RICERCHE ED EXPERIENZE SULLA TRASFUSIONE DEL SANGUE

By: GIOVANNI POLLI

A TRANSLATION BY PHIL LEAROYD

The monograph titled 'Research and Experiments on Blood Transfusion' written by Dr Giovanni Polli (1812-1880) was published in the journal *Annali Universali di Medicina* [Vol. 4, No. 3, pp. 449-504] in Milan in 1852, a copy of which can be read or downloaded from the following site:

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

NOTE: This paper can also be accessed via the following website addresses but the scanned document is missing the first part of the text:
https://catalog.hathitrust.org/Record/002072542
https://books.google.co.uk/books/about/Ricerche_ed_esperienze_sulla_trasfusione.html?id=R8U0AQAAMAAJ&redir_esc=y

Polli starts by identifying that his purpose in writing this 'memoir' is to identify and confirm the safety of blood transfusions and their therapeutic indications, stating that these topics can only be discussed by means of experience of practical applications which he subsequently identifies to be not only his own but also that obtained from other researchers.

He starts by summarising six animal transfusion experiments that he has performed on four dogs and two horses, aimed at proving the effect of transfusion in resuscitating animals that have been bled to the point of near death. He identifies that he has used defibrinated blood for these experiments, stating that he believes that although the presence or absence of fibrin in transfused blood is currently being debated by different authors he believes fibrin to be of little importance [he also mentions keeping blood fluid be the use of '0.001 caustic soda']. The defibrinated blood used in these experiments is stated to have been stored in metal containers, exposed to air, stored for several hours and injected without pre-warming – all of which he states has no adverse effects on the animal recipients. He also states that he injected the defibrinated blood without worrying about the presence of air bubbles, which he again identifies as something he regards as being unimportant.

The author then quotes some comments made by Prof. Giacomini in questioning the validity of transfusion and the outcomes both in transfusions between animals of the same or different species and to humans as being unsuccessful. Polli provides summaries of the animal experimental research work of Rosa and others that he states provides evidence against these assertions. He provides summaries of the five animal (lamb) to human blood transfusions that have been performed up to that time by others, i.e. three in France (by Denis), one in England (by Lower and King) and one in Italy (by Manfredi), as well as providing summary information of 21 transfusions of human blood to humans performed by other researchers and then provides summary details of the three human to human transfusions that he has performed (all using defibrinated blood).

The author uses the details of these different examples to support his contention that transfusions can be safely (and easily) performed and that have a beneficial clinical effect in the majority of cases, especially those relating to treatment of anaemia following haemorrhage, contrary to the comments made by Prof. Giacomini.

Polli concludes by identifying the types of clinical cases where he believes the use of transfusion is appropriate, starting with concentrating on haemorrhagic situations, i.e. in women during and immediately after childbirth, arterial wounds and spontaneous bleeding in haemophiliacs, as well as its (recently published) potential use in asphyxias. The author then however goes on the suggest its use as a 'nutrient' and in other clinical conditions not directly related to blood loss – suggesting its beneficial effects in such conditions that reflect long held misconceptions of one of the 'roles of blood'.

NOTE: Some of the research work and discussions presented in this monograph are also included within an additional paper by Giovanni Polli published in two parts in 1882, that is also titled 'Research and Experiments on Blood Transfusion', published in the journal *Archives Générales de Medicine*. The first part (Vol. 4, No. 30, pp. 203-214) can be read or downloaded from:
https://archive.org/details/BIUSante_90165x1852x30/page/202/mode/2up
The second part (Vol. 4, No. 30, pp. 332-349) can be read or downloaded from:
https://archive.org/details/BIUSante_90165x1852x30/page/332/mode/1up
Both parts of this paper can also be read or downloaded from:
https://books.google.co.uk/books?id=ygVLAQAAMAAJ&printsec=frontcover&source=gbs_atb&redir_esc=y#v=onepage&q&f=false

I have produced a translation of this section of this paper from Italian 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.

The paragraph settings and general layout of each part of this paper (including words and phrases originally published in italics) have been reproduced within the translation. However, some experimental information (from other researchers) is printed in smaller font in the original publication – this has not been reproduced in the translation. The spelling of the names of people has been reproduced as printed. The references and authors comments listed within the original text are identified by numbers and placed at the bottom of the relevant pages where they occur. I have sequentially re-numbered these and placed them at the end of the translation, reproduced as originally printed - I have also produced translations of the comments and placed these in square brackets after the original. The word schizzetto (i.e. that would I believe translate to 'irrigator' or 'water pistol') is used within the original text – the context in which it is used indicates that this word can be interpreted to mean a 'syringe' though this is obviously not a direct translation it is how I have translated it. I have placed this word in square brackets within the translated text to indicate where it has been used.

RESEARCH AND EXPERIMENTS ON BLOOD TRANSFUSION.

Of Doctor
GIOVANNI POLLI
Series V of Experiments and Research on human blood

The transfusion of blood appears in the history of medicine, first as one of man's most daring and successful attempts, and then as one of the most uncomfortable failures in the art of medicine. This great attempt, not being able to give everything at once, was abandoned as incapable of giving anything. But who does not think that in the transfusion of blood the fabulous purpose of eternalizing life by renewing the decrepit fibres of an organism already devoted to death, and limits himself to considering it as a means of restoring circulation in healthy individuals, suddenly rendered lifeless by haemorrhage; to help the muscle fibre languishing due to the lack of its essential stimulus, oxygenated blood; to facilitate certain difficult moments of blood formation in individuals whose vessels are incapable of completely processing blood materials, etc., etc., it is not to be feared that he sets himself a strange goal, or that he wishes to stun with miracles.

An body which ceases to live, for the sole reason that its blood vessels have been emptied of blood, why will it not be restored to life when by an injection it can still be made to run blood into its vessels? An individual who languishes because his vascular system cannot process the blood elements well, no differently than one who falls into emaciation because his digestive organs are incapable of preparing good nutritional materials from food, why cannot he be helped by the injection of good blood into his veins, at least as he would be helped by light and well-prepared food who is troubled by difficult digestion? An individual has contracted such a movement of dissolution in his blood mass that his vessels can no longer understand it, and he loses himself due to haemophilia, or is fuelled by such poor blood reproduction that he never reaches the point of having in his circulation more than a few and imperfect red blood cells, whereby he languishes with chlorosis; why can neither one nor the other rationally expect help from the injection into their circulatory stream of a certain amount of physiological and robust blood, which, multiplying in their bosom, helps the aforementioned imperfect repairs by a kind of inoculation?

But these and other applications of blood transfusion, which some recent physiological investigations support, and which I will touch upon in detail, have already encountered no obstacle in being received due to the failures actually experienced, or the dangers resulting from it; but yes, now for the method of carrying out the operation, now for the ignorance of the laws of tolerance that the human organism presents to this treatment, now for the imperfect knowledge of the properties of blood.

The purpose of this memoir, therefore, will be to determine:

1. Within what limits, and under what conditions can blood transfusion be declared innocent, in order to establish an easy and safe method of injecting blood into living man.

2. What are the most precise therapeutic indications for this operation, and what success can be expected in the present state of physiology.

This topic cannot be discussed except by dint of experiences. Many good ones can already be found even in the midst of the jumble of those consigned to the annals of science, many of which I undertook myself, either to fill the gaps still left by my predecessors, or to acquire myself the certainty of some phenomena, which in transfusion appear incredible, or at least very strange.

Both in my own experiences and in the choice of those of others, I always took care that they were as many precise questions asked of nature on the question for which it found the solution. And it is by proceeding in this way that I trust I have brought some light and some precision to a topic hitherto considered as curious, rather than as interesting.

FIRST PART.

Experiment 1[a] - A haystack dog, of medium height, was bled to death with a bloodletting of the crural artery. His lips had become livid, his eyes dull, his breathing so frequent that one could barely count. He no longer made any movement with his extremities, and lay with his body completely limp on the table where he was placed. He was evidently at the extremes. In the meantime, almost all of the arterial blood that flowed from this dog was collected in a container, beaten with a bundle of rods until its fibrin had coagulated, poured through a diaper, and then injected again with a [schizzetto] into his jugular. Due to the high external temperature (it was the summer of 1847), the blood had only cooled by 5 or 6 degrees in this handling during the injection, not much attention was paid to avoiding the introduction of some air bubbles into the veins. Nonetheless, the dog tolerated this injection very well, and in fact recovered promptly; his breathing became more placid, and soon normal, his eye brightened, and a few minutes after the injection he was already walking around the room.

Experiment 2[a] - A English breed dog (bull-dog), robust and well fed, was bled to the right crural artery, and all the blood that spontaneously gushed out was allowed to flow; the animal appeared to be at the end of its life. His breathing was almost imperceptible, his labial mucosa purple, his gums white and cold. The defibrinated and poured blood was, as in the previous experience, re-injected into the jugular vein. The dog recovered in a few minutes from his very serious condition; he remained dejected and crouched for a quarter of an hour, and then began to move, and after a few hours he showed himself perfectly restored to his former state.

Both the dog from the first experiment and that from the second still lived in good health several days after the painful operation, and were sacrificed for other research.

Experiment 3[a] - The success of the two previous experiments encouraged us to push the bleeding even further, and to verify in the bled animal not only the symptoms of a life in the extreme, but those of absolute death. Therefore, when the arterial blood had ceased to flow from one crural artery, the crural on the other side was opened, and the oozing of the arterial blood continued to be encouraged until the dog no longer had any heartbeats or breathing. At this state the injection of blood through the jugular could no longer be carried out. The immobile heart seemed to be the main obstacle to the injection. The dog could not be revived (1).

Experiment 4[a] - In an eight-year-old mare, of the Hungarian breed, of rather small stature, who had lost a hoof due to trauma, the left jugular was prepared, isolating it from the surrounding tissues for a few inches, then the jugular on the opposite side was bled with a large wound, and all the blood that could come out of it was allowed to flow out. The mare, after the loss of 10 kilos of blood, began to stagger, to become breathless, and fell on the straw that had been prepared under her feet. The mucous membrane of the lips and gums was completely white, the eye was motionless, the limbs completely relaxed. The blood that had been collected in a copper bucket, beaten with rods to separate the fibrin (which was also promptly mangled to separate all the serum and adhering red corpuscles) had been kept at a temperature of +40°C, with a convenient hot bath, about 20 minutes after the mare had fallen to the ground, the time necessary for the indicated preparation of the blood, it began to be inject it again with a large brass [schizzetto] through the prepared jugular vein, favouring the flow of the blood towards the heart, with a gentle rubbing along the direction of the vessel. In the space of about half an hour, by pushing the blood wave with some slowness, I managed to inject about 5 kilograms of blood into the animal's circulation. Following this injection, the mare, having become very breathless, was left quiet. A quarter of an hour later she began to move her extremities and make some attempts to get up; and, aided in this effort, she was able to be placed on her feet, where she stood for about 20 minutes without any support. She then fell back, and under the growing anxiety she from time to time turned her head and gazed towards her belly. The suspicion of some intestinal complication arose. She was covered, had to be rubbed and then left to rest. She died seven hours after the experiment with convulsions. Upon section, an extraordinary quantity

of food was found in the large intestine, and an effusion of a gelatin-like liquid in the ventricle.

Experiment 5[a] - A 14-year-old horse, of Hungarian breed, thin and Czech, had 2½ kilograms of blood removed from the jugular. The blood that had just flowed had the density of 1026 at 35ºC, its serum had that of 1011.5. Before the bloodletting, the horse had a pulse of 43 beats and was breathing 6 times a minute; after the loss of blood the pulse was at 48, and the respirations at 15. The horse was thrown to the ground: his right jugular was prepared, and they began to inject the already defibrinated and drained blood, taken half an hour earlier from another horse, simply suffering from chronic paronychia: this blood had a density of 1023.5 at 35ºC, and its serum of 1010.5. The operation was carried out in the space of 20 minutes they injected 1.35 kilos of this blood, then, as usual, the jugular was tied above and below the wound, the skin wound was dressed, and the horse was set free. After the operation, the horse was very breathless; his breaths had risen from 15 to 44 per minute, his pulse from 48 to 58, with intermittences and double beats. Listening to the chest with the ear, one could hear a very exaggerated and harsh respiratory murmur, and a deep and somewhat irregular heartbeat. An hour later the breathing and pulses had already calmed down a lot and become more regular. The horse lay on the ground for a few more hours, then got up again, ate and drank very greedily. The next day he was busy and with a great appetite. Breathing had become so normalized that it gave no more than 8 breaths per minute; pulses had never increased in frequency; they beat 72 times a minute. This notable change in the speed of the circle, however, did not seem to disturb the remaining normal state of the individual.

Experiment 6[a] - From the horse used in the previous experiment, after a week of rest, during which time he had recovered perfectly, 2 kilos of blood were extracted, which was, as usual, defibrinated. It was left alone until the next day in a tinned copper bucket, exposed to the air and at a temperature of 9°C. The following day, 1.35 kilos of this blood was injected into the jugular of the same horse, after having mixed the blood which had left the red corpuscles deposited at the bottom of the container, and after having heated it up to 35°C, immersing the bucket in a convenient warm bath. The operation was carried out in about 20 minutes, and the [schizzetto] was loaded 6 times, and special care was never taken to avoid the entry of air bubbles together with the blood. The horse, immediately after the injection, was quite breathless, but then gradually recovered and remained lively for 15 days, after which it was used for an experiment on ether, and then it was killed (2).

The conclusions that these preliminary experiments allow us to draw are the following:

The 1st and 2nd experiments demonstrate that an animal *reduced to extremes* as a consequence of the loss of arterial blood, which occurred due to a wound in a large artery left to moan until the end, was *briefly brought back to life* and restored to its functions by injecting previously defibrinated arterial blood into its veins.

The 2nd experiment demonstrates that if the haemorrhage of arterial blood is promoted by repeated cuts of the arteries (3) to the point of bringing the animal to absolute death, *it is not revived* by the injection of its defibrinated arterial blood, for the reason probably that the heart, made immobile, does not allow the blood wave pushed by the piston to pass further.

The 3rd experiment demonstrates that if so much venous blood is removed from an animal that it *falls bloodless to the ground*, and then a good part of its own defibrinated blood is thrown back into it, it is revived to the point of *getting back on its feet*.

The 4th experiment demonstrates that an animal can receive into its veins *without harm*, or only with some transient inconvenience, the blood of another individual of its species, previously defibrinated, albeit of a much lower density.

The 5th experiment finally demonstrates that a considerable quantity of its own blood can be injected into an animal with impunity, even if it has been extracted from its body for 24 *hours, beaten, defibrinated, poured through a diaper, left in the air in a metal container at a temperature of 9ºC*, and finally mixed again and heated to 40°C before loading the syringe [schizzetto] (4).

Let us consider each of these conclusions separately for a moment:

1. Blood *does not lose its revivifying power even when stripped of its fibrin*. The 1st, 2nd and 4th experiments demonstrate this.

It should not be ignored, however, that *Bischoff* (5) and *Magendie* (6) believe they have observed differently; but the experiments on which they rely are very imperfect. *Magendie* did not really see any sad effects resulting from defibrination except when he continued to extract new quantities of blood from an animal, and then to re-inject them defibrinated, until the animal succumbed. When, however, he conducted the experiment with such moderation as to allow the animal to live, he himself saw that this injection of defibrinated blood was the cause of the increase in the mass of the fibrin. (Op. cit., p. 184).

On the other hand, it is well known that *Dumas* and *Prévost* (7) had already shown as early as 1821 that blood is fairly well tolerated, and *restores to life for a few days* an animal dying of bleeding even when the injected blood is defibrinated, or is kept liquid by the addition of 0.001 of caustic soda.

Müller and *Dieffenbach* have then shown with several experiments on animals that fibrin is really useless for resuscitating bloodless animals.

Too much regard for blood fibrin always gave rise to the greatest impediments in blood transfusion trials. It was, in fact, to transfuse whole blood that all the devices that were no less ingenious than embarrassing were devised in order to directly convey the blood from one animal to another. In spite of this, if as soon as the circulation of the blood in the transfusion tubes was delayed for some reason, a portion of fibrin coagulated, and then a cork was carried in the animal's veins, which when it reached the vascular bifurcations was the cause of the most dangerous accidents.

That fibrin really has less importance than it would seem at first sight, at least for the object of the transfusion, and that it can therefore be left aside without harm, could be inferred: 1. From being found in very small quantities in the blood mass (from 2 to 3 thousandths in the physiological state, according to *Andral* and *Gavarret*); 2. By its easy reproducibility, either by metamorphosis of albumin, or by transmutation of red corpuscles, or by other sources, so that its proportion may rapidly vary, under pathological circumstances, from $^{0}/_{100}$ to $^{1}/_{1000.}$ Although fibrin, due to its property of coagulating, entanglement of the red corpuscles, and holding a lot of serum between its meshes, appears as a predominant element, and, giving substance to the crastination, catches the eye more than the other components of the blood, which are found in it in a much greater proportion, it cannot be considered as mainly representing the properties of blood, nor as its most elaborate element, but rather, following the most recent physiological investigations, as a substance of regress, and destined for elimination.

2. Blood is not only *not offensive*, but it is very well tolerated, and would in all probability produce its reviving effects, not unlike fresh blood, even when, after being defibrinated by whisking, it is stored in *metal containers, exposed to air, and for several hours* (up to 24 hours) before being re-injected.

This fact, which seems to have already been partially verified also by *Dumas* and *Prévost* (8) and by *Dieffenbach*, makes blood injection even more convenient and easy, since it is no longer necessary to use freshly drawn blood in every case to ensure the beneficial effects, but in many circumstances, in which the need for this assistance will be presumed, it will be possible to have it ready in order to avoid the dangerous wastes of time which most often compromise the success of this remedy, and in many others it will be possible to draw on it from that source which will be most convenient, however distant from the individual into whom it wants to be injected. And the circumstance mentioned in our experiments, and which was also noted by some authors, of the tolerance of the injection of blood left to cool, or at least reduced to a lower temperature than that of the animal into which it is infused, favours the aforementioned applications by removing the embarrassment of the precise temperature believed to be an essential condition of every transfusion.

3. The mixing of the blood with the atmospheric *air* under its agitation or verberation to defibrinate it, and for which it always acquires a more vermilion colour, rather than harmful, must be considered as very useful, it having been recognized that the arterial blood,

precisely because it is richer in oxygen, is better at vivifying than venous blood, and because venous blood thus impregnated with air is similar in its properties to arterial blood.

But to calm down the fearful who believe that every *air bubble introduced into the veins together with the blood is deadly* (9), I will remember that both in the experiments on dogs and in those on horses, I have repeatedly allowed various air bubbles to enter by design, together with the blood fluid that I was injecting, which could be felt passing, gurgling, from the syringe [schizzetto] into the injected vein; that the operated animal never showed any sign of suffering from; and that similar experiments, and with the same result, were also performed many times on dogs by doctors *Restelli*, *Strambio*, *Quaglino*, and *Manzolini* during their *researches* already mentioned.

Here are the words with which doctors *Quaglino* and *Manzolini* recall their tests on this topic (10):

“To better persuade ourselves of the harmlessness of the air introduced into the veins of the dogs we exposed now a jugular, now a femoral, and tightened it with a thread around the tube of a syringe [schizzetto], so that it did not come out of the incision, we injected it, towards the heart, two or even three syringes [schizzettate], without the dogs suffering the slightest dismay. These experiments were carried out in the presence of Professor *Minich* and other colleagues, and are entirely in accordance with those of doctors *Restelli* and *Strambio*."

Neither the question, however, nor its solution are new things, however they have been revived in recent times from another aspect.

The following passage from *Magendie*'s “Precis elémentaire de physiologie” will suffice to demonstrate this:

"I cannot understand by what inadvertence *Bichat* repeats in twenty places of his works, that a bubble of air, accidentally entering the veins, instantly produces death. Nothing could be more inaccurate than this assertion, and anyone can easily ascertain it by pushing air into a vein with a syringe. I have been announcing this fact as early as the year 1809 in a Memoir read to the first class of the Institute, and since this time *Nysten* has published a special work on this subject.”

"Many animals receive enormous quantities of air introduced into their veins without perishing. I remember pushing, with all the strength and readiness of which I am capable, up to 20 or 28 *litres of air* into the veins of a very old horse, without it dying instantly; at last, however, he died, and at the sectioning of the corpse we found the whole circulatory system filled with air mixed with blood."

“I have frequently shown, in my lectures, the important difference which results from the manner in which the air is introduced into the veins. If it is introduced slowly, nothing sinister happens: if it is pushed in all at once, the animal does not take long to experience a remarkable acceleration of respiration; a particular noise is heard in his chest, due to the shocks that the air experiences in the quarries, the right auricle, the ventricle and the pulmonary artery; the animal screams and doesn't take long to die (11)."

To clarify the subject better, and to explain how it really happens that with a breath of air in the veins a horse can be knocked dead (as is frequently practiced by veterinarians), and that by an aspiration of a column of air from a large injured vessel many surgical patients are suddenly killed, I will recall again some of the results obtained by *Nysten* cited by *Dieffenbach* (12).

“All the animals into which the author pushed a considerable quantity of air into the veins in a single stroke died suddenly. In small dogs, 40 to 50 cubic centimetres of air were sufficient; in larger animals, 100 cubic centimetres were sometimes needed to cause death. When the quantity of air injected was small and done in stages, the animals always recovered promptly. - The death of the animals was produced by the violent distension of the cavity of the heart, and by the prevented entry of the blood into the lungs."

"A dog was injected with 390 cubic centimetres of air in the space of 1 hour 40 minutes' 30 seconds before it died, and death did not occur because of the extraordinary dilation of the right ventricle of the heart, but rather because of the universal weakening of all the organs and especially of the heart."

"By injecting air into the arteries, the animal dies suddenly of cerebral palsy, and organic life continues for some time; by injecting air into the veins, death arises from disturbance of the circulation."

“By injecting nitrous oxide, which dissolves in the blood, *Nysten* managed to infuse, little by little, up to 1390 cubic centimetres into a dog before producing death, and at one time 240 cubic centimetres without the heart being found considerably dilated. Another dog had 1040 cubic centimetres injected, and the following day he was fine."

In summary therefore the things said so far, it is clear that the major difficulties of blood transfusion are removed. In fact, it is possible to use defibrinated blood that no longer offers the inconveniences of coagulation; of blood taken from a living animal several hours ago; exposed to the air for several hours, or rather agitated in it for a long time; of a blood that does not have precisely the temperature of the animal; it can be injected into the veins using a common syringe, and without fear by its contact with the metal walls of the containers or instrument; and you can rest assured about the possible introduction of some air bubbles together with the blood. This operation is therefore reduced to its maximum simplicity; the transfusion of blood, or rather its injection into the living animal, is no more difficult than any other anatomical injection.

Let's now see in which cases it should be practiced in humans, and what therapeutic advantages can be expected from it.

SECOND PART.

Before identifying the most useful and precise therapeutic indications for blood transfusion, it is best to remove a serious prejudice that weighs heavily on this operation in the minds of doctors and non-doctors. Demonstrating with facts the beneficial action of transfusion on bloodless animals, the ease with which it can be practiced in any case by means of a very simple preparation of the blood, the perfect harmlessness of this preparation, and of the other concomitant circumstances the artificial injection of blood could perhaps not be enough to make this medical aid acceptable: since it is generally considered as an operation, either never usefully successful, or highly dangerous, and to seal this opinion almost everyone limits themselves to noting that, although initially welcomed with the greatest enthusiasm, fell and is now forgotten, and that its inconvenience was even confirmed with a pontifical interdict.

The unfavourable prejudice against this operation would therefore pose:

1. On the failures and dangers which have occurred so far in the transfusion trials.
2. On the forgetfulness, or rather on the condemnation encountered by this operation.

In the refutation of the first of these charges against transfusion, which we will attempt, relying entirely on facts and experiences, we will prepare the way for discussing the most reliable indications of the same, and we will also have implicitly refuted the second charge mentioned; since forgetting something proven to be good cannot constitute an argument in its favour, but is an error; and an interdict in a non-dogmatic topic, but solely of natural history, is another error equal to that which opposed the motion of the earth defended by *Galileo*, and the vaccination taught by *Jenner*, or other similar questions that anyone can freely discuss, because they refer to subjects included in the biblical *mundum tradidit disputationi eorum*.

And as for the accusation of danger and failure of the transfusion, no one expressed himself more clearly than the Prof. *Giacomini*: his propositions on this subject can satisfy even those most averse to the operation, and we will report them as those that best and most authoritatively represent the objection we intend to respond to. Of transfusion in animals, Prof. *Giacomini* says (13): "that *in the majority of cases it was completely unsuccessful*, that is, with the death of the animals that underwent it"; and after having reviewed some transfusion experiments (those of *Dumas*, *Blundel* and *Dieffenbach*) he concludes “it appears only too evident that the blood of animals of *different species* not only

does not save from death by bleeding, but itself produces very serious dismay and death in those animals that did not lose much or any blood, and that the blood of *the same species* put back in place of the same or slightly different quantity of blood extracted either *kills* the animal or causes *very serious harassment* to it; that only when a great emptying of the blood vessels was preceded, and new blood of the same species was transfused in small quantities, did the animal *sometimes* recover its well-being".

Regarding the blood transfusion between animals of the same species, we reply that at least four of the six experiences reported by us in the first part of this memoir, show anything other than failure or death resulting from the operation, since either the most decisive revival from an extreme state, or the greatest tolerance to the injection of blood, however much manipulated.

Regarding the transfusion between animals of different species, we would like, in refutation of Giacomini's assertion, to report some of the experiments carried out by Mr. *M. Rosa*, and delivered in the "Letters above some philosophical curiosities" (Milan 1782), not only daring experiments and well done, but also described with such truth that it amazes us how we almost never see them cited by authors who deal with similar topics, however simply for simple erudition, and how the very learned Prof. *Giacomini* did not also know them, or at least mention them.

Experiment 1 (14). The jugular in a lamb was opened, and the blood was allowed to flow slowly to avoid the convulsions which usually follow from too hasty emptying. The jugular stopped giving blood, that the animal was abandoned; the motion of the heart lost; there was no sign of breathing. The lamb had more of a whitened lip, the coincidental eyelids, the clouded eye, and a neck and limbs completely relaxed; he was dead, or in a mortal swoon. Blood from the carotid artery of a calf was transmitted to it by means of a special tube. The blood entering through the vein, descending to the heart, excited a great tremor, and re-excited the movements of the heart, which at first became perceptible by a slight expansion, then by an undulation or vermicular motion, and finally with a manifest pulsation. The lamb wrinkled its nostrils then seemed to be breathing minutely and lightly, then to the joyful surprise of all those present it began to raise one eyelid, to breathe freely, to open its already brightened eyes. Once the wound was reunited, the animal was on its feet; he pissed, then immediately drank and shook his fleece several times; then, seeing a little dog belonging to his family, he rushed to butt him, and jumped into the room. After this operation the lamb never showed a sign of any harm, it grew and gained weight visibly compared to three of its brothers.

Experiment 2 (15). A ram weighing 90.6 pounds was taken; he fainted in 15 minutes, losing about 60 ounces of blood, and urinating twice in the interval. The animal was also judged dead by his master; he was dragged, lifted, and all dangling and sagging, without giving any more drop of blood, he was brought near to a calf weighing 146 pounds, from whose carotid artery the blood was conducted into the jugular of the ram. The first effect in the ram was that of a delicate heat which spread to his whole body: the second, that his limbs, all abandoned and drooping, gradually took on a new consistency and vigour. The head began to stand on itself, the mouth closed, the nostrils narrowed, the eyes opened, revived, the ram appeared alive, and began to agitate to change his place. The ram re-weighed was 92 pounds. He was impatient to get back to freedom.

Experiment 3 (16). A lamb weighing 50 pounds slowly fainted from the jugular: every last bit of blood was drained from it, now by lifting and folding its head in various ways, now by lightly milking the jugular, until the thread was interrupted and it dissolved into drops, failed completely, and the animal remained resolute in every part of it. In this state he was seen, handled in various ways, pronounced dead by all those present; his eye was dead and half-closed, his lip pale and his tongue hanging out of his mouth, and no minimal movement could be felt to the precordi. Due to an accident that occurred in adapting the tubes, five minutes passed before the blood coming from the carotid artery of a calf willing to do so could be sent into the jugular of this lamb. The blood seemed to flow down the vein with a trembling and an evident pulsation. Soon a tremor was felt in the precordi, as if coming from

afar, then a dull, confused, and finally manifest pulsation. Meanwhile, the lamb gradually began to open its nostrils, and its chest felt itself dilating, and its abdomen was seen to move a little, and a new warmth spread through all its limbs; finally the eyes opened and the lamb came to life again. When the external wound was reunited, the lamb pissed. When he was reweighed he found to be exactly 50 pound 8 ounces, so that he had received 8 ounces of blood more than his own, not counting the urine. The lamb was at once on his feet, walking as if healthy: he took food that very day, and in the evening he jumped with his companions.

"These three facts therefore prove", adds Rosa:

1. That the mixing of blood between species and species is possible, it saves the life of the animal.

2. That it is possible and almost certain to revive an animal rendered bloodless, and therefore physically dead, with the sole infusion of arterial blood, even of a different species.

This result could already constitute a sufficient response to the Prof. *Giacomini*; but since, to support the failure and danger of blood transfusion, he also cites and analyzes the experiences of *Denis, Prévost and Dumas*, so let us follow him and listen to these authors directly.

Denis in a letter written as early as 25 June 1667 says:

"We performed the transfusion in dogs in many ways, now from the artery to the vein, now from vein to vein, both from the carotid artery and from the crural artery, in weak dogs and in vigorous dogs, in small and large dogs, and in some even they had already received and communicated blood with past transfusions; and of the nineteen dogs subjected to the transfusion, not even one died, but on the other hand, having always noticed some admirable circumstances in those who had received the new blood, we remained fully convinced that the transfusion could not be dangerous."

The news of Denis's experiments reaching Italy made *Ippolito Magnani*, from Rome, want to try them again. Among others he succeeded in the following: "A dog that had been generously bled had lost all ability to move, so that it was necessary to lift it off, once the operation was finished, and lay it on the ground; after 24 hours he was *picked up bodily* and taken to the place designated for the experiment, without moving at all on his own. Having given him the blood transfusion, he recovered enough to run away, so that the following day he was found in the city and for many days afterwards he was seen healed. And therefore from this we learned, *Magnani* continues, that the restitution of blood to someone who had lost it due to injury or fluxions also serves to restore their life" (17).

Let us now listen to *Prévost* and *Dumas*:

"When an animal is bled to the point of syncope, until all muscular movement is abolished, until the action of the heart and respiration are suspended for a few minutes, it is *almost certain that life is extinguished in it forever*. If then any liquid, whether pure water or blood serum at 38°C, is injected, death is *no less the consequence* of the haemorrhage that the animal has suffered; but if the blood of an animal of the same species is injected, each portion of blood injected *significantly reanimates this species of corpse*; and it is not without surprise that after restoring an amount equal to that which he lost, he is seen breathing freely, moving easily, taking nourishment, and *recovering completely*, when the operation has been well conducted" (18).

Who would believe that from these same experiments the Prof. *Giacomini* was careful to conclude that they "do not prove, in the most adventurously successful cases, other than that the injection of blood was more or less tolerated ... and there is an immense distance from being tolerated to being considered useful?" (19).

Rosa certainly concluded much more reasonably when, summarizing the result of his own and others' experiments on this subject, he said: "I understand well that many will struggle to be persuaded of these facts, which although they are certain, verified, passed under many eyes, not made to deceive, not easy to deceive, seeking the truth to see it not to pretend it. But such is the effect of great and un-thought truths, and repugnant to received ideas. Thank goodness that the fact is such that it can be easily verified by anyone who wants to, but with the certainty that they will still be equally surprised even when they see it" (20).

So far we have only dealt with transfusion in animals: we remain to see whether in man it is really as harmless and as useful as it seems to have occurred in brutes.

Science already has at this time a sufficient number of well-observed facts to give the broadest answer to the question. We will briefly report all these facts, or at least all those that we could know, and we will finally draw some corollaries from them.

They are not very many, and the majority, especially the modern ones, are still scattered here and there in the newspapers, so gathering them together is not a great job, but it is worth it, because from their thoughtful consideration the truth of which we are tracing will emerge. We will distinguish them into only two series: in the first of which we will understand the facts of the transfusion of brute blood into the veins of man; in the second the facts of transfusion of human blood into man.

FIRST SERIES.

Fact I. - To a healthy and robust 45-year-old butcher, *Denis* removed 10 ounces of blood from his arm, and transfused him with 20 ounces of arterial lamb blood. The subject assured that he had *not suffered anything, that he felt very well*, and was invited to rest a little, and take some broth, but he did not want to do so because he considered it useless, and instead set about slaughtering the lamb that had served in the experiment, and inflate it, and flay it; then he went to the tavern to drink the money he had received as a gift, he worked hard the rest of the day, and the following day, meeting *Denis* on the street, he assured him that he *felt more vigorous than usual*, and asked him if he wanted to start the same operation again to make use of no one but him, and that this second time he would have shown himself more docile (21).

Fact II. - To a 16 year old young man, who after a fever of 2 months, in which he was bled 20 times, leaving him stupid and drowsy, *Denis* removed 3 ounces of blood, and then infused him with 9 of the arterial blood of lamb. The young man had three or four drops of blood from his nose, then he calmed down; *the morbid sleep escaped him, he acquired greater strength and agility of limbs, he gained weight and continued to improve until he recovered completely*.

Fact III. - There was a man who had been mad for eight years, in whom the alienation showed itself in fits, which lasted from 8 to 10 months, and during which he did not sleep at night, and ran madly through the streets. The last attack had been going on for four months, when *Denis* removed 10 ounces of blood from his arm, and transfused him with 6 ounces of calf arterial blood. The operation was followed by *great mitigation* of the symptoms, so *a new transfusion* was performed, but of a pound of blood. After this the patient had vomiting and diarrhoea, sweating, deep sleep for 10 hours, then *ever-increasing improvement until full recovery*.

Fact IV. - A patient had been suffering from vomiting and hepatic flux for three weeks: he had been purged, bled and treated with many remedies in vain. He was declared a *desperate case* by his four attending doctors, who however approved, *as a last resort*, the transfusion that his relatives begged *Denis* to perform. The transfusion was done at a time when the patient was in lethargy, had convulsions, a deep and tingling pulse. After the first injection of 8 ounces of blood *the convulsions stopped, his pulse was raised, consciousness returned, so that the patient recognized the bystanders and spoke to them, he drank broths and barleys without vomiting, and maintained this well-being for 24 hours*. As he relapsed again, he was given *a new transfusion*, which was followed by a *temporary reinvigoration of strength*; but as the diarrhoea did not cease, the exhaustion increased, and 11 hours later he expired. On section, an extended volvulus of the enteric tube was found, with bruised and ulcerated intestines.

Fact V. - *Manfredi*, from Lucca, says that he had (on 2 January 1668) *happily transfused* some lamb's blood, with an immediate cannula, into the arm vein of a certain Angelo di Utina from Forli (22).

Fact VI. - *Richard Lower* and *Edward King* took 6 or 7 ounces of blood from a man, and transfused him with 9 to 10 ounces from the carotid artery of a lamb. The patient received *such benefit* from this operation that four days later he requested that it be done again (23).

In the facts set out in this 1st Series we therefore have six experiences of transfusion of lamb's blood into the circulation of living man, not only well tolerated, but followed by decided advantages; an experience that was simply well tolerated, and one which, however well tolerated, due to the damage present in the transfused subject, was followed by death. The most rigorous conclusion will be: that *the injection of lamb's blood is well tolerated* in the veins of living man; that it was, in the majority of cases, *useful*, and was followed by *improvement* and *healing* of the diseases against which it was directed; and that in the only case in which death followed, it *evidently due to other causes* pre-existing the transfusion.

Of other experiences of the transfusion of brute blood into man, followed by a favourable or unfavourable outcome, I don't know of any.

SECOND SERIES.

Fact I. - In a 30 year old man, admitted to Guy hospital of London for scirrhous disease of the pylorus, and already reduced by continuous vomiting to such emaciation as to have the appearance of a skeleton covered in yellow skin, he asked for a blood transfusion to sustain his life for a while longer. *Blundell* initially refused to perform the transfusion in such a proclaimed case, so as not to discredit it, but then he gave in to the demands, and did it by injecting 12 to 14 ounces of blood repeatedly, over the space of 40 minutes, into the cephalic vein. The patient recovered a few hours later, *his face coloured, his limbs regained movement*, and he said: I feel much better, and I feel less weak. The following day, however, prostration occurred again, vomiting and bodily evacuations were renewed, and the patient died 56 hours after the operation. Upon section, the pylorus and the upper part of the duodenum were found to be scirrhous; the intestines narrow and hardened (24).

Fact II. - To a woman who was reduced to extremes due to excessive bleeding following childbirth, and who, although the bleeding had already stopped 6 hours ago and was treated with the most suitable stimulating means, did not recover, *Blundell*, in the company of his students *Doubledey* and *Uwins*, injected, in the space of 10 minutes, 14 ounces of blood supplied by bystanders. The pulse, the eye, the heat and the colour of the skin soon gained life, and the woman said she *already felt strong "like a strong dog"* and in a short time she *recovered completely* (25).

Fact III. - To a middle-aged woman, who after giving birth was struck by heavy bleeding so as to make her pale, cold, without strength, with a small and contracted pulse at 130°, 140°, and putting her in great danger, *Blundell*, together with *Uwins*, transfused 6 ounces of blood supplied by *Wright*. The woman's face immediately calmed down and she regained some strength; but falling into a new languor two hours later another 6 ounces of blood supplied by *Uwins* was injected. Her pulse dropped to 110, her strength returned, and soon she was completely healthy despite the inflammation that had occurred in the vein of her injured arm, which required the application of some leeches (26).

Fact IV. - *Doubledey* gave a transfusion to a new mother who was dying of a haemorrhage and was already cold and almost dead, but to no avail. *Doubledey* had been called too late: the most precious time had been consumed in the use of other remedies and in indecision (27).

Fact V. - A 25-year-old woman, who quickly relieved her weight, suffered a very strong haemorrhage due to uterine inertia; it was reduced to the gravest danger. Pulses small, and occasionally imperceptible; face and lips pale and cold as in a corpse. *Waller* and *Blundell* were called. They delayed the transfusion for another hour; but when vomiting, strong agitation and a tingling and intermittent pulse occurred, they immediately began to inject two ounces of blood taken from the woman’s robust husband into the right cephalic vein: after a few minutes another two ounces were injected. A little agitation, a more intermittent pulse

and then a brief fainting, from which, upon recovering, *the patient progressively improved* (28).

Fact VI. - A 32-year-old woman, of weak constitution, already emaciated due to vomiting which had been troubling her for three weeks, was overcome by the pains of childbirth, and at the same time by a serious uterine haemorrhage which was reduced to extremes: the pulse was at 140 and intermittent, the face and hands cold, the appearance of the whole person cadaverous. The fetus was presented by one shoulder. *Waller* made the turn and took it out. The new mother was given an egg yolk with brandy, but neither the pulse nor the heat improved, and instead the convulsive agitation continued. She also vomited the remedy. *Waller* and *Doubledey* decided on the transfusion, but they had to waste another hour to get the blood to inject, since the woman who had first offered hers at the moment of giving it refused, and took her husband's blood. The woman showed almost no signs of life; she didn't make any movement even when he cut her skin for the operation. The first injection was 13 drachms of blood, and so on every 5 minutes, until $8^1/_2$ ounces were injected. The patient *gradually began to revive and progressed* so well that a week later she could already sit up in bed (29).

Fact VII. - A 20-year-old woman was extremely exhausted due to a large uterine loss that occurred after giving birth, and she had not spoken for six hours. Brigham injected into the vein of her arm, first 2 ounces of blood, without seeing any change: he repeated the injection a few minutes later, and *the pulse rose again*, the cadaverous face *revived*. The injection continued of 10 in 10 minutes, until 10 or 12 ounces of blood were introduced. The *revival of this patient was admirable*; she spoke, and a few hours after the operation she fell fast asleep for several hours at a time, and from the moment she awoke *she continued to improve rapidly until she completely recovered* (30).

Fact VIII. - A woman of small stature took great pains to relieve herself of a dead fetus, and was struck by heavy bleeding as soon as she was freed from the placenta. The pulse became very small, the extremities cold, the danger of imminent death. Much laudanum was given to her, more than 120 drops, together with brandy, as well as carbonate of ammonia, aromatic spirit of ammonia, etc., but continuing the cold of the limbs, and threatening the death sweat, *Jewel* who attended her decided on the transfusion. The vein in the arm being too small, he opened the jugular, and in 20 minutes he injected four ounces of blood into it, in small increments, using a squirt which contained no more than 3 drachms. During the operation the patient's condition did not change much, but all the symptoms were fatal, and *death*, in fact, *followed a quarter of an hour later*. – The section was carried out three days after death, and it was mainly investigated whether the 16 [schizzettature] made had not introduced air into the veins. The cavities and arteries were tied, and by pricking the heart under the water, about a drachm of air was collected. The cavities of the heart contained only a little coagulated blood (31).

Fact IX. - A 28-year-old lady was attacked by repeated menorrhagia, against which ice, laudanum, ergot, alum and tamponades were no longer of any use. The exhaustion was at its worst: one could barely feel the pulse from time to time, the breathing was very slow, almost imperceptible, the eyes were half closed, with a glassy appearance, the loss of urine was involuntary, and only a few hiccups from time to time still hinted its existence. Doctor *Banner*, of Liverpool, took some blood from the patient's husband, and, in stages, transferred it to her with the small *Blundell* pump. The difficulty of breathing and the disorder of the pulses increased for some time; the body remained cold and covered in sticky sweat for three hours after the operation; but from this time the pulses *developed*, breathing became *more normal*, the patient was able to swallow a few spoonfuls of brandy with water; she was then given soda water and port wine. Little by little she *recovered completely*, so that 21 days after the operation she left *healed* for the countryside (32).

Fact X. - A woman of 37 years of age, who had been suffering from epilepsy for a long time, was so exhausted after childbirth that she could not recover from heat, rubbing, or stimulants (ether, ammonia, mustards). Cold sweats, small pulses, anxious breathing. *Brown* injected 4 ounces of blood into the basilica of the right arm. The patient immediately accused of feeling a sense of heat passing from her arm to her heart: she soon acquired

colour and warmth, and was consoled by seeing the objects in front of her eyes no longer green, but of their natural colour. In short, without any notable symptoms, she *recovered entirely* (33).

Fact XI. - A 39-year-old woman, ten days after her ninth birth, was struck by such a serious haemorrhage that in five hours she was pale, exhausted, with difficulty breathing, a small, frequent pulse, dilated pupils, a voice barely sensitive, nausea and vomiting. The haemorrhaging had stopped, but the frequent fainting, the freezing cold of her extremities, the difficulty of breathing, the smallness of her body made one fear imminent death. Dr. *Berg*, of Jugelfingen, injected into the basilic vein of her left arm two and a half ounces of blood supplied by a healthy man present at the operation. The patient remained unconscious for a few more minutes, but shortly thereafter her breathing became deeper and less interrupted, her *pulse rose again*, a few minutes later she *was able to answer* questions, and at the end of four weeks the woman found herself *perfectly healed* (34).

Fact XII. - A young man suffering from a congenital disposition to haemorrhage (haemophilia) was reduced, due to a continuous loss of blood for five days and five nights following the wound sustained during the strabotomy operation, to such a state of anaemia that he was in extreme danger. *Lane* subjected him to the transfusion of 5 and a half ounces of blood taken from a young woman, and this injection, which was given repeatedly in the middle of the arm, not only remedied the most pressing accidents, but also *freed* the patient from his *disposition to bleed* for the slightest breaks in continuity (35).

Fact XIII. - In the hospital of St. John in Brussels there was a 30-year-old woman, exhausted by continuous haemorrhages of all the mucous membranes, which had already been troubling her for four years. She was losing blood from her eyes, nose, mouth, stomach, bronchi, genitals, auditory meatuses, breasts; moreover, he had a sort of bloody sweat under his fingers, and in some other parts. She was treated with all the means that medicine can suggest: the most distinguished doctors of every country who visited the hospital were consulted on the matter, and no therapy helped in this obstinate haemophilia. The transfusion was finally proposed to the patient, who accepted it with enthusiasm. *Uytterhaeven* and *Bougard* practiced it, first injecting two ounces of blood through the cephalic which produced heat from the arm to the chest, reduction of the pulse from 108 to 88 and *great improvement*. They then injected another two ounces of blood, and the *advantage was progressive*, so a third injection of a greater quantity of blood was also considered useful (36).

Fact XIV. - From *Bougard*, $2^1/_2$ ounces of blood taken from a very robust woman were infused into the vein of a 26-year-old woman, who, following haemoptysis treated with large blood removals, developed metrorrhagia, resulting in chloro-anaemia accompanied by the greatest weakness. The danger then increased due to spontaneous haemorrhaging in the vulva, in the inches of the lower extremities, in the mouth, in the eyes, in the breasts. The pulse *rose immediately* after the transfusion, the strength gradually returned, the *skin regained colour, the vomiting stopped, the haemorrhage stopped*. Eight days later, at the patient's request, a *second transfusion* of three ounces of blood was given, which was followed by the *most satisfactory effect*. She got up, and was already close to leaving the hospital when she was struck by severe metrorrhagia, and then by peritoneal suppuration from which *she died, approximately four months after the transfusion* (37).

Fact XV. - A woman at the end of her pregnancy, due to the vicious insertion of the placenta, she was affected by such abundant haemorrhage that it was forced to forcibly provoke the birth by puncturing the membranes and use ergot. The bleeding stopped, but the woman remained so exhausted that she showed barely any signs of life. After hesitating for an hour, the danger becoming more and more imposing, Dr. *Nelaton* (who reported this fact to the Surgical Society of Paris towards the end of 1850) decided to resort to transfusion. Having cut the woman's cephalic vein for one centimetre, with a hydrocele syringe, the blood freshly flowed from a perfectly healthy man, that is from a young doctor who offered it spontaneously, was slowly injected. There was neither agitation nor appearance of pain. The patient thus received, in three doses, 350 grams of blood. At the moment of the injection the pulse was imperceptible, and the heart beats were tumultuous:

the precordial anxiety immediately ceased. The next day *the heat had returned, the pulse developed, the intelligence clear*, the patient felt nothing other than great exhaustion and thirst. Things were progressing regularly and *always getting better*, when seven days later abdominal pain appeared, and the patient died of metro-peritonitis, while the epidemic reigned in the infirmary of the hospital (San Luigi) where this operation was located, *metro-peritonitis also confirmed by necropsy findings* (38).

Fact XVI. - A 30-year-old woman, after having given birth with surgical assistance, due to a very pronounced anteversion of the matrix, is attacked by a great loss of blood, which does not stop until she faints; shortly thereafter a second haemorrhage occurs against which cold and astringent fomentations, concentrated ergot infusion, dry rubs and warming of the limbs are of no help. The mother presented desperate weakness, cadaverous pallor, cold extremities, almost numb and sometimes soft pulse, darkening of vision, repeated syncope. Everything pointed to an imminent, inevitable death. The Dr. *Marmonier* advises to move to blood transfusion. Alone, without any particular instruments, with a small children's enema barrel, capable of holding 70 grams of liquid, he collected blood several times, which a neighbour of the patient gave him from his arm, and through a longitudinal incision of 3 centimetres, of the basilica vein of the patient's right arm, introduced approximately 90 grams of blood without any acridity or any pain. Almost immediately after the transfusion, breathing became *more regular*, the pulse *stronger*, the *syncopes ceased*, and *the blurring of vision dissipated*. Hot frictions and the use of ratanhia and ergot were continued; and two hours after the operation the patient had recovered so much that she fell asleep, and this sleep was followed by a rapid unexpected improvement. From this moment the convalescence was *rapid*, and the secretion of milk occurred rapidly. Thirty days later the patient was *perfectly recovered*, and had already resumed her usual occupations (39).

Fact XVII. - A 28-year-old woman, subject since childhood to frequent and abundant haemorrhages, when she entered the hospital of St. Antony in Paris had only a bloody discharge from the uterus alternating with petechiae, excessive discoloration of the skin and mucous membranes, considerable adiposity, ecchymoses here and there over the whole body, and larger on the limbs; extreme muscle weakness; syncopation at the slightest movement; skin temperatures above normal; pulse dropped to 112, very weak on the radial side, while the carotid arteries were strongly raised at each diastole. Weak heartbeat and systolic murmur, strong thirst, constipation, meteorism, pale urine. Despite the tonic treatment, the general and local condition worsened; syncope, repeated vomiting, agitation, suffocation, numb pulse, meteorism, strong, incessant thirst, etc. One day (7 October 1851) the patient resembled a corpse: her death seemed imminent. *Monneret*, judging that the blood alteration that had led to this anaemia was primitive, independent of visceral diseases, proposed transfusion. 120 grams of blood serosity separated from the fibrin by whisking was injected gradually and with a single interruption of no more than two minutes. Complete calm during the injection; *the pulse soon regained its strength, as in a plethoric subject, the patient took a little broth, which was well tolerated*. For about 10 hours cold hands and feet which required the application of warm bodies. From this moment on, great agitation, groans, yawns, burning thirst, strong pulses, permanent intelligence. Little by little a gradual weakening occurred, the pulse disappeared: the patient stopped complaining, and *passed away* like a person dying of a disease of consumption. – All the cadaveric lesions found at autopsy belonged to anaemia which had reached an extreme degree; no alterations could be related to the transfusion. The blood examined during life and after death did not show any special alterations either in the blood cells or in the fibrin (40).

Fact XVIII. - To a pregnant woman who suffered a haemorrhage considered fatal following a rupture of the saphenous vein, Dr. *Sarristan* injected 6 ounces of blood into the median vein; with this operation she was *almost restored to new life*, and twelve hours later she underwent an abortion, which did not prevent her from *recovering to full health* (41).

Fact XIX. - A 38 year old woman, following an abortion, suffered a very serious haemorrhage which reduced her to the greatest weakness and insensitivity. Doctor *Masfen* injected six ounces of blood into her veins three times, and *the patient soon recovered her health* (42).

Fact XX. - A 40-year-old man, admitted to St. Thomas's Hospital, London, and under the direction of Dr. *Simon* was in the throes of severe bleeding due to fistulous ulcers that had progressed to gangrene. Compression of the femoral artery was instituted, and at the same time, to hold back his evanescent life, 16 ounces of good blood from a student were passed through his veins. The injection was so successful that Simon was happily able to amputate the affected limb. But after this the general strength began to run out, so that 14 hours later, even despite a new transfusion, the patient died. At autopsy the lungs were found to be inflamed and softened (43).

Fact XXI. - A 27-year-old woman suffered a very copious haemorrhage due to premature birth, which left her in such a state of weakness that she was unable to utter a word and appeared lethargic. The skin and mucous membranes completely discoloured, the body cold, the heartbeat barely sensitive, the pulses elusive, and at 130 per minute. The following day the symptoms had all worsened, so *Devay* judged a transfusion to be indicated; and called doctor *Desgranges*, surgeon at the Hôtel-Dieu, with his advice and that of many other doctors, the operation was carried out (26 October 1851) with all the necessary precautions. Dr. *Lardet*, inside the hospital, gave the blood, which was directly collected in the [schizzetto] heated to 40°C and surrounded by warm compresses, and then in two and a half minutes, *without the slightest accident*, it was passed into the patient's venous system. The pulse increased to 138, the energy in the artery and its resistance became greater, the contractions of the ventricles became stronger; *the patient opens her eyes and notices what is happening around her*. The excitement manifested immediately after the transfusion grew during the rest of the day, and in the following two nights, even with a bit of delirium, which was followed by severe prostration. But two days after the transfusion, *the pulse is at 90, free speech is easy, the lips regain colour, the eyes are revived*. Canker sores appear on the tongue, later a painful phlegmasia of the right limb, which does not prevent the patient from leaving the hospital, healed, on 29 November, i.e. 43 days after the transfusion (44).

In these *twenty-one facts*, which are all that I could gather regarding transfusion into man with human blood, we note:

1. That in only five cases (I, IV, XVII, VIII, XX) did death follow transfusion, or rather transfusion was useless, because it did not succeed in saving the patient to the extreme. In cases XIV and XV, for example, the transfusion had a very happy result, and the morbid accidents which subsequently developed, and which ended in death, are in no way related either to the transfusion or to the state which indicated it.
2. That in sixteen cases out of twenty-one the transfusion was very wonderfully beneficial, since already dying individuals returned to life and health.
3. That the transfusion was very useful, in three cases (XII, XIII, XIV) to radically overcome the haemorrhagic accidents caused by haemophilia which had, with grave danger, resisted any therapeutic aid.

Now considering all the twenty-seven cases collected in total in the two series of facts exposed so far, and which are almost all those that science possesses, we see that the transfusion in itself would have in no case brought about death, since the six cases (IV of the 1st series and I, IV, VIII, XVII and XX of the 2nd series) ending in death shortly after the transfusion are evidently such as to demonstrate only that either the organic lesions were too serious to be able to find help in this way , or that it was practiced too late. We see that in no case would the transfusion have been poorly tolerated or supported with signs of instantaneous or consecutive suffering; and that in the vast majority of cases it proved to be readily useful and brought about healing.

To the facts of others discussed so far I can add some from my observations that speak the same language, and they are the following:

1. On 17 October 1851, a young 16-year-old girl (Maria De Filippi, from Trarigo) had been suffering from mild fatuity for six years, following the profound pain suffered for the loss of her mother, and for two years from a recurrence of sub-epileptic insults, she was subjected by me to a transfusion in the following way. I drew blood an hour earlier from a 40-year-old,

robust woman suffering from incipient arthritic inflammation. The plethoric and fibrin-rich blood was defibrinated by beating, and kept ready for injection, without heating it. In the young patient I incised the median vein of the left arm longitudinally for about 5 or 6 millimetres, I let a few ounces of blood drain, then I removed the lace placed above the cubit to swell the vein, I loaded the pre-prepared defibrinated blood into a small pewter syringe [schizzettino], with a thin and straight cannula, I inserted it into the open vein, and pushed the injection into it. I repeated this operation three times, 4 minutes apart from each other; but a good part of the injected blood flowed back, due to the excessive width of the wound made in the vein compared to the smallness of the cannula of the syringe [schizzetto], so that with these three injections I did not introduce into the circulation more than a third of the blood contained in the syringe [schizzetto], that is, from 7 to 8 grams of blood. Part of it then also spread into the surrounding cellular tissue, as the thrombotic tumidity that appeared immediately after the operation, and the yellow-purple mottling that occurred later, demonstrated this. The young girl, moreover, did not show any sign of any notable suffering: she only complained of a kind of burning sensation that from the point of the wound extended along the vein for about half a decimetre, and which lasted a few hours; this sensation is certainly attributable to the repeated insertion of the cannula of the syringe [schizzetto] into the wound, and to the bit of thrombus formed. The wound was treated as in an ordinary bloodletting, the patient found herself completely recovered from the local wound after two days.

2. On 19 October, I opened the cephalic vein of the left arm of the same young girl with a cut of only three millimetres, and let four ounces of blood flow out. This beaten with a wicker bundle gave a fibrinous clot so divided and retained the foam in the blood in such a way that it made its free aspiration and emission in the squirt impossible. I filtered it through a piece of cloth, and thus prepared, and without heating it, although due to these manipulations it had dropped to room temperature, i.e. 12ºC., I sucked it into the pewter syringe [schizzetto] used in the previous experiment, only slightly curved in the cannula so that the jet of blood better entered the lumen of the vein, and I injected it into the open cephalic. By favouring the progress of the blood, which seemed to swell the vein too much at the beginning and to remain there, by means of a gentle friction made with a finger on the course of the vein towards the heart, I managed to let in, without reflux, almost all the blood included in the syringe [schizzetto]. I repeated, five minutes later, the injection of an equal quantity of blood in the same manner and with the same result; so I was able to estimate that no less than 12 grams of her defibrinated and aerated blood had been introduced into the girl's circulation in the above-mentioned manner. This time too she complained of some burning in the wound and along the vein, but less than in the previous experience. The wound also healed more quickly than the one in the other arm, and only very slight signs of a thrombus appeared around it.

As for the effects explained by these two operations on her illness, I dare not comment; since although during the few days that I still had her under observation after the transfusion she was much more lightly affected by her insult, and some days she passed completely immune to it, which was not the case before, the character of the affection is such that it cannot really be declared improved or cured unless after the trial of a considerable period of time. Both of these experiments, however, did not fail to demonstrate the perfect tolerance and harmlessness of the operation, and this was for me, who was undertaking it for the first time, the main aim he loved to achieve (45).

3. This is a young lady of 18 years (T..... P.....) who has been suffering from chlorosis associated with cerebrospinal irritation for several years. She had already been bled more than 300 times; it had been treated repeatedly with ferruginous drugs, quinaceous drugs, with narcotics, purifiers and solvents; she had been tortured with every type of revulsion on almost all regions of her body; and all with very little advantage, since the menstruation became increasingly scarce and difficult until it ceased altogether, so that for two years she had also become amenorrhagic; the digestion languid, the nutrition imperfect, the skin colour a pale-yellowish almost jaundiced. She painfully dragged on with her existence, abandoning her bed from time to time, only to fall back into it a few days later, prey of congestive

irritations now in her head and now in her chest, which forced the doctors to once again strip her of the little strength she had during that respite collected.

Lately she had already been lying in bed for 15 days due to a very annoying dry cough, accompanied by evening fever, and had already been bled three times, without any reduction in the symptoms. I therefore proposed to try the transfusion of a small quantity of a robust blood into her veins, and the proposal was accepted by the patient and by the attending doctor, who, after having put her to sleep with some *passes* that used to easily lure her into sleepwalking, offered his blood for injection. I took about four ounces of blood from the vein of his left arm, and promptly defibrinated it by beating. I then incised the cephalic vein of the patient's right arm with a 2 to 3 millimetre wound, and loaded the same squirt that was used for the previous transfusions; I injected the aforementioned blood of my colleague. The operation was repeated twice, with the [schizzetto] not filled, so, having calculated the portion of blood that flowed back at the beginning and end of each injection, it can be assumed that approximately 7 grams of blood was introduced into its circulation. The blood seemed to swell the vein at its beginning and stop: but some slight frictions on the injected vein, made simultaneously with the pushing of the plunger, were enough to start the blood forward.

Once the operation was over, the young lady was woken up, and when questioned she assured that she hadn't noticed anything, and even calling her attention to the injured arm, she protested that she didn't feel any discomfort there. - The following day the cough had completely disappeared: three days later she found himself ready to leave her bed, and the morning of the last day she left the room, and walked for a good distance along the shore of the lake to reach the steamboat and take a little pleasure trip, something he had neither dared nor been able to do for months.

The operation was performed on the 20th of October, and at the end of the following December the patient in question wrote to me that *since that time she had continued to improve*, so that she now found herself completely recovered, her long-suspended menstruation having also returned, and among some expressions of gratitude, she herself declared that *she owed her recovery to the transfusion* (46).

I do not yet dare to draw this last conclusion so certainly; however, I cannot deny a certain value to the judgment of a patient who had to experience many treatments, and who, despite herself, had to acquire a lot of practice with the remedies, and much education regarding in the manner of accounting for their effects. The most severe conclusion to which this fact leads me for now is that even in this patient the blood transfusion was not followed by any damage, but in all probability gave the healthiest boost to convalescence.

Now, if it is from the facts that we must judge the merit and applicability of blood transfusion, and the facts reported to us are, as I said, all those that, without any selection, it was possible for us to gather, who will not find it strange that this very simple operation has been practiced so few times? Who will not find inconceivable the horror or fear that this operation, so little deadly and so beneficial, inspires in the generality of doctors and patients? What is the reason why the latter do not hesitate to undergo surgical operations that are infinitely more serious and more painful, and why they are much less afraid of the injection into the veins of substances completely foreign to the body, for example of medicinal substances, much less than they fear injections of blood, which is also the natural liquid of the vessels? (47). It is certainly difficult to find the reason for this strange inconsistency of the human spirit, which however seems to have no small part in the prodigiousness of the effects that men have always expected or proclaimed from a mixture of living bloods. While, if you consider it carefully, blood transfusion is, as *Denis* says, an operation that nature already teaches. The fetus in the mother's womb is kept alive by a kind of transfusion, and ordinary nutrition is also a transfusion, by a longer route, of the animal and vegetable substances we eat.

Therefore, considering the results of our own and other people's experiments on brutes, and giving due weight to all the successful cases of transfusion in humans, we can already

establish, with a some certainty, some indications for this operation, just as some others can be establish a priori on the basis of some recent physiological investigations. Here they are:

1. The transfusion or injection of blood is appropriate in cases in which the individual is placed in serious danger due to excessive or rapid loss of blood, as often occurs in mothers who have recently given birth or in the wounded.

New mothers affected by severe haemorrhage during labour, or shortly after it, offer the case in which the transfusion was performed more frequently and was more successful. In the second series of facts cited, eleven eloquent cases of this kind appear (II, III, V, VI, VII, X, XI, XV, XVI, XIX and XXI). I hope that in similar cases transfusion will henceforth be proposed and carried out by us too.

In cases of arterial haemorrhages due to gunshot or bladed weapon wounds, in which even after the artery has been ligated, the life is in danger due to the serious blood loss already sustained, the transfusion of even a small quantity of blood can ensure it.; and in the absence of human clinical facts, I will recall, in favour of this indication, my experiments on dogs and horses, and those of *Rosa* on lambs.

2. The injection of blood is convenient in cases of *unstoppable spontaneous or constitutional haemorrhages*, in the so-called *haemophilias*. The cases XII, XIII, XIV reported above are proof of the advantage of transfusion in these contingencies, and show that in addition to having saved the life seriously threatened due to the profuse or repeated loss, it also succeeded in radically medicating the haemorrhagic tendency. The modification induced in the crisis of haemophilic blood by the newly injected blood certainly plays a large part in this therapy.

3. Blood transfusion is appropriate in cases of *exhaustion* and *tabescence* due to *deficient or suspended nutrition* due to a defect in the intestine or a general languor in the innervation. By immediately transmitting the final and most perfect result of food digestion to the circulatory tree, through the transfusion of good blood, who knows, says *Denis*, that many sick infants who die only from inanition could not be recovered? While the child left to himself would infallibly perish within a given period of time, before the resolution of the intestinal disease, for which he is deprived of nutrition, with a methodical blood transfusion he could be kept alive enough to give rise to the resources that its progressive assimilation, favoured by the injected blood, will be able to explain in its favour. – I believe that in children this operation is practically very difficult, although not impossible; but I do not consider analogous cases of its convenience in adults equally impossible or difficult, although rare. However, I do not know of any experience that has so far confirmed its success; is to try.

4. The injection of blood into the veins of *cachexics* and *dyscrasias* can give rise to a *normal regeneration of humors and tissues*. In *chlorosis*, *rachitis*, *scrofula*, the injection of good blood into the circulatory tree can be considered as a grafting of a new germ capable of favouring a more normal reproduction of the tissues, and consequently a correction in the entire constitution. By injecting a few ounces of healthy blood into a living organism we introduce into it light millions and millions of corpuscles or globules, which in their turn will produce other globules of good nature, among the spoiled ones, and thus establish a new generation of these organised corpuscles circulating with the blood, which have very important functions of excitation and nutrition of solids. By increasing the number of normal blood cell *generators* (48), by methodically repeating the injection at certain intervals, it is probable that we will be able to make these good elements of life prevail, and gradually reconstitute a sinful organism.

5. *The injection of blood previously beaten and impregnated with air, as an energetic means of vivifying the movements of the heart and muscles, is suitable in all asphyxias and in all apparent deaths*.

The observation of *Phillips Kay* (1832) by which it was demonstrated that limbs which had lost muscular irritability could regain it by an injection of arterial or venous blood; the recent experiments of *Brown-Sequard* who succeeded in restoring muscular irritability in the already stiffened limbs of a corpse by injecting blood into its veins (49); the experiments of *Fontana*, *Humboldt*, *Tiedemann* and my own on the action of oxygen, carbonic acid and other gases on the contractility of the heart of frogs (50); and finally the facts collected and

analyzed by *Liebig* on the respiration of the muscles, by which their oxygen absorption and the production of carbonic acid are demonstrated (51) put beyond any doubt the powerful action of the oxygen conducted by the blood in the restoring contractility to extinct muscles. Therefore, blood injection should perhaps not be neglected in any case of asphyxiation or shock, whether from carbonic acid or carbon monoxide, or from drowning, or from electrocution, etc.

6. Finally, since the condition of the blood changes rapidly and profoundly according to its content the way the nerves function, we also dare to propose, as the first transfusers did in ancient times, and later *Schneider* and *Hufeland* (52), *the injection of blood as a means to be attempted in certain cases of mental alienation or madness not supported by evident organic alterations of the sensorial apparatus or of the consenting viscera*. –

If with this communication of ours we succeed in freeing the transfusion or rather the injection of blood into man, from an unfavourable prevention, and to make it once again considered as a powerful therapeutic means unjustly abandoned, we will have achieved the only goal we had set ourselves. We believed it was useful to try to persuade our colleagues of a truth to which we could not refuse our entire conviction, and for which indeed we find it difficult to conceive of the need for an apology.

REFERENCES

1. Questi tre primi esperimenti sui cani vennero eseguiti coll'ajuto de' colleghi, i dott. *Gaet. Strambio, Quaglino, Tizzoni Manzolini*, che gentilmente si prestarono a questi miei tentativi, interrompendo per poco la preziosa serie di ricerche che stavano facendo sui cani : “Intorno all' influenza che esercitano molte sostanze putrefatte, il pus, la bile,”, ecc. (V. “Annali univ. di med.” compilati dal dott. C. A. Calderini, fascic. di novembre e dicembre 1848).
   [These three first experiments on dogs were carried out with the help of colleagues, Drs. *Gaet*. *Strambio*, *Quaglino*, *Tizzoni Manzolini*, who kindly lent themselves to these attempts of mine, briefly interrupting the precious series of researches they were doing on dogs: “On the influence exerted by many putrefied substances, pus, bile, etc..“ (See “Annali univ. di med.” compiled by Dr. C. A. *Calderini*, fascic. of November and December 1848).]
2. Questi tre esperimenti sui cavalli furono eseguiti all'Istituto veterinario di Milano per graziosa permissione del Direttore sig. dott. *Arvedi*, e coll'ajuto del sig. dott. *Minoja*, professore di clinica in quello stabilimento. Alcuni altri distinti colleghi, fra i quali i dottori *C. Beltrami, C. Broglia e G. Pavesi*, mi furono cortesi della loro assistenza, e sono lieto di poter loro pubblicamente attestare la mia riconoscenza.
   [These three experiments on horses were carried out at the Veterinary Institute of Milan with the gracious permission of the Director, Mr. Dr. *Arvedi*, and with the help of Mr. Dr. *Minoja*, Clinical Professor at that establishment. Some other distinguished colleagues, including Doctors *C. Beltrami, C. Broglia and G. Pavesi*, were kind to me with their assistance, and I am happy to be able to publicly express my gratitude to them.]
3. Osservammo che l'arteria ferita si contrae mano mano sopra sè stessa durante il dissangnamento, adattandosi, allá, diminuita colonna di sangue, e che questa contrazione giugne sino al completo obliteramento del vaso, per cui l' emorragia, comunque di arteria, spontaneamente cessava, e per aver nuovo sangue era necessario ferire ancora un'altra arteria.
   [We observed that the injured artery gradually contracts upon itself during bleeding, adapting to the diminished column of blood, and that this contraction reaches the point of complete obliteration of the vessel, so that the haemorrhage, in any case from the artery, stopped spontaneously, and to get new blood it was necessary to injure yet another artery.]
4. Dell'innocuità di questo sangue injettato, che *Giacomini* dice *sostanza morta, sostanza eterogenea ed affatto straniera*, e che noi potremmo aggiugnere resa ancor più

straniera-e-nocevole pel suo lungo soggiorno fuori dell'organismo vivo, e per le molteplici manipolazioni cui venne assoggettata, fanno fede i 15 giorni di benessere del cavallo dopo di avere sostenuta quest' injezione.
[Of the harmlessness of this injected blood, which *Giacomini* calls a *dead substance, a heterogeneous and completely foreign substance*, and which we could add has been made even more foreign-and-noxious due to its long stay outside the living organism, and due to the multiple manipulations to which it was subjected, the 15 days of well-being of the horse after having sustained this injection are attested.]

5. Müller's Archiv. 1835.
6. “Leçons sur le sang.” Paris 1842, p. 182 and 192.
7. “Bibl. univ. de Genève”, Tom. XVII, page 226.
8. Op. cit. “È indifferente injettare sangue fresco o lasciato in riposo in luogo fresco per 12 o 24 ore; l'animale (dissanguato) venne ristabilito per alcuni giorni in un gran numero di casi”.
[Op. cit. “It makes no difference whether you inject fresh blood or leave it to rest in a cool place for 12 or 24 hours; the (bled) animal was recovered for a few days in a large number of cases”.]
9. Il professore *Giacomini* pensa infatti che fra i gravi pericoli dai quali è accompagnata la trasfusione si debba annoverare principalmente la *introduzione nelle vene delle bolle d'aria che sarebbero prontamente mortifere*. (“Ann. univ. di medicina”, dicembre 1848).
[Professor *Giacomini* in fact thinks that among the serious dangers which accompany the transfusion we must mainly include the *introduction of air bubbles into the veins which would readily be deadly*. (“Ann. univ. di medicina”, December 1848).]
10. Ann. univ. of med., Vol. CXXVIII, pag. 338.
11. Edit. de Bruxelles 1834, p. 306.
12. *Dieffenbach*. “Die Transfusion des Blutes”:
13. “Trattato filosofico sperimentale de' soccorsi terapeutici”, Tom. V, pag. 338.
14. Esperienza 118 dell' op. citat., pag. 167, Tom. I.
15. Esper. 128 dell' op. citat,
16. Esper. 119, dell' op. cit.
17. “Relazione delle sperienze fatte in Inghilterra, in Francia e in Italia intorno alla celebre e famosa trasfusione del sangue”. Roma 1668.
[“Report of the experiments made in England, France and Italy regarding the celebrated and famous blood transfusion”. Rome 1668.]
18. “Biblioth. univ. de Geneva". Ann. 1821, Tom. XVII, page 226.
19. Op. cit., page. 243.
20. Op. cit., page. 168
21. Denis “Lettres sur la transfusion”, Paris 1667.
22. “De nova et inaudita medico-chirurgica operatione sanguinem transfundente de individuale ad individuum, prius in brutis et deinde in homine, Romae expert”: Auctore P. *Manfredo*, Lucense. Romae 1668.
["On the new and unheard of medical-surgical operation of transfusing blood from individual to individual, first in brutes and then in man, an expert of Rome": Author P. Manfredo, Lucense. Rome 1668.]
23. “Gazette médicale de Paris”, 1848, p. 65.
24. “Medico-chirurg. Transact.”. Vol. X, 1819. Annali univ. di med., Vol. XXVI, pag. 437.
25. “The Lancet”. Vol. IX, p. 134, October 1825.
26. “The Lancet”. Vol. IX, p. 205, November 1825,
27. “The Lancet”. Vol. IX, p. 782.
28. “The Lancet”. Vol. IX, p. 342.
29. “Froriep's Notizen.” Band XIV, p. 318.
30. “Edinburgh Journal” - Froriep's Notizen. Band XV.
31. Non dubito che la quantità d'aria qui indicata colla frase una *dramma* circa, debbasi intendere non in peso, ma in un volume eguale a quello di una dramma d'acqua. E per le cose dette nella *prima parte* di questa Memoria una tale quantità d'aria è lungi dallo

spiegare la morte avvenuta, la quale, a nostro avviso, era già inevitabile quando si è intrapresa l'injezione.
[I have no doubt that the quantity of air indicated here with the phrase approximately one dram must be understood not in weight, but in a volume equal to that of a dram of water. And from what has been said in the first part of this Memoir, such a quantity of air is far from explaining the death that occurred, which, in our opinion, was already inevitable when the injection was undertaken.]

32. “The Loudon med. and surgical journal”, June, 1833.
33. “Oesterr. med. Wochenschrift”, 2 Nov. 1837.
34. “Med. Corresp-blatt des Würtemberg. arztl. Vereinisz; herausg.” von den D. *Blum-Hardt Duvernoy* und *Seeger*., 1838, n° 2.
35. “Bulletin de thérapeut.”. Vol. XX, p. 65, 1847.
36. “Journ. de méd. de Bruxelles, e Gazzetta med. di Milagno”, 15 maggio 1818.
37. “Gazette méd. de Paris”, 3.e serie, T. V, 16 fevr, 1850
38. “Bullet. génér. de thérapet.” 30 décemb. 1850.
39. “Gazette méd. de Paris”, juillet 1951 (3 gennajo 1851).
40. Acad. de méd., séance 14 octob. 1851; e Annali univ. di med., Vol. CXXXIX, pag. 413. – Le conclusioni che da questo fatto si permise di trarre il dottor Monneret, che aveva proposta ed eseguita questa trasfusione, sono sfavorevoli all'operazione medesima; ma chi ponderatamente esamina questo fatto non può a meno di vedere dimostrar esso soltanto che nella paziente trasfusa la malattia era già troppo avanzata per aver sollievo dalla trasfusione, la quale forse l'avrebbe salvata se praticata prima; e che, del resto, tutti gli appunti critici sull' injezione del sangue da un individuo nell' altro sono vittoriosamente confutati dagli altri numerosi fatti fin qui addotti.
[The conclusions that Dr. *Monneret*, who had proposed and performed this transfusion, allowed himself to draw from this fact are unfavourable to the operation itself; but whoever thoughtfully examines this fact cannot help but see that it demonstrates only that in the transfused patient the disease was already too advanced to have received relief from the transfusion, which perhaps would have saved her if performed earlier; and that, moreover, all the critical notes on the injection of blood from one individual into another are victoriously refuted by the other numerous facts adduced thus far.]
41. Dal giornale spagnuolo l' “Union”, il “Journ. de conn ais méd.-chirurg,”, sept. 1851.
42. “Journal des connaiss. méd.-chirug.”, ibid.; e “Gazzetta medica di Milano”, N° 4 gennajo 1852.
43. “Gazzetta medica di Milano”, citata.
44. Accad. di med. di Parigi, 8 dicembre 1851, e “Annali univ. di medicina”, Vol. CXXXIX, pag. 414.
45. In queste due sperienze che eseguii alla mia villeggiatura di Travallino sul Lago Maggiore, fui coadjuvato dal sig. dott. *Zaffanelli*, al quale mi è grato di manifestare la mia riconoscenza. E fu tale la semplicità dell'operare, e così priva d'ogni sofferimento l'esperienza che avevamo compiuta, che facilmente si convenne di tentarla poco dopo, con uno scopo terapeutico più nuovo e più importante, nel caso che forma l'argomento del fatto seguente.
[In these two experiments that I carried out during my holiday in Travallino on Lake Maggiore, I was assisted by Mr. Dr. Zaffanelli, to whom I am grateful to express my gratitude. And the simplicity of the operation was such, and the experience we had completed was so devoid of any suffering, that it was easily agreed to try it shortly afterwards, with a newer and more important therapeutic aim, in the case that forms the subject of the following fact.]
46. Più recenti notizie (15 febbrajo 1852) datemi da un distinto medico che la vede frequeutèmente mi confermano taltora la perseveranza di quell' iûnspettata guarigione.
[More recent news (15 February 1852) given to me by a distinguished doctor who sees her frequently confirms to me sometimes the perseverance of that unexpected recovery.]
47. Sopra 27 casi, o poco più, infatti, che la scienza possiede di injezione di sangue nelle vene dell'uomo, si può citare di leggieri quasi un centinajo di casi, e in genere molto

meno felici, di injettamenti di materie medicinali nell'albero sanguigno; tali sono, p. e., le injezioni di aqua tepida fatte da *Magendie e Gaspard*; quelle di tartaro stibiato da *Knopf,* da *Gräfe* e da *Krähe*; di caufora in emulsione da *Ortel* e da *Hennius*; di înfusione di senna e di guajaco, con ittiocolla e gomma arabica da Regnandot; di þelladonna da *Froriep*; di datura stramonio da *Percy* e *Laurent*; di oppio da *Hufeland*; di noce vomica e di acido solforico da *Horn*; di olio di ricino da *Hale*, ecc.

[Out of 27 cases, or a little more, in fact, that science possesses of the injection of blood into the veins of man, one can cite almost a hundred cases, and generally much less happy, of injections of medicinal materials into the blood tree; such they are, for example, the injections of tepid water made by *Magendie* and *Gaspard*; those of stibiate tartrate from *Knopf*, from *Gräfe* and from *Krähe*; of caufora in emulsion from *Ortel* and *Hennius*; of infusion of senna and guajaco, with ichthyol and gum arabic from *Regnandot*; of þelladonna from *Froriep*; of datura jimsonweed from *Percy* and *Laurent*; of opium from *Hufeland*; of walnut vomica and sulphuric acid from *Horn*; of castor oil from *Hale*, etc.]

48. Vedi i lavori di *Barry* nei *Proceedings of the Royal Society* 1842, nei quali si dimostra come dai globuli abbiano origine tutti i tessuti ed anche la fibra nervosa; e perciò questi *globuli o corpuscoli rossi* vennero da *Barry* distinti felicemente col nome di *parėnt-cells*.

    [See the works of *Barry* in the *Proceedings of the Royal Society*, 1842, in which it is demonstrated that all tissues and even the nerve fibre originate from globules; and therefore these *red blood cells* or *corpuscles* were happily distinguished by *Barry* with the name of *parent-cells*.]
49. L'Autore injettò sangue defibrinato nelle arterie della mano del cadavere di un giustiziato, morto da *tredici ore*, e già da 1 ora 1/2 preso da rigidità, e ottenne in tal modo di ristabilire la irritabilità in parecchi muscoli. Sopra 19 muscoli della mano del cadavere, sul quale cadde l'esperimento, 12 di essi sono ridivenuti irritabili, e 3 suprattutto a tal grado da contrarsi in tutta la loro lunghezza sotto una semplice eccitazione meccanica.

    Il sangue injettato, che era di color rosso vivo, sgorgava dall'arteria cubitale incisa di color rosso-nerastro, e dalle vene ferite dell'arto usciva ancor più nero. Il sangue sgorgato dale vene durante l'injezione, raccolto e ridivenuto rosso per l'azione dell'aria, era riinjettato, e dopo essere passato pei vasi della mano esso ne usciva di nuovo nero, soprattutto nelle vene. La parte che ha l'ossigeno nella riproduzione della irritabilità in questo esperimento, è evidente. (*Gazette méd. de Paris*, 5 *juillet* 1851. *Ann. univ. di med*., *Vol. CXXXIX*, p. 444).

    [The author injected defibrinated blood into the arteries of the hand of the corpse of an executed man, who had been dead for *thirteen hours*, and had already been seized with rigidity for $1^1/_2$ hours, and thus succeeded in re-establishing irritability in several muscles. On 19 muscles of the hand of the cadaver, on which the experiment fell, 12 of them became irritable again, and 3 above all to such a degree that they contracted along their entire length under simple mechanical excitation.]

    [The injected blood, which was bright red in colour, flowed from the incised blackish-red cubital artery, and came out even blacker from the wounded veins of the limb. The blood that flowed from the veins during the injection, collected and turned red again due to the action of the air, was re-injected, and after passing through the vessels of the hand it came out black again, especially in the veins. The role that oxygen plays in the reproduction of irritability in this experiment is evident. (*Gazette méd. de Paris*, 5 *juillet* 1851. *Ann. univ. di med*., *Vol. CXXXIX*, p. 444).]
50. V. Annali di Chimica applicati alla medicina, Vol. XIII, 31 ; e Ann. univ. di med., Vol. CXXXIX, pag. 186.
51. Aun. univ. di med., Vol. CXXXIX, pag. 424.
52. Entwurf zu einer Heilmittellehre gegen psychische Krankheiten: vun *Schneider*. Tubingen 1824.