of rods, which produced a fibrinous clot so divided and combined with the foam of the blood, that it would have been impossible to inject it by means of the small syringe. Consequently, I passed the blood through a cloth and without warming it, although the result of these manoeuvres was to lower its temperature to about 12° centigrade; I loaded the small syringe mentioned above with it, only I curved the cannula so that the stream of blood penetrated more easily in the direction of the vein, and I injected it into the cephalic vein, favouring the penetration of the blood, which seemed at first to swell the vein immeasurably and stop there, by means of gentle frictions made with the finger on the course of the vein from bottom to top; I was able to get all the blood in the syringe to penetrate without difficulty. I repeated the injection five minutes later, with an equal quantity of blood, in the same manner and with the same result; in this way I succeeded in getting 12 grams of defibrinated and aerated blood into the circulation, as has been said. This time the patient also felt a burning sensation in the wound and along the vein, but less than in the previous experience; the wound healed very quickly; the thrombus was not very pronounced.

Regarding the effects produced by these two operations on the patient, I would not venture to comment: too few days have passed since the transfusion. In truth, the attacks were less violent, she passed several days without having any; but the affection from which she suffers is one of those whose improvement or cure can only be admitted when these have only been experienced over a considerable period of time. However, what these experiments show is the perfect harmlessness of the operation, and it is even this circumstance that has induced me to return to it on this patient.

OBS. XXIV. – A 23-year-old young lady had been suffering for several years from chlorosis with cerebrospinal irritation, for which she had been bled more than 300 times; it

had also been treated with ferruginous drugs, cinchona, narcotics, depuratives, and resolvatives; she had been tortured in every way by revulsives applied to every part of the body, and all this without advantage, since menstruation had become more and more rare and difficult, especially during the last two years, languid digestion, imperfect nutrition, pale yellow skin, almost jaundice. The patient thus endured a painful existence, abandoning her bed from time to time, only to be taken back a few days later from congestive irritations of the head or chest, which obliged the doctors to deprive her again of the little strength she had been able to gather

For two weeks the patient had been confined to bed with a dry and fatiguing cough, accompanied by fever in the evening; she had already been bled three times without any reduction in symptoms.

I proposed the transfusion of a small quantity of blood from a robust man, and my proposal having been accepted by the patient and the attending physician, the latter having previously been plunged into magnetic sleep, I drew 4 ounces of blood from the doctor, who was kind enough to agree, and having defibrinated it by beating, I incised the cephalic vein of the right arm in an extent of 2 or 3 millimetres; then, having loaded a small syringe with the defibrinated blood of my colleague, I injected it into the veins of this young girl. I returned to the injection twice without filling the syringe; so that, taking into account the portion of blood which flowed back, I introduced into the circulatory torrent approximately 7 grams of blood; slight friction on the vein made it easier to penetrate.

When the operation was finished, the young lady was awakened. She assured that she had noticed nothing; her attention having been drawn to the injured arm, she declared that she did not suffer at all. The next day, the cough was gone; three days later she was able to get up; on the fourth day she left her room, and took a good walk on foot to reach a steamboat, on which she embarked for a pleasure trip.

The operation was performed on the 20 October, and at the end of December I received a letter from this young lady announcing that she was perfectly cured, and that the menstruation, which had been suspended for a long time, had been restored; she did not hesitate to report her recovery to the transfusion. I heard from her again on the 15 February, and the healing had not diminished.

I do not wish to draw too absolute a conclusion from this observation; however, we must attach some value to the assertion of a patient who, having been tested in some way by the remedies, could well realize what she was experiencing. In all probability, the transfusion gave a salutary boost to the disease; but, in any case, it has not produced any kind of inconvenience.

If we now want to judge the merit and the scope of application of transfusion by the preceding facts, which I have reported without making any choice, will we not find it strange that this operation, so easy, should have been performed so rarely? Will we not find it inconceivable the horror that an operation so harmless and so useful inspires in the generality of doctors and patients? Even those who do not hesitate to subject patients to infinitely more serious and painful surgical operations, who have not feared, for example, to inject into the veins substances completely foreign to the body, medicinal substances for example (1), can they be afraid to inject blood, which is the natural fluid of the vessels? It would be difficult to find the reason for such inconsistency of the human mind, except in that widespread prejudice, which ascribes prodigious effects to the admixture of blood. However, when we consider it carefully, transfusion, as Denis has said, is an operation that nature teaches; the foetus, in its mother's womb, lives by a kind of transfusion, and ordinary food is nothing else than the transfusion by a longer course of the vegetable and animal substances on which we nourish ourselves. We therefore believe, in view of the results of our own experiment and that of others on animals, and also of the numerous cases of success of transfusion in humans, that we can establish the indications for this operation in the following manner:

1. Transfusion or injection of blood is appropriate in cases in which the individual is in great danger from *very abundant or rapid loss of blood*, as occurs in women in childbirth and in the injured.

It is in women in childbirth who suffer from severe bleeding during labour or shortly after it that transfusion has been more often successful. In the second series of facts cited above, there are eleven that testify to its effectiveness (obs. 2, 3, 5, 6, 7, 10, 11, 15, 16, 19 and 21). We therefore have the right to wish that this operation will become naturalized in practice.

In the case of arterial haemorrhage resulting from gunshot wounds or bladed weapons, in which, even after the ligation of the arteries, life is endangered by the abundance and duration of the flow of blood, the transfusion of even a small quantity of blood may give the patient more chances. In the absence of facts borrowed from the human clinic, I will cite in favour of this practice, my experiments on dogs and horses, and those of Rosa on lambs.

2. The injection of blood is appropriate in the case of *spontaneous or constitutional haemorrhage which cannot be stopped* and which is understood under the name of *haemophilia*. The cases we have reported (obs. 12, 13, 14) show the advantages of transfusion in this circumstance; they also show that, while ensuring the salvation of patients whose lives were greatly threatened by abundant and repeated haemorrhages, it can bring about a radical cure of the tendency to haemorrhage. The modification introduced in the composition of the haemophilic blood by the new injected blood is certainly a major factor in this cure.

3. Transfusion of blood is appropriate *in cases of exhaustion and wasting due to a defect or suspension of nutrition*, as a result of intestinal injury or general languor in the innervation. By immediately sending into the circulatory system the ultimate and most perfect result of food digestion, by means of the transfusion of good blood, who knows, said Denis, whether many children, exhausted by starvation alone, might not be saved! Whereas, left to its own devices, the child will infallibly perish within a given time, and before the resolution of the intestinal disease which disturbs the nutrition, with a methodical transfusion of the blood, it could be sustained long enough to allow assimilation to resume its natural course. For my part, I believe that this operation is very difficult, not to say impossible, in children; but what I do not regard as so difficult or so impossible, is the use of this operation in similar cases in adults. However, I am not aware of any experience that confirms this assertion; but it is an attempt to be made.

4. The injection of blood into the veins of cachectic or dyscratic individuals may result in a normal regeneration of the humors and tissues. In chlorosis, rickets, and scrofula, the injection of good blood into the circulatory system may be regarded as the deposit of a new germ destined to promote a more normal reproduction of the tissues, and consequently a modification in the whole constitution. By injecting a few ounces of blood into a living organism, we introduce billions of blood cells which, in turn, produce other globules of a good nature; in place of those altered, and which establish a new generation of these globules, which play the most important role in the excretion and nutrition of solids. Hence it follows that by methodically repeating these injections, at certain intervals, it may be possible to make the good elements of life prevail, and gradually reconstitute an altered organism.

5. The injection of blood *previously beaten and impregnated with air is suitable, as an energetic means of reviving, in all asphyxiations and in all apparent deaths*.

The observation of Philipps Key, who demonstrated twenty years ago that members which have lost their irritability can recover them by an injection of arterial or venous blood; the recent experiments of Mr. Brown-Séquard, who succeeded in restoring muscular irritability in the already stiff limbs of a cadaver by means of an injection of blood into the veins; the experiments of Fontana, Humboldt, Tiedeman, and my own, on the action of oxygen, carbonic acid, and other gases, on the contractility of the hearts of frogs; and, finally, the facts reported by Mr. Liebig, Jr., concerning the respiration of muscles, which

demonstrate that they absorb oxygen and produce carbonic acid; all this puts beyond doubt the powerful action of the oxygen contained in the blood to restore the contractility of the extinct muscles. Transfusion should therefore not be neglected in all cases of asphyxiation by carbonic acid, by carbon monoxide, by submersion, by lightning, etc.

6. Finally, since the conditions of the blood modify, more or less profoundly and rapidly, the mode of functioning of the nerves, we venture to propose, following the example of the first transfusions, and as Schneider and Hufeland did later, to try blood injections in certain cases of mental alienation or madness which are not connected with any obvious organic alteration of the sensory apparatus or of the viscera which may awaken ones sympathies.

(1) For at most twenty-seven facts which science possesses of the injection of blood into the veins of man, we could site hundreds of cases in which medicinal substances have been injected, with more or less success, into the circulatory torrent: thus the injections of hot water made by Magendie and Gaspard, those of stibiated tartar made by Knopf, Graefe, Krahe; those of camphor in emulsion by Ortel and Hennius; the infusion of senna and guaiac, with ichthyocolla and gum arabic from Regnaudot, injections of belladonna from Froriep, those of datura from Percy and Laurens, those of opium from Hufeland, vomic walnut and Horn's sulphuric acid, Hale's castor oil, etc. (*Author's note*.)