TRANSFUSION INSTANTANÉE DU SANG

BY: Dr MONCOQ

A TRANSLATION OF CHAPTER VI (PAGES 51-95) BY PHIL LEAROYD

'EXPOSÉ HISTORIQUE ET CRITIQUE DE LA TRANSFUSION DU SANG, DEPUIS SON ORIGINE JUSQU'À NOS JOURS.'

The book 'Instant Blood Transfusion' by Dr. Moncoq was published in 1874 in Paris [by Adrien Delahaye]. A copy of this 348 page book can be viewed or downloaded at:

https://wellcomecollection.org/works/hfb6rhfg

https://books.google.co.uk/books/about/Transfusion_instantan%C3%A9e_du_sang.html?id=QxyNegIvooQC&redir_esc=y

The full title of this book is: 'Transfusion instantanée du sang: solution théorique et pratique de la transfusion médiate et de la transfusion immédiate chez les animaux et chez l'homme', i.e. 'Instant blood transfusion: theoretical and practical solution of mediate transfusion and immediate transfusion in animals and humans'.

Chapter VI of this book is titled 'Historical and critical statement of blood transfusion, from its origin to the present day' (pages 51-95) contains six sections:

Art. I. - General considerations
Art. II. - Division of its history
Art. III. - Main deductions from animal experiments since 1818
Art. IV: - Experiments with defibrinated blood in animals
Art. V. - Temperature to be given to blood for transfusion
Art. VI: - Conclusions of the previous experiments

Part 1 contains a short but rather 'wordy' introductory background. The second part contains the historical aspects, which (as used by a number of authors) is broken down into three time periods; the first is stated to cover the beginning of the 17th century to 1668, but also includes some pre-history material (e.g. Medea); the second is from 1668 ('the judgment of Chatelet') to 1818, whilst the third period is from 1818 ('the year of Blundell's experiments'), which is described by Moncoq as being 'the only true scientific period'.

I have included the rest of Part VI as it contains interesting summaries of the experimental work performed up to 1874 together with a number of conclusions related to animal experiments, defibrination and the temperature of transfused blood that make interesting historical reading, but which still of course do not challenge the fundamental problem of how to inhibit coagulation.

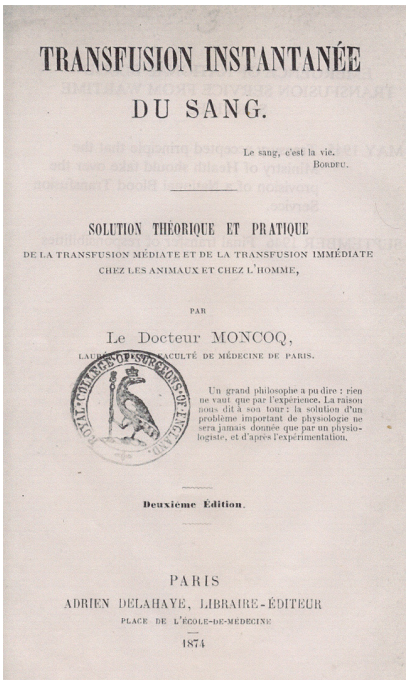
The author presents some of the references to the text numerically, which are included at the bottom of individual pages, whilst he also includes others within the body of the text. I have re-numbered all of these together and placed them as a list at the end of the translation. Please note that they are reproduced as written, some of which are incomplete, whilst others I am aware, are inaccurate. In addition, some

aspects of the text are rather annoyingly not actually referenced at all, e.g. the work of Magendie and Dieffenbach.

The use of italics and ordinary brackets within the translation are the author's own. I have also maintained the same paragraph settings used by Moncoq (some of which are single sentences), as well as his spelling of the names of different people, though I have added amendments, contained within square brackets, to some of these.

I have translated this 'historical' chapter of Moncoq's book from the original French into English in the hope that the content may be appreciated by a wider audience. Whilst I am obviously aware that instantaneous computer-generated translation is possible, this process struggles with specialist terminology and also produces a 'colloquial style' not always representative of the original text. I have purposely made this translation to be as 'un-interpreted' as possible, in that I wanted to maintain the author's original meaning / wording as much as possible. As with any translation the wording may be purposely or inadvertently altered to 'make it read better' but in doing so there has to be an element of personal interpretation involving something on the lines of 'I believe that this is what the author is trying to say'. I wanted 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. Whilst some of the words / terms originally used are obviously open to interpretation, I have attempted wherever possible to hopefully maintain the author's meaning, intent and detail. Although I have taken great care not to misrepresent 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 French text.

Photograph of Dr. Moncoq
(1874 book – 1st Edition)
(Image credit: catawiki.pl)



TRANSFUSION INSTANTANÉE

DU SANG.

Le sang, c'est la vie.
BORDEU.

SOLUTION THÉORIQUE ET PRATIQUE

DE LA TRANSFUSION MÉDIATE ET DE LA TRANSFUSION IMMÉDIATE
CHEZ LES ANIMAUX ET CHEZ L'HOMME,

PAR

Le Docteur MONCOQ,

LAURÉAT DE LA FACULTÉ DE MÉDECINE DE PARIS.

Un grand philosophe a pu dire : rien ne vaut que par l'expérience. La raison nous dit à son tour : la solution d'un problème important de physiologie ne sera jamais donnée que par un physiologiste, et d'après l'expérimentation.

Deuxième Edition.

PARIS
ADRIEN DELAHAYE, LIBRAIRE-ÉDITEUR
PLACE DE L'ÉCOLE-DE-MÉDECINE
1874

Title page of 'Transfusion instantanée du sang.'
(1874 book – 2nd Edition)
(Image credit: Wellcome Collection)

HISTORICAL AND CRITICAL STATEMENT OF BLOOD TRANSFUSION, FROM ITS ORIGIN TO THE PRESENT DAY

Art. I. - General considerations

Transfusion has not escaped this great law which seems to dominate all the conquests of the human mind. At first it gave rise to exaggerated expectations; but, as this discovery was premature, when physiology was not there to enlighten it with its indispensable light, one understands that, directed by a blind empiricism, it was to fall into abuses that would destroy all illusions; and, by the very fact that, from the outset, it had been endowed gratuitously with absolute power, it was soon, by a natural turnaround, to deny it any usefulness.

Such must indeed have been the history of transfusion. But, as there is always truth in what makes so deep and so general a sensation, this question arises again, and better studied, reduced to its true proportions, it was to take its place definitively among the assured conquests of science. A question of the highest scientific interest, it could not fail to attract the attention of the first physiologists truly worthy of the name; and, because healthy physiology should be favourable to it, the therapist, in turn, should from time to time turn to it in serious circumstances.

Before 1823, when a long oversight had rejected very far from unscientific test, it was possible to doubt at first that it could ever be taken into great consideration; but, after the far-sighted genius of Mr. Milne-Edwards had dared to take the part of blood transfusion so energetically, supported in his thesis in 1823 at the Faculty of Medicine of Paris; when, since 1823, all the men placed at the head of physiological and medical sciences had been unanimous in recognizing its incontestable usefulness in specific cases, it was, without a doubt, a good way to seek a procedure that would finally allow this operation to be performed.

Art. II. - Division of its history

The history of transfusion includes, if you will, three periods: the first would extend from the beginning of the 17th century to 1668, when the judgement of Chatelet, forbidding the practice of transfusion in humans without the approval of a doctor from the Faculty of Paris.

The second period would consist of a hundred and fifty years, from 1668 to 1818, the year of Blundell's first experiments.

Finally the third period, inaugurated by the work of this scientist, constitutes the only truly scientific period.

§ I. First period

The idea of rejuvenating blood, of transfusing new blood, is found in the metaphorical language of all times. We only want to give as an example the famous verses from Ovid's Medea, which we find placed, as an epigraph, at the head of several monographs devoted to this subject:

> Stringite, ait gladios; veteremque haurite cruorem,
> Ut repleam vacuas juvenili sanguine venas!
> (Métamorphoses, livre VII.)

This is properly the heroic period in the history of transfusion; and it goes without saying that we do not have to deal with it.

It took the discovery of the circulation of blood to inspire the idea and scientific practice of transfusion.

This immortal discovery of the circulation of blood by William Harvey, in 1628, led the movement towards anatomical studies. We first thought of making injections into the blood vessels, to study the most tenuous branches. Soon, following the natural course of ideas, it was thought to introduce medicinal substances directly into the circulatory torrent. This bold way was performed, not only in animals, but also in man.

In fact, shortly after the discovery of circulation, in 1656, Dr Christopher Wren, professor of astronomy at the University of Oxford, proposed to Robert Boyle (1), founder of the Royal Society of London, to Wilkins, Bishop of Chester, and to other learned friends, a means that seemed to him convenient for immediately injecting liquors into the mass of the blood, whose effects on the circulation should be studied. This method was to tie a vein, opening that vein above the ligature on the side of the heart, and to make the injection at that point. Robert Boyle made many experiments in this way, which he published in a work entitled *On the Utility of Experimental Philosophy*: we can clearly see that intravenous injections do not date from today, since here they are well expressed in 1656.

These experiments caused a great stir then, and the following year, this method was tested on a man in London, in the house of Mr. de Bourdeaux, Ambassador of France, in the presence of the doctor of the Queen of France. The operation was successful, and became the starting point for what was then called *infusory surgery*.

Sigismund, physician to the Elector of Brandenburg, and Fabricius, surgeon in Bremen, applied this method to therapy, and obtained success.

A surgeon from Breslau, Purmann, suffering from continuous fever, had a bitter decoction injected into his veins.

The idea of blood transfusion naturally arose from infusory surgery. Since a medicinal liquid could be passed through a man's veins with impunity, it was natural to think of passing the blood of a healthy man through the veins of a sick man.

Transfusion emerged from this scientific movement. There was much discussion to find out who had the honour of the first attempt of this kind; England, France, and Germany have claimed this glory: from that time on, we had a high idea of the future of this operation.

We wanted to find the germ of transfusion in the works of André Libavius (1615) and J. Colle (1628), it is possible; but for us, the discovery of circulation only really dates from the memorable period, when the genius of Harvey provided experimental proof of it, the birth of transfusion must not go back beyond the day when, for the first time, experiments were carried out to demonstrate the possibility and the consequences.

To foresee the possibility of a good thing, to have an idea about something, proves that one is doing an act of intelligence; but any idea that is not translated into a practically feasible fact does not advance the question.

The *Journal des savants* (2nd July 1668) gives the following summary of the memoir published in Italy under the title: *Relatione delle experienze fatte in Inghiterra, Francia ed Italia intorno la transfusion del sangue*.

The author says that more than fifty years ago, transfusion was known in Germany; and indeed, he reports a passage from Libavius where it is so well described that it is impossible to speak of it more clearly.

“Adsit juvenis robustus, sanus, sanguine spiri tuoso plenus; adstet exhaustus viribus, tenuis, macilentus, vix animam trahens. Magister artis habeat tubulos argenteos inter se cruentes, aperiat arteriam robusti et tubulum inserat muniatque; mox et tubulum faemineum infigat, jam duos tubulos sibi mutuo applicet et ex sano sanguis arterialis, calens et spirituosus saliet in aegrotum, unaque vitae fontem afferret omnemque langorem pellet.

But Libavius describes this operation only to make fun of it. He adds immediately afterwards: "Sed quomodo, ille robustus non languagescet?"

Timothy Clarck [Clarke] and Dr. Heushaw [Henshaw], members of the Royal Society of London, were the first to attempt blood transfusion in animals. But they failed completely and, in 1665, they explained to the Royal Society that the difficulties were such that they had not been able to succeed.

In 1665, Richard Lower, professor at Oxford, in the presence of Drs. Wallis, Millington and Savillian, passed blood from the carotid artery of one dog into the jugular vein of another dog. He had been unable to get the venous blood through, which immediately coagulated in the tubes he was using. The founder of the Royal Society of London, Boyle, having heard of Lower's successes, begged him to explain to the Royal Society the method he had employed.

Boyle (2) asked Lower a series of questions, proving to us today that this serious mind had a high idea for the future of this nascent operation. He was careful not to fall into the extravagances of a few experimenters who followed him.

Edmond King (3) was the first to perform a vein-to-vein transfusion, from a calf to a sheep.

Clarck [Clarke], the scientist of whom we have already spoken, presented to the Royal Society a sheep, through whose veins he had passed calf arterial blood.

In France, we also set to work. In 1666, Gayant, provost of the Company of the Surgeons of Paris, passed the blood of a young dog through the veins of an old and blind dog. The latter, far from being bothered, seemed to be doing better than before the experience.

For his part, Denys, a doctor from Montpellier, undertook a series of experiments in Paris with the surgeon Emmerez. He even made public experiments, at Quai des Augustins, the usual place of his lectures. He passed calf's blood through a dog's veins, and the latter was in no way inconvenienced.

Claude Tardy, doctor regent of the Faculty of Paris, published, in 1667, a treatise on the usefulness of passing a man’s blood in the veins of another man in cases of illness. He believes that if necessary, the blood of an animal could be used. But Tardy is content to write, while Denys does real operations on man.

We find in a letter written by Denys to Mr. de Montmor, master of requests, the account of two transfusion experiments carried out on man.

Before reporting these two observations, Denys insists on the reasons that determined it. It is important to make them known. If they are not always based on exact physiological facts, they at least have a remarkable character of originality.

“By performing transfusion”, says Denys, “we are only imitating the example of nature which, in order to nourish the foetus in the mother's womb, continually transfuses the mother's blood into the child's body through the umbilical vein. To be given the transfusion is nothing other than to feed oneself by a shorter route than usual, that is to say to put ready-made blood in one's veins, instead of taking food, which only turns to blood after several modifications. This abbreviated way of feeding is preferable to the other, in that the food taken by mouth, having to pass through several parts that are often ill-disposed, can contract several bad qualities, before having reached the veins; it is subject to several alterations, which can be immediately avoided by putting perfect blood in his veins; moreover, this operation brings together the doctors who approve the bleeding, and those who do not approve it: these, because it evacuates the corrupted blood, and those, because by putting again blood in place of that which is drawn, the strength of the patient is not diminished; and that finally, reason seems to teach that diseases caused by inclement weather and the corruption of the blood must be cured by the transfusion of pure and well-tempered blood.”

After having thus answered those who condemn transfusion as useless, Denys answers those who condemn it as barbaric.

“What gives them this opinion is that they imagine that, in order to do the right thing, the animal that provides the blood must be of the same species as the one which receives it and thus the life of one can only be prolonged by shortening that of the other, one cannot can prolong the life of one, only by shortening that of the other.” But Denys shows that this is not necessary, and that, on the contrary, the blood of animals is better for men than that of men themselves. The reason he gives is that men, being agitated by various passions and poorly regulated in their way of living, must have more impure blood than animals, which are less subject to these disorders; and that in fact one hardly finds corrupted blood in the veins of beasts, whereas one always notices some corruption in the blood of men, however healthy they may be supposed; and even in the blood of little children, because having been fed with the blood and milk of their mother, they sucked corruption with the food. Moreover, adds Denys, why shouldn't the blood of beasts be cleaner for men, since it is of the same species as the milk and the flesh on which they usually eat? We could add, if what some authors have noticed is true, that barbarians who feed on human flesh are subject to several unfortunate diseases, from which those who feed on the flesh of animals are exempt. It must be concluded that, as the flesh of men is more unhealthy than that of animals, their blood is also less suitable for transfusion.

All these reasons serve as a preamble to the two transfusion operations performed on humans.

The first was made on a young man of 16, plagued for two months with a stubborn fever. The surgeon Emmerez drew 3 ounces of blood through a vein in his arm and, through the same opening he injected 8 ounces of arterial blood from a lamb: the young man, continually dozing before the operation, gradually wakes up, and eventually regains complete health.

The second experiment, which had less reason for being than the previous one, was carried out for a sum of money, on a strong and robust man of 45 years. He was bled for 10 ounces, and 10 ounces of arterial blood from a lamb was transfused to him.

The transfused man was so little inconvenienced by the operation that, the same day, he spent the money he had received with some friends and the next day he came to ask Denys to ask him, as soon as it pleased him, to repeat his experience.

In Paris, many opponents had already risen up against transfusion.

We will cite among the most determined, Lamartinière [Martinère], Lamy and Perrault – from there, many discussions between supporters and opponents of the operation. Some scholars were from a mixed party, including Tardy, who nevertheless proposed human-to-human transfusion.

Denys says that, without stopping to refute all the reasons of those who have written against transfusion, he wants to combat them only by experience; but he operates under disadvantageous conditions.

At the same time, a work by Eutyphronus, philosopher and physician appeared, entitled: *De nova curandorum morborum ratione per transfusionem sanguinis dissertatio*; in which the author refuses to admit transfusion; he does not care that, in order to authorize transfusion, it has been argued that it is an abbreviated means of nourishing oneself by putting ready-made blood in the veins, instead of having fun doing it in the ventricle (old word put for stomach); he says that it is indeed the shortest route, but not the safest, and that it is almost as if a person who is on a third floor, wanting to come down, does not take the trouble going down the stairs, but, to take the shortest route, would jump out the window; for nature having shown no other way to conduct blood in the veins, than to make it pass into the ventricle, it is temerity to take other paths.

The author points out, moreover, that it is to overwhelm the sick, and not to relieve them, to give them blood by transfusion, since the greatest secret of medicine is to remove it by bloodletting, experience having shown that the abundance of blood is a burden to nature in almost all diseases. It is true that it is said that transfusion is

always accompanied by bleeding, and that no blood is given that has been removed before; but the author replies that it is to destroy what the bleeding has done; that this is not unloading nature, but only making it change its burden; and that a sick person would be no more unloaded of it than a porter would be unloaded from a sack of peas, to load it with a sack of beans.

But admitting that transfusion was of some use, it would be necessary, in order to do it, to use human blood and not animal blood; for woman's milk being better for children's food than that of any other animal, it follows that man's blood should be preferable to any other for transfusion. (4)

Tardy, in his letter to Breton, doctor of medicine at the Faculty of Paris, admits that the blood of men is better for transfusion than that of animals; but he also confesses that, whilst transfusion is not good for all diseases, and particularly for pleurisy and all hot diseases, in which it is more useful to remove blood than to give it, however it does not should not be rejected, because it can be useful in many other cases.

At the same time, in Germany, Daniel Major published, in 1667, a work on infusory surgery and blood transfusion.

Daniel Major (5) tells us that he tried to pass the blood of a dog into another dog, by means of tubes joined together by a vertebral artery of the horse: is this not the idea of the rubber ball, which was proposed later, and without much more success, as we shall see.

In 1667, Richard Lower and Edmond King transfused blood in London on a man of letters, Arthur Coga. Seven ounces of blood were taken from him, and 10 ounces of sheep's arterial blood was passed through his veins. Arthur Coga could not be cured, but he did not become any more ill.

The previous successes were soon to be followed by two setbacks, which would bring the transfusion operation into disrepute.

Baron Bond, son of the Prime Minister of the King of Sweden, in Paris, was attacked with severe dysentery. The doctors who treated him, and Denys was one of them, seeing him at the end, had the unfortunate idea of attempting transfusion as a last resource.

Two pallets [sic] of calf's blood were passed through the veins of the dying man. The patient revived, the dysentery subsided for twenty-four hours; then the accidents reappeared with the same violence. It was thought that it was good to renew the transfusion. The patient, who was at all ends, found himself again relieved for twelve hours, then he died.

The second setback took place on a poor maniac, Antoine Mauroy. To cure him, it was thought useful to remove 10 ounces of venous blood, which was replaced by 6 ounces of arterial calf blood. The maniac felt a little better after this first operation. A few days later, he was given another pound of blood: he recovered his reason, and was passed for healed. But he died a few days later; and the adversaries of the operation did not fail to attribute this death to the operation itself; which was not true at all, as we will see later. (6)

It was then that the criminal-lieutenant of Chatelet issued, on 17th April 1668, a judgment by which it was formally indicated that blood transfusion could henceforth only be practiced with the approval of a doctor from the Faculty of Paris. .

I borrow from the thesis of Mr. Nicolas (7) the judgement of Chatelet that he translated.

This authentic piece offers too much interest not to appear in the physiological history of this question. We will give a summary:

Extract from the sentence given to Chatelet by the lieutenant of criminal cases.
Paris, 17th April 1668.
In this case, the following facts have been proven:

1. The operation of transfusion was performed twice on Mauroy, who was insane, and a third was tried. It succeeded so well the first two times that this man was seen to enjoy all his good sense and perfect health for three months.
2. From the first two operations, his wife gave him eggs and broth for food. In spite of the defence of those who treated her, and without speaking to them about it, she led her husband to her house, who only went there with great reluctance.
3. Since that time, having fallen ill again his wife made him drink spirits and broth, with which she mixed certain powders. Mauroy having complained that she wanted to poison him and that she gave him arsenic in her broths, she prevented the assistants from tasting it, and, feigning madness, she threw the contents of the spoon on the ground. [Note: This point is actually not labelled as No.3 in the book]
4. Mauroy had frequent quarrels with his wife; she beat him although he was ill; the latter having once thrown a box at his head, she said that he would repent of it, though she was to die of it.

We see in the rest of the judgment, that Mauroy eventually died and that his wife would not allow anyone to approach her husband, to verify the type of death.

The woman was put in prison on suspicion of having killed Mauroy. While waiting for the cause to be informed, it was ruled that transfusion could not be performed in humans without the approval of a doctor from the Faculty of Paris. (8)

It is with this edict of the Chatelet that the first period in the physiological history of blood transfusion ends.

Just as the discovery of circulation, which had nevertheless presented itself to observation in an admirable form of simplicity and obviousness, had met with violent opposition, so the transfusion of blood, a corollary of the first discovery, had to be vigorously pursued in turn. Because every truth is a ray of light, which destroys illusions, prejudices or errors: the more it destroys false assumptions, the more clamour it raises.

The extract from the sentence handed down at the Chatelet on 17th April 1668, is in the collection of the *Académie de Dijon*, volume II, page 144; and in number 36 of *Philosophical Transactions*.

Blood transfusion was therefore never absolutely forbidden, as has often been printed, but wisely regulated. It had already given results which, in effect had to contraindicate an absolute ban.

But this regulation did not suit Denys, who was a doctor at the Faculty of Montpellier.

Lower, in England, had, by his experiments, prepared the operation of the transfusion of blood, but Denys, the first, had practised it in France. However, while Lower and King were encouraged in London, Denys, who had however achieved nothing but success, was persecuted in Paris. It was because by his very attempts, and by his successful attempts, he had attracted jealousy: everyone had their eyes open to overwhelm him with his first failure. Jealousy unleashed a bitter war against Denys, and all the more unjust as the death of Mauroy, the last operated by Denys, was due, not to the transfusion, but to the ill-treatment suffered by the patient. It was subsequently proved that Mauroy's wife, won over by the enemies of Denys, had poisoned the patient some time after the operation: this woman, put in prison, was punished for this crime. But the judgment of the court of Chatelet was not revoked, and Denys had to withdraw from the struggle, which left him with only deep discouragement.

This ends the first period of transfusion in our country.

Lower (9), in England, is careful to point out that the first animal experiments were carried out in his country.

Thus, a French doctor has the honour of having carried out, the first transfusion in the human species; and to the English professor that of having prepared, by his

experiments, this daring attempt. Lower was honoured in England. We know the rest.

History will add, we hope, for our country, that it is again a French doctor who deserves the honour of having given the complete and truly practical solution to this important problem, and for so long in the study.

The French surgeons of this period, while granting the English the honour of having been the first to have experimented on animals, maintain that in France, and before the experiments of Richard Lower, which were made in 1666, *the first idea of transfusion was born*. "Thus," said Denys, in a letter to Mr. de Montmor, "it is known, and there are several persons of honour who can testify, that it is more than ten years since Dom Robert des Gabets, a Benedictine cleric, gave a speech on transfusion, in the assembly that was held at Mr. de Montmor's house, and there are still several copies of it; it is true that most of them scoffed at this proposition, and that it was believed to be impossible. The English, seeing that no state of this invention was being made in France, wanted to seize it as something abandoned, and practiced it on animals; but we finally claimed it, and we found a way to regain possession of what belonged to us, by practicing it first on man." (10)

An answer to the above is found in a passage borrowed from the *History of Philosophical Transactions*, where it is said: "We gladly agree in England, that the French were the first, as far as we know, who took this big step in transfusion, to practice it on man, but they must also learn a truth, is that the philosophers in England, would have made this experiment a long time ago on men, if they were not so circumspect, when it is a question of putting the life of the man to chance, for the conservation and the recovery of which, however, they spare neither care nor penalties; and if they had not been held back by fear of a law that is more precise and more rigorous, in similar cases, than the laws of several other nations." (11)

While this was happening in France, transfusions were also being done in Italy. We find in the *Giornale dei litterati*, 1668, an account of the experiments made in Bologna by Magnani, on lambs and dogs. Cassini and Griffoni also experimented with animals.

In Rome, surgeons Riva and Manfredi (12) performed it several times on humans. In the *Éphémérides des curieux de la nature*, we find an observation reported by Georges Elsner on the operations of Guillaume Riva. But this doctor had not understood that the transfusion of blood can do nothing against organic diseases, and he pretended to cure phthisis by this means. As we can see, he had taken the thing by its worst side. And he did so well that in Italy too, it was necessary to take measures against innovators who were a little too careful.

§ II. Second period

From the year 1668, blood transfusion, banned or almost from medical practice, however always remained a scientific question.

Claude Perrault (13) experimented with it on animals, kept in the Académie des Sciences. The main conclusion is that an animal can only receive blood in its veins from an animal of the same species; we will soon see that later we were to arrive at the same conclusions. However, in 1683, the *Archives scientifiques* counted another human transfusion success, Kaufmann and Godefroy performed transfusion in an anaemic subject, and he returned to health. They used lamb's blood.

De Gurie [De Gurye] (14) says that this operation can, in certain cases, which he does not specify, be useful; but that in most cases it must have unwelcome effects. He bases his conjectures on "that the blood of different animals, being of a very different nature and having many spirits, cannot mingle in the body of another animal without fermenting, and cannot ferment without causing many alterations."

Fortunately, an idea had survived all attempts made in France and Italy. Richard Lower, wiser in this than his contemporaries, had already insisted on the necessity of tracing the indications for transfusion, and in the first line, he had indicated haemorrhages of any kind. It was a time out; but soon the idea would resume its progressive course.

In 1714, a scientist of the time, Nuck, made the history of this operation. He thinks it has been too much forgotten for fifty years. He says formally that it should not be banned from the medical arsenal; that it can offer great resources, in wounds followed by considerable haemorrhages. But he is not of the opinion that animal blood is used for the operation in humans. The work that contains these wise reflections is entitled: *Operationes et experimenta chirurgica*.

In 1749, Cauttwel, doctor-regent of the Faculty of Medicine in Paris, was of the opinion that since blood transfusion had once given some success, it is logical not to outlaw it in desperate cases. (15) This period, it is seen, has only a small number of facts: it is a period of almost zero for progress.

In the great *Encyclopédie des sciences*, published in Neufchâtel, there is a purely historical article, in which little is said of the struggle of Denys and his adversaries.

Senac (16), in making the history of the discovery of circulation, speaks of the transfusion of blood as further evidence of Harvey's discovery.

So we see that transfusion has completely disappeared from medical practice. This abandonment is fairly well explained, if we consider that the experiments were not always successful, even on animals, as it happened at the *Académie des sciences*; operations on man did not always have very positive results, and death sometimes followed them; finally, many writings, contrary to this method, came to add their authority to the disapproval of the judgment of the Chatelet.

We have to go to the beginning of the 19th century to find new transfusion attempts.

§ III. Third period

It is the first scientific era.

Until then, it can be said, they had only been chance trials. And if one thing should surprise us, it is that with such bad management, there was no more failure.

But by this third period, science had worked, and operations could now be done, with the spirit of wisdom and method brought about by the progress of enlightenment.

Blood transfusion had long since been forgotten, when in 1818 a highly valued English surgeon, Dr. James Blundell, again called attention to the operation.

Called to a woman of high birth, who had had uterine haemorrhage, he arrived when the flow of blood had completely ceased. Despite all his care, he could not revive her, and this woman died two hours after his arrival. Blundell, a serious mind, began to reflect on this melancholy scene. He thought and wrote that this woman would probably have been saved by the transfusion of blood.

He then undertook a series of animal experiments, and he came to the conclusion that blood transfusion is not a dangerous operation. But he is of the opinion that in order for the danger to be avoided completely, the blood should be defibrinated. (17) [Note: Whilst Blundell's experiments identified in this reference investigate the time taken for blood to coagulate and the problems that this causes, he does not investigate defibrinated blood and does not state that it should be used, as quoted here by Moncoq – PL]

The following year, in 1819, Blundell performed a transfusion at Guy's Hospital in London on a 40-year-old man who had pyloric cancer. He was injected, in several times, with 14 ounces of human blood. The patient appeared better at first; but he died, as he was to die, of his cancer, after a few days. Blundell concludes from this that transfusion should be reserved for haemorrhages only. The preceding operation

had not been injurious, but it had simply supplied for some time the functions of the stomach.

We are surprised that Blundell had fallen into this trap: he could not ignore that it was compromising a good thing, to sacrifice it in this way to a disease of the nature of cancer.

In 1825 another case presented itself to the observation of this English physician. This time the transfusion was well indicated. It was a uterine haemorrhage. The patient was in a desperate state. Despite his great confidence in the transfusion, Blundell tells us, he no longer hoped. He ventured, however, to attempt this great means. (18)

The first time he injected 4 ounces of blood; the patient gradually recovered from her syncope. He again gave two injections of the same amount and was successful.

Emboldened by this first attempt, Blundell, convinced that he had a heroic remedy in these extreme cases, again had the opportunity to perform the same operation twice in 1826 (19) and in 1827 (20). He was careful not to miss it, and he again saved one of his patients.

These successes obtained, and the facts and circumstances of which could be ascertained, were to ensure the triumph of transfusion. Mr. Milne-Edwards had already taken the part of the proscribed operation with conviction, in his thesis of 1823. Their eyes were opened, and from then on all physiologists held honour to study the question, and to experiment in turn.

Also, after Blundell and Mr. Milne-Edwards, Prévost and Dumas, Bichat, Nysten, Larrey, Magendie, Dupuytren, Dieffenbach, Bischoff, Brown-Séquard, and a host of other scientists of the first merit, deal with transfusion, and each adds some facts to the facts already known, so as to ensure a certain place for transfusion in therapy. In the second rank we can cite the research of Tardy, Doubleday, Brigham, Swel, Reng, Roux, Rosa, Brown, Klett, Bauner, Furner, Olivier, Ashwel. I quote all these names to prove the importance that has been attached to this issue. We will find moreover a certain number of them in the observations that we reserve to quote. Today progress continues; physiologists devote their finest pages to it, therapists are careful not to forget the advantage that can be drawn from it when all else is lacking. Quote men such as Messrs. Claude Bernard, Longet, Grisolle, Malgaigne, Nélaton, Velpeau, that is to say that there was a truth to be added to so many other truths, a progress to be made finally: as we will see, progress has been made.

Art. III. - Main deductions from animal experiments since 1818

Before reproducing in some detail the perfectly authentic transfusion operations that have been performed in humans, it is interesting to take a look, but a quick glance, at the main deductions, which we have been able to draw from experiments in animals: this order was the logical order of facts; it will be the order of our narration.

According to the experiments of Bichat, Dower, Blundell, transfusion succeeds when it is practiced on an animal with the blood of an animal of a related species; and already the experiments of Lower, of Denys, had shown that the blood of calves and lambs could be used without danger in man. These facts, which we will hardly be tempted to imitate, nevertheless prove that, if we interpret everything correctly, blood transfusion is not dangerous in itself, and that the abuses that have been made of it have alone compromised it.

One of these more interesting experiments is the one Blundell noted in his 10th observation. (21) A dog, which he rendered bloodless, remained five minutes without breathing at all; he performed the transfusion after that time, and he brought this dog back to life, when he no longer counted on success at all, after such a relatively long time. This experience, of which we will discuss later, proves that life is maintained for some time in a latent state, when it no longer manifests itself by any function; and

that the nervous system is able to be impressed again if the blood is returned to the circulatory system, before the nervous system has undergone any significant changes.

The English surgeon's memoir ends with the account of experiences, which can be divided into three series:

FIRST SERIES: Arterial blood was transfused into dogs which had suffered severe haemorrhage, and which appeared to be in a state of near death. Soon the heart's movements recovered, and the animal came back to life. Blundell points out that to achieve this result *it always took a much smaller amount of blood than the animal lost.*

SECOND SERIES: *Transfusion of arterial blood from an animal into the veins of the same animal*. The result was almost instantaneous: the animal came back to life.

THIRD SERIES: *Transfusion of human blood into the veins of the dog*. After giving three dogs a fairly large amount of blood, Blundell transfused them with human blood. Immediately after the operation, the animal appeared to revive, but soon succumbed.

The experiments that I have just mentioned are not the only ones that have been made by the English surgeon; in fact, he reports others in which he sought to establish what would happen if the blood were allowed to stay for a certain time in the vessel intended to receive it, before injecting it into the veins of an animal, and moreover, by borrowing blood from an animal of another species.

Thus, human blood, having spent *thirty to sixty seconds* in a vessel, was introduced into the veins of several dogs; *they all died*, either immediately after the operation, or some time after, or after several days. These experiments, already attempted by Mr. Goodrige of Barbados and by Dr. Leacock, had given them the same results.

Blundell, fearing that the introduction of blood would allow air to enter the vessels, and fearing the presence of this gas, investigated whether it could not be endured at a low dose without compromising life. For this he made a few experiments, *from which he concludes that air, if there is not too great a quantity in one of the veins, can be endured without disturbing the functions of the animal in a sensitive way*.

All the experiments reported so far have been made with arterial blood; it was important to see if venous blood would produce the same results. Blundell's research has taught him that venous blood from humans, introduced into animals, does not bring back life any better than arterial blood.

Blundell concludes from these experiments that transfusion of blood into the veins of a human creature can produce the most beneficial results.

Blundell's experiments, in somehow resuscitating the transfusion of blood, were not to be lost. As we have seen, during the first period from 1665 to 1668, the surgeons of all countries deal seriously with this question, so the example given by the English surgeon had to be followed. It was, in fact, and important works soon appeared.

In 1821, Messrs. Prévost and Dumas published a memoir entitled: *Examin du sang et de son action sur les phenomenes de la vie*. [Review of blood and its action on the phenomena of life] We see, in this memoir, that when one bleeds an animal to the point of syncope, when all muscular movement is abolished, when the actions of the heart and of the respiration remain suspended for a few minutes, it is certain that life is for ever extinct within him.

If one then injects water or blood serum into the veins of this animal, death does no less happen. But if blood from an animal of the same species is injected into its veins, each portion injected somewhat revives this species of corpse, and it is not

without great astonishment that we soon see it breathing freely, moving with ease and recovering completely. If we inject blood of a different species, but whose globules are of the same shape, the animal eventually dies after a few days.

If we inject blood with circular globules into a bird, the animal dies in the midst of very intense nervous accidents, absolutely as if a very violent poison had been passed through its veins. It is essential to note that, in these experiments, these scientists acted sometimes with defibrinated blood, sometimes with non-defibrinated blood. Despite the results obtained by these scientists, their conclusion was that transfusion in humans should be postponed until the time when the active principles of the blood would be better known (22).

Messrs. Prévost and Dumas have observed that, when blood of a different species is injected into an animal, the globules of which are of the same form, but of different size, the animal dies after some time.

Animals subjected to these tests present the following phenomena: the pulse is faster, respiration retains its normal state, but the heat is lowered with remarkable rapidity when it is not maintained artificially. These observations apply to the injection of fresh blood, as to that of blood drawn for twelve and even twenty-four hours, when it has been defibrinated.

Four years later (1835-1838), Bischoff carried out a series of experiments whose results, for science, were these important facts: that the red globules are the revivifying principles of the blood; that blood can only be usefully employed from one species to the same species, but that, however, blood of a different species poisons only when venous and not arterial blood is used. Bischoff presumes, without asserting it, that in these cases the poisoning is due to the scum mixed with clots in the venous blood. (23)

Brown-Séquard's many experiments, published in 1855 and 1857, shed new light on this interesting question of transfusion. These experiments of the eminent physiologist demonstrated that the efficiency of the blood employed depends on the quantity and the nature of the gases that it contains; that venous blood has the same revitalizing force as arterial blood, if it is made red by the introduction of oxygen, or if it is injected slowly enough to allow it to decarbonise in the lungs; that on the contrary, arterial blood acts as a poison, if it is changed into venous blood, under the influence of carbonic acid; that it is then that intoxication and death may be produced in the midst of very violent nervous accidents, provoked principally by the deleterious action of carbonic acid (24).

In 1823, Mr. Milne-Edwards, after having himself made numerous experiments in animals, argued before the Faculty of Medicine of Paris, that, in certain definite cases, the transfusion of blood could and should be introduced in surgical practice. (25)

This scientist thinks that, in haemorrhages, death is mainly determined by the subtraction of the blood cells. But he mainly treats the question as a zoologist. He establishes that the blood foreign to the organism is all the less able to fulfil its function, since the animal, from which it comes is in a degree of zoological kinship; more distant from the one in which it is transfused. He cites, in support of his opinion, the experiments of Bischoff, who saw frogs perish when the blood of mammals or birds was introduced into their veins, while the blood of fish did little harm to them.

On the other hand, in an experiment which Mr. Milne Edwards made with Mr. Delafond, a donkey was bled to the point of being rendered almost bloodless. A fairly large quantity of horse blood was injected into his veins; not only did the donkey revive, but he made a permanent recovery.

In 1830, a memoir by Dieffenbach appeared. The best summary that we can make of this memoir is to quote its conclusions:

1. An animal depleted of blood, can be brought back to life by the blood of an animal of its kind, and continue to enjoy perfect health.
2. When the blood comes from different species, it can sometimes produce signs of revitalization; but he can never keep life.
3. If, to effect the transfusion, we use the blood of an animal of a very different species, death is always the result, even when the quantity injected is very small.
4. A prior bleeding makes mammals less sensitive to the deleterious action of the blood of birds or cold-blooded animals.
5. The injection of the blood of mammals or fish always kills birds, and death is always accompanied by accidents similar to those produced by narcotic poisons.
6. If, after the injection of foreign blood, the animal experiences strong evacuations by vomiting, stool or urine, this sort of crisis usually lessens the danger.
7. Blood, exposed to the air for a long time, loses its revitalizing properties only when it begins to decompose; but when putrefied it produces the same effects as any other putrefactive animal substance.
8. Neither age, nor sex, nor the different states of the body, determine any change in the action of the transfused blood.
9. Transfusion does not always transmit diseases.
10. Venous blood is the one that is best suited for this operation.
11. Transfusion, even with blood from animals of the same species, is always dangerous, and more so than some physiologists have thought. As to its use as a therapeutic means, this operation seems indicated in the case of imminent death by haemorrhage, and only when all the other resources of the art have been employed uselessly; but one should never use only human venous blood.

Some authors of educational works have, since 1830, devoted important chapters to the study of the question that concerns us.

Mr. Bérard does not want to defibrinate blood, because the beating cannot be done without altering the blood cells. He advises the operation mainly after puerperal haemorrhages. He draws the attention of doctors to this operation, too neglected in his opinion.

In 1838, Magendie dealt with transfusion in his *Leçons sur le sang*, volume IV, page 181. He does not doubt that, in certain cases, medicine can take advantage of it. But we must be careful not, he says, to use defibrinated blood.

And he proves his assertions by experiments; he injects 300 grams of human blood serum into the veins of an adult dog. This dog died within twenty-four hours. He repeated the same experiment with blood serum, taken from a dog of the same breed as that into whose veins the injection was being given: death nevertheless came after the same time. These facts are important; they explain to us how partial transfusions of serum, practiced in humans to fight against cholera, should not be more successful. On the other hand, the learned physiologist injected the blood of 15 frogs into the veins of a dog, and he did not feel any trouble.

As for the operations of transfusion by blood in kind, Magendie insists on these conditions of success; that the blood should be injected as fresh and as slowly as possible and, as far as possible, protected from contact with air.

Venous blood, says Magendie, is the most suitable for this operation, because it coagulates less quickly than arterial blood; but Magendie finds transfusion a difficult operation, because the blood coagulates very quickly in humans.

His opinion as to the source from which we should borrow the blood is clearly formulated in the following lines:

1. A mammal put into a state of apparent death by the sudden loss of its blood may be resuscitated by the blood of a mammal of another species; but he always ends up succumbing a few days later.

2. A mammal put into a state of apparent death by the sudden loss of its blood can not only be revived, but it can be kept alive indefinitely, by the transfusion of blood from a mammal of the same species.

Art. IV: - Experiments with defibrinated blood in animals

It was very important to know what the transfusion of defibrinated blood would produce in animals. I have made a certain number of experiments in that direction; but I prefer to quote the experiments that Magendie made publicly in his course of 1837: I arrived at absolutely the same conclusions.

I borrow from the famous French physiologist the following passage, drawn from his lessons on the phenomena of life: “Dieffenbach, wishing to rehabilitate blood transfusion, had recommended extracting fibrin in order to prevent obstruction of the capillaries. A few months ago such a process would have seemed very rational to me. Today my experiences have taught me that it is no longer suitable: if we remove the fibrin, the animal must inevitably succumb."

Experience of 17th February 1837. "The jugular vein of a dog, exposed and opened, 8 ounces of blood was taken out, collected and beaten to remove the fibrin, which was deposited on the rod in yellowish filaments. The blood was filtered through a fine cloth, and then injected back into the vein. The animal seemed worried; he went to bed, refused food, and made efforts to vomit. He gradually weakened, his breathing became difficult, and he died the evening after the second injection.

At the autopsy, carried out twelve hours later, we have already observed a most fetid odour of putrefaction, as we find in all diseases that result from an alteration of the blood, and which the ancients called putrid. This dog died because the viscosity of his blood being reduced, this blood could not circulate in its channels: its serous part was extravasated in the lung, through the walls of the capillaries.

These are the lesions observed at the autopsy: the blood, which remains in the vessels and the heart, is not coagulated, but it has retained a remarkable fluidity. The hepatized lung is no longer permeable: the pleural cavity contains reddish serosity, and the abdominal cavity a notable quantity of citrus fluid. So the fact is clear: the serum and the colouring matter have transuded by imbibition.

Do not the pulmonary infatuations that occur during the course of the fevers called typhoids depend on such a change in the viscosity of the blood? I insist on this fact, because it seems to me rich in therapeutic applications?”

In his public lesson of 24th February 1837, Magendie repeated the same experience. He reproduced it again in the lesson of 1st March of the same year.

On 21st June 1837, continuing the same research, Magendie expresses himself thus: “Having wanted to remove from the blood the faculty that it enjoys of becoming en masse, we have subtracted the fibrin. The same experiment, repeated a number of times on various animals has always given us the same results: the animal always died, and all the more quickly the less normal blood remains.

Defibrinated blood can no longer move in the vessels: the serum passes through them by imbibition, it forms congestions and extravasations, mainly in the lungs, and it quickly brings about asphyxia and death.

Thus the same substance which solidifies when it is outside the vessels, but which is liquid inside them, fibrin, gives the blood the wonderful viscosity to travel through the finest capillaries; and it is interesting to know that this coagulable blood alone is suitable for sustaining life: its very viscosity is precisely what makes it circulate.”

These conclusive experiments of Magendie make it clear to us that transfusion with defibrinated blood could never succeed in humans. We will soon see that indeed it has always failed – because we will have to come back to this crucial point.

Poiseuille says that blood slows down its course through capillaries as it becomes depleted of fibrin. We see that this author is in perfect agreement with the previous one.

Art. V. - Temperature to be given to blood for transfusion

Mr. Nicolas-Duranty (Paris thesis 1860) related experiences that it is just and useful to mention, and which Mr. Oré, from Bordeaux, reported in the good memoir he published in 1868; it is from the latter that I borrow the following lines:

I am talking about the temperature that the blood that is used for the transfusion must have.

After indicating the experiences of Hunter, Scudamore, Blundell, Davy, he reports his own experiences, the conclusion of which can be formulated as follows: *The cold, far from producing coagulation of blood, seems on the contrary to prevent it, and when we want to attempt transfusion, we will now know that, to keep it liquid, the best is to cool the vessel and the syringe* (p. 39).

This opinion had already been formulated by Professor Malgaigne, in his *Traité d'anatomie chirurgicale*. (26)

Here, moreover, are the experiments on which M. Nicolas bases this opinion: In a large rabbit, the carotid artery was opened and blood was allowed to flow until the heartbeat and respiratory movements stopped. The temperature was considerably lowered, the pupils were dilated; the animal had lost sixty cubic centimetres of blood.

Six minutes after the end of the haemorrhage, he injected into the jugular vein *ten cubic centimetres of arterial blood* taken from another rabbit, and brought to a temperature of *eight degrees centigrade*.

The injection lasted five minutes. Two minutes after the operation, some slow and weak breathing movements, and a slight tremor in the precordial region occurred. After six minutes, the animal is untied and walks with difficulty. The temperature remains low, the heart beats weakly. Twelve minutes later, the heartbeat is still weak, but it is rushed. After thirty minutes, these beats are very sensitive, less precipitous, but closer to the normal type; finally, an hour and a half after the operation, the animal walks and takes food; the respiratory movements, the circulation, the temperature, are in the normal state.

In a second experiment performed on a rabbit, the animal lost fifty-five cubic centimetres of blood. Mr. Nicolas injected it with ten cubic centimetres at *eight degrees centigrade*. The phenomena indicated in the preceding experiment manifested themselves again, and two hours after the operation the functions of life were performed regularly. The animal was quite lively; it would take food and flee when approached.

In a third experiment, after removing fifty cubic centimetres of blood from a rabbit, Mr. Nicolas injected it with *ten cubic centimetres of arterial blood, at nine degrees centigrade*. Twenty minutes after the operation, the heartbeat that had stopped, as well as the respiratory movements, were in the normal state.

These three experiences are of great interest; they show *that there is no need for the blood to have the same temperature as the body*, so that coagulation to be delayed.

In the second place, they show that, in three animals from which *fifty cubic centimetres have been removed*, it only took *ten cubic centimetres to bring back life*, after an hour and a half or two hours, or twenty minutes, when one experimented with arterial blood.

Art. VI: - Conclusions of the previous experiments

Transfusion operations carried out from the most remote times to the present day, either as an experiment or as a means of bringing a sick person back to life, a certain number of facts acquired in science have emerged. These facts, we will present them in the form of propositions, which seem to us to summarize the physiological knowledge acquired to date, on this important question:

1. That when an animal has been reduced to a state close to death, following a considerable loss of blood, it can be immediately brought back to life by transfusion (Richard Lower, Denys, Blundell, Bischoff, etc.) blood borrowed from an animal of the same species.
2. That the quantity of blood necessary to produce this result is *always much less than that which the animal has lost*.
3. That arterial blood and venous blood both possess the ability to revive the animal, but their action is different: the first, the red blood, gives the tissues *the ability to act, the power*; the second increases *the action and uses this power* (Brown-Séquard).
4. The transfusion, to be successful, must be made with blood belonging to animals of the same class, but especially of the same species; for as Blundell has shown, like all experimenters, that the blood of the dog revives the dog, he has also proved that human blood does not have this property; for all animals, except man who received it in their veins, quickly succumbed.
5. If an animal of one class is injected with blood taken from an animal of another class (mammals and birds), it succumbs almost immediately, presenting phenomena which offer a great deal of analogy with those of poisoning (Bischoff);
6. That the cold retards the coagulation of the blood.
7. The accidents produced by the transfusion of the blood of an animal into the veins of an animal of a different species are not due to a toxic action of the fibrin, as Bischoff wanted, but to a mechanical obstacle, brought into the circulation by the coagulation of this substance (Oré).
8. Blood does not lose its regenerative properties by its contact with air, or by its passage through an inert tube (Blundell, Dieffenbach).
9. The regenerating principle of the blood is neither serum nor fibrin, but it resides in the blood cells (Dumas and Prévost).
10. The penetration of air into the veins is an accident which can be fatal.
11. Immediate transfusion, by means of special devices, protects from contact with air and from accidents that may result from the introduction of this gas into the veins, at the same time as it makes it possible not to fear coagulation of fibrin. It should therefore be preferred to mediate transfusion (Oré). We will see later that, for his immediate transfusion experiments, Mr. Oré used the Moncoq apparatus. (27)

Mr. Nicolas-Duranty, whom we named a little earlier, arrived for his part, at the following conclusions:

1. That the blood of cold-blooded animals is very injurious to mammals.
2. That, in all cases, birds are killed by the injection into their veins of venous blood from mammals.
3. That the injection of the arterial blood of mammals into the veins of birds produces considerable accidents, but which are not always fatal;
4. An animal which has undergone a severe haemorrhage succumbs when the blood of an animal of another species is transfused to it.
5. An animal, which has undergone only a slight haemorrhage, may not succumb if it is transfused with a small quantity of blood from an animal of another species.

In spite of all the interest that physiological experiments deserve, which made it possible to arrive at such important conclusions, we did not want to report too many of them, so as not to tire the reader. We have repeated much of these experiences ourselves, and we have come to the same general conclusions. We will moreover be obliged to recall some of them later. What we have just said suffices for the practical purpose that we have specifically proposed; but, on the other hand, all the above was necessary to inform our progress towards transfusion in humans.

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