DE LA TRANSFUSION DU SANG

By: Dr CHARLES MARMONIER

A TRANSLATION BY PHIL LEAROYD

A copy of this 164 page book titled 'Of Blood Transfusion' by Dr. Charles Marmonier, published in 1869 in Paris (by V. Masson & Sons) can be viewed or downloaded from the following site:

https://books.google.co.uk/books/about/De_la_transfusion_du_sang.html?id=bIc-AAAAIAAJ&redir_esc=y

This is essentially a 'practically orientated' book, which although frequently referencing the published research work performed on a variety of theoretical and practical aspects of blood transfusion, the author consistently comments on their relevance in relation to a doctor having to perform a transfusion outside the confines of a hospital environment. This is exemplified by the fact that he chooses to give 'personal details' of a transfusion performed by his father Dr. Marmonier (Sr) in 1851, which provides a graphic and somewhat heartfelt description of transfusing a woman who was dying from an uncontrollable uterine haemorrhage following childbirth.

Within the introduction the author in fact states that his objectives are to identify that transfusion is not an 'exceptional operation' which has fewer dangers and difficulties than generally imagined and that it has indications relevant to everyday clinical practice. He defines the purpose of transfusion simply as being "to remedy an alteration in the quantity or quality of the blood in a sick individual".

The scope of this book is wide ranging – as can be seen from the contents list reproduced below. It includes an extensive set of tables that contain the details of 192 blood transfusion events collected together by the author. Of these events, it can be identified that transfusion has been performed the greatest number of times and with the greatest success related to the treatment of puerperal metrorrhagia. Via the information compiled within these tables, Marmonier examines in some detail when transfusion has been used in the past and how successful it has been; discussing and comparing how transfusion has been stated to have prolonged life compared with actually curing the patient – the latter being related broadly to traumatic haemorrhages.

The history section is stated to be 'selective to relevance' and identifies how transfusion has been denigrated, rejected and condemned because, as the author puts it, early transfusion experiments appeared to indicates a 'secret of life', claiming to cure diseases and to even have the ability to lengthen a person's lifespan – exemplifying that transfusions without specific rules or precise indications had many failures. The history section ends with an extensive bibliographical index (produced by date and reproduced below as printed).

Marmonier examines in detail both the physiological as well as the practical considerations relating to blood transfusions, including such topics as species incompatibility between donor and patient; the use of venous compared with arterial blood; the advantages and disadvantages of transfusing natural compared with defibrinated blood together with information available at the time relating to what causes coagulation (and how it can be delayed / avoided).

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 original paragraph settings and general layout of the text including the author’s use of italics. The spelling of the names of people is reproduced as originally printed. Not all details of the cases provided in the tables are able to be included as written within my translated text, but the tables reproduced below contain the essential information the author originally provided. The references within the book are provided at the bottom of the individual relevant pages. I have sequentially renumbered these and placed them all (as originally written) at the end of the translated text.

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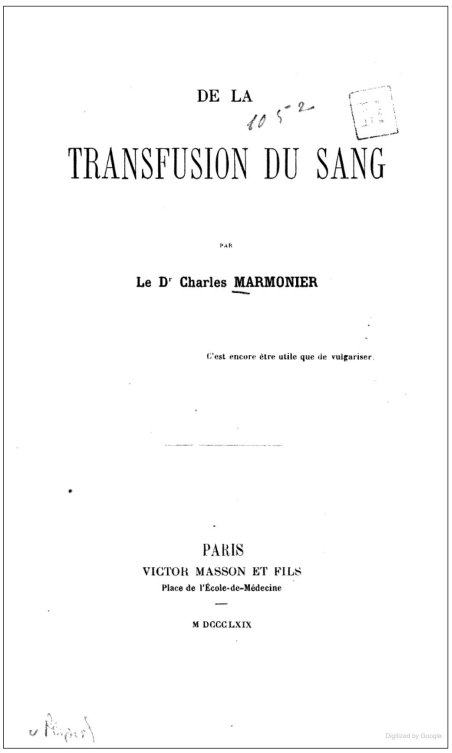

DE LA

TRANSFUSION DU SANG

PAR

Le Dr Charles MARMONIER

C'est encore être utile que de vulgariser.

PARIS
VICTOR MASSON ET FILS
Place de l'École-de-Médecine

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Title-page: De la transfusion du sang (1869)
(Image credit: Google Books)

FOREWORD

Although it is generally agreed that the forewords are seldom read, it is advisable, I think, before entering upon the study of the transfusion of blood, to briefly set forth the reasons which have led me to study this question thoroughly, the practical spirit which has presided over my researches and the writing of this work, the object which I pursue, and the plan I laid out for myself.

During the course of my medical studies, I had the rare pleasure of being present at a transfusion operation performed at Montpellier by Professor Courty. The immediate results of this operation produced such an impression on my mind, that from that moment I devoted myself in a very special manner to the study of this question, and with all the more ardour as the recent experiments of learned physiologists gave it a certain topicality.

The author of this work is therefore not only a man who has read, but also a man who has seen and observed at close quarters.

Besides, apart from the foregoing considerations, an equally powerful reason, or at least a sentiment which will be found legitimate, induced me to study the question of transfusion in a special manner.

Son of a physician who, since the judgment of 1668, was one of the first to practice transfusion in France with complete success, and of whom it has recently been said that "he had contributed to restore transfusion to honour"[1] I had more than once the opportunity of practical reflections, and of guarding myself early against the discouragement that might have seized me in approaching a subject so full of difficulties.

This is why, while I hope to present as complete a work as possible, I have nevertheless borrowed from history only what is most interesting to know, from physiology only what is essential to know; but I have chiefly endeavoured, as far as it was in my power to do so, to specify, from the numerous observations which I have collected, the indications for transfusion and the various processes by which this operation can most easily be practised at the present time.

I am not a proponent of any system; I do not base myself on hypothetical theories, but only on what experience alone has shown.

I have had no other aim, in producing this work, than to seek to spread the study of transfusion, in order to make it more practically practised. If I succeed in showing that it is wrong to regard it as an exceptional operation, that it offers fewer dangers and difficulties than is generally imagined, that it finds its indications every day in practice, and if I can, in my small part, contribute to the generalization of this operation, I shall believe that I have attained the object of my efforts. I shall at least have justified the words at the beginning of this book: *It is still useful to popularize*.

This would be the place to indicate the plan I have adopted. But, in order to avoid unnecessary repetition, I urge the reader to refer to the table of contents, which is so arranged as to enable him to embrace at a glance the divisions of this work.

At the end of the History section will be found a Bibliographical Index, which I have only succeeded in creating after long and arduous labours. In doing so, I have filled one of the important gaps in the literature on transfusion. I thought I might thus facilitate the study of this question by those who wish to deal with it after me, and save them the burden of such laborious researches.

BLOOD TRANSFUSION

Blood transfusion is an operation that involves passing blood from one individual's vessels into another individual's vessels.

Transfusion is *immediate* when blood passes directly from one vessel to another, without coming into contact with the outside air; it is *mediate* when the blood which is to be injected is obliged to remain for some time outside the vessels from which it is extracted, and is in direct contact with the outside air.

The purpose of transfusion is, in short, to remedy an alteration in the quantity or quality of the blood of a sick individual.

This operation, which at first sight seems to be out of the ordinary ways of surgery, is of interest to both the physician and the surgeon, the scientist and the practitioner; it belongs at the same time to the domain of physiology and therapeutics: these are all reasons which may already indicate the importance of our subject.

FIRST PART
HISTORICAL

It is above all of transfusion that we can say, in the words of Bordeu: "History not only tells, but it teaches."

As soon as it was discovered, this operation, which was greeted by all minds with frenzied enthusiasm, was almost immediately denigrated, rejected, and condemned. It is subject to the law common to most of all the great conceptions of the human mind, and after a long oblivion it has at last returned to take the place in science which its importance and usefulness, now unquestionable, assured it.

I thought it might be interesting for some of you to know the circumstances under which transfusion originated, the struggles it had to sustain, the work to which it has been subjected up to now; and I have given a summary of it, brief it is true, but as complete as possible.

I will begin by saying what I have learned from my researches concerning the idea which the ancients had of transfusion; then I shall examine the various periods during which, directed from the beginning by blind empiricism, it then proceeds only guided by the principles of experimental physiology.

I. TRANSFUSION AMONG THE ANCIENTS

The idea of transfusion, if the authors are to be believed, dates back to the earliest antiquity.

It appears in the *Book of Wisdom* of Tanaquilla, wife of Tarquinius the Elder; in Herophylus' *Treatise on Anatomy*.[(2)]

Pliny and Celsus condemn it in their works.

Ovid mentions it in his poems, and places these words in the mouth of Medea, in reply to the daughters of Pellias, who begged him to restore to their father his youth and his former courage:

..... Veteremque haurite cruorem
Ut repleam vacuas juvenili sanguine venas!
(*Metamorphoses*, liv. VII.)

This idea still appears in the writings of Fabrice d'Aquapendente.

But this is just data lost in the mists of time.

Earlier writings would seem to indicate that transfusion was performed before the time to which its origin is generally attributed. Thus we read in Villari's *Life of Jerome Savonarola* this fact mentioned by Sismondi:

"In his last illness, Pope Innocent VIII allowed himself to be persuaded by a Jewish physician to try the remedy of blood transfusion, which until then had only been experimented on animals. Then they exchanged the blood of the old and feeble pontiff for that of a young man. Three times the experiment was repeated, and three times the experiment cost the life of a young man, for air had probably entered the vessels of the latter. The Jewish doctor fled. No results were obtained; the pope died on 25 April 1492"[(3)]

Later, the transfusion was described by Libavius in this sentence, of which I quote only the essential words: "*Adsit juvenis robustus, sanus, sanguine spirituoso plenus; adstet*

exhaustus viribus, vix animam trahens ..... Ex sano sanguis spirituosus saliet in ægrotum, unâque vite fontem afferet, omnemque langorem pellet." But the author adds to make fun of it: "*Sed commodo ille robustus non languescet? Danda ei bona confortantia, et medico vero helleborum*."[4]

Finally, at a more recent period, J. Colle spoke of transfusion as a means of rejuvenating the elderly.[5]

This is all that is known of transfusion before the middle of the seventeenth century, when its true history begins; for it may be said, without wishing to diminish the importance which the foregoing quotations may have, that hitherto this question has not been studied at all. But from the second half of the seventeenth century it was the object of serious work, which, though interrupted for some time, was afterwards resumed with renewed vigour, and attracted the attention of scholars throughout Europe.

From that time to the present day, the history of transfusion can be divided into three distinct periods, which will be successively reviewed.

II. TRANSFUSION AMONG THE MODERNS

The three periods into which the history of transfusion in modern times is generally divided extend:

The first, from the year 1656 to 1668, when a judgment of the Châtelet forbade the practice of this operation in France;

The second, from 1668 to 1818: a period of oblivion;

The third, from 1818, when Blundell published an important memoir, to the present day, a truly scientific period.

First period. - The idea of injecting the blood vessels, in order to be able to study their ramifications more easily, led to the other idea of injecting drug agents into these same vessels for therapeutic purposes. From these latter experiments to the transfusion of blood, there was but one step.

In 1650, a certain Dom Robert des Gabets, a French Benedictine monk, delivered a speech on transfusion in an assembly;[6] but what value could his words have?

Although Major[7] claimed to be the inventor of transfusion, it was Christopher Wren, professor at the University of Oxford, who first spoke of it, in 1656, in his public lectures; and Richard Lower was the first to practise it on animals.[8] His attempts, crowned with complete success, were taken up by Robert Boyle,[9] by Fracassati,[10] by Riva,[11] and many others, who also obtained favourable results.

These experiments had a great impact. Science believed that it had discovered the secret of life: it is easy to imagine how passionate the minds were for this discovery, and how anxious they were to know what would be the result of the transfusion performed on man. Their impatience was soon satisfied.

In 1667, Denys, a physician at the Faculty of Montpellier, with the help of Emmeretz, was the first to perform transfusion on humans in Paris.[12] If the learned professor of Oxford may boast of having been the propagator of this new idea, at least it is to a French surgeon that the honour belongs of having been the first to practise transfusion on man.

Denys had taken three ounces of blood from a young man exhausted by a severe fever, and had injected him with eight ounces of calf's blood: the patient made a full recovery. Further success was achieved by Emmeretz, who injected an adult with sheep's blood; by Richard Lower and Edmond King, who injected ten ounces of sheep's arterial blood into a maniac named Arthur Coga;[13] by Tardy in France;[14] by Cassini (of Bologna); by Griffoni;[15] and by Manfredi.[16]

Denys renewed with the same success the transfusion on a patient to whom he injected twice, a few days apart, ten ounces of blood.[17] I will not speak of a madman or a paralytic, whom he claimed to have cured, nor of so many other cases, the relation of which was of great concern to the minds of men.[18] I will only say that Denys acquired an immense

reputation, and that he was obstinately pursued by envy and jealousy, the inseparable companions of all those who devote themselves with perseverance to the triumph of a new and fruitful idea. The doctors of the Faculty of Paris, to which Denys was a stranger, swore the destruction of the latter, and took advantage of the first failure he suffered to have a decree pronounced by the Court of the Châtelet which forbade any doctor to perform transfusion on men without the approval of a doctor of the Faculty of Paris (17 April 1668).

Now this was the failure which caused the downfall of Denys. He had already performed two transfusions on a poor madman named Mauroy. A few months later, as he was preparing to give him another injection, Mauroy was seized with a general tremor before the transfusion was performed. Denys did not complete the operation. The enemies of the latter had won over Mauroy's wife, that she might poison her husband. The latter was, however continued,[19] but the judgment nevertheless remained.

There then arose a very lively controversy between Denys and his adversaries, at the head of whom were Lamy and de la Martiniere, on the details of which I shall not insert.

But we have to admit everything. Transfusion without specific rules or precise indications had many failures. It was used to fight all kinds of diseases. It was performed in Paris on Baron Bond, son of the Prime Minister of State of Sweden, who was suffering from intestinal gangrene. Moreover, it was hoped by transfusion not only to rejuvenate the elderly, but also to act on the morale of an individual, to tame his hot-tempered character by injecting him with lamb's blood, or to make him courageous by transfusing him with lion's blood.

It is not surprising, therefore, that the transfusion, so badly directed, then gave disastrous results. And it may be supposed that the abuse which was made of this operation contributed not a little to induce the court of the Châtelet to pronounce its decree of proscription, and that the failure obtained by Denys was for it only a pretext.

Be that as it may, the successes of transfusion were forgotten and only the unfortunate cases in which it had been powerless to hold back a life already doomed. And this operation was all the more quickly decried and forgotten, because it had enjoyed greater and more rapid favour.

Second period. - The effervescence of the spirits was succeeded by a considerable torpor. During the long space of time which constitutes this second period of the history of transfusion, it is only at rare intervals that we see the appearance of a few writings which prove that this question had not fallen into complete oblivion.

Shortly after the Châtelet shutdown, Richard Lower wrote about it in his book on the heart.[20] Manfredi had another success, in 1670; but as a result of a failure obtained by Riva, the court of Rome, in 1679, also proscribed transfusion in Italy.

Despite these successive attacks, the transfusion still had supporters. Without mentioning Merklin,[21] Nück (1714), Rosa of Modena (1783), Purmann,[22] Darwin,[23] I will come to more recent and better known names. Claude Perrault, who spoke to the Paris Academy of Sciences about it, Paul Scheele,[24] Bichat[25] and Portal, Hufeland[26] and Leacock.[27]

But it was not until after the appearance of Blundell's memoir that transfusion saw the opening of a new era for her, and one which was to be more fruitful in results. It is only from this period that its truly scientific history dates.

Third period. - It belonged to an experiment, directed by sound notions of physiology, to raise the profile of transfusion in public opinion, and to establish it on a solid foundation.

It was Blundell who, in 1818, rescued the transfusion from the long oblivion in which it had been left. His animal experiments carried out methodically and with that spirit of observation which distinguished him, were such as to encourage him. Therefore he was not slow to apply the fruit of his observations to man. In 1819 he was the first to perform human-to-human transfusion. His important memoir was followed by other no less important writings by Prévost and Dumas (1821) in Switzerland, Dieffenbach (1828) in Germany, and many others, a fairly complete list of which will be found below. Since, in the course of this work, I shall have occasion to quote them, to relate the principal experiments, and to relate

their conclusions, I have been obliged, in order to avoid useless repetition, to yield to my original intention, which was to analyse them here briefly.

In France, transfusion had fallen into complete disrepute, in spite of the efforts of Mr. Milne Edwards, who, in 1823, demonstrated the usefulness of this operation in combating haemorrhage, and requested that it might resume its place in practice. Two unfortunate attempts in 1830[(28)] and 1831[(29)] contributed to aggravate this situation. Transfusion enjoyed such disfavour that a legal action was brought, only a few years ago, against an honourable doctor of the south of France who had performed transfusion without a happy result.[(30)]

But the temporary success obtained by Mr. Nélaton in 1850 began to draw attention again to this question, which had been too long neglected, and on which, it must be confessed, foreign work had already thrown a new light. A few weeks later, a new case of transfusion, "which caused a real sensation"[(31)] and was due to Mr. Marmonier senior (of Isère), helped to strengthen many convictions that were still tottering.

The example set by Mr. Marmonier soon bore fruit, and shortly afterwards Messrs. Devay and Desgranges (of Lyons) published a new observation of transfusion also practised with complete success. From then on, transfusion was generally regarded as an operation that had to be put into practice. In spite of this, it is still a few years before work on transfusion appears in France, and we are forced to admit that the study of this question has tempted German and English doctors much more than French doctors.

If one reads the authors who wrote in France before 1850, one has reason to be surprised at the unfavourable judgment they give on transfusion. But since the first successes obtained, a fortunate change has gradually taken place in the minds of the people, and although Messrs. Alphonse Guérin[(32)] and Chassaignac[(33)] are still almost opposed to it, one cannot help noticing a growing progress in perusing the recent treatises on physiology and the treatises on childbirth, with the exception of that of Mr. Joulin, who only talks about transfusion for the sake of mentioning it. Finally, by adding that Messrs. Cl. Bernard, Brown-Séquard, Longet, and Ch. Rouget have devoted several lessons in their learned courses to treating especially of the transfusion of blood, this is enough to show how important this question has recently become, and how worthy of its study is.

To complete this first part of my work, it remains for me to indicate the important work to which transfusion has been subjected.

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The restricted limits within which I have wished to confine this work, do not permit me to relate with all the details which accompany their relation in the works in which they have been published, all the observations which I have collected.

To describe one of them will be to describe them all. This is because the most recent transfusion operations are similar to those performed a few years ago. There may be some difference in the quantity of blood injected into the apparatus used; but the symptoms that the patient presents before and after the operation, the operating manual, which basically boils down to transfusing the blood, whether in a mediate or immediate manner, are more or less the same. I thought that to present here with all its details an observation of transfusion would be to avoid a reproach which might have been addressed to this work. Which one to mention? Each also commends itself by the skill with which the operation has been conducted. In choosing, among all others, the observation made by Dr. Marmonier senior, I will be forgiven for having been guided by a sentiment which will be understood, and which finds its excuse (if it needs to be excused) in its very origin. I am merely following the course adopted in their pamphlets by Messrs. Ed. Martin and Belina, placing before all others a fact which was more or less personal to them.

I will leave the floor to the author of the operation himself.

On the 3rd of January, 1851, at six o'clock in the morning, I was called to give birth to the woman Mallet (from Lancey, canton of Domène, Isère), about thirty years of age, with a lymphatic constitution, a little weakened by several pregnancies in close proximity, by previous laborious deliveries, and by some moral and physical pains.

When I came to this woman, the pains that accompany the labour of childbirth had almost ceased; she was weak and exhausted by long and useless efforts, which had not been able to bring about the expulsion of the child, on account of the existence of a very pronounced anteversion of the womb; I recognized a presentation of the head, and then judged that I could not finish the delivery in this position; I promptly operated the fetus' version and brought it by the feet. At the same time there was a stronger than usual loss of blood, which obliged me to rapidly extract the placenta and excite the contraction of the womb, which was in a rather sensible state of inertia. This manoeuvre was followed by success; after a few moments the loss was stopped, and the patient was well.

I remained with her for three-quarters of an hour; I examined the pulse, which I found good, though a little faint; I examined the matrix, which appeared to be in a satisfactory condition; then I thought I could retire, leaving her in the care of the midwife and her family. I had left her half an hour before, when she experienced an extremely profuse uterine haemorrhage, which was followed by a long fainting; then she regained consciousness and felt a little better; but this improvement was not to be of long duration, for a second haemorrhage, also very abundant, occurred again, and this time left the patient in a longer fainting spell and with greater weakness.

It was at the moment of the first loss that they came back for me; I ran, and when I found myself near her it was about three hours after she gave birth, and an hour and a half after the first heavy discharge. I learned from the midwife and the parents all that had passed

during my absence, and I was able to appreciate for myself, when I saw the patient, the gravity of the situation. This woman, whom several times those present had believed to be dead, was desperately weak, with a deathly pallor; the extremities were cold, the pulse almost insensible and sometimes non-existent; the obscuration of the vision, which existed almost constantly, ceased for a few moments only to recur soon after, and almost always announced the return of a new syncope.

I was a witness for three-quarters of an hour of all the accidents I have just mentioned, and during that time I employed all the means at my disposal to stop a slight loss which still recurred from time to time, and to bring back the heat and circulation ready to be extinguished.

I first made astringent and refrigerant applications to the abdomen; I took advantage of the suspension of the syncopations to make her drink a few sips of concentrated infusion of ergot rye; I administered, when possible, a few spoonfuls of a cordial potion; I rubbed the skin with a brush and wool; I applied heated cloths to the limbs, to the body; every time she fainted, I applied vinegar under her nose, on her lips, etc. I struggled in this way for three-quarters of an hour, without obtaining the slightest improvement; on the contrary, the problem was always getting worse. I foresaw an imminent death, inevitable, in which I believed all the more because a few months before I had seen a neighbour of the patient, the Perrin woman, die four hours after childbirth, from the effects of an absolutely similar haemorrhage.

I was in despair when the idea of transfusion, which had already preoccupied me, appeared to me as the only means of salvation; this idea was suggested to me by what I knew of the operation performed some time before by our learned colleague, Dr. Nélaton.

At that moment, therefore, I decided that I would attempt the transfusion, if there was still time, and if I could speedily assemble the instruments which were indispensable to me, and which I was not equipped with, not having foreseen that I should be obliged to perform such an operation alone, without the assistance of other surgeons.

I found in the house a small child's syringe which I thought I could use, and which might contain 70 grams of blood. I had the hot water, the vases, and the linen prepared, which I supposed I needed; I ascertained the good disposition of the daughter Fagnet, a neighbour of the sick woman, who was willing to consent to give us her blood. All these arrangements having been made, I proceeded with the operation in the following manner:

The right arm of the patient was stretched out on the bed in the supinating position, and was held by a woman only, the state of semi-insensibility in which the woman I was to operate found herself requiring no further precautions; I made an incision in the basil vein and in its direction of about three centimetres, and then I completely isolated this vein within an area of about two centimetres; I passed a thread carried by a needle under it: this thread was to be used to lift it at will, and to press it slightly on the cannula of the syringe, to prevent the introduction of air at the moment when the syringe was applied.

I made an opening in the vein, in the meaning of its direction, about half an inch, through which only two or three drops of blood came out, which flowed gently, without any perceptible impulse; I caused the vein above and below the opening to be slightly compressed, on the one hand to prevent the introduction of air, on the other to prevent the exit of a few drops of blood; immediately I bled the girl Fagnet. I received the blood in a cup, which was itself in a vessel full of water hot enough to preserve its ordinary heat, which I could only calculate in an approximate manner, having no thermometer at my disposal; I quickly took the syringe, which had been prepared and heated, so as not to alter the state of the blood, and to prevent the presence of air; I filled it exactly with the blood in the cup; I applied the plunger of the syringe, which I pushed slightly, to make sure that there was no air at the end of the cannula; I inserted the end of the cannula into the opening of the vein, on which I tightened the thread slightly; then I slowly and carefully pushed the blood that was in the syringe into the vein. After having made the piston make a third of the way it had to travel for the injection to be complete, a sudden resistance opposed the forward movement which I imparted to the piston, which made me understand that the blood no longer

penetrated, either because it had begun to coagulate, or from some other cause which I could not explain; I was, therefore, obliged to suspend my operation.

In spite of this little success, I decided that I would try a new injection, since the first, though very incomplete, had not produced the slightest accident.

In an instant, the syringe filled with the blood of a new bleed was introduced into the opening of the vein. In this second attempt, I took the precaution of wrapping the syringe in cloths constantly soaked in hot water. This time I was happier: all the blood in the syringe was pushed into the vein, or nearly so.

I estimate that 90 grams of blood I had introduced in two injections.

The introduction of the blood was followed by no accident, no pain, no crisis, of no shock.

I found that, almost immediately after the transfusion, the respiration became more regular, the sensibility more apparent, the pulse became stronger, the disposition to syncope suddenly ceased, and the obscuration of the vision, which had been one of the permanent symptoms, rapidly dissipated. After dressing the little wound made by the introduction of blood, I busied myself with consolidating the best which had so suddenly manifested itself.

I began again the rubbing and the application of heated cloths; I had Ratanhia and ergot rye taken again, and at three-quarters of an hour before the time of the operation, the circulation and heat were restored and continued to develop. Two hours later, the patient was so well that she fell asleep for a few moments, and this sleep was succeeded by an unhoped-for improvement which announced the end of the terrible crisis which had frightened me, as well as the seven or eight persons who constantly attended me.

From that moment on, the convalescence was rapid; the work of secreting milk was done on a regular basis. Ten days later, the patient was able to get up for one hour a day; twenty days later she was completely cured, and thirty days later she had resumed her usual occupations. There was not the slightest trace of phlebitis in the vein through which the blood was introduced; however, there was a slight inflammatory swelling in the vicinity of the wound in the bend of the arm, and the healing was not complete until about the twenty-fifth day.[34]

NOTE. - This woman is still in good health today, August 1869.

"This, simply obtained and simply told," said Messrs. Dechambre and Diday, "is a fine and legitimate success. But there is more than praise to be given to the author for the firm and prudent decision he has shown on this occasion. Above all, his conduct will have the great advantage of inspiring practitioners with a confidence which they lacked. In the eyes of the public, the transfusion of blood, in order to be successful, in order not to be dangerous, required a very special dexterity, a complicated instrumental apparatus, and educated and attentive assistants. Well! seeing it happily performed in the country, by a doctor whose first title to illustration this is, with no other instruments than those in his kit, with no other auxiliaries than inexperienced villagers, the practitioners, we have no doubt, will take courage, and Mr. Marmonier will have deserved better of science than perhaps he himself hoped, by the example at once full of boldness and circumspection which it has been given to him to provide."[35]

SECOND PART
Indications and contraindications for transfusion

CHAPTER ONE

We are a long way from those times when it was claimed that everything could be cured by the transfusion of blood: madness, phthisis, cancer, cutaneous diseases, paralysis, fever, without any discernment, without certain physiological principles; where it was hoped to change the morale of a carried away individual by injecting him with lamb's blood, to make a pusillanimous man courageous by injecting him with lion's blood, to restore to an old man all the vigour of his adolescence by injecting him with blood taken from a robust young man.

Happily, reason and experience soon did justice to these exaggerated hopes, which had been produced by the enthusiasm which had been aroused by the discovery of transfusion.

Therefore we must not take much into consideration those cases which the first transfusions left us, and which they regarded as successes. For it may be questioned whether, under these conditions, they have really cured the patient, and whether the success which they claim to have obtained does not depend on the natural course of the disease or on the treatment following the transfusion.

Before saying in what cases science now believes transfusion to be of unquestionable utility, and those in which this operation, in order to be practised with any chance of success, still needs to be confirmed by experiments, I have thought it necessary to present a general statistic of the observations published up to the present day.

I collected 192 transfusion observations. This number is much higher than that given by even the most recent publications.[36] They will be found later in tables. For the time being, I shall confine myself to indicating in a general way the cases in which transfusion has been carried out up to the present time, and we shall see in a second chapter whether the number of such indications should be further extended or restricted.

The blood transfusion was performed as follows:

94 times in the case of puerperal metrorrhagia:	Outcome Known	Outcome Unknown
Before childbirth	7	2
During	8	4
After	57	20
On the occasion of an accident. Premature	1	-
At the time of abortion in the 3rd month	1	-
At the time of abortion in the 4th month	3	-
At the time of abortion in the 6th month	2	2
At the time of abortion in the 7th month	5	2
In the 3rd month of pregnancy	7	-
In the 8th month of pregnancy	3	3
Sub-total	94	33

24 times in the case of traumatic haemorrhage	Outcome Known	Outcome Unknown
Cubital artery injury	1	-
Arterial haemorrhage – cause unknown	1	1
Rupture of varicose veins in pregnant women	2	-
Haemorrhage of the haemorrhoidal vein	1	-
In the cases of fractures	2	2
From a gunshot wound	1	1
Following the removal of a neck tumour	1	1
Following the maxillary region	1	1
Following epithelioma	1	1
Following a thigh amputation	3	1
Following the forearm	1	-
Following a phimosis operation	1	-
Due to the presence of a nasopharyngeal polyp	1	-
Due to a fibrous uterine polyp	3	-
From a wound	1	-
Following the extirpation of the blood	1	1
Vomit. blood following exercise	1	-
Arterial rupture, consecutive to the suppur.	1	1
Sub-total	24	10

8 times against nervous patients:	Outcome Known	Outcome Unknown
In the case of mania, without result	1	-

In the case of madness	2	1 res.nul.
In the melancholy with terror	1	1
In the erotomania	1	1
In epilepsy	2	1
In puerperal eclampsia	1	-
Sub-total	8	4

16 times against certain blood diseases	Outcome Known	Outcome Unknown
Anaemia	4	2
Essential anaemia	2	1
Purpura haemorrhagica	1	1
Scurvy	1	-
Chlorosis	3	1
Leukocythemia	2	2
Haemophilia	3	2
Sub-total	16	9

19 times against exhaustion – resulting from	Outcome Known	Outcome Unknown
Serious illness (intestinal gangrene)	1	1
Repeated bloodletting	1	-
Vomiting	2	1
Advanced age	1	1
Prolonged stay in bed	1	-
Dysentery, melaena	1	1
Prolonged breastfeeding	1	-
Eating disorder	1	1
Suppuration following injury. Weapons, by fire.	5	5
Suppuration following surgery.	3	2
From acc. and went. successive	1	1
From severe trauma?	1	1
Sub-total	19	14

5 times against organic patients.	Outcome Known	Outcome Unknown
Cancer conditions	2	2
Tuberculosis conditions	3	2
Sub-total	5	4

3 times against pyohemia	3	2
6 times against asphyxiation by coal vapour	6	5
4 times against asphyxia of newborns	4	3
4 times against cholera	4	4
2 times against hydrophobia	4	2
1 time for slow fever	1	-
2 times against puerperal fever	2	2
1 time against typhus	1	1
1 time against leprosy	1	-
8 times against diphtheritis	8	1
1 time against syphilitic laryngeal ulcerations	1	1
Transfusions performed	192	91

Out of 91 failures, it should be noted that:
1°: Some of these failures are independent of the operation itself:

A. Either because an accidental illness has struck the patient who is already recovering; this is what has happened, for example, in the cases listed under the following numbers in the tables at the end of this work.

N° 41. Uterine phlebitis took the patient 7 days later.
N° 56. The patient died of metroperitonitis 7 days later.
N° 67. Death did not occur until 10 days later, as a result of a phlegmon in the posterior part of the arm, on which a hardness had already been felt, a fortnight before the operation.
N° 96. Gangrene took hold of the amputee's stump, and carried off the patient 3 days later.
N° 103. A rapid-progressing pneumonia, which was found at autopsy, took the patient away 5 days later.
N° 115. Death did not occur until two days later, and was the result of pyohemia, as noted at autopsy, following the extirpation of the tongue invaded by a cancroid.
N° 132. Gangrene had already invaded the intestines when the operation was attempted.
N° 158. The patient was fully recovered when a catarrhal gastrointestinal illness occurred, which took the patient's life 42 days later.
N° 173. The spontaneous contraction of the umbilical ring prevented the blood from entering.

B. Or because the operation was attempted too late, as in the observations bearing the following numbers:

N° 28. The agony had been going on for some time, when the idea of transfusion was considered.
N° 165, 166, 167, 168, 170, 171, 172. In which it is possible to admit that the time which elapsed from the moment when the asphyxia was complete to the moment when the doctor performed the transfusion, was of such a long time as to believe that the return to life was almost impossible.

2°: Some of the cases considered to be unsuccessful are, in the end, favourable results. In fact, as transfusion is generally performed only when death is imminent, we must regard as successes those cases in which, the economy being exhausted by an ancient disease and having left its imprint on the whole system, the transfusion has succeeded in preserving life for a certain time, during which the vital centres could have reacted, if they had retained the strength to do so. These are the following observations:

N° 120. (Haemophilia); life was extended for 4 months;
N° 128. (leukocythemia); His death did not take place until 2 months later;
N° 162. (tuberculosis);
N° 163. (tuberculosis); the death did not take place until 1 month after;
N° 148, 149, 150, 156. (suppuration); death did not take place until 1 month after;
N° 151. (suppuration); The patient survived for five weeks.

3°: Death has not been the result of transfusion in all cases of failure, since it has produced several transiently favourable results; these are the ones found in the following numbers:

N° 71. The transfusion allowed the doctor to complete the delivery quickly.
N° 89. There was a noticeable improvement; death was delayed for 8 days.
N° 108. There was a noticeable improvement; death was delayed for 3 hours.
N° 110. There was a noticeable improvement; death was delayed for 10 hours.
N° 39. There was a noticeable improvement; death was delayed for 1 hour.
N° 79. There was a noticeable improvement; death was delayed for 2 hours.
N° 121. Death was delayed for a few hours.
N° 123. Death was delayed for 48 hours.
N° 124. Death was delayed for 5 days.
N° 125. Death was delayed for 16 days.

N° 142. Death was delayed by 15 hours.
N° 145. Death was delayed by 20 hours.
N° 147. Death was delayed by 12 hours.
N° 166. Death was delayed by 13 hours.
N° 168. Death was delayed by 8 hours.
N° 185. Death was delayed for 2 days

4°: Many of the failures are due to the fact that, the patient having returned to feeling by means of the transfusion, there has been a relapse or recurrence of the same accidents; this can be seen in the following: Nos. 72, 80, 92, 117, 177.

5°: A fatal result has been deplored almost every time a man has been injected with blood from an animal: Nos. 116, 132, 133, 134, 141, 142, 143, 153, 161, 180 and 181.

6º: The same consideration must be made for cases in which the injected blood was mixed with a saline substance: Nos. 71, 88, 89, 90.

7º: The fatal result of observation 152 has been attributed to the fact that the injected blood had been taken from a sick man (gout).

8º: Finally, I would add that today failures will be less frequent, because experience and physiology have limited the number of indications for transfusion, and it will no longer be practised in cases where it is known that it will be attempted in vain: Nos. 185, 186, 182, 183, 181, 132, etc..

If this statistic has been carefully followed, it must have been seen that the number of failures is less than is at first supposed, and that, owing to the foregoing considerations, the final result of transfusion operations is likely to be of a great encouragement to practitioners.

CHAPTER TWO

1°: *Puerperal metrorrhagia*. - There are few accidents as terrible as those devastating haemorrhages which too often hang, as the crowning glory of the hard work of maternity, on the heads of unfortunate women. In spite of the skill of the midwives of our time, in spite of the brilliant progress of obstetrics, there are unfortunately too frequent, cases in which all the means which the most consummate experience and the most accomplished knowledge direct against these haemorrhages are powerless to restrain the life which flees at full speed: prudence, attention, effort, science, all are in vain. This breath that begins is going to be the last; this interesting life is about to be cruelly sacrificed to the accomplishment of the very physiological act for which it was received! "It is at this solemn hour," says Mr. Giraud-Teulon, "that a supreme means is offered: the transfusion of new blood, a heroic aid, which today has a right to claim its place, its rank, its formula in the table of obvious indications to be fulfilled at this delicate moment."

I shall say later at what stage of the haemorrhage the blood transfusion should be performed. For the moment, I will only remind you that this blood loss can occur before, during or after childbirth, during an abortion, inertia of the uterus, a vicious insertion of the placenta, a deep tear of the cervix, the vagina, and finally an obstetric operation.

There is no practitioner, there are few pupils who have assiduously frequented hospitals, who have not witnessed one of those rapid, unexpected haemorrhages which suffice in a few minutes to compromise the life of a woman. "Haemorrhage![37] how this word reminds the midwife of terrors and anguish! Never has a drama presented such striking twists and turns. Action may proceed at first slowly, and keep the man of the art in a deceptive security; then the scene suddenly unfolds with a frightful rapidity that chills the most intrepid with terror. Who will not remember all his life the long hours full of anxiety spent alone in the

middle of the night with women who, after God, became the sole arbiter! The inefficacy of ordinary means, even of compression of the aorta, as proper means of stopping haemorrhages after childbirth, presages inevitable death. Whatever one does, transfusion alone can leave some chance of salvation. It is there that gives the midwife that security, that confidence so necessary in such cases. He feels that he is the master of the woman's existence, and he draws from this confidence, which he communicates to others, the strength and composure that he so badly needs. He can then, with order, method, and promptness, make use of the means which alone can save the patient.

The existence of this woman, just now still full of life, depends on a fatal delay or a quick decision. Alone, the midwife takes advice only from himself; he devours his anxieties to hide them from the audience and show them a calm face. He is the point towards which all eyes are directed, on which all hopes rest; he reads terror and dread in everyone's eyes: will he have to wait coldly or fold his arms? It is especially in these cases that the transfusion has been performed the greatest number of times and that it has had the greatest success: this thought will be an encouragement to the midwife and will indicate to him the course to be followed; it is in these cases that transfusion should become, and will become, we have no doubt, a duty, a general rule of practice.

Generally speaking, it may be said that transfusion is much more successful in a woman who is exhausted by a loss immediately following childbirth, than in a woman who experiences it a few days after. "In the first case," say Messrs. Devay and Desgranges, "the sudden withdrawal of the blood fluid occurs without any considerable change having taken place in the organism; in the second, fluxionary movements have already established themselves on the organs of the lower abdomen. The best condition, therefore, is this: sudden and accidental withdrawal of blood in a subject who has not yet undergone morbid changes. But transfusion is also indicated in a woman who has just given birth and has been reduced to a state of complete annihilation as a result of metrorrhagia which occurred on the seventh or eighth day; in this case, it seems to us that before we can concern ourselves with the indirect results of transfusion, we must face an imminent danger, which is the extinction of life. Future hazards can be averted by other means; the present danger can only be so on one condition, and it must be fulfilled."[38]

2°: *Haemorrhages of a traumatic nature*. - It is also against haemorrhages of this nature that transfusion is formally indicated. It has been attempted against the consequences of haemorrhages produced by gunshot wounds (observation 97), by ruptures of varicose veins (obs. 95 and 104), against those accompanying fractures (obs. 96 and 100), against those which occur during (obs. 98) or after a surgical operation (obs. 99, 101, 105, 112 and 115), against those produced by the spontaneous rupture of a vessel following exertion (obs. 113) and against those resulting from a wound (obs. 102). It must also be practised in cases of stab wounds (knife, foil, etc.), secondary haemorrhages following the ligation of the arteries, and finally against those accompanying the traumas to which the improvident workers now employed in many factories are so often victims.

Here again, I said, transfusion is a rational operation. "In fact," says Mr. Moncocq,[39] "let us suppose a man, a healthy man besides, who by some accident loses a considerable quantity of blood; experience shows that, even in this case, death is not immediate; life still exists, although it no longer manifests itself through any external phenomena. The heart, emptied of its essential stimulus, ceases to beat; the brain, no longer receiving blood, can no longer dominate the organism; the lungs, paralyzed, stop its reciprocating movement; it is a syncope, it is not death, as experiments on animals have abundantly proved. It is understood that, in this case, nothing can replace the blood that is lacking. All possible stimulants, sinapisms, electricity, caloric in all its forms, all these cannot succeed. It's understandable; what this heart that no longer beats needs is the blood that has just escaped it; and if we hurry to intervene, to give it back its stimulant, it will react again, send a new flood of blood to the brain. The brain will in turn react on the lungs, and all functions will gradually recover.

3º: *Passive haemorrhages*. - The above reflections also apply to the consequences of passive haemorrhages, among which we classify certain forms of epistaxis (obs. 132) and enterrrhagia (obs. 145), which have lightning results. Extreme blood loss leads to a syncopal state; if the practitioner has no hope of reviving life by ordinary means, why should he not then resort to transfusion?

4°: *Haemorrhages depending on the presence of certain tumours*. - When tumours not connected with the existence of one of those diatheses which mark the economy with their indelible seal, when tumours (of a fibrous nature, for example) have only a local connection with the organism, if I may so speak, and under the influence of these tumours haemorrhages occur, recur, and endanger the life of the patient, transfusion should not be hesitated (obs. 106, 107, 108, 109, 111 and 114).

It is obvious that if these tumours, the cause of the haemorrhage, had been removed at their beginning, the loss of blood would not have taken place. But often, either because the subject has waited too long or has refused to be operated on, there comes a time when the removal of these tumours is only a secondary indication, and when the haemorrhage must be remedied first and foremost. It is only later, when the organism, which is otherwise healthy, has been able to repair its strength that the surgeon will have to think of operating on these tumours.(40)

5°: *Constitutional haemorrhage*. - Blood injection is appropriate in cases of haemorrhage related to a particular condition of the blood: such as haemorrhage dependent on a haemophilic diathesis, occurring spontaneously (obs. 120), or caused by accidental injuries that are often insignificant, by leeches, or by epistaxis, or by an operation (obs. 119), or finally recognising the existence of a tumour as the cause (obs. 124); such, too, are haemorrhages dependent on certain alterations of the blood, such as those occurring under the influence of purpura haemorrhagica (obs. 118) and scurvy (obs. 129). Observations 119, 129, show the advantages of transfusion in this circumstance; they also show that, while ensuring the salvation of the sick, whose lives were greatly threatened by abundant and repeated haemorrhages, it can bring about a radical cure of the haemorrhagic tendency. The change introduced in the composition of the haemorrhagic blood by the new injected blood is certainly a major factor in this cure.

I would like to point out that transfusion is less successful in cases of anaemia caused by repeated or prolonged haemorrhage, although slight (as often happens in haemophiliacs), than in those where the anaemia is produced by one or more considerable blood losses occurring at short intervals. Observation 120 can only confirm these words.

Finally, I would add that, in these cases, the body will take longer to repair its strength, to rebuild the blood it has lost: greater caution and better monitoring will therefore be necessary.

6º: *Haemorrhages produced by ulceration of vessels*. - These ulcerations occur under the influence of suppuration work (obs. 110).

I refer to paragraph 7 of that chapter for the assessments relating to this particular condition.

7º: *Anaemia.* - When the anaemia has come of its own accord, so to speak, without any appreciable cause, it is seldom that ferruginous, tonics, exercise, and climate, do not check the progress of this affection. It is therefore conceivable that instead of thinking first of transfusion, appropriate treatment should be resorted to.

"But," says Polli, "when in chlorosis and anaemia due to imperfect haematosis, treatment with iron, manganese, and tonics, has not been successful, in these cases the injection of good blood into the circulatory tree may be considered as an inoculation of new blood germs, very useful for furnishing a more physiological reproduction. With a few drops of blood we introduce thousands of globules, which, in their turn, reproduce others of good source among those which, weak and impotent, are the cause of the morbid condition, and

which end by gradually disappearing and giving place to the new and stronger generation, introduced by means of methodical and repeated injection. The important functions of excitation and nutrition of the solids belonging to these small organized bodies in circulation with the blood, explain how the transfusion of good blood can restore a defective organism."[41]

It is on the basis of this theory that Mr. Polli advises transfusion in *rickets, scrofula*.

Anaemia has multiple causes. We have talked about the one that is the result of haemorrhage; we are going to review the one that is the result of a serious illness or that which has accompanied a chronic disease, that which occurs as a result of suppuration following an operation or an injury, and finally the essential anaemia.

a. "If, after typhoid fever," says Mr. Béhier, "the convalescent subject does not recover in spite of the administration of tonics, if there is hydroemia, if the blood is not replenished, and if the globules and fibrin are not in the proper proportion to stimulate the organism adequately, then a small quantity of this serous blood equal to that which is proposed to be transfused should be taken from the patient so as not to overfill the circulatory system, and to act only by the quality of blood, which is more apt to combat general debility. In this way we could hope to revive the nervous system, and through it the digestive and absorbing systems, and to restore to the blood its qualities necessary to continue the vital movement. This indication would exist in a case of imminent death."

But when we consider that transfusion, as we shall see in the third part of this work, causes rather intense side effects, may we not ask ourselves whether such phenomena, determined in a subject whose organism is profoundly deteriorated by a chronic disease, would not give rise to a fatal reaction on the part of solids?

b. We have seen that transfusion has been performed a number of times on patients exhausted by long suppuration (obs. 110, 148, 149, 150, 151, 152, 153, 155, 156). Life may have been prolonged for a longer or shorter time, but very rarely has health been definitively restored.

Of course, it is the duty of the physician to have recourse, in desperate cases, to all means which seem to offer some chance of success; but in those particular cases where the anaemia is produced by a suppurating source, which it has not been possible to dry up, we do not see the advantages which may result from transfusion. It would be necessary to renew the whole mass of blood in order that this fluid could exert a favourable influence on the wound. A few ounces of good quality blood may for a moment raise the strength, but the effect will not be lasting, because the cause of anaemia and the fall of strength still exists.

These considerations also apply to cases in which a vessel, situated in the middle of a suppurating focus, ulcerates and tears. Moreover, in addition to the anaemia caused by a long suppuration, there is also a loss of blood which the patient so badly needs. One understands the seriousness of such a situation, and one is not surprised at the failure to do so (obs. 110).

Now, when we consider the failures that have been obtained in several cases of transfusion for anaemia resulting from injuries, can we say that if this operation was not successful, it was because it was not indicated there? And is there nothing to be feared from the influence exerted by a traumatic cause on the nervous system of certain subjects? Of the nervous excitement which is so often noticed, and the effects of which are so cruelly felt in individuals with gunshot wounds?

c. Messrs. Richet (10 August 1868) and de Cristoforis (12 September 1868) used transfusion to combat essential anaemia. The first tried it in vain on a patient in Mr. Béhier's department (obs. 130); the second, at Milan, with complete success (obs. 131). I believe that transfusion is also applicable here, but that we should not wait until the last moment, as Mr Richet has done. "For," says Mr. Révillout, "if oxygenated blood carries within itself its qualities as a stimulus, it is also necessary, in order for it to act on the tissues, that the latter

be stimulable. This is the case with the dog's head, which Brown-Séquard separated from the trunk in full vigour, and which he momentarily brought back to life by injections of blood."

"But an organism which has gradually lost the faculty of making blood for itself may at the same time have lost the faculty of being animated by the blood which is lent to it. Then the red blood cells, not being renewed, quickly disappear into the vessels, as they would everywhere else; white blood cells resist advantageously.(42)

8°: *Before major operations*. - When, for example, an amputation is necessary, it must be performed as soon as possible and the patient has already lost a lot of blood, transfusion may be used before the operation is performed; for the loss of blood which, whatever might be done, during the amputation, might lead to the death of the subject before the end of the operation, as has sometimes been seen.

Transfusion has been performed under these conditions in the past (obs. 96, 103, 107). In observation 96, it is a man with a comminuted fracture of the leg, who was to undergo amputation; but he was so weakened by haemorrhage, that it was feared that he would die during the operation. Eight ounces of blood were injected into him, and the operation was very well tolerated. The next day the sick man was better; but death occurred on the third day, caused by gangrene of the stump, an accident quite unrelated to the transfusion. In observation 107, it was a carpenter who also had to have his arm amputated; but he had lost so much blood that Dr. Higginson thought proper to transfuse him with 360 grams of blood before performing the operation, which was performed the next day, and was perfectly successful.

9°: *Lipothymia*. - In certain cases of severe lipothymia caused by nervous action, which sometimes ends in death, as in the case of unexpected news, of the sight of a person whose appearance produces a general seizure, of certain hysterical states, etc., Mr. Rognetta thinks that as the heart is in some way paralyzed, transfusion could be practised as an extreme means with some chance of success, as an inner stimulus.(43)

10°: *Apparent deaths*. - Mr. Bourgeois, in a memoir on apparent deaths, does not fail to recommend transfusion as a means of recalling life in desperate cases, especially when one is called to a woman in labour who presents all the symptoms of death as a result of uterine haemorrhage. He says that if many of these haemorrhages have been fatal, it was because, having judged the syncope into which they had thrown the patients to be definitive, all assistance has been neglected.(44)

11°: *Agony*. - With the help of transfusion, it is possible, according to Brown-Séquard, to temporarily bring dying individuals back to life.

Here transfusion would be employed, not with the foolish idea of the first transfusers, who believed that they could cure all affections by substituting fresh blood for diseased blood, but in the hope of seeing awakened for a few moments an organism scarcely alive and necessarily condemned to an imminent death.

Brown-Séquard obtained this result on animals by several means: "1° by the partial substitution of normal blood for blood altered by an inflammatory disease and by the asphyria which exists in agony; 2° by injecting alternately to the head and to the heart, in order to act on the brain in order to establish respiration, and on the muscle fibres of the heart to increase their irritability; 3° pulmonary insufflation; 4° by disgorging the right heart by bleeding the jugular." The success of these various operations is all the more probable because, in order to perform them, one would not wait, as Brown-Séquard has done on animals, until the agony had made considerable progress, and that they would be performed even before it had manifested itself in convulsions.

"It is obvious that, in the vast majority of cases, it would be useless, if not cruel, to snatch from death, for a necessarily too short time, an individual who is condemned to die by irreparable material damage. But there may be cases in which it would be important that the intellect, speech, senses, and voluntary movements should be restored to a dying person.

Now, the experiments of Brown-Séquard (Journal of Physiology, 1858, page 666), by showing that all the functions of animal life can be restored for a few hours to animals in which agony has already almost completely given place to death, render it extremely probable that the intellectual faculties, the senses, speech, etc. could be recovered for a few hours, in patients who have just lost these faculties and in whom agony begins."[45]

It is "in asphyxiation as a result of blows to the head, or as a result of an inflammatory disease, in certain poisonings, at the moment of agony," that Brown-Sequard recommends the use of the means we have enumerated above.

Transfusion can therefore become, in some cases, a weapon in the hands of the judiciary, to protect morals, safeguard the honour and interest of families, and enforce the laws that govern society as a whole. A crime is committed, the murderer has escaped without being recognized; the dying victim can, thanks to the transfusion, regain speech or at least his senses, and designate the person who struck him.

And let no one imagine that we want to make transfusion a universal panacea. Everyone knows what powerful interests are often attached to prolonging the life of an individual, even if he or she would survive only a few minutes. Sometimes a single word uttered on the deathbed suffices to save an innocent man, to restore to a family an honour or a fortune, to bequeath a name to a child, etc., etc.

12°: *Asphyxia*. - In the previous number, we already talked about some asphyxiation; it remains for us to deal with the asphyxiation produced by certain gases, and the asphyxiation of newborns.

a. On the basis of the favourable results of the Kühne experiments, an attempt was made to perform transfusion on man poisoned by carbonic acid (obs. 164, 165, 166, 167, 168 and 169). The success achieved by Mr. Martin in 1866 can only encourage those who would like to take this path. If the transfusion has failed most of the time in these cases, may we not wonder if it is not because we have always injected defibrinated blood?

Certain gases, carbon monoxide and carbonic acid, render the blood incapable of performing its respiratory functions, substituting itself for the oxygen in red blood cells; it's a real blood poisoning.

Eulembourg and Landois recommend in these cases *combined* transfusion, that is to say, simple transfusion, but repeated several times, combined with the most perfect depletion possible of the poisoned blood. It's a real substitution of blood (according to Panum). We believe that after several depletions and transfusions, the resorption of the poison will evidently be facilitated, and that its toxic action will be so annihilated as to give rise to no more imminent symptoms. Moreover, in the experiments which Eulembourg and Landois have made with carbon monoxide, "combined transfusion has shown itself to be the safest and most efficacious remedy, even in severe cases where there is asphyxiation and absolute paralysis, cases entirely resistant to treatment either by bloodletting alone or by the most energetic artificial respiration (faradization of the phrenic nerves, insufflation into the open trachea)."[46]

Asphyxiation can be produced by other gases; such are lighting gas, sulphurous acid, hydrosulphuric acid, chloroform, etc.

Is it still necessary to point out here what services transfusion can render in wine-producing countries, where those who press the grapes in the vats so often die of asphyxiation? Can it not also be useful for those night workers who are responsible for emptying certain sewers?

b. Transfusion has been performed a small number of times to combat asphyxia in newborns (obs. 170, 171, 172, 173). A favourable result was obtained, and of the three remaining cases, transfusion was attempted twice on a newborn infant who had been asphyxiated and removed from the mother's breast following post-mortem caesarean section. No doubt these attempts are commendable, but should these failures be

unquestionably attributed to the transfusion itself? And is it not to be feared that, in these two cases, the transfusion was performed rather on a corpse than on a dying person?

In any case, it is a resource that the birth attendant will be able to use.

13°: *Poisonings*. - It is not only by gases that man can be poisoned, but by certain substances. In these cases, animal testing only was attempted.

a. Messrs. Eulembourg and Landois have transfused animals to which they had administered poisonous substances exerting a deleterious influence on the nerve centres through the blood. In experiments with opium, they ascertained by injecting the tincture into the veins:

"1° That by employing doses below those which are absolutely deleterious, it is possible, by the substitution of blood, to diminish the duration as well as the severity of the toxic symptoms."

"2° That by subjecting animals to deleterious doses, life can also be saved and the integrity of all functions preserved, by the rapid practice of combined transfusion."(47)

These observations, though founded on a single substance (opium), nevertheless allow us to expect the same success with regard to other narcotics, and even with all poisons acting on the nervous organs in a similar manner.

b. Mr. Eulembourg, in a Study on the Antidotes of Phosphorus, communicated to the Medical Society of Berlin his experiments on transfusion in phosphorus poisoning. "In animals poisoned by means of considerable masses of phosphorus, transfusion could not arrest the fatal march, but at least seemed to retard it. However, animals which had absorbed only a small amount of phosphorus at a time were able to be preserved in life, and those which succumbed under these conditions presented ulcerations of comparatively early stages."(48)

Phosphorus enters tissues in the form of vapour; mixed with the blood, it behaves like a poisonous agent, and is only incompletely burned in the lungs. This explains the fatty degeneration of the liver, which cannot be stopped by transfusion.

c. We will add that transfusion, for the same reasons, would be indicated by poisoning by a venom or by any virus. Although the attempts against hydrophobia have not been successful so far (it is true that there are only two of them), they should perhaps not be abandoned altogether. It is needless to repeat that here again the transfusion should be combined with successive depletions. The difficulty would be to know at what period of the poisoning it would be expedient to act.

14°: *Cholera*. - Transfusion was abandoned as a treatment for cholera because of the unfavourable results, but it is now being revisited. Dr. Willis (of Montmouth) advises three principal means in the treatment of cholera: 1° hypodermic injections of morphine; 2° injections of hot water into the veins; 3° transfusion of the blood of a healthy person.

"We understand the importance of this last method, since cholera, in a broad sense, could be defined as a haemorrhage of the serous part of the blood. Moreover, Dr. Richardson's researches, and his discovery of ammonia as the cause of the fluidity of the blood, show the necessity of restoring this agent to it in a disease where this fluid is so strangely altered."(49)

We believe that it is difficult to say, and that it is better to wait until further research has yielded something more positive.

15°: *Nervous diseases*. - Mr. Polli, whose important work on the blood is well known, advises transfusion in cases of simple neuroses, that is, those which are not maintained by obvious organic alterations of the sensory apparatus and viscera, among others several eclampsias, epilepsies and insanities. He is not the first to propose this means; the first transfusers had already done so, and after him Schneider and Hufeland. According to Mr.

Polli, this indication is supported by the fact that the conditions of the blood modify the mode of functioning of the nerves more or less profoundly and rapidly.

If epilepsies, eclampsias, and insanity occur in chlorotic and anaemic subjects, the indication for transfusion is even more pronounced.

Out of eight observations that I have been able to collect, there is not a single fatal case. There are two cases of recovery, five cases in which the result was null, and a sixth case in which it was impossible for the physician to monitor the subject for any time.

In all probability, the transfusion gave a salutary boost to the disease; but in any case it has not produced any kind of inconvenience. And then, might we not ask ourselves whether the successes would not have been more numerous if the operators had not injected either animal or defibrinated human blood?

It is well understood that here again, before the injection is made, care must be taken to withdraw a certain quantity of blood from the patient.

To observations 133, 134, 135, 136, 137, 138, 139 and 140, I will add the one bearing No. 54, in which an epileptic attack had occurred during the course of childbirth. Professor Brown resorted to transfusion, which immediately terminated the access.

Mr. de Belina proposes to try transfusion against tetanus.(50)

Mr. Mignonnac also advises it in the case of uncontrollable vomiting that nothing has been able to stop, and which puts the woman's life in imminent danger.(51)

16°: *Starvation*. - Transfusion has been performed twice under these conditions, either because the subject could not take any food (obs. 144) or because he did not want to (obs. 147). In the first case, the patient was cured, and life seemed to be reborn at once; in the second, there was a temporary improvement.

Messrs. Eulembourg and Landois, having deprived a dog of all food, have found that the transfusion of the blood of an animal of the same species, practised in starvation, prolongs life and compensates for a certain time for the lack of food and the loss of worn organic matter during this period. So far, they have succeeded in preserving a dog deprived of food for twenty-four days, by repeating from the sixth day, at regular intervals every forty-eight hours, the injection of blood into a jugular or crural vein. "This dog's body lost 39 percent in weight; but the decrease was comparatively much greater before the first transfusion than after the establishment of the process of which we have just spoken."(52)

17°: *Organic diseases*. "An organic affection," said Mr. Desgranges, "would singularly complicate the chances of transfusion. The same would be true of a widespread inflammation of the viscera or limbs which would have begun before the haemorrhagic accident against which the doctor would think it necessary to inject blood. In this case, the transfusion only increases the stimulus; the benefit would only be temporary."(53)

The language of this skilful practitioner does not yet seem to us sufficiently absolute, when it comes to organic diseases. For our part, we would never advise the practice of transfusion against wasting or haemorrhage which occurs under the influence of diathetic disease, cancer, phthisis, etc., against haemoptysis occurring in a subject with tuberculosis, metrorrhagia occurring in a woman with an organic uterine tumour, etc.

Under these conditions, transfusion, assuming that it exerts no adverse influence, would at least produce no therapeutic results, since the blood is only a temporary stimulant; it is not regenerative, despite what Dr. Polli says, who thinks that injecting blood into the veins of cachectic individuals can result in normal tissue regeneration.(54)

The recent essays of Mr. Neudörfer (obs. 162, 163) confirm the reflections we have just made. In fact, everyone knows that haemoptysis occurs in a phthisic only at an advanced period of pulmonary tuberculation, against which therapy has hitherto remained for the most part impotent; whereas haemorrhage which is due to the existence of a cancerous tumour, for example, generally occurs only at an extreme period of the morbid work of which these tumours are the seat; that, moreover, these tumours, once removed, are often very quick to recur.

It would therefore be useless to subject the patient to the operation of transfusion, which, though not in itself be dangerous, may nevertheless at a given moment be hindered by circumstances independent of the skill of the man of art.

Nevertheless, there are circumstances in which transfusion may be indicated in a diathetic subject. It is when a serious haemorrhage occurs in him, independent of the diathesis, at a time when, for example, the organic tumour of which he is the carrier has not existed for a long time, is located in a region where it can be tolerated as long as possible, in which there is nothing to suggest a rapid and invasive march. Or the transfusion might still be carried out when, a haemorrhage occurring in consequence of the extreme progress of the tumour, it would be of undue importance to prolong the life of the subject for some time, if he were placed in one of the conditions of which we have spoken above, in connection with patients in agony.

18°: *Finally*, it remains for me to enumerate simply the few cases in which transfusion has still been advised:

"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" (Polly);

In all cases where the digestive organs do not function, especially in narrowing of the esophagus (Belina);

In cases of diabetes (Mosler):

In cases of acute septicaemia (Professor Lücke), but so far transfusion into individuals with pyohemia has given only a favourable result;

In cases of uremic poisoning, when this uraemia is only temporary, as in cases of eclampsia" (Belina).

Nor will I multiply the quotations of cases of exhaustion, from whatever cause, in which transfusion has been attempted or advised.

I believe that the number of these indications should be greatly restricted: it is impossible to specify them, because each doctor will have to act according to the particular circumstances in which he finds himself placed; he will be guided by the operations that have already been performed, by the experiences that have been made, and he will refer above all to his own judgment and discernment. We only recommend caution in the choice of indications; for, instead of being favourable to the cause of transfusion, which is entitled to his full attention, it might perhaps be injurious to it.

PART THREE
Physiological Considerations

I. CAN BLOOD FROM AN INDIVIDUAL OF THE SAME SPECIES OR FROM A DIFFERENT SPECIES BE INJECTED INTO THE VESSELS OF AN INDIVIDUAL?

The transfusion of blood, in an individual of the human species, must be made with blood taken from an individual belonging to the same species.

This proposal is of paramount importance, and must be scrupulously implemented. It has been formulated according to the results obtained by experiment.

1°: *Transfusion of blood from an animal to an animal of a different class*. - Examples of failure become more pronounced, and death is more rapid as the difference between the animals on which one operates becomes greater.

Thus, while the blood of a calf or a sheep transfused to cats or rabbits rendered bloodless, has awakened life in them only temporarily,(55) on the contrary, by injecting birds with the venous blood of mammals, Prevost and Dumas and Dieffenbach have seen death occur very quickly, in the midst of convulsive movements.(56)

According to Bischoff, Brown-Séquard, arterial blood or defibrinated venous blood of mammals does not kill at once, but it remains unfit to revive the bloodless animal: venous blood, they say, kills because it is charged with carbonic acid; venous blood defibrinated by

beating would be oxygenated in the air by this operation and would approximate arterial blood. In a memoir published in 1857, Brown-Séquard said that the blood of a vertebrate animal of one species is not poisonous to other vertebrates, even of very distant species.

Messrs. Prévost and Dumas attributed the failure of these experiments to the shape and volume of the globules contained in the injected blood. "If blood is taken," they said, "and injected into the vessels of an animal of a different species, the animal is but imperfectly recovered, and can seldom be kept for more than six days. A bird, which is injected with blood with circular globules, succumbs. The same is true of the duck to which sheep's blood is injected."

Mr. Oré in turn argues that natural blood can be injected from one animal into an animal of a different species, by means of *immediate* transfusion. This is how he successfully injected blood from a dog into a duck. But Mr. Oré wants the injected blood to arrive in the veins of the sick animal as it circulates in the veins of the first, that is to say, without having undergone any beginning of coagulation.

2°: *Transfusion of the blood of an animal into the vessels of an animal of a different species, but belonging to the same natural group*. - Milne-Edwards and Delafond injected blood taken from a horse into the veins of a bloodless donkey, and the donkey made a full recovery.(57)

3°: *Transfusion of human blood into the vessels of an animal, and vice versa*. - Denis, Richard Lower, Edmond King, and several others injected man with animal blood, usually from a lamb, a sheep, a calf, or a goat. The successes they have achieved should not be taken into great consideration; because, as the operation was seldom performed for the purpose of preventing the consequences of haemorrhage, it must be assumed that a certain quantity of blood remained in the vessels of the individual.

Dieffenbach successfully injected human blood into a cat.

4°: *Transfusion of blood from an animal to an animal of the same species*. - The experiments of Blundell, who successfully injected blood-taken from other dogs into bloodless dogs, prove that this mode of operation is generally successful. Lower also injected blood taken from other dogs into the veins of a small dog, but the first one did not succumb. Bichat(58) and Harwood,(59) not to mention more, obtained the same results.

5°: *Transfusion of blood from man to man*. - This operation can bring back to life a man exhausted by a heavy haemorrhage. There is no need to repeat the facts in support of this proposition. What else could argue in favour of transfusion from man to man more than the figures shown by our statistics?

In comparing a number of experiments in which transfusion from animal to man, and vice versa, or from one animal to an animal of a different species, has been performed, and compares, I say, with an equal number of transfusion operations performed from man to man, one is struck by the enormous difference which exists in favour of the latter method of operation.

Therefore it may be said that just as the blood of an animal should be injected into the vessels of an animal of the same species, so also only human blood should be injected into man.

"Even in the absence of what we know," says Mr. Desgranges, "of the plasticity of the blood, which differs from man to animals, of the shape and volume of the globules, which are not the same throughout the animal scale, common sense would suffice."

II. WHY DO WE CHOOSE VENOUS BLOOD RATHER THAN ARTERIAL BLOOD?

The first transfusions injected arterial blood from an animal into the vessels of humans. But since it is known that human blood alone is capable of recalling life in a man exhausted by haemorrhage, only venous blood is injected.

Since the time of the immortal Bichat, it has been known that arterial blood alone is capable of sustaining life: why then inject venous blood? This is because the latter does not act, at the beginning of the injection, as restorative blood; in other words, it acts as venous

blood only during the first moments of the operation, for it is only after it has passed through the lungs that it is fit to bring down life that is about to be extinguished. Pushed into the heart, it first excites that organ, which contracts and drives it into the lungs, where, under the influence of the air, it becomes arterial blood.

If the action of arterial blood is nourishing, that of venous blood is exciting. "Red blood," says Brown-Séquard, "gives the tissues the faculty of action, the power; black blood begets action, implements this power. The stimulating effects of the latter are said to be due to the carbonic acid it contains."[60] It is under the influence of this acid that the muscle fibres of the heart enter into contraction.

Obviously, the injection of arterial blood into the veins of an individual may also produce favourable results (see Tables); but considerations of a different order prevented it from being chosen. In the first place, what would be the subject who would gladly offer himself to the dangers of arteriotomy? What doctor would want to take responsibility for the consequences of such an operation? And then, to speak only of the immediate dangers to which the person on whom it is practised might run, could not the doctor, at the moment when he needs all his freedom of action, find himself placed between two patients, each of whom requires imminent care? Finally, arterial blood is not indispensable, since venous blood can bring back life as well as it can. Moreover, venous blood has another property, that of bringing into play, that of the contractile power of the heart. Moreover, phlebotomy is an easy operation to perform, and the consequences of which are generally not to be feared. Let us add that when the surgeon has extracted from the vein the quantity of blood which he thinks proper, it is easy for him to stop the flow of this fluid, or to have it stopped by an assistant: he can therefore attend to the patient immediately, and need only attend to him.

These are the reasons why venous blood is injected today.

We may also ask ourselves with Mr. Morely whether, since in a bloodless person the haematosis is annihilated, there is no reason to believe that the shower of venous blood expelled from the right heart is more apt to awaken the respiratory function than the arterial flow itself.

Is it difficult to find venous blood? Of course not. I am not talking about cases where the transfusion is done in a hospital; for, among these young men who follow the Master and surround the bedside of the sick, the most difficult thing is not to know whether there will be any one who will give blood, but to know whom to give the preference, so spontaneously do they all offer themselves and are anxious to begin this career full of devotion, paying with their person. In civil practice, whether in the bosom of a city or in the depths of a country, there will always be found some relative, some friend, sometimes a servant or a stranger, who will devote himself to the safety of the patient, especially when the physician has told him that phlebotomy is an operation of little danger, and that the quantity of blood which will be taken from him is not considerable, and will not cause any disturbance to his health.

Sometimes the physician, being alone, can give his own blood, as Professor Nusbaum did. But I do not advise the surgeon to adopt this practice, because an unexpected syncope may, while making it impossible for him to assist the person for whom he has been called, jeopardize his existence to a certain extent.

III. AMONG THE ELEMENTS OF THE BLOOD THAT IS INJECTED, WHICH CONTRIBUTES MOST TO THE RETURN OF A LIFE READY TO BE EXTINGUISHED?

The vital action of blood lies in its fundamental anatomical element, the red blood cell.

This proposal has been formulated by many experiments.

1º We tried injecting serum alone. The experiments attempted in this direction by Dieffenbach, Magendie, Prévost, and Dumas, Oré, have not yielded any favourable results. The animal into whose veins the serum alone was injected could never be brought back to life.

2° Bischoff, Polli, Oré, were able to recall life in bloodless animals by injecting them with defibrinated blood. These results obtained on animals have been confirmed by numerous experiments made on man, as we shall see shortly.

3º By the injection of the globules alone, advantageous effects have been obtained, which have enabled Mr. Oré and others to conclude that it is to the globules that the blood owes its revivifying properties. Nevertheless, says this distinguished physiologist, although the globules are the really active part of the blood, it would sometimes be dangerous to rely too much on them.

Here is how Mr. Sée expresses himself about blood cells:

"In the transfusion of blood, the injection of plasma without the globules produces only fatal effects (Bischoff); transfusion of blood cells without fibrin often produces a true resurrection (Cl. Bernard, Brown-Séquard); therefore the globules are indispensable to the functions of the organs; they are the lifeblood of the blood in the same way that living cells are the lifeblood of tissues."(61)

As to the action itself exerted by the blood corpuscles, it may be explained by the affinity of oxygen for these globules (Longet), and by the property possessed by oxygen-laden blood of awakening the vital properties of tissues, a property which is all the greater the more oxygen-laden it is (Brown-Séquard).

IV. SHOULD THE BLOOD BE INJECTED AS IT COMES FROM THE VESSELS, OR SHOULD IT ONLY BE INJECTED AFTER HAVING BEEN STRIPPED OF ITS FIBRIN?

This is a serious question, the solution of which has not yet been completely resolved, and on which quite opposite opinions have been expressed.

Müller, Dieffenbach, Bischoff, Polli, Monneret, and nowadays Belina (from Heidelberg) and Enrico Albanèse (from Palermo), show themselves to be the advocates of blood defibrination.

Panum, Neudörfer, Brown-Séquard, carried out experiments which enabled them to conclude that the injection of defibrinated blood was safe.

"Defibrinated blood has always acted as powerfully as natural blood" (Brown-Séquard). Elsewhere this physiologist concludes: 1° that the presence of fibrin in the blood transfused is not only unnecessary, but seems to be useless; 2° that the defibrination of the blood by threshing does not alter the blood cells; 3° that since the defibrinated blood of an animal of one species can be safely transfused into the vessels of an animal of another species, the defibrinated blood of any mammal could be used for transfusion in humans.(62)

Muller(63) and Monneret also think that the defibrination of the blood by threshing does not alter the vitality of the blood cells. Mr. Monneret adds, however, that by injecting defibrinated blood, "only altered blood is allowed to enter the vessels." Messrs. Devay and Desgranges are of the same opinion on this point, and conclude all the better against the defibrination of the blood. "We find it inadmissible," they say, "that the globules are not altered by threshing, when earlier Mr. Monneret insisted on the alteration of the blood as it leaves the vessel. It is possible that the microscope and the analysis will not show anything; but if the blood received in an inert vessel is reputed to be a corpse, we may well maintain that beaten globules are killed globules. To sum up, defibrination deprives the blood of an element which can be very well guaranteed; in the second place, it distorts it to the point that it is no longer blood that is transfused, but a medicated infusion that is practiced. It must therefore be postponed."

Panum(64) points out that defibrinating the blood avoids the inconvenience of injecting blood concretions; it is made more active by oxygenating it more than natural venous blood, and the dangers of the existence of too great a quantity of carbonic acid in venous blood are avoided. Messrs. Eulembourg and Landois also say that only blood oxygenated by defibrination and free of carbonic acid can be used for transfusion.(65) In addition to these opinions in favour of the defibrination of the blood, we will quote those of men no less competent in this matter. We already know what Mr Devay and Mr Desgranges think.

Magendie, in 1837, by injecting defibrinated blood from a dog into the vessels of another dog, always saw the latter die more or less quickly. "The animal into whose vessels defibrinated blood is injected always dies," he says, "because the defibrinated blood can no longer show itself in the vessels: the serum passes through them by imbibition, it forms extravasations, congestions, chiefly in the lungs, and it speedily leads to death. It is fibrin that gives the blood the viscosity it needs to travel through the finest capillaries. Coagulable blood, that is to say, not stripped of its fibrin, is the only one capable of sustaining life." More recently, Mr. Poiseuille has also shown that without fibrin the lives of animals would often be compromised, because the blood slows down its course in the capillaries, as it becomes depleted of fibrin; this is because defibrinated blood does not flow into a tube a hundred times larger than that of a mammal's capillaries.(66)

It will be seen that we are far from the opinion of Dieffenbach, who recommended the injection of defibrinated blood, because he feared the obstruction of the capillaries. Mr. Moncocq (of Caen) concurred with Magendie's opinion. Mr. Roussel (of Geneva), in a very interesting letter which he did me the honour to address, explains the failures obtained by Mr. Neudörfer (see the Tables) because this practitioner injected defibrinated blood. "He wants," says Mr. Roussel, "to heal soldiers with vast wounds of unbearable suppuration, and whose scars cannot be completed for want of plasticity of the blood. And it is defibrinated blood that he transfuses, blood deprived of its plastic part, the only one useful to these patients!"

I am entirely in agreement with Mr. Roussel on this point, but I think that he is perhaps too absolute when he says that it is better not to transfuse than to use defibrinated blood; for it must be admitted that, if the injection of defibrinated blood did not cure Mr. Neudörfer's patients, it at least produced a manifest improvement in them.

On the other hand, as there have been successes obtained by the injection of defibrinated blood, it may at least be said that this injection, which has sometimes produced happy results, is almost always ineffective, but that it is seldom harmful. Some of the failures that followed the injection of defibrinated blood might not have been achieved if the precaution had been taken to filter the blood after it had been defibrinated, which was not always done. Fortunately, when defibrinated blood is used, it is not forgotten to filter it out. In these circumstances, Messrs. Enrico Albanèse and Belina have achieved undeniable successes (see the Tables).

Moreover, Mr. Oré demonstrated in 1865, by skilfully directed experiments, that the transfusion of defibrinated and filtered blood can be performed successfully, but that "the defibrination of the blood is useless, especially in man, where the blood does not begin to coagulate until four or five minutes after it leaves the vessels."

In a note accompanying the sending of some observations of transfusion made by Dr. de Cristoforis, chief physician of the hospital of Milan (for which I beg him to receive here the assurance of my gratitude), this skilful practitioner expresses himself as follows: "For me, there is no more difficulty in injecting non-defibrinated blood than in defibrinated blood. Defibrination adds a little more safety to the operation, because it delays the clotting of the blood a little." I could not sum up my thoughts better than Mr de Cristoforis does, but I will say that the defibrination operation requires a loss of precious time. And "as it appears, from observations taken on man, that natural venous blood has been more successful than defibrinated blood, and that according to Messrs. Devay and Desgranges, according to Mr. Brown-Séquard himself, there is perfect time to make the injection before the blood to be transfused has coagulated, it seems that the present indication is still in favour of the blood as it comes out of the vein. Practitioners, therefore, should not put untoward haste into their actions...."(67)

It seems natural to me that, since transfusion consists of replacing in a man exhausted by haemorrhage the blood he has lost by new blood, a fluid must be injected exactly like that which these vessels contained just now, that is to say, natural blood. This is what always happens when immediate transfusion is performed. But when one is obliged to perform mediate transfusion, when one presumes that the blood to be injected has remained a relatively long time outside the vessels, one should not fear defibrinating this fluid. The

defibrination must be well done, and for this we must not be content, unless we can do better, with beating the blood with a glass rod or with a paddle, but with a wicker broom: finally, we will finish by filtering.

V. WHAT ARE THE VARIOUS INFLUENCES THAT CAN PROMOTE OR HINDER THE TRANSFUSION OPERATION?

1°: *Blood clotting*. - The blood coming out of the vessels always ends up clotting, even when it is completely removed from the action of the air. It coagulates, it is true, faster and more completely when it comes into contact with air.

To prevent or at least to delay this coagulation is to avoid a danger and to ensure a further chance of success. It is for this purpose that some have advocated the defibrination of the blood.

So what is *fibrin*, and how does blood clot?

According to Mr. Sée,[68] the coagulable matter which is designated by the name of fibrin is an albuminoid matter which is in a fluid state. Blood clotting is the result of the formation of fibrin. Fibrin does not exist before coagulation; it is not liquid for some time before condensing; its appearance and coagulation are signs of its formation. It only materializes under the influence of a coagulant substance called *globulin*, which sits in red blood cells, and its formation is the result of the splitting of a substance called *plasmin*. Plasmin, considered to be the origin of fibrin, readily accounts for the fluidity of fibrin during life; but in order for it to split and give rise to *post-mortem* coagulation, i.e. to the formation of concrete fibrin, it is necessary to intervene by auxiliary means which we shall enumerate later.

A new theory, which commends itself by the scientific position and previous work of its authors, is presented by Messrs. Béchamp and Estor. In a recent note, which I owe to their kindness, Messrs. Béchamp and Estor express themselves as follows: "There exists in the blood of all the animals we have examined (dog, cat, ox, etc.) microzymas similar to those of the liver, but nevertheless smaller and more transparent than the latter. It is doubtless because of their tenuousness and transparency that they have escaped the observation of physiologists.

To isolate them, we have used the following procedure: when blood is received in a vessel which already contains alcohol spread with water, in proportions which vary with the temperature and nature of the animal which supplied the blood, this blood remains liquid; the microzymas, which are the only solid parts, are initially suspended, but gradually precipitate and can be collected on a filter. The meshes of the paper retain the greater number, some pass with the liquid; at a temperature of 25° to 35°, these microzymas, so few in number that the liquid was perfectly transparent, proliferate with such activity that, after 48 hours, a new deposit has formed. The same set of phenomena can occur three or four times.

These microzymas live up to their name; in some circumstances, in less than 24 hours they liquefied the creosoted starch; they are *microphyte ferments*. This result has often been achieved by microzymas which have retained their original form and mobility, and in the midst of which it was impossible to find a single bacterium.

Numerous experiments allow us to affirm the following conclusion: what is vulgarly called the fibrin of the blood is nothing else than a false membrane formed by these microzymas at the expense of the albuminoid matter of the blood; it may also be noted, as a result of direct observation, that almost all microzymas are encompassed in fibrin; in defibrinated blood, microzymas are not found."

These facts are important to our work and deserve to be taken into consideration. In fact, according to them, transfusion should only be carried out with natural blood, because by defibrinating, it would be deprived of the microzymas, which are the ferments, i.e. the active part of the blood. The injection should be done as quickly as possible.

Fibrin is found in greater amounts in arterial blood.[69] And if venous blood contains fewer globules than red blood,[70] it is still advantageous to inject it, since arterial blood has a greater tendency to coagulate than venous blood.[71]

2°: *How long can the blood stay outside the vessels without clotting?* - That is the question that now naturally comes to mind.

Blundell claimed that blood could remain out of the vessels for twenty-four minutes without losing its reviving properties. This period of time would extend further, according to Dieffenbach; and the blood out of the vessels for three hours could still be successfully injected. Mr. Polli also said that the coagulation of human blood does not take place, on average, until eleven minutes later.(72)

But Mr. Oré, on receiving the blood in a vessel which had not been previously heated and which was in equilibrium of temperature with the surrounding environment, was able to observe that the man's blood did not begin to coagulate until four or five minutes after it had left the vessels.

I myself have been able to verify this conclusion of the physiologist of Bordeaux; the experiments I have made have led me to the same result. Moreover, this is the generally accepted opinion today.(73)

Well! So is it necessary to take a longer time to perform medial transfusion successfully? When everything has been prepared, when the instrument is at hand and the patient's vein is ready to be injected, does it take more than four to five minutes to bleed, receive the blood in a syringe and give an injection? The injection can even be done slowly, in small strokes, and the surgeon can avoid any unfortunate precipitation. As can be seen, the difficulties of this operation have been greatly exaggerated.

3°: *Influence of air contact*. - Contact with atmospheric air promotes blood clotting. This is a proposition whose truth cannot be disputed.

J. Hunter had observed that the blood, when it comes slowly out of the vessels, or pours out on the surface of a large and flat vessel, coagulates more rapidly.(74) The evaporation produced on the surface of the blood would therefore promote coagulation.

Mr. Oré(75) perfectly demonstrated that the blood withdrawn from contact with the air remains fluid longer. To collect the blood, he used a rubber bulb with a tap that can be turned on and off at will. From the tap comes a rubber tube and ends with a cannula whose opening offers 5 to 6 millimetres in diameter. After vacuuming the bulb with the help of suction, the tap being closed, he inserted the tapered cannula into the jugular vein of a medium-sized dog. He then turned on the tap: the blood filled the bulb. *After ten minutes*, he noticed an obvious fluctuation, pressing on the sides of the container. Wanting to assess the state of the blood, he opened the valve and was able to make sure that it *was still liquid*.

But the influence of contact with air has been greatly exaggerated. This consideration should not detain the practitioner for long, for coagulation is often accomplished without the assistance of external agents, since it can also take place during life in the vascular system, in the vacuum itself, where J. Hunter assures us that it is even more rapid than in the open air. Adding that Davy, on receiving the blood under a layer of oil, saw it become a mass as usual, it is evident that the influence of atmospheric air is little to be feared. Moreover, this influence, being exerted on the blood for only four or five minutes, will not be able to hinder the success of the operation.(76)

It is needless to point out that these considerations apply only to mediate transfusion.

4°: *Influence of temperature*. - For a long time, it was thought that cooling hastened the coagulation of the blood; also, to prevent cooling, the blood was received either in a vase heated in a water-bath, or in a syringe that had been kept in hot water or surrounded by heated cloths.

"Now," says Malgaigne, "this is a first instance of the practical errors maintained by false notions about the coagulation of the blood."(77)

It is indeed surprising, in the presence of such manoeuvres, that the failures were not more numerous; for experiments has now established that heat, far from retarding it, hastens the coagulation of the blood. Let us quote a few facts.

Hunter[78] has shown that blood surrounded by water at 55° coagulates in five minutes; that, when placed in water at 8º, the blood of the same subject takes 20 minutes to coagulate. On the other hand, having taken a fish out of the sea, he immediately measured its temperature and caused a certain quantity of blood to flow; this fluid soon coagulated, though it had attained a higher temperature than that which, having remained in the vessels of the animal had remained liquid there.

Hewson,[79] after excising two portions of the jugular vein of a dog between two ligatures, and immersing one in cold water, the other in lukewarm water, found at the end of three-quarters of an hour that the blood of the first was liquid, while that of the second was coagulated.

Scudamore[80] has observed that blood left in the open air in a chamber takes five minutes to clot; that the one placed at a temperature of 48° took three minutes, and that another surrounded by a refrigerant mixture at 40° was still perfectly liquid at the end of twenty minutes.

Finally, Davy[81] preserved the blood coming out of the vessels for more than an hour, in a state of perfect fluidity, keeping it at a temperature of 0°. He also observed that coagulation was accelerated, but in an irregular manner, by a somewhat high temperature: thus, it took place more rapidly at 30°R than at 20º or 25º, and less rapidly at 38ºR than at 25º; so that, at a certain degree of elevation, heat would have an action analogous to that of cold.

Moreover, the blood could still be successfully injected, after it had been frozen and returned to a fluid state. Mr. Nicolas has arrived at the same results:[82] the blood whose coagulation has been retarded by the cold, he says, does not seem, when observed under the microscope, to offer any deformation of the globules.

Mr. Oré[83] has verified these experiments. Having placed a rubber bag, empty of air, and full of the fresh blood of an animal, in the midst of a mixture of ice and sea salt, he gave back to the same animal, at the end of twenty minutes, the blood which he had just taken from it. The animal survived; he received, without feeling any discomfort, blood whose temperature had dropped to 0º.

"It is not, therefore, the cooling which brings about coagulation," says Malgaigne;[84] on the contrary, and when we want to try the transfusion, we will now know that, to keep it liquid, the best thing to do is to cool the blood and the syringe."

Thus, the practitioner will no longer have to think about keeping the blood to be injected at the level of the body temperature. Far from it, he will receive the blood in a vase which in turn is immersed in another vase filled with water as cold as possible, or in a syringe surrounded by cloths or compresses soaked in fresh water. But if he cannot cool it, he should not be afraid to inject the blood after leaving it at the temperature of the environment of the place in which it will be found. Since, by heating the blood, a very reasonable number of successes have hitherto been obtained, it is to be hoped, by acting as has been said above, to obtain an equal, if not more, number.

In conclusion, I would like to point out that the idea generally accepted today, that the blood *to be injected must be cooled*, is perfectly in accord with the facts advanced by Messrs. Béchamp and Estor. Indeed, according to them, fibrin is a product of post-mortem fermentation; and it is known that cold can stop or at least delay fermentation. So, this is another question solved, when it comes to mediate transfusion.

5°: *Addition of certain substances to the blood to be injected*. - It has been proposed, again with the aim of delaying blood clotting, to add drug substances to the blood to be injected.

Hewson[85] found that a fairly large number of salts of soda or potash cause the coagulability of the blood to disappear.

According to Messrs. Prévost and Dumas[86], one thousandth of a solution of caustic soda or potash suffices to produce this effect.

Denis recommends sodium sulphate. "Fourteen parts of this salt," says Mr. Desgranges, "suffice to delay the coagulation of 1000 parts of blood for several hours." Soda ash produces the same effect at half the dose.

Professor Rouget[87] advises that the apparatus to be transfused should be filled with bicarbonate of soda, so that the latter, expelled by the arrival of the blood in the instrument, and expelled in sufficient quantities before making the injection, maintains fluid the first layers of blood which penetrate the instrument.

Mr. Pavy[88] says, on the contrary, that carbonate, bicarbonate, and nitrate of potash are immediately fatal if injected with the blood; that carbonate of soda can be tolerated for a while, but that its harmful action soon makes itself felt.

Recently Mr. Branton Hicks[89] has proposed to add a solution of sodium phosphate to the blood as it is collected: six to eight ounces of this solution are sufficient for an operation. Unfortunately, he was unable to succeed in the three cases in which he used this method. (See Tables, obs. 88, 89, 90).

It should be noted that, proportionately speaking, the failures were more numerous when salts were added to the blood.

For our part, we do not believe that these substances are of convenient use for transfusion. First, they reduce the plasticity of the blood, increase the tendency to haemorrhage,[90] and finally alter the natural composition of the blood. Secondly, it is not always easy to have one of these substances on hand immediately. The addition of any salt to the blood is an unnecessary complication to the operation. If transfusion is to be made more practical, it is necessary to remove from the mind of the surgeon the idea that it is necessary for him to add foreign substances to the blood, which are often difficult to find.

6º: *Influence of the walls of the instrument, the shape of the vases, etc.* - Hitherto many different devices has been used to perform transfusion. Direct observation has shown that the blood is not subject to any fatal influence from the substance of which the walls of the instrument are formed, provided that this substance is not one of those which act in a peculiar manner on liquids. Thus success has been achieved by the use of syringes; either of glass, tin, silver, or nickel silver (See the Tables).

It is only necessary that their walls should be as perfectly polished as can be demanded; for, although the blood is not destined to remain long in the instrument, it must not be forgotten that the roughness can promote coagulation, the formation of small clots, since "the very folding of the inner membrane of the vessels suffices to coagulate the blood, that is, to act as a foreign body."[91]

If the blood is received in a vessel, it is better that the vessel should be narrow and deep, for coagulation takes place more rapidly when the blood is received in a flat and wide vessel. Receiving it directly into a syringe avoids wasting time; secondly, this instrument does not have the shape of a vase that promotes blood clotting.

VI. CONDITIONS IN WHICH THE SUBJECT WHO PROVIDES HIS BLOOD MUST BE FOUND.

The person who donates blood must not be sick, for if the patient escapes the immediate dangers of injection, he may succumb as a result of the inoculation of the altered blood. Numerous experiments have demonstrated the truth of this proposition. Thus it was that a dog died of the plague to which Mr. Deidier had transfused blood into which he had passed the bile of a plague-stricken patient; that the glanders were imparted to healthy horses in which Viborg had transfused blood from other snotty horses.

It is therefore necessary to avoid taking the blood of individuals with syphilitic, cancerous, scrofulous diathesis, etc. Mr. Neudörfer attributes one of his failures to the injection of blood he had taken from a man suffering from a violent attack of gout.

Let us add, however, that if, in order to remedy the accidents of haemorrhage, the physician could only take blood from a single individual, of a strumous constitution, for example, he should not hesitate. Fighting impending death, at any cost, must be his first thought; once this urgent indication has been met, he will take care of modifying the quality of the introduced blood by an appropriate treatment.

But when he can do otherwise, his choice should not be doubtful. In a healthy man, indeed, especially in one who possesses a sanguine temperament, we may hope to find a blood rich in globules, and consequently very apt to awaken rapidly the activity of the heart.

And besides, while we wish to save an individual, we should not make another individual sick by an inopportune withdrawal of a certain quantity of blood. If we know that 200 or 300 grams of blood can be taken with impunity from an adult man or woman who is vigorous and healthy, we also know that it could not be safely taken from them if they were sick. Moreover, the blood they would provide would be low in blood cells.

The person who donates blood should not be too old. The increase in the number of blood cells corresponds to adulthood (Polli). From five months to forty years, the number of globules increases and the quantity of water decreases; from the age of forty until death, it is the opposite: the proportion of water increases that of globules decreases (Denis).

To conclude, we will agree with Mr. Desgranges that the blood of an adult person who is not yet 40 years of age is to be preferred, since the globules are rightly regarded as the life-giving part of the blood.

The blood of a man is to be preferred to that of a woman. This is because a man's blood contains more blood cells, a woman's more water. According to Mr. Becquerel and Mr. Rodier, the difference between the two is as follows:

Blood	Men	Women
Water	77.9	79.1
Blood cells	141.1	127.2
Fibrin	2.2	2.2
Albumin	69.4	70.5

As we can see, a man's blood deserves preference, whether it is transfused to another man or to a woman. Generally, especially in cases of puerperal metrorrhagia, it is the husband of the woman who gives blood. But if there were only a woman with the patient, we should not lose confidence, for the constitution of the woman's blood is very similar to that of the man's blood. Moreover, in perusing the Tables of Observations, we see just as many successes obtained by the injection of a woman's blood, although it contains a little more albumin.

Mr. Belina argues that it is better to take blood from an individual in whom digestion has just taken place, because this blood contains more elements of nutrition. But we will remark, with Mr. Sée, that the nearer we approach digestion, the more coagulable the blood is, because its temperature is higher than during abstinence.

VII. OF THE QUANTITY OF BLOOD THAT MUST BE INJECTED.

Let us say in the first place, that it is not necessary to restore to an individual who has been rendered anaemic or plunged into a state of apparent death, a quantity of blood equal to that which he has lost. "If it were otherwise," says Mr. Béclard,[92] "one existence could only be redeemed at the expense of another, or else it would be necessary to practise a multitude of bloodlettings which would render the procedure inapplicable. A haemorrhage is fatal only if the amount of blood lost exceeds a certain limit; as long as the haemorrhage remains below this limit, the quantity of blood contained in the vessels, though much diminished, is sufficient to sustain life, and the mass of the blood is gradually replenished, when the source of the haemorrhage is dried up."

The amount of blood to be injected varies according to the circumstances in which the patient is placed. You can't give a fixed number; you can't set a precise rule. The physician should take advice only from his own judgment, as to what course he will follow. In fact, depending on whether a more or less long time has elapsed since the haemorrhage took place, according to the fact that a first injection has not produced any obvious improvement, a greater or lesser quantity of blood should be injected. The average amount of blood

injected was 250 grams. (See the Tables) And yet it is not always necessary to inject such a large amount. Didn't Mr. Marmonier succeed by injecting only 90 grams?; 60 grams (Kilian), 30 grams even (Soden), have sometimes sufficed; and if we see that 300 grams (Collins), 450 grams (Clement), 720 grams (Wheatkroft), 1,000 grams (Richet), were necessary, it should be noted that this quantity was injected several times, the operator allowing a variable amount of time, even a few days, to elapse between each injection. Often a 60 gram injection produced happier effects than an injection of 300 grams of blood. All in all, we believe that 200 to 300 grams must suffice, if one does not wish to expose oneself, by injecting too great a quantity of blood, to the occurrence of phenomena of congestion, either towards the lung or towards the brain.

If it is remembered that, although a man loses all the blood he can lose through an open vessel, there is still a certain quantity of it left in the organs (Haller), it will be less surprising to reflect that a small quantity of injected blood suffices to bring back to life a dying man exhausted by haemorrhage. "The urgent indication," says Mr. Bérard,[93] "is to set in motion the cogs which have ceased to function, so that the individual who has been subjected to the transfusion may afterwards form blood by his own activity." What is required of the transfusion? An excitation of the central organ of circulation, an awakening of its contractions. Well! When this revival is obtained, the desired result is obtained, since the excitation produced allows the forces to repair themselves, gives the physician time to assist this improvement and to ensure the final cure by appropriate means.

Moreover, there is in man a peculiar disposition, varying according to each individual, a power to resist more or less a loss of blood. It must not be forgotten that the blood is repaired and reformed with a rapidity of which we do not know the exact extent.[94]

This last reflection applies both to the person who gives blood and to the bloodless individual who receives it. In short, it will not be difficult for the practitioner to calm the alarms which the donor of his blood may have, and to find, even if he has only one helper with him, a quantity of blood sufficient to perform the transfusion successfully.

VIII. OF THE ACTION EXERCISED BY THE INJECTED BLOOD.

Blood acts in various ways on the new organism into which it enters.

1°: It acts primarily as a *stimulant*. Its immediate effect, through its contact with the inner wall of the heart, is to awaken the contractility of the muscle fibres of this organ. Under the influence of the heart's excitation, the arteries resume their functions; life, on the verge of extinction, is brought back by them into the organs; in a word, there is vascular excitation.

Experiments have confirmed this opinion which Haller had left us. I will mention only the most remarkable. Schiff has shown that a frog's heart no longer shows any contractile movement when it has been bled dry, and that the beating is immediately felt again, as soon as blood is injected into the atrium. Budge went further: after cutting fragments of the heart at the moment when that organ contracted, and after removing from them all the blood with which they were impregnated, he saw the contractile movements cease instantaneously, and return immediately after bringing these fragments into contact with blood again.

The stimulating action exerted by the blood on the walls of the vessels is confirmed by Blundell's experiment. Thus, in a dog which had lost all its blood in consequence of an injury to the femoral artery, the transfusion was performed, and the action of the heart and vessels was so energetic that the clot which had formed at the opening of the injured artery was violently thrown out. More recently, Brown-Séquard has revived muscular contractility by injecting blood into the vessels of the arm of a torture victim already suffering from cadaveric rigidity. Vitality has been maintained for forty hours,[95] by means of injections of blood, in a rabbit's limb separated from the body.

"As to the stimulatory property," says Brown-Séquard, "arterial blood possesses it in a lesser degree than venous blood, only because it contains less carbonic acid. - It is to the oxygen which the blood contains that we must especially attribute its power to regenerate the vital properties of the contractile and nervous tissues; for this, the integrity of blood cells

is necessary, as altered blood cells do not carry as much oxygen to the tissues as normal blood cells."[96]

In a learned lesson, Professor Küss (of Strasbourg)[97] has ingeniously developed this theory, which recognizes that the stimulating action of the blood belongs properly to the red blood cells, which themselves seem to act only as carriers of oxygen to the tissues. The facts related by Mr. Liebig, Jr., concerning the respiration of the muscles, which show that they absorb oxygen and produce carbonic acid, the experiments of Fontana, Humboldt, Tiedemann, and Polli, on the action of oxygen, carbonic acid, and other gases on the contractility of the heart of frogs, all this puts beyond doubt the powerful action of the oxygen contained in the blood to restore the muscles to their contractility.

2°: The blood can act through *its mass*. The fact is not doubtful: thus it has been possible to preserve alive an animal into the vessels of which blood was injected, without the addition of any other food. But, in general, it is rather by its action of contact than by its mass that the blood acts; otherwise, how can we explain the resurrection effects produced by the injection of 90 or 100 grams of blood into the vessels of an exhausted individual?

3°: The blood also acts as a local and general *modifier*. In the first case, it might almost be said to act as haemostatic, for a haemorrhage which could not be stopped has often ceased immediately after the transfusion has been performed. The mechanism is easy to understand. The collapse into which the person is plunged when exhausted by the haemorrhage prevents the vessels from contracting; but under the influence of the injected blood, their contractility reappears and puts an end to the haemorrhage.

On the other hand, it can be thought that injecting new blood into a diseased organism can advantageously alter its moods. Thus it is that Mr. Sotteau claims that the transfusion of good blood in an individual suffering from haemophilia may go a long way towards diminishing or permanently arresting this previous tendency to lose a fairly large quantity of blood, often through a trifling injury.

FOURTH PART

CHAPTER I
Practical considerations

I. WHEN THE TRANSFUSION SHOULD BE PERFORMED

The vitality of the vascular walls is an obstacle to blood clotting. In general, as soon as the irritability subsides, the tissues lose their fluidizing power (Brücke). The transfusion should therefore be carried out as close as possible to the time when the haemorrhagic accident occurred.

Should the transfusion be performed for the duration of the haemorrhage, or should it wait until it has ended? When there is a severe haemorrhage, and there is reason to fear that it will soon recur, as in cases of puerperal metrorrhagia, against which all ordinary means have failed, transfusion should be made during the course of the haemorrhage. The same will be true if there is a sudden haemorrhage, resulting, for example, from an arterial lesion.

But as long as it is hoped that the haemorrhage can be stopped or moderated on the basis of the general condition of the subject and the nature of the disease, it will be necessary to wait; for it is not uncommon, once the haemorrhage has stopped, to see patients, though previously reduced to excessive weakness, gradually and fairly rapidly regain vigour under the influence of tonic and restorative means. We can only congratulate ourselves on having been able to spare the patient the dangers of the operation.

Transfusion is only one supreme means of combating haemorrhage. When all the means used in such cases have failed (stimulants on the outside, diffusible stimulants on the inside), and the collapse becomes more pronounced, only then should the surgeon perform the operation. It appears from a full reading of the observations which I quote below, that the patients generally presented, at the time of the operation, the following symptoms: pallor

of the integuments; extreme weakness; swallowing difficult and often impossible; pulse varying from 120 to 140, often imperceptible, sometimes stopping beating at times; frequent syncope; rare, irregular, stertorous breathing, often seeming to be suspended; general cooling; sweats; weakened intelligence, sometimes non-existent; obscured vision; glare, dizziness, vomiting. Sometimes one symptom was dominant in this one, another in that. Often all these symptoms were not present in the same individual. Although the reading of the Tables which I present below shows that success has been achieved in cases where life seemed to have completely abandoned the subject, yet we must not wait to the last extremity, because, according to Panum, the shock produced by the nutrition of the nervous system in extremely weakened individuals, can be very dangerous. If the substitution of foreign blood in an organism is safe in itself, when it is made in small successive doses, this harmlessness diminishes more the further the weakening has gone and the more abruptly the strength is sought. Such a degree of weakness and the shock to the nervous system greatly diminish the hope of success.

Unfortunately, it too often happens that the doctor, summoned too late, does not run until the haemorrhage has ceased, and that he finds himself face to face with a corpse that is still animated by the breath of life. But he must not be discouraged; he will have to try the operation, even though it seems to him that it is no longer time to perform it again; for life is not extinguished immediately by even the most intense haemorrhage. Let him not forget, I repeat, that death by haemorrhage is death by syncope; that it is also by syncope that drowned people die (and it is known that they are often brought back to life when for two hours it had been believed that the care given to them was useless); let him remember that life may remain for some time in a latent state. Thus Blundell[(98)] revived a dog which he had made bloodless and which had remained without breathing for five minutes. "This experiment," says Mr. Moncocq,[(99)] "proves that life is maintained for some time longer in a latent state, when it no longer manifests itself by any function, and that the nervous system is apt to be impressed again if the blood is brought into the circulatory system before it has undergone important modifications."

If the haemorrhage occurs suddenly, says Branton Hicks,[(100)] the nervous system receives such a shock that there is little or no reaction to be expected; if the blood loss has been prolonged slowly, the shaking is not as great, and the case is less severe. The absence of a pulse at the wrist is not enough to make it appear that the operation is useless; for patients have been seen to recover quickly, although in them there was an absence of pulse for nearly an hour.

The amount of blood lost cannot be taken as a guide, even though it has been ascertained; for the loss of blood varies according to the strength of the patient and the conditions in which he is placed.

As to the loss of the voice and the muscular resolution, one is often surprised to find the voice loud and energetic efforts to the end, and which, no doubt, hasten the fatal termination. Nor should we entertain much hope when from the beginning there is a persistence of the imperceptibility of the pulse.

II. EFFECTS PRODUCED BY INJECTED BLOOD

No sooner has the transfusion been performed, or only a few minutes later, than the picture changes immediately.

The sick person seems to be waking up from a long sleep: she recovers speech; she can perform movements, sit on her bed, takes a few sips of a comforting drink that is presented to her. She said she felt a sensation of heat from the point where the injection was made, spreading in the direction of the vessels, going up to the shoulder and going to the heart. The breathing, which was irregular and embarrassed, becomes calmer and easier; the integuments regain some of their normal colouration; the eyelids open, and the more intelligent gaze rests with elaboration on the assistants; the heat returns to the skin; the

pulse is felt again, but more regular and less frequent. Most patients do not remember what happened before they lost consciousness.

During the operation, palpitations are sometimes noticed in the patient; sometimes it seems as if the subject is on the verge of suffocation. This is due either to too much blood being injected or to being too abrupt. Some experience tremors in their limbs. Others, after the operation, show a very keen thirst or are sometimes seized with vomiting.

The revival of organic movements, according to Messrs. Devay and Desgranges (and the observation which they have produced confirms this opinion), immediately follows the transfusion effected in cases of apparent death or post-haemorrhagic collapse.

III. OF THE CHOICE OF THE VESSEL

All the veins on which phlebotomy is performed could be used for blood transfusion. Generally speaking, the veins of the fold of the arm have been chosen: sometimes the cephalic median, sometimes the basilica median, because they really seem more convenient than the others. "They are taken to the right or to the left, depending on whether the volume or the appearance makes it easier to discover one than the other. These veins, in fact, are superficial enough to be dissected by means of a shallow wound, small enough so that there is no need to fear the entry of air, and so that the flow of blood can be stopped, as after bloodletting, and large enough to allow the use of instruments of sufficient calibre."[(101)]

The veins of the lower limbs are excluded because they are too far from the heart. It may be asked, however, whether this circumstance would not rather be an advantage, for a very large quantity of blood might perhaps be introduced into the body through this region, without fear of a sudden congestion in the heart. Could it not also be possible to inject into the internal saphenous vein, towards the place where the bleeding of the foot is chosen, in the event that this vein is more visible than the veins in the fold of the arm?

The aponeurotic sheaths, which keep the veins of the neck and armpit gaping, when they have been incised, render the introduction of air very easy. That's why they were reserved for animal experimentation. In the cases, very rare indeed, where the jugular has been chosen to perform transfusion on man, there has almost always been a fatal accident to deplore (Jewel, Scott).

IV. CARE TO BE GIVEN

1°: *During the operation*. - If the physician has an intelligent helper near him, he should ask him to warn him when the patient's pulse begins to beat again; because it will be a warning to him to slow down the injection.

The chances of success will be further increased if he can, at the same time as he pushes the injection, compress the chest walls of the patient in turn, so as to establish a sort of artificial respiration. Very good effects have often been obtained, by Mr. Brown-Séquard among others[(102)], by the simultaneous use of these movements, aided by pulmonary insufflation.

It is understood that the arm on which the transfusion is to be performed will be firmly held so that these movements do not cause the cannula to come out of the instrument engaged in the vessel.

2°: *After the operation*. - Once the transfusion has been performed, the surgeon's care should not be limited to that, as the transfusion has only awakened life that is about to be extinguished; through a local, temporary action, it has made it possible to save time.

The reaction we wanted to produce has been achieved, but it must be prolonged and sustained. The organism, overexcited for a moment, may again fall back into a state of prostration and stupor, if we do not come to its aid, if it is not helped to repair its losses, to

sustain its strength. The doctor will therefore give the patients hot and stimulating drinks; he will order dry rubs, tonics that seem useful to him according to the circumstances, etc.

When there is no accident unrelated to the transfusion, and nothing has interfered with the operation, recovery is fairly rapid. After fifteen or twenty days, patients have been seen to resume their usual occupations.

V. ACCIDENTS THAT MAY DEPEND ON THE TRANSFUSION

Although observation has shown that the dangers to which the operation of transfusion might give rise have been greatly exaggerated, it must nevertheless be admitted that, for want of precautions, and often in spite of the precautions with which he sought to surround himself, the physician might have feared certain accidents, the sudden arrival of which would compromise the success of the operation. We will mention the following:

A. DURING THE OPERATION.

1°: *Blood clotting*. - In addition to the fact that the coagulation of the blood prevents this fluid from entering the vessels, it can also give rise to the formation of embolisms, the dreadful consequences of which need not be recalled here.

In the third part of this work, I have laid sufficient stress on the means of preventing the coagulation of the blood that it will be useful to return to it.

By looking through the Tables that follow, it will be possible to convince ourselves that this accident was much less frequent than has been stated.

2º: *Air penetration*. - It is the accident that is most to be feared, and we can never do enough to try to avoid it; for we know with what rapidity and violence fatal symptoms manifest themselves when the air penetrates the heart (Denys, Jewel, Scott). This is a misfortune that may befall the most experienced surgeon, since he has arrived at Dupuytren.

Air may be introduced with the blood, if the precaution has not been taken to make the vacuum as perfect as possible in the syringe or pump casing of any transfuser. It can enter it of its own accord, by the mere fact of the opening of the vein, especially if the latter, by its anatomical relations, remains gaping after having been incised: this is what happens with the veins of the neck; the operation should also be avoided on them.

But air can also enter through the incision made in the veins of the arm. To prevent this, care should be taken, before opening these previously dissected vessels, to make a loose ligature above the point where the incision is to be made, in order to be able to introduce into the vessel the cannula of the syringe or the tapered end of a transfuser at the very point of the vein included in the node of the ligature; an assistant then tightens the knot of the ligature, which applies the walls of the vessel exactly to the cannula, so that air cannot pass between them.

If, in spite of all the precautions taken, the patient should experience a general convulsive movement, a twisting of the muscles of the face, during the injection, as happened without fatal result to the patients of Mr. Soden and Mr. Dutems, the injection should be stopped instantly, and waiting until these accidents had dissipated, if they did not lead to death. But, according to the experiments of Blundell, Magendie, Nysten, and Amussat, it is certain that a small quantity of air injected into the vessels can be sustained without causing lasting disturbances.

As this question is an important point in the study of transfusion, it will not be surprising that I should dwell on it for a moment. I can do no better than reproduce the following conclusions from the important work of Mr. Oré on the introduction of air into vessels.

"1°: The air introduced into the vessels of an animal can be tolerated if the dose is low. If the animal is of medium size (dog) and the dose does not exceed 50 cubic centimetres, it will be tolerated without determining accidents. It is therefore reasonable to suppose that

this tolerance, observed in dogs, must all the more exist in humans. This complication is therefore not to be feared during the transfusion, for the syringe used for the transfusion[103] is too perfect in its mechanism to allow so great a quantity of air ever to enter the circulatory system.

"2°: If, on the other hand, the dose of air introduced rises above 60, 80, or 100 cubic centimetres, it will lead to death after two or three minutes.

"3°: The air, on entering the vessels, causes the distension of the right chambers of the heart, and strikes the muscular fibres of the walls of the right ventricle with immobility. On the contrary, the contractions persist, although weakened, in the walls of the left cavities and a little in the right atrium, despite the distension of the latter.

"4°: The distension of the pulmonary heart and the interruption of the pulmonary circulation are not the only causes of death, as Nysten and Amussat, and with them most physiologists and surgeons, think; for gases (nitrogen, hydrogen, oxygen, carbonic acid) may be introduced into the veins in quantities equal to, and even greater than that of the air which kills animals, without causing death. Now, while taking into account their degree of solubility in the blood, my experiments allow me to think that they must distend the heart, so distension is not sufficient to explain death.

"5°: The air has a sedative action on the muscular fibre of the heart, and causes the paralysis of the right ventricle to be more or less complete. The immobility of the muscle fibres of the heart depends on the mechanical distension of the right chambers and the sedative action of the air; for it is sufficient to puncture the wall of the ventricle, and to give an outlet to a part of the gas which it contains, to see the movements of its walls immediately reappear.

"6°: The paralyzing sedative action of the air being admitted, reasoning led me to think that by opposing it with an excitatory force, an energetic stimulation, local or general, I might perhaps be able to neutralize it, and prevent the fatal consequences determined by the presence of this gas.

"7°: The excitation of the pneumo-gastrics to the middle part of the neck by means of electric currents prevents death.

It is not necessary to electrify the trunk of the nerve directly; it is sufficient, in fact, to place one of the conductors on the sheath which encloses it, in its vicinity or even in the mouth of the animal, and the other in a wound made on the chest wall.

"8°: This procedure causes a dilation of the thoracic walls which results in the dilation of the lungs. Now, if inspiration is enough to draw atmospheric air into the heart, through an opening made in one of the deep veins of the neck or armpit, it is rational to admit that the forced dilation of the walls, and consequently of the lungs, by the action of currents, enables these organs to rid the heart of a part of the air which it contains; that finally, they act as a suction pump."[104]

The interesting researches of Mr. Oré, and their happy results, are certainly of a nature to calm the concerns of the surgeon who performs an operation on the neck or in the armpit. This is the first time this application of electricity has been reported. But if the physiologist is indebted to Mr. Oré for a new and ingenious means, which may assist him in the work of his laboratory, and perhaps facilitate other discoveries, I believe that the medical practitioner can derive but little benefit from it, unless he knows the day and hour on which he is to perform an operation and that he had not had time to arrange everything around him for the critical moment. But blood transfusion operations are not only performed in anatomical lecture halls or hospitals, when the surgeon has all the apparatus at hand, arranged in advance and ready for operation; suppose (and this is the most general case) a doctor called at night, for example, at a distance, to finish a laborious delivery: he cannot know beforehand whether he will need to perform the transfusion, nor in what conditions of environment he will be placed, if this operation becomes necessary. Will he have to carry an electrical appliance with him every time?

But it is no less true that Mr. Oré has endowed science with an important fact which has been appreciated, and which indicates the beginning of an era of perfection in the history of the transfusion of blood.

In summary, it becomes evident that the fear of air penetration is not such as to prevent practitioners, even the least inexperienced, from attempting transfusion. Moreover, it will be seen, by consulting the Tables, how this fear has hitherto been wrongly exaggerated, and how few cases of death are due to the penetration of the air.

3°: Sometimes, during the operation, the patient presents symptoms of asphyxiation, or experiences a nervous breakdown. This is due to the injection of too much blood, or because it was done too suddenly. So I can't stress enough to push the injection slowly and in small successive strokes.

B. AFTER THE OPERATION

Phlebitis has long been regarded, but unjustly, by Mr. Cazeaux in particular, as one of the accidents almost inseparable from the operation of transfusion. Fortunately, there is a tendency today to reverse this prejudice. In perusing the Tables, one may be convinced that, if it has sometimes appeared after the transfusion, it has at least been very slight, and that it has very seldom led to an unfortunate result. The fear of phlebitis cannot be frightening, for it cannot be compared with the urgent indication which the operation of transfusion entails. Why should it be more to be feared here than in phlebotomy or varicocele surgery? In the majority of cases, the healing of the wound made by the incised vein was completed in a regular manner, even in the case reported by Mr. Martin, in which the vein was bare to the extent of an inch. "This fact," says Mr. Jaccoud, "seems very apt to demonstrate, even to the most incredulous, what is to be thought of the alleged irritability of the inner membrane of the veins. Is it not time to reduce the somewhat fantastic domain of primitive endophlebitis to its true extent? Is there not in this fact (and others no less significant) the clinical confirmation of Virchow's precise experiments?"

According to Professor Velpeau, there is no wound amputation without phlebitis of the divided veins: but nothing less serious than adhesive phlebitis. In any case, well-done applications with cold water, with an astringent solution, can prevent the onset of phlebitis. If it occurs, it requires no other treatment than that used for phlebitis which occurs as a result of a simple bloodletting.

CHAPTER II
Operating manual

I. IMMEDIATE TRANSFUSION

The purpose of immediate transfusion is to pass immediately, instantaneously, from the vessels of one individual into those of another individual, natural blood, containing all its principles, and completely removed from the influence of atmospheric air.

A. BLOOD SUPPLIED BY VEINS

The typical device would be a tube that would connect the patient's vein to that of the person who would donate blood. But the impulse of the blood coming out of the vein of the latter is not great enough to allow the blood fluid to penetrate far forward into the vein of the patient, and to reach the heart. On the other hand, it would be necessary that venous blood should still be able, like arterial blood, to penetrate successively and in waves of blood. It is to replace these qualities that various devices has been proposed, which are in the end, only a more or less modified tube.

I will not attempt to describe all the devices that have been presented, there are too many of them; I will leave aside those who have been abandoned,[105] and speak only of those who have remained in practice.

1. Devices of Messrs. MATHIEU[106], AVELING[107], ROUGET[108], ORÉ[109]

These devices are generally made up of a reservoir, a rubber sphere to which two tubes terminate, one intended to be introduced into the vein of the person who gives blood, the other into the vein of the patient. At the point where each tube ends at the common ladle, there is a valve operating in the opposite direction in each of the tubes. Vacuum is made by pressing with the hand, and when the sphere is full of blood, it is squeezed and released alternately, so as to simulate the movements of diastole and systole of the heart. The blood, thus squeezed, escapes by lifting one of the valves, while on the contrary it applies the other, which opens in the opposite direction, against the internal orifice of the tube.

2. Device of Mr. MONCOCQ (from Caen)

By means of this apparatus, to which he has given the name of haematophore, Mr. Moncocq has proposed to connect, by an uninterrupted current, a plethoric subject destined to supply blood, and an anaemic subject destined to receive it.

The middle part of this intermediate-circulating instrument is a small cylinder of graduated glass, playing the role of an artificial ventricle in which a full piston forms systole and diastole, by its alternating movements of elevation and descent.

Two small, very sensitive valves, placed in opposite directions at the lower part of the artificial ventricle, serve to direct the blood stream. These valves are replaced by a capillary rubber tube, 15 to 20 centimetres long. Each capillary tube is terminated by a curved silver needle, canaliculated, and carrying on its convex part, 45 millimetres from its tip, an opening which terminates the canal with which it is pierced.

The blood in the vessels being perfectly liquid, if its instantaneous contact with an unorganized tube did not coagulate it, it would have to pass through the apparatus, according to the physical laws of ordinary liquids.

Now, this is how, in Mr. Moncocq's mind, the haematophore was to function: given two animals immobilized for transfusion, the vein of the animal which is to receive the blood is pricked with a needle, so that the opening of the canal which it carries to its convex face, after having crossed the vein at two points, comes out.

With the other needle the vein of the animal which is to give the blood is similarly pricked, with this difference that the opening of the needle is in the very centre of the vein, and plunges into the bloodstream.

The two needles being thus arranged, if the diastole is made in the cylinder, by raising the piston which runs through its interior, the first effect of the vacuum which is made is to open from outside to inside the valve placed at the entrance of the tube, the tapered end of which receives the blood of the healthy animal; this valve is pressed first by a few bubbles of air contained in this tube, and immediately by the blood which flows from this tube.

If systole is then performed by lowering the piston, the blood and air of the ventricle are expelled into the tube which is to enter the vein of the diseased animal, and the whole comes out through the opening of the second needle placed at the end of this tube. From then on all the air is expelled from the apparatus, and by bringing the opening of this second needle into the centre of the vein which is to receive the blood, the current is established, and it only remains to operate the ventricle, each systole of which expels a wave of blood proportional to the movement which is imparted to the piston, a wave of blood which can be estimated by the graduation in grams of the crystal cylinder. The piston is driven by means of a cogwheel.[110]

This apparatus is very ingenious and quite easy to handle.

3. Device of Mr. ROUSSEL (from Geneva)

In 1865, Mr. Roussel presented an apparatus based on two new ideas: 1º to surround the blood sample with a sleeve empty of air and impermeable to air; 2º to make the bleeding under water, to expel the blood into a channel full of water and empty of air, directly and hermetically connecting the vein that gives to the one that receives.

This device is less simple than the previous ones: it is made up of several parts, which makes it more difficult to apply. But it is very ingenious, and avoids several disadvantages which the preceding devices present.

B. BLOOD DRAWN FROM CAPILLARIES

Device of Dr. GESELLIUS MÜNX.

Mr. Gesellius (of St. Petersburg) presented a new apparatus by means of which he could transfuse the blood extracted from the capillaries. The blood is exhaled on a healthy man by a kind of scarifying suction cup and injected into the patient's vein.(111)

I regret not to give a fuller description of this apparatus: I have not been able to obtain the work of Mr. Gesellius.(112) But it is to be feared that in order to expire the blood, a mere scarification will not suffice; it is probably essential to penetrate deep into the tissues, in order to obtain a certain amount of blood. And then, independently of the slowness required by this mode of operation, it may be questioned whether the force of impulse of the blood coming out of the capillaries is great enough to allow this liquid to penetrate to the heart of the bloodless subject.

II. MEDIATE TRANSFUSION

Mediate transfusion is the one that has almost always been performed on humans. Obviously, immediate transfusion is preferred. And if the latter has not been practiced more often, it is because we have not had a necessary device on hand.

But mediate transfusion is too successful to be considered any less useful. On the contrary, it is chiefly to the study of mediate transfusion that attention should be attached, because the instruments necessary for its practice are less difficult to obtain.

The device that has generally been used by those who have performed mediate transfusion is the syringe. Only in the last few years it has been practised sometimes with Mr. Mathieu's device.

1. Device of Mr. MATHIEU (fig. 3).

This device, presented to the Academy by Mr. Mathieu,(113) consists of an inverted pump body, surmounted by a funnel A; at the lower part the piston, perforated along its entire length, communicates to an elastic tube E bearing at its end a small adjustment F, intended to penetrate the cannula of the small trocar G, which is previously placed in the vein.

The play of this device is easy to understand: the supplied blood is received in the funnel; by moving the piston by means of the key B, it is driven into the pump body and passes naturally through the hollow rod of the piston, to arrive in the cannula F and in the vein of the receiver.

Air penetration is impossible; the blood passes very quickly through the patient's vein; it is in contact with the air for a very short time. In short, it is only a modification of Mr. Moncocq's haematophore.

2. Of the syringe

All the devices we have just reviewed, however excellent they may seem, have one immense defect, that of being too little used.

As long as it is possible to believe that a special apparatus is needed, complicated, difficult to handle, not easy to procure, transfusion will never become a practical operation. You need an instrument that is widely used, whose playing is known to all. What instrument better achieves all these conditions, if not the syringe? The doctor does not know when he will be called upon to perform a transfusion operation. He is far from home, or he does not have a transfuser in his surgical arsenal (this is not uncommon). What will it do? Pressed by circumstances, he will look for some instrument that can replace those that are absent. There are few families who do not have a syringe. If, by chance, this instrument should be wanting in the house of the patient, there is always, in such cases, a friend, a relative, or a neighbour at the bedside of the dying man, who can procure one easily and promptly.

Have the majority of transfusion operations not been performed with this instrument? Well! "From a very practical point of view, we can give birth attendants the prudent advice to have in their 'snack' kit an injection or hydrocele syringe, graduated, always clean and in good condition. In how many cases would the idea of the operation not be discarded by the mere circumstance that the apparatus considered necessary would not be ready at hand! Now, we have seen in the remarks of Mr. Marmonier, in those of Messrs. Devay and Desgranges, that the only thing necessary is, in short, a syringe proper."[114]

"The syringe, by its depth, leaves the blood in contact with the air only over a small area, and as soon as the plunger is placed and the internal air expelled, the blood is perfectly isolated from the atmosphere."[115]

Finally, the small volume of the instrument, the ease with which it can be immersed in a vessel filled with cold water, and the ability to remove it from compresses which cool it, all combine to make the syringe considered as an instrument of very convenient use, and to redeem by special advantages the disadvantages which may be attributed to it.

Operating mode. - The necessary instruments are in the surgeon's kit; these are: a scalpel with a convex edge, a lancet, and a dissecting forceps. In addition to the syringe, care should be taken to have thread, compresses, a cord to bleed, an empty vessel (to receive the blood, if there is no other option), and a vessel filled with cold water (either to plunge the instrument into, or to be able to avoid the inconveniences of syncope in the person to be bled). The operator will very gently calm any unfair fears that the latter might conceive about the role he will play in this delicate moment.

The veins in the patient's arm are first swollen by means of a phlebotomy ligation (a precaution that does not often lead to this desired result, but which always has the effect of making the skin of the fold of the arm on which an incision is to be made less mobile). The surgeon then looks in the crease of the patient's elbow for the largest and most suitable vein for injection, namely: the medial cephalic, or the superficial ulna, or the radial, or even the basilica. He makes an incision 2 centimetres long in the skin in the direction of the vein. The latter is uncovered, isolated, dissected in the same extent, and lifted with a loop of thread. In this way, it is flattened and the circulation is interrupted. The return of blood through the lower end can also be prevented by compressing the vein with an aid below the place where it was dissected.

The vein is then cut into an area of 3 or 4 millimetres, which varies with the size of the syringe spout. This incision can be made with the lancet or with the help of the scalpel. In another case, the superficial wall of the vein is grasped with forceps, above the loop of thread which lifts it, and the vessel is divided with scissors into half its circumference. This incision is made in an oblique direction, so as to form a small V-shaped flap, the apex of which is directed towards the peripheral extremity of the vessels.

A small cannula, if one is contained in your kit, is inserted from bottom to top, through the incision or by insinuating it below the small flap of the venous wall, and it is inserted in a sufficient quantity so that the venous wall, being applied exactly to its surface, can oppose an obstacle to the reflux of the injected fluid. The constrictor is then removed from the

patient's arm, and the things thus prepared are entrusted to an assistant. The cannula can be attached by a thread.

The person who is willing to do so is then bled and the blood is received in a vase, and better directly in the syringe. When it is almost full, the bleeding is momentarily stopped (the subject will be seated to prevent syncope). The syringe is placed vertically, and the plunger is squeezed so that a first stream of blood comes out; the air in the syringe will be expelled and the injection will be carried out immediately.

The spout of the syringe is also inserted from bottom to top into the cannula, or if there is none, into the incision of the vein itself, taking care to have the walls of the vessel fixed to the end of the syringe by means of the loop of the thread which passes under the vein.

The whole operation must be done very quickly, but it is necessary to bring extreme slowness in the pressure of the piston, the injection will be made in small successive strokes.

It is good to keep the arm elevated during the operation, to exert some upward friction on the limb, if it is deemed necessary.

If you think you need a second injection, don't be in too much of a hurry; the heart must have, so to speak, digested the blood of the first.

Once the operation is over, the wound will be dressed as a first intention.

Before I conclude, I think I should mention two changes that have been made to the regular syringe.

a. Modification made by Mr. ORÉ (fig. 2).

At the end of five minutes the blood coagulates out of the vessels, but it does not immediately collect into a mass, small, very small, fibrinous clots begin to form at first. Fearing to inject these small clots, if the operation lasted one or two minutes longer than had been anticipated, Mr. Oré proposed to place in the flared part of the cannula a flattened circular frame (fig. 2), made of steel, over which is stretched a wire mesh whose network, with a very tight mesh, must retain the small clots and allow only the part of the blood that remains liquid to pass through.

With the help of this modification, Mr. Oré tried experiments which were crowned with complete success.

b. Modification made by Mr. PAJOT (fig. 1).

It is a syringe whose pump body is made of very strong crystal walls. The two ends are made of metal and connected together by two lateral rods to the pump body, provided with a graduation which gives the measurement of the liquid contained. At the lower part of the instrument is a funnel A, on a friction collar which communicates with the interior of the pump. A hole, B, arranged in the same way, is intended to leave a free outlet for the air, when the blood of the subject who supplies it enters the syringe through the funnel. As soon as the instrument is loaded, a small rotational movement is made to the collar, and the two communications A and B are intercepted; the piston is then pushed, as above, to purge the instrument of air; then the cannula is immediately placed in the small ivory tube C, which has been previously placed in the vein D and which serves as a conductor for the injected liquid.

From all the foregoing, we think we are entitled to conclude, from a purely practical point of view only, that:

1°: The operation of transfusion is not very difficult to perform; that it does not require a special device.

2°: That the dangers of this operation for the patient are less than has generally been believed.

3°: That it is not necessary to heat the blood to be injected.

4º: That 150 or 200 grams are enough most of the time.

5°: That it is not essential to defibrinate the blood.

6°: That this operation is only an extreme means, reserved especially to combat post-haemorrhagic collapse.

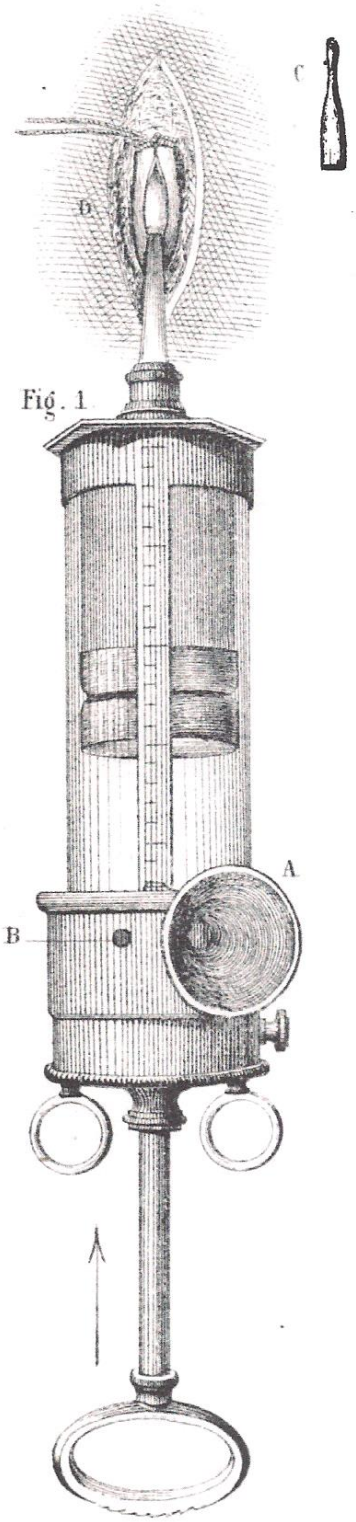

Fig. 1

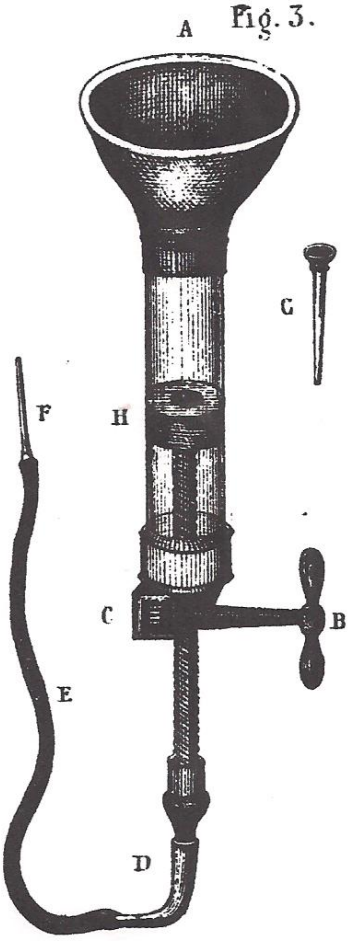

Fig. 3.

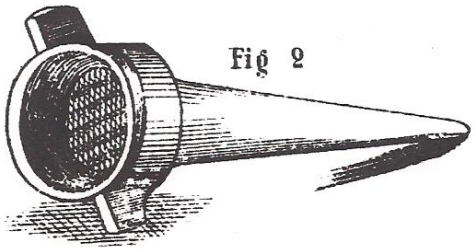

Fig 2

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(32) Éléments de chirurgie opératoire, 1858, pag. 83, 2^{e} édit.
(33) Traité cliniq. et pratiq. des opérat. chirurg., tom. I, pag. 408; 1861.
(34) Gazette des hôpitaux, 1851 (18 mars), et Revue médicale, 1851.
(35) Gazette médicale de Paris, 3 janvier 1851.
(36) Je saisis l'occasion de remercier M. Gasser, docteur de l'Université de Wurtzbourg; M. le Dr Gordon, bibliothécaire-adjoint à la Faculté de médecine de Montpellier; et M. Alengrin, aide-anatomiste en cette même Faculté: c'est grâce à leur concours bieveillant que j'ai pu puiser dans les ouvrages étrangers.
(37) Chailly-Honoré; Traité des accouchements, pag. 920 et suiv.
(38) Gazette des hôpitaux, 1852.
(39) Moncocq, thèse citée, pag. 59
(40) Cette note a déjà été communiquée par moi, il y a quelque temps, à mon collègue et ami le Dr Baumelou, et a paru dans son excellente thèse: *Des hémorrhagies passives de l'utérus*.
(41) Gazette des hôpitaux, 1854, pag. 6.
(42) Gazette des hôpitaux, 1868, pag. 373.
(43) Bulletin de thérapeutique, 1836, tom. X, pag. 122.
(44) Archives de médecine, 1828, pag. 470.
(45) Journal de physiologie de Brown-Séquard, 1858, pag. 669 et suiv.

(46) Archives de médecine, 1865, pag. 748 et suiv.
(47) Archives générales de médecine, 1865, pag. 749.
(48) Archives de médecine, mars 1868, pag. 378.
(49) Gazette des hôpitaux, 1865, pag, 586.
(50) Op. cit., pag. 146.
(51) Mignonnac; Des vomiss. incoërcibles. (Thèse de Montp., 1866, nº 6.)
(52) Archives générales de médecine, vre série, tom. VI, 1865, pag. 749.
(53) Gazette médicale de Paris, 1852, pag. 21 et suiv.
(54) Archives de médecine, tom. XXX, 4e série, pag. 347.
(55) Prévost et Dumas; Biblioth. univers. de Genève, tom. XVII, pag. 306.
(56) Bischoff; *Muller's Archiv*., 1835, pag. 347, et 1858, pag. 351.
(57) Leçons sur la physiol. et l'anat. comp., 1857, tom. I, pag. 326.
(58) Recherches physiologiques sur la vie et la mort, 1813, pag. 167.
(59) *Philos. Transact*., tom. I
(60) Union médicale, 1858, pag. 3.
(61) Leçons de pathol. expérim: *Du sang et des anémies*, 1866, pag. 3.
(62) Journal de physiologie de Brown-Séquard, 1862, pag. 653.
(63) Müller; Manuel de physiologie, tom. I, pag. 113.
(64) Archives de Virchow, tom. XXVII.
(65) Archives générales de médecine, 6^{c} série, tom. VI, pag. 747.
(66) Malagutti; Leçons de chimie, tom. IV, pag. 243.
(67) Giraud-Teulon; Gazette médicale de Paris, 1857.
(68) Leçons de pathol. expériment.: *Du sang et des anémies*. Paris, 1866, pag. 11 et suiv.
(69) Müller; Manuel de physiol., tom. I, pag. 97. Paris, 1851, trad. franç.
(70) Dumas; Traité de chimie, tom. VIII, pag. 505. Paris. 1846.
(71) Longet; Traité de physiologie, 1869, tom. I, pag. 600.
(72) Polli; *Ricerche ed esperimenti intorno alla formazione della cotenna nel sangue*. Milano, 1843.
(73) Longet; tom. II, pag. 18.
(74) OEuvres complètes, trad. franç. tom. III, pag. 46.
(75) Oré, *op. cit*. pag. 171.
(76) *Researches Phys. and. anat*., tom. II, pag. 64.
(77) Malgaigne; Traité d'anat. chirurgic., tom. I, pag. 480, 2^{e} édit.
(78) OEuvres complètes, tom. III, pag. 100.
(79) Longet; tom. II, pag. 27.
(80) *Essay on the blood*, pag. 19, London, 1824.
(81) *Edinburgh medic. and surg. Journ*., tom. XXX, pag. 251; 1828.
(82) Nicolas, thèse nº 79, pag. 38. Paris, 1860.
(83) Oré, *op. cit*. pag. 172.
(84) Op. cit. pag. 482.
(85) *Experim. Inquir. into the properties of the blood*, chap, I, exper. III.
(86) Bibliothèque universelle de Genève, 1821, tom, VII.
(87) Leçons orales, février 1865.
(88) *Guy's hospital reports*, 1869, pag. 6.
(89) *Guy's hospital reports*, 1869.
(90) Journal de physiologie de Robin, 1869, pag. 118.
(91) Sée; *op. cit*., pag. 60.
(92) Béclard; Traité de physiologie, 1866, pag. 293.
(93) Bérard; Traité de physiologie, tom. III, pag. 216.
(94) Longet; tom. II. pag. 30.
(95) *New-York medical Times*, 1852, pag. 355.
(96) Brown-Séquard; Journal de physiol. 1858, pag. 105 et 734.
(97) Leçons orales., janvier 1864.
(98) Annales des sciences, 1821.
(99) Moncocq; thèse citée, pag. 23.

(100) *Guy's hospital reports*, 1869. pag. 2.
(101) Gazette médicale de Paris, 1852.
(102) Brown-Séquard; Journal de physiol., 1858, pag. 667.
(103) M. Oré veut parler de la seringue dessinée dans la Planche qui se trouve à la fin de ce travail (*fig*. 1)
(104) Oré *op. cit*., pag. 153 et suiv.
(105) Blundell, Sotteau, Bougard, etc.
(106) Gazette des hôpitaux, 1853, pag. 480.
(107) *Obstetrical Society of London*, 1er juin 1864.
(108) Leçons orales, février 1865; et Mignonnat, these cite.
(109) Oré; Thèse pour le doctorat ès-sciences naturelles. Bordeaux, 1865, pag. 25.
(110) Moncocq, thèse citée, pag. 45.
(111) Gazette hebdomadaîre de méd. et de chir., 1869, pag. 45.
(112) *Capillar Blut undefibrinirtės zur Transfusion*. Saint-Pétersbourg, par le Dr Gesellius Müux.
(113) Gazette des hôpitaux, novembre 1866.
(114) Gazette médicale de Paris, 1857, pag. 817.
(115) Gazette médicale de Paris, 1852.
(116) *Sette casi di transfusione di sangue*. *Osservazioni di Enrico Albanese*. Palerme, luglio 1869.

TABLES OF TRANSFUSIONS PERFORMED

While the Tables were in press, we received a pamphlet from Dr. Enrico Albanese (of Palermo), in which is found the simple account of seven cases of transfusion:(116)

1º Transfusion performed against anaemia consequent on severe haemorrhage of the haemorrhoidal vein; 95 gram injection of blood; Healing (January 1869).

2º Transfusion performed in a case of anaemia following considerable metrorrhagia; Pulse at 140; Convulsions; Syncopations; 100 gram injection of blood eight hours after the haemorrhage; Healing (December 1868).

3º Transfusion performed in a case of anaemia following haemorrhage of the ulnar artery; imperceptible pulse at the other artery; cooling of the extremities; cadaverous pallor; 100 gram injection of blood; Healing (March, 1869).

4º Transfusion performed in a case of pyohemia, the result of a serious and old ulcer; 200 gram injection of blood in two instalments twelve days apart. There was a slight improvement. Died 24 days later (December 1868).

5º Transfusion performed in a case of pyohemia following severe trauma; 90 gram injection of blood; improvement. Died 7 days later (February 1869)

6º Transfusion performed in a case of pyohemia following fungal arthritis of the humeroulnar joint; deep slump; sweats. Resection of the lower end of the humerus; 116 gram injection of blood. Healing (June 1869).

I have elsewhere quoted the seventh observation (see the Tables, obs. 112); this brings the number of cases I have collected to 192, of which 101 have been cured.

Dr. Albanese has always used only venous human blood, defibrinated and filtered. The two failures which it has obtained should not be surprising: we have already said what we think of the use of transfusion against pyohemia.

TABLE OF THE TRANSFUSIONS PERFORMED

Note: The translation is as accurate as far as is possible given the original shortened wording together with the available space - PL

No	Year	Operator	Pathological indications	Operating manual	Result	Reflexions	Sources
1° - Against puerperal metrorrhagia							
1	1819	Blundell	Hem. during childbirth: breathing had stopped 5 minutes ago	Inject. of 480 gr. of blood taken from two men	Death	-	Rech. physiol., 1824, p. 136
2	1820	Blundell	After delivery: sterile breathing	Inject. from 100 to 120gr. of blood taken from a woman	Death	-	Transact. med. chir. t. XXXV, p. 428
3	1821	Blundell and Doubleday	After delivery: vague look; unresponsive pulse	Inject. of 420 gr. in 6 or 7 times	Healed	No consecutive accidents	Lancet, 1825
4	1825	Blundell and Uwins	After delivery: considerable weakness: pulse 140.	Inject. of 180 gr. of blood taken from two men	Healed	Trans. 4 hrs after hem. stopped; slight phlebitis	Lancet, 1825, t. IX, p. 205
5	1825	Blundell and Waller	After delivery: apparent signs of death: syncope.	Inject. of 180 gr. of blood received in a glass	Healed	Trans. 2 hrs after hem. stopped; slight phlebitis	Journ. d'Edimbourg, 1826, p. 353
6	1825	Brigham	After delivery: cadaveric coldness.	Inject. from 300 to 360 gr. with a syringe	Healed	-	Rev. méd.-chir., 1826, t. IX
7	1825	Blundell and Doubleday	After delivery: retention of the placenta, pr collapse	Inject. of 10 ounces of blood received in a glass, by syringe	Healed	Mild phlebitis	Arch. de Med., 1re ser., t. IX, p. 566
8	1826	Doubleday	After childbirth	-	Death	-	Lancet, t. IX, p. 783
9	1826	Waller and Doubleday	After childbirth: uncontrollable vomiting lasting for three weeks	Inject. 50-60 gr. taken from a robust man and a 14 yr child	Healed	-	Lancet, t. XII. p. 290.
10	1826	Ralph	Abortion in the 3rd month: haemorrh. during 10 hrs: deep annihilation.	Inject. 120 gr.	Healed	Trans. 10 hrs after the cessation of hem.	Lancet, 29 mai, 1826
11	1826	Georges Jewel	After childbirth: during injection had nausea & turned her cervix	Inject. 120 gr. blood through the jugular vein.	Death	The autopsy showed air bubbles in the heart.	London medic. & physiol., 1826
12	1827	Barton-Brown	After childbirth: insensitivity and dilation of pupils	Inject. 50-60 gr.	Healed	-	Edimb. Med. & sugic. Journ, avril 1828
13	1827	Douglas Fox	Before expulsion of the placenta: profound collapse	Inject. 120 gr.	Healed	-	London medic. & phys.., juin 1827
14	1827	Waller	After delivery: swallowing impossible, pulse imperceptible	Inject. 240 gr.	Healed	Headaches; subsequent hysteriform phenomena	Diss. sur la trans. du sang. Erl., 1832, p. 27
15	1828	Clémont	Abortion in the 6th month: extreme prostration	Inject. 400 gr. in the two median veins	Healed	-	Lancet, 2 févr, 1828
16	1828	Howel, Ravis, Doubleday	Before childbirth: insensitive pulse	Inject. 400 gr.	Healed	-	Lancet, 9 févr. 1828
17	1828	Klett and Schraegle	Hemorrh. in the 3rd month: general resolution	Inject. 60 gr.	Healed	Hem. of 18 hrs stopped immediately after transf.	Gazet. médicale, 1834, p. 744

18	1828	Klett	After childbirth – deep subsidence	Inject. 75 to 90 gr.	Healed	-	Arch. génér. de méd., 2e sér., t. VI, p. 117
19	1829	Blundell, Davis, Pointer, Lambert	After delivery – general coldness	Inject. 240 gr.	Healed	-	Lancet, 1829
20	1829	Savy	In 3rd month of pregnancy – signs of imminent death	Inject. 60 gr. taken from a woman using a tin syringe	Healed	-	J. univ. des sc. méd., t. LVII, p. 153
21	1829	Goudin	In 3rd month of pregnancy: repeated syncope, freezing cold.	Inject. 120 gr. taken from a sturdy girl	Healed	-	J. des progrès, 2es., t. II, p. 236
22	1830	Bird	Before childbirth. : placenta previa, collapse	Inject .120 gr.	Healed	-	Rec. de méd. et de chir. de Midlane, 1830
23	1830	-	At 3 months	-	Healed	-	J. univ., 1830
24	1830	Kilian	After childbirth	Inj. 60 to 75 gr. from a woman, made with a metallic syringe	Healed	-	Diss, de trans. sangue by Schiltz, p. 18. 1852
25	1830	Ingleby	After delivery: stertorous respiration	Inject 120 gr. 6 hours after delivery	Healed	-	*Id.*
26	1831	Kilian	During childbirth: considerable weakness	Inject. 60 gr. made with a metallic syringe	Healed	-	*Id.*
27	1831	Kilian	After giving birth : prostration becoming	Inject. 90 gr. taken from a woman	Healed	-	*Id.*
28	1831	Les internes de l'Hôt-Dieu	During childbirth complete annihilation	Inject. 10 ounces	Death	The agony had begun when the transf. was done	Bull. de thérap. t. I, p. 164
29	1831	Crosse	Hem. recurring for three weeks general cooling	Inject. 300 gr.	Death	-	Martin, op. cit., p. 29
30	1832	Banner	Following an abortion the patient seemed deprived of all feelings	Inject. 12 to15 ounces using Blundell's device	Healed	After tranf. - hiccups, headaches, agitation	Arch. génér. de m. 2es, t. III, p. 128; 1833
31	1833	Schneemann	Before delivery – signs of forthcoming death	Inject. 7 to 8 ounces	Healed	Mild consecutive phlebitis.	Gazet. médicale. 1833, p. 455
32	1833	Höring	After childbirth – collapse	-	Healed	-	Martin, op. cit., p. 29
33	1833	Bickersteth	At 8th month – imminent death	Inject. 300 gr. of blood from a woman	Healed	The transf. was made 2 hrs. after the haemorrhage	*Id.*
34	1834	Collins	After childbirth: imperceptible pulse, frequent vomiting	Inject. 300 gr. taken from a woman	Death	-	Martin, op. cit., p. 30
35	1834	Ingleby	After delivery: difficult and noisy breathing, agitation	Inject. 4 ounces	Healed	-	Arch. génér. de m. 2es,1834, t. IV, p. 339
36	1834	Kilian	After childbirth: disorders of vision, ringing in the ears	Inject. 120 to 180 gr. taken from a woman	Healed	-	Diss. de Schiltz, op. cit.
37	1835	Healey and Fraser	After childbirth: collapse lasting for 6 hours	Inject. 120 gr.	Healed	Full recovery 1 hr after	Lancet, mars, 1835
38	1835	Berg	After childbirth: seized face, vomiting	Inject. 75 gr.	Healed	After ~8 mins., patient opened eyes and spoke	Gaz. médicale, 1838, p. 381

39	1836	Twedie, Ashwell and Jackson	After childbirth: considerable prostration	Inject. 420 gr.	Death	Improvement only 1 hr after the last injection	Gaz. médicale, 1837, p. 460
40	1841	Richard Oliver	After childbirth: syncope, coma	Inject. 600 gr. taken from three people	Healed	-	Rev. médicale. 1841
41	1841	May	After childbirth	Inject. 735 gr. taken from four men	Death	Transf. stopped haemorh: phleb. uterine: death day 7	Rev. médicale. 1841. Tom. I, p. 294
42	1842	Wolf	*Id.*	-	Healed	-	Canstatt, 1842: par. 18
43	1842	Wolf	*Id.*	-	Death	-	*Id.*
44	1842	Wolf	*Id.*	-	Death	-	*Id.*
45	1842	Wolf	*Id.*	-	Death	-	*Id.*
46	1842	Wolf	*Id.*	-	Death	-	*Id.*
47	1842	Abele	After childbirth: placenta previa	-	Healed	-	Von Belina, op. cit., p. 47
48	1842	Neumann	*Id.*	Inject. 60 gr.	Death	-	*Id.*
49	1842	Ritgen	*Id.,* syncope	Inject. 60 gr.	Death	Sudden death caused by air penetration into vein	*Id.*
50	1842	Bayer	After childbirth: uterine inertia	-	Death	-	*Id.* – p. 49
51	1844	Bery	*Id.,* signs of asphyxia	Inject. 75 gr.	Healed	-	Carré; thèse de Paris, 1844
52	1844	Schroegle	After childbirth: adhesion of the placenta	-	Healed	-	*Id.*
53	1844	Schroegle	*Id.*	-	Healed	-	*Id.*
54	1845	Brown	After childbirth: epileptic seizure, craniotomy	Inject. 120 gr.	Healed	-	Von Belina, op. cit., p. 49
55	1848	Waller and Greaves	In the 8th month: profound annihilation	Inject. 660 gr. - blood taken from a man and a woman	Healed	The transfusion was followed by a long sleep	Times medical, jan. 1848
56	1850	Nélaton	During childbirth	Inject. 285 gr. – made with a hydocele syringe	Death	Metroperitonitis by autopsy - died on the 7th day	Arch. générales de méd., 1851, t. XXV
57	1850	Marmontier	After giving birth: imperceptible pulse, syncope, patient considered dead	Inject. 90 gr. – blood taken from a woman – child's syringe	Healed	Sleep occurred 2 hrs later	Gaz. médicale, 1851, p. 457
58	1851	Masfen	Abortion in the 4th month	Inject. Into the veins of both arms	Healed	Start. of phlegm. in right arm, near the incised vein	Bul. de thérap., 1851, tom. XL, p. 428
59	1851	Devay and Desgranges	Childbirth premature: immobile pupils, cadaveric pallor	Inject. 180 gr. – made with a hydocele syringe	Healed	-	Gaz. médicale, 1851, p. 4

60	1851	Marmontier	-	Inject. 240 gr. – blood taken from a woman	Healed	The healing ended slowly	Canstatt, 1851, t. V. Para. 153
61	1852	Schneemann	Adhesion of the placenta	-	Healed	-	Martin, op. cit., p. 37
62	1852	Schneemann	*Id.*	-	Healed	-	*Id.*
63	1852	Schneemann	*Id.*	-	Death	-	*Id.*
64	1852	Schneemann	*Id.*	-	Death	-	*Id.*
65	1852	Soden, Norman and Ormond	After delivery: stertorous breathing, swallowing impossible	Inject. 1 ounce blood with one nickel silver syringe	Healed	Transfusion followed by a general body convulsion	Médec. chir. transac., 1852, t. XXXV, p. 422
66	1852	Brigham	After childbirth: the patient has not spoken for 6 hours	Inject. 12 ounces of blood in 5 times	Healed	Operation followed by deep sleep	Arch. de méd., 1852, p. 336
67	1852	Turner and Wells	After childbirth: continuous dizziness	Inject. 240 gr. in the vein of the left arm	Death	Death 10 days post trans.; abscess left arm	Lancet, 1853
68	1856	Higginson	After delivery – complete prostration	Inject. 300 to 365 gr.	Healed	-	Journ. m. -chir. de Liverpool, 1857
69	1856	Higginson	*Id.*	Inject. 180 to 200 gr.	Death	-	*Id.*
70	1856	Higginson	*Id.*	Inject. 360 gr.	Death	-	*Id.*
71	1856	Higginson	During childbirth – adhesion of placenta – only part extracted	Inject. 140 to 150 gr. of thick black blood then salt solution	Death	Delivery could be made quickly but died before	Journ. m. -chir. de Liverpool, 1857
72	1856	Higginson	After the delivery	-	Death	Improvement then return of haemorrhage	*Id.*
73	1856	Simpson	*Id.*	-	Healed	-	Martin, op. cit., p. 41
74	1857	Wheateroft	After childbirth: dull eyes, cold sweat, unresponsive heartbeat, pinched nose	Inject. 510 gr.	Healed	Instant effect; inhaled and sudden return of heartbeat	Union médicale, 1858
75	1857	Wheateroft	In the 3rd month – syncope	Inject. 22 ounces of blood	Healed	-	Brit. m. Journ., avril 1858
76	1857	Martin (Ed.)	After delivery: extreme pallor, general cooling	Inject. 120 to 150 gr.	Healed	-	Gazette d'Augsbourg, 1857
77	1858	Dutems	At 4 months haemorrhage; no apparent cause; cadaverous appearance	Inject. 120 gr. – made with a hydocele syringe	Healed	During inject. – violent but temporary convulsions	Bullet. de thér., t. LVI, p. 85
78	1862	Martin	During childbirth	Inject. 290 gr. – made with Martin's device	Healed	-	Oré, op. cit., 1863, p. 158
79	1862	Hicks	After childbirth: adhesion of the placenta, general coldness, agitation	Inject. 18 ounces of blood	Death	Improvement then death 2 hrs after delivery	Gaz. m. de Lyon, 1863, p. 158
80	1862	Hicks	Before childbirth	Inject. 5 ounces in 2 times	Death	After 1st inj. pulse returned; then return of haem.	*Id.*

81	1862	Weickert	During childbirth – syncope	-	Healed	Despite denudation of vein to 1" – no phlebotomy	Gaz. des hôpitaux, 1862
82	1863	Greenholly	Abortion in the 7th month – collapse	Inject. 80 gr.	Healed	-	Lancet, mars 1863
83	1863	Vernou and Thorne	*Id.*	Inject. of 2 ounces	Healed	-	Bullet. de thér., mars 1863
84	1865	Simon Thomas	-	Inject. 60 gr.	Healed	The blood clots and the injection not continued	Von Belina, op. cit., p. 61
85	1865	Roussel (of Geneva)	Abortion in the 4th month – syncope, imminent death	Inject.320 gr.	Healed	Injection followed by a general trembling	Je dois cette obs. à l'oblig. de M. Roussel
86	1866	Mosler	Before and after forced childbirth	Inject.120 gr. of defibrinated blood	Healed	-	Mosler; Uber Transf., op. cit., p. 20
87	1867	Knauff	After childbirth – general cooling	Injection was made with a silver syringe	Death	Death occurred during the operation	Von Belina, op. cit., p. 61
88	1868 ?	Branton Hicks	After delivery – haemorrhage had lasted for three days	Inject. 4 ounces mixed with a solution of sodium phosphate	Death	-	Guy's hosp. Reports, 1869, t. XIV, p. 7 et s.
89	1868	Branton Hicks	Abortion haemorrhage had brought extreme anaemia	Inj. 1 oz, 4x, at 1/2 hr. intervals mixed with sodium phosphate	Death	Notable improvement then collapse – death on 8th day	*Id.*
90	1868	Branton Hicks	After childbirth	Inj. 8 ounces mixed with 4 ounces sodium phosphate	Death	-	*Id.*
91	1868	Branton Hicks	After childbirth – breathing had stopped	Inject. 2 ounces of pure blood	Death	-	*Id.*
92	1868	De Belina	Abortion, repeated haemorrhages, extreme anaemia, syncope.	Inject. 180 gr. defibrinated blood	Death	Death occurred following further haemorrhage	Von Belina, op. cit., p. 61
93	1869 11f	Dr Lorain (Hôsp. Saint-Antoine)	-	Inject. 145 gr. blood donated by Mr. Billet, ext.	Death	I was unable to obtain and further information	N° du 22 f. 1869 du Petit Journ.
2° Against traumatic haemorrhages							
94	1825	Blundell	Arterial wound in a young man; breathing stopped 3 or 4 minute ago	-	Death	-	Carré; thèse de Paris, 1844
95	1829	Philpott	Rupture of varicose veins of the leg in a woman	Inject. 120 gr. blood	Healed	-	Von Belina, op. cit., p. 62
96	1829	Danyau	Haemorrhage after leg fracture - wound and bone issue; amputation necessary	Inject. 16 ounces; 8 ounces before the operation	Death	Improved - weak; 2nd tranf. died 3rd day - gangrene	Revue de Paris, 1851
97	1830	Roux	Injury of the subclavian artery by a firearm	Inject. 14 ounces of blood	Death	Sudden death; autopsy - heart & vessels with clots	Bulletin de therapeutic t. X, p. 214
98	1833	Scott	Opening the jugular during neck tumour removal	Inj. of 10 ounces. blood in the 4 veins of the arm	Death	Entry of air	Lancette franç., 1833, p. 519
99	1833	Walton	Haemorrhage following the operation of phimosis	Inject. 360 to 400 gr. in three times	Healed	-	V. Belina, p. 65
100	1833	Walton	Comminuted fracture of the tibia; haemorrhage; amputation	Inject. 240 gr.	Death	-	*Id.*

101	1835	Furner	Haemorrhage following thigh amputation due to existing knee cancer	Inject. 3 ounces	Healed	Pulse imperceptible; syncope	Carré; these de Paris, p. 19
102	1842	Blasius	Haemorrhage consequent to a thigh wound	Inject. 120 gr.	Healed	-	V. Belina, p. 64
103	1851	Simon	Hemorrh., post phlegmon erysipelatosis of the thigh; amputation necessary	Inject. 16 ounces; 8 before amputation - well supported	Death	Died 5 days post operation - autopsy pneumonia	Union médicale, 26 avril 1851
104	1851	Sacristan	Rupture of saphenous vein in woman affected by varicose veins; syncope	Inject. 6 ounces of blood	Healed	pulse imperceptible	Oré, op. cit., p. 94
105	1854	Maisonneuve	Haemorrhage after ablation of cancerous maxillary tumour	Mathieu's device was used for injection	Death	Post inject, restlessness and feeling like vomiting	Leroux; thèse de Paris, 1856
106	1860	Michaux	Haemorrh. repeated due to presence of a nasopharyngeal polyp; anaemia	Inject. 4 ounces of blood	Healed	Success aided by 3 enemas of wine + alcohol	Bull. de thérap., 1860, p. 162
107	1860	Higginson	Haemorrh. Repeated due to presence of phlegmon of forearm; amputation	Inject. 360 gr. into veins of right arm pre amputation	Healed	-	Gaz. médic. de Lyon, 1863
108	1860	Neudoerfer	Haemorrh. in a man with fist-sized epithelioma	Inject. 45 gr. defibrinated and filtered blood	Death	Death did not occur until 3 hours later	V. Belina, p. 66
109	1863	Braun	Metrorrh. repeated, due to a uterine fibrous polyp; extreme anaemia	Inject. 30 gr. with a glass syringe	Healed	Cannula escaped from the vein – no further injection	*Id.*, p. 69
110	1866	Courty	Haemorrh. ruptured artery destroyed by ulceration; prostate phlegmon	Inject. 150 to 210 gr. from Dr. Balp, using Moncocq device	Death	Improvement; dead 10 hrs later due to new haemorrh.	Augé; thèse de Montp., 1867, n° 50
111	1866	Gentilhomme, Thomas, et al.	Metrorrh. repeated, due to fibrous tumour in anterior uterus wall; syncope	Inject. 125 gr. of blood, using the Moncocq device	Healed	During op. suffocation, trembling; numb & sweat	Goulard; thèse de Paris 1866, p. 43
112	1868	Enrico Albanèse	Haemorrh. following thigh amputation.	Inject. 220 gr. defibrinated + filtered blood, x 2 from 2 men	Death	Purulent infection took the patient away 127 hrs later	Courrier médic., 1868, p. 383
113	1868	Braman	Vomit blood suddenly in a man who lifted a very heavy weight above head	Inject. 5 ounces of blood	Healed	Imperceptible pulse; complete prostration	Boston Medic. Journal, janvier 1868
114	1868	De Cristoforis	Metrorrh. Repeated due to presence of a uterine fibroid – anaemia,	Inject. 350 gr. defibrinated blood, 3 times, 12 days apart	Healed	Pulse 120, drowsiness	Reference given by Mr. D^{r}. de Cristoforis
115	18.?	Laersen	Haemorrh. following extirpation of the tongue invaded by a cancer	Inject. defibrinated blood	Death	Death 2 J. after; autopsy showed pyrohemia	Archiv. de Virchow, Panum. par. 244
3° Against blood diseases							
116	1693	Kaufmann and Godefroy	An anaemic subject	Inject. of lamb's blood	Healed	-	Goulard: thèse de Paris, p. 17
117	1831	Bougaed	Anaemic woman; considerable metrorrhagia over the last 4 years	Inject. 135 gr. in two times	Death	Improved: new haemorrh. died 5 days later	Belina, op. cit., p. 73
118	1832	Josenhanns	Purpura hemorrhagica; haem. nasal and stomach; imperceptible pulse	Inject. 240 to 300 gr.	Death	There was, however, a temporary reaction	*Id.*
119	1839	Samuel Lane	11 yr old hemorrhagic child; strabismus; considerable haem. 3 days; syncope	Inject. 5 x ½ ounces of blood in 4 times	Healed	1st inject. - return of pulse; 2nd - return of knowledge	Lancet, oct. 1840
120	1848	Uyterroheven and Bouyard	30 yr woman; 4 yrs continuous haem. via eyes, nose, stomach and bronchi	Inject. 6 ounces of blood	Death	Improvement: death 4 months; peritoneal supp.	Gaz. médicale, 1851, p. 132

121	1851	Chassaignac and Monneret	Anaemic woman; frequent + abundant metrorrhagia for many years	Inject. 120 gr. of defibrinated blood	Death	Improvement; died 1850; peritoneal suppuration	Gaz. médicale, 1851, p. 644
122	1851	Giovanni Polli	Young girl with long term chlorosis, cerebrospinal irritation; languor	Inject. 7 ounces of defibrinated blood	Healed	Recovery was complete and very rapid	Arch. de méd., 1852, p. 342
123	1853	Fenger	Chlorosis; abundant nasal haemorrh.; swollen and bleeding gums	Inject. 300 gr. defibrinated warmed blood, x 7; tin syringe	Death	Dead 48 hours after	Belina, op. cit., p. 77
124	1857	Lever and Bryant	Haemophilic woman, decent of uterine fibrous tumour; metrorrhagia.; incision	Inject. 180 gr. several times	Death	Excellent night, improvement; died 5th day	Monit. des hôpitaux. 1857, p. 65
125	1861	Blasius	Leukocythemia	Inject. 90 to 100 gr.	Death	Improvement – died on the 16th day	Blasius, op. cit., n° 77
126	1861	Nusbaum	Chlorosis and loss of vision after painful venous section	Inject. 340 gr. defibrinated and filtered; from girl; syringe+tube	Healed	-	Belina, op. cit., p. 81
127	1864	Nusbaum	30 year old woman with the highest degree anaemia	Inject. 360 gr. of defibrinated and filtered blood	Healed	During the inject., convulsions, loss of sense	*Id*., p. 85
128	1866	Mosler	Leukocythemia	Inject. 180 gr. defibrinated and filtered, using injection syringe	Death	Improvement – died 2 months later	*Id*., p. 97
129	1868	Mader	Scorbutic condition; nasal haem. profound anaemia	Inject. 240 gr. *ut supra*	Favour. result	-	*Id*., p. 97
130	1868	Richet	Progressive essential anaemia in a man	Inject. 1000 gr. in 4 times, some days apart	Death	-	Gaz. des hôpit., 1868, p. 373
131	1868	De Christoforis	High degree essential anaemia; amenorrhea for one year; dyspnoea	Inject. 600 gr. in 3 instalments at intervals of several days	Healed	-	Reference given by Mr. Dr. de Cristoforis
4° Against nervous diseases							
132	1667	Denys and Emmeretz (1)	Baron Bond, son of the PM of Sweden, exhausted by illness: severe?	Injection of 2 pallets of calf's blood	Death	At the autopsy: intestines found to be gangrenous	Goulard; thèse de Paris, p. 14
133	1667	Lower and King	Transfusion performed on Arthur Coga, maniac	Inject. 10 oz. of arterial calf's blood; 7 oz. bled prior	Null result	-	*Id*., p. 13
134	1668	Denys	Transfusion performed on Mr Mauroy, a madman (observ. cited)	Inject. 10 oz. of arterial calf's blood; 10 oz. bled prior	*Id.*	-	*Id*., p. 14
135	1830	Dieffenbach	Melancholy with terror and agitation	-	*Id.*	-	Dieffenbach, op. cit., § 48
136	1830	Dieffenbach	Erotomania in a young girl	-	*Id.*	-	*Id.*
137	1851	Giovanni Polli	Epilepsy in a 16 year old girl	Inject. 12 gr. pts defib.; 2 days later, 30 gr. defib. from woman	Null result	-	Archives de médicine, 1852, p. 343
138	1852	Giovanni Polli	Young girl – been crazy for 6 years following being raped	Inject. 30 gr. defibrinated and filtered blood; after pt. bled	Improve ment	-	*Id.*
139	1864	Nusbaum	Epilepsy in a 22-year-old girl; daily attacks	720 gr. defib. + filtered; from 2, inject. x 2, 25 days apart	Healed – slow	Convulsions during the 2nd injection	Belina, op.cit., p. 83
140	1868	Lange and de Belina	Puerperal eclampsia; 32 attacks; lockjaw; loss of feeling	240 gr. defib. + filtered blood; after 420 gr. of blood removed	Healed	-	*Id*., p. 99

5° Against exhaustion produced by various causes							
141	1667	Denys	Transf. on a young man exhausted by bloodletting; frequent syncope	Immediate transfusion of 3 oz. of arterial lamb's blood	Healed	-	Journ. des sav., 1868, p. 95
142	-	Denys	Vomiting and hepatic flow dating back 3 weeks; lethargy and convulsions	Inject. 16 ounces of blood	Death	Improvement: death 15 hrs later; volvulus of intestine	Archives de médicine, 1852, p. 335
143	1868	Manfredi	Performed the transfusion on an old man weakened by age	Injection of lamb's blood	Death	-	Manfredi, op. cit.
144	1843	Pritschard and Clarck	Consumption resulting from dyspepsia - stomach not endure anything; syncope	Inject. 480 gr. of blood	Healed	Life instantly reappeared on the patient's features	Bulletin de thérapeut., 1844, p. 239
145	1853	Thouvenet	Dysentery; intestinal haemorrhage; pulse at 130	Inject. 6 ounces of blood	Death	Improvement, and death 20 hours later	Gaz. des hôpit., 1853, p. 236
146	1855	Higginson	Exhaustion caused by prolonged breast-feeding two twins; syncope	Inject. 12 ounces of blood	Healed	-	Arch. de méd., 5e sér. t. X, 1857, p. 346
147	1857	Higginson	Exhaustion: caused by lack of food in a crazy woman who refused to eat	Inject 12 ounces of blood taken from a woman	Death	Passing improvement; died the next day	*Id.*
148	1860	Neudörfer	Exhaustion: caused by long suppuration following gunshot wounds	Inject. 4 to 5 ounces of defibrinated + filtered	Death	General improvement for 5-6 days; died 4 wks later	Goulard, thèse citée, p. 41
149	1860	Neudörfer	*Id.*	*Id.*	Death	*Id.*	*Id.*
150	1860	Neudörfer	*Id.*	*Id.*	Death	*Id.*	*Id.*
151	1860	Neudörfer	*Id.*	*Ut supra*; but a 2nd inject. was made	Death	Death did not arrive until almost 5 weeks later	*Id.*
152	1860	Neudörfer	*Id.*	Inject. 4 to 5 oz. defib. blood from a man suffering from gout	Death	Death came shortly after the operation	*Id.*
153	1860	Esmarch	Exhaustion by suppurate following the disarticulation coxo-femor.	Inject. 420 gr. defibrinated and taken from a calf	Death	Breathing artificial after the op.; then convulsions	Belina, p. 67
154	1860	Esmarch	Exhaustion, occurring following a serious trauma?	-	Death	The patient died at the start of the operation	Arch. Virchow, t. XXXVII. p. 241
155	1860	Nusbaum	Emaciation from abundant suppuration following resection of the humerus	Inject. 360 gr. defibrinated + filtered blood via a tin syringe	Healed	Improved quickly; next day wound with fleshy buds	Belina, op. cit., p. 81
156	1862	Nusbaum	Emaciation from abundant suppuration following knee resection	Inject. 300 gr. defibrinated blood using a glass syringe	Death	Notable improvement - died 4 weeks after	*Id.*, p. 83
157	1863	Nusbaum	Exhaustion: in young girl forced to stay in bed for 15 years; extreme anaemia	1st inject. 300 gr. in England; 2nd months later - tin syringe	Healed	-	*Id.*
158	1867	De Cristoforis	Woman exhausted after 6 childbirths.+ breast-feedings + illnesses; pulse 108	Inject. 130 gr. blood in 2 instalments, 3 days apart	Death	Improvement; then gastro., catarrh, died 42 days later	Reference given by Mr. Dr. de Cristoforis
6° Against organic diseases							
159	1670	Riva	Performed transf. on medic Cinibaldi, suffering from stomach cancer	-	Death	-	Goulard, thèse, p. 41

160	1819	Blundell	Young man; pyloric stenosis; incessant vomiting; excessive prostration	Inject. 12 to 14 ounces of blood	Death	Improvement then death 56 hours later	Medic. chirurg. Transact., t. X; 1819
161	1839	Bliedung	Hemoptysis lasting for 5 days; deep annihilation	Inject, 120to 150 gr. of blood taken from a goat	Healed	Oppression at the time of the injection	Gaz. des hôpit., 1843, p. 366
162	1861	Neudörfer	Pulmonary tuberculosis; deep wasting	Inject. 60 gr. defibrinated + filtered blood, heated to 30°	Death	Improvement; in appetite + sleep; died 1 month later	Belina, op. cit., p. 81
163	1867	Neudörfer	Pulmonary tuberculosis; tuberculous caries of the knee	Inject. defibrinated blood	Death	Improvement – died 2 months later	Belina, op. cit., p. 93
7° Against coal vapour poisoning							
164	1864	Moller and Wagner	Loss of feeling; pulse at 180	Inject. 180 gr. of defibrinated blood, in 3 times	Death	-	Belina, op. cit., p. 84
165	1864	Sommerbrodt	Apparent death	Inj. 120 gr. defibrinated blood from a woman; glass syringe	Death	At autopsy, oedema of the lungs	*Id.*, p. 85
166	1864	Traube	*Id.*	Inj. 240 gr. defib. + filtered; tin syringe; bled patient 180 gr.	Death	Improvement; died 13 hours later	Friedberg; Berlin, 1866, p. 166
167	1865	Mosler	*Id.*	Inj. 240 gr. defib. + filtered; tin syringe; bled patient 180 gr.	Death	Improvement; died 8 hours later	Mosler, op. cit., 1857, § 6
168	1865	Mosler	*Id.*	Inj. 240 gr. defib. + filtered; tin syringe; bled patient 180 gr.	Death	Improvement; died 5 hours later	*Id.*
169	1866	Martin	*Id.*	Inject. 6 to 7 ounces of defibrinated blood	Healed	-	Gaz. m. de Paris, 1868, p. 124
8° Against asphyxia of newborns							
170	1830	Dieffenbach	Asphyxia in a newborn; caesarean removal post mortem from mother	Inject. 60 gr. blood into the umbilical vein	Death	When injected, contortion of the facial muscles	Dieffenbach, op. cit., § 46
171	1832	Blasius	Asphyxia in a newborn; caesarean removal post mortem from mother	*Id.*	Death	-	Blasius, op. cit., n° 75
172	1867	Bennecke	Asphyxia in a newborn	Inject. 80 gr. of placental blood in the umbilical vein	Favour. result	-	Belina, p. 93
173	1868	De Belina	*Ut supra*; imperceptible heartbeat for 20 minutes	*Id.*	Death	Umbilical contraction prevents blood penetration	*Id.*, p. 97
9° Against the following various cases							
174	1831	Dieffenbach	Cholera	Inject. 150 gr. of blood in 3 times	Death	There was, however, a slight reaction	Dieffenbach, op. cit., § 52
175	1831	Dieffenbach	*Id.*	Inject. 90 gr.	Death	*Id.*	*Id.*
176	1831	Dieffenbach	*Id.*	Inject. 135 gr.	Death	*Id.*	*Id.*
177	1832	Walthon and Routh	Asian cholera – collapse	Inject. 900 gr.	Death	Improvement for 36 hours – died 3 days later	Belina, op. cit., p. 72

178	16??	Riva	Hydrophobia	-	Death	-	Moncocq, thèse citée., p. 34
179	1830	Dieffenbach	*Id.*	Inject. 630 gr. in 3 times	Death	Improvement; after the 2nd inject. but had a fit after 3rd	Dieffenbach, op. cit., § 46
180	1667	Denys and Emmeretz	16-year-old young man with stubborn fever that was ruining his health	Prior removal 3 oz. pts blood; inj. 8 oz. lamb arterial blood	Healed	Improvement after the operation	Goulard, thèse, p. 13
181	166?	Peet	Puerperal fever	Inject. animal blood	Death	-	*Id.*
182	182?	Blundell	Puerperal fever with prostration	Inject. 180 gr.	Death	-	Belina, p. 70
183	1832	Stokes	Woman suffering from typhus: collapse	Inject. 240 to 300 gr.	Death	Passing improvement – died after 3 days	*Id*., p. 72
184	1863	G. Purman	Performed a transfusion on a man suffering from both leprosy and scurvy	-	Healed	-	Gottf. Chir. Lorbeer-Kranz, 1864, p. 4
185	1867	Demme	10 yr. old child with diphtheria: damage to mouth, throat and nasal passages	Inject, 120 gr. defibrinated blood in 2 times	Death	Improvement – dead 2 days later	Belina, p. 91
186	1868	Heine and Knauff	Syphilitic ulcerations of larynx + Bright's disease; unnecessary tracheotomy	Inject. 150 to 180 gr. from man with herpes tonsurans	Death	Dead 8 hrs after; autopsy – ulcerations and nephritis	*Id*., p. 97

1: This observation was placed here inadvertently; it was to be inserted between Nos. 142 and 143.