RELAZIONE SULLA TRASFUSIONE DIRETTA DI SANGUE D'AGNELLO PRATICATA DUE VOLTE IN UNA SIGNORA

By: G. ALBINI

A TRANSLATION BY PHIL LEAROYD

A copy of the paper titled 'Report on the direct transfusion of lamb's blood performed twice in a lady' by Giuseppe Albini, published in 1872 in the journal *Rendiconto dell'Accademia delle scienze fisiche e matematiche* (reference Volume 11, pages 258–273) can be viewed or downloaded from the following sites:

https://books.google.co.uk/books?pg=RA1-PA261&id=kkQsAAAAYAAJ#v=onepage&q&f=false

https://babel.hathitrust.org/cgi/pt?id=hvd.hnl7ml&seq=270

Albini describes being asked to perform two direct animal (lamb) blood transfusions to a woman suffering from anaemia due to metrorrhagia. He takes the opportunity in not only reporting the details of the case for the Academy but to also give more precise details of how the transfusions were performed. These details are placed in quotation marks within the body of the text. Although the procedure is described in detail, it is unfortunate that the only diagram he provides is of his haemodometers (together with a diagram reproduced from Manfredi's paper) as Albini also describes the cannulas that he uses, the description and method of use, which would have benefited from relating to some diagrams. The described technique involves the need of two or preferably three assistants. He describes the use of a bicarbonate of soda solution within the haemodrometer, which is used to avoid transferring air into the patient's vein. He points out, in separate quotations, that Lower (English), Denis (French), Manfredi (Latin) and Rosa (Italian) would have, by using their direct transfusion techniques, pushed air out of the connecting tube into the recipient.

The author then briefly discusses some of the recipient's symptoms seen post transfusion, but not having actual clinical care of the patient, these are identified to be incomplete. He then defends using lamb's blood due to the size of its red cells being 'presumably' smaller than human red cells and is therefore able to move through the patient's circulation, but he also states that he believes that the transfused blood 'does not take the place of the patient's own blood but gives time and place for the patient to reproduce the missing blood and regain health.'

Finally, Albini considers the different methods used for giving a blood transfusion. He immediately denounces the idea of using human arterial blood in a direct artery to vein transfusion method due to the dangers of exposing the donor to an arteriotomy. He therefore then comments on the possible use of human venous blood, in a direct vein to vein technique, and provides objections to this method related to lack of sufficient pressure, the blood being un-oxygenated and the danger of phlebitis. He states that as a consequence most Italian and foreign surgeons have used indirect techniques – even though he has used a direct animal to human technique.

He concludes the paper by questioning the use of defibrinated blood, which he believes must be physiologically different from 'that which flows in the vessels' and states that there is an ignorance as to the actual effects defibrination has on the blood and that researchers should concentrate on identifying the actual changes instead of maintaining the illusion that they actually know.

I have produced a translation of this paper from the original Italian into English to hopefully enable its content to be appreciated by a wider audience. Whilst I am obviously aware that instantaneous computer generated translation is available, this process however struggles with accurately reading the original text and interpreting specialist terminology, as well as producing a 'colloquial style' not always representative of the original text. In addition, an 'automatic translation' may either purposely or inadvertently alter the wording to 'make it read better' but in doing so there has to be an element of interpretation involving something on the lines of 'I believe that this is what the author is actually trying to say'. I want to avoid that as much as possible and try to present what the author actually wrote and as a result the reader may find that the English text does not 'flow' as well as it could. Although I have taken great care in accurately identifying the original text and producing a true representative translation of the author's original wording I cannot guarantee that this work does not contain 'translational errors' and the reader is recommended to check specific details against the original text.

I have maintained the original paragraph settings and general layout of the text within the translation, together with words that are in italics. The references within the original text are numbered separately within each separate page. I have sequentially renumbered these and placed them together at the end of the translation as originally printed, together with translations of each of these, which I have included in italics within square brackets.

As identified above, large sections of the text have been placed in quotation marks – this is used by the author to distinguish the 'additional details' of the method used by the author. This is included within the translation.

Giuseppe Albini
(Born in Milan 27 September 1827 – Died in Turin on 18 January 1911)
(Image credit – Wikipedia)

GIUSEPPE ALBINI – BIOGRAPHICAL INFORMATION

Born in Milan on the 27th September 1827, Giuseppe Albini began his medical studies in Pavia but was expelled for having taken part in the 'Springtime of the Peoples' revolution of 1848, he also took part in the 'Five Days of Milan' insurrection that started the First Italian War of Independence and the battle of Novara. Following these events, he went to Vienna, where he completed his medical studies and graduated in 1852. He then travelled to Berlin and after that to Bonn, Halle and Utrecht. In 1857, he was named professor of physiology at the University of Krakow, but in 1859 he resigned and returned to Italy to work as a natural history teacher at the secondary school of Casale Monferrato. In January 1860, he was appointed professor of physiology in Parma and in October of the same year, he was hired by the University of Naples, where in February 1861 he became director of the Institute of Physiology, a position he held until 1905. On 27 October 1877 he was elected foreign honorary member of the Royal Academy of Medicine of Belgium. He died in Turin on 18 January 1911.

Report on the direct transfusion of lamb's blood performed twice in a lady;
NOTE from Ordinary Member Giuseppe Albini.
(Meeting of 7 December 1872)

On the evening of 14 November, Dr. Frusci came to propose to me in his own name and in the name of Professor Gallozzi to perform the blood transfusion in a lady not yet thirty years of age entrusted to their care, who was in a serious state, which they believed depended mainly on repeated and abundant metrorrhagia, due to which the patient had become anaemic.

At the same time, Dr. Frusci declared that he entrusted himself entirely to me, both for the choice of blood to transfuse and for the way in which to practice the transfusion.

Having performed so many times and always with excellent results the direct transfusion of blood from animal to animal (of the same and different species) for example from dog to dog, from ram to horse, from lamb to dog, and having studied the question sufficiently a few years ago (1) ventilating the pros and *cons* of the various methods proposed and especially of the one most in use in our times, that is, the injection by means of syringes of beaten and defibrinated human venous blood, without much delay I replied to Dr. Frusci that I agreed to perform the proposed operation, and that for my part I was in favour of the direct transfusion of live lamb's blood, like the domestic animal that had the smallest blood cells.

Although the state of the patient made the transfusion deemed urgent, however, due to a series of circumstances that it is useless to recall here, it had to be postponed until the following day. In fact, as had been arranged, as soon as it was day break they came to call me, and then I went at once to the Physiological Institute to obtain an assortment of my haemodrometers with their respective pressure tweezers, a saturated solution of carbonate of soda, and the instruments necessary to expose the artery of the lamb. Foreseeing the possible case of the patient's aversion to receiving the blood of an animal in her veins, or even that some assistant professor would give preference, for his own special reasons, to the injection of defibrinated human venous blood, I did not forget the syringe device for transfusion, which had recently been purchased from Mathieu.

Having thus completed the paraphernalia, I went to the patient's house, taking with me the custodian of the Physiological Institute, as a man practiced in assisting in living sections and experiments of this nature. As I went I gave him all the recommendations I thought necessary to fix the animal well, to keep him calm at the decisive moment, to fill the haemodrometer completely with carbonate of soda, etc. etc.

When I arrived at the patient, whom I found very pale, dejected and exhausted of strength, a brief consultation was held with Professor Gallozzi and his assistants Frusci and Lennaco, from which emerged the urgency of not leaving this therapeutic means untried, although it is considered not yet free from dangers and effects that are certainly not determined. For my part, I guaranteed that I could avoid the danger considered most serious, that is, the passage of air in a column or in bubbles into the veins of the patient, especially since in the difficult task I knew that I had the intelligent cooperation and assistance of such skilled and distinguished surgeons. And to them I entrusted the care of exposing any vein of the patient's arm for more than a centimetre, provided that it had a calibre approximately equal to that of the carotid artery of the lamb, so that it would then allow the introduction of the end of the haemodrometer, which I would have previously fixed with the other end in the carotid artery of the animal.

While the above-mentioned Professors attended to the preparation of the vein, which was perfectly successful in spite of the difficulties encountered for the natural execution of the patient's cutaneous veins, made even greater by her anaemic state, I occupied myself in another room with preparing the lamb and the haemodrometer, reduced to less than half their length, that is, between forty and fifty centimetres.

And since the present paper is not only intended to report the fact of the transfusion to the Academy, but must serve as a reply in the form of a circular to the many Italian and foreign colleagues, who wrote to me in a letter to learn about the method, please allow me to accompany this report with all those minute descriptions that I consider indispensable to those who wish to try the test again, because even an experienced and skilled surgeon may lack the necessary practice of eye and hand in haemodrometric and haemodynamometric experiments, which are pertaining to experimental physiology.

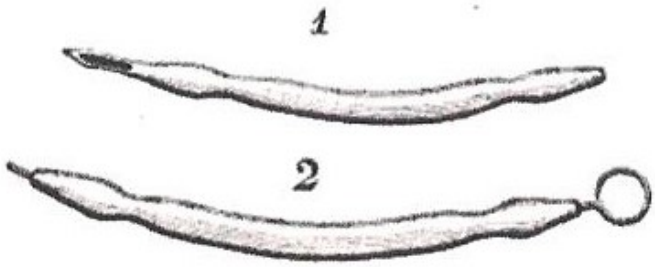
“Having fixed the lamb supine on a strong but not too heavy table, and about as high as the patient's bed, all the wool in the neck region must first of all be cut off with curved scissors, and then the denuded region cleaned very well using a damp sponge, to remove any trace of hair or other debris. Having done this the operator takes a fold of the skin of the neck between the index finger and thumb of the left hand, lateral and transversally to the trachea, with the help of an assistant, who equally supports the same fold of skin at the opposite end, that is, on the side of the trachea. By placing the cutting edge of a large bistoury at the middle of the vertex of the fold, the operator makes a cut in the fold with one stroke and without any danger, up to the base of the same, so that left by the fingers of the operator and assistant there is a longitudinal incision in the neck three or four centimeters from the midline.”

“Then the operator lays down the bistoury and has the lips of the skin wound kept apart to look either with the fingers or with the probe for the carotid, vagus and deep jugular bundle. The carotid artery is isolated for a distance of five to six centimetres, and three threads of strong silk are passed under it at a distance of 2 to 3 centimetres from each other (2).”

“The lowest thread, or, to be clearer, the one closest to the heart, takes the place of a tap or a pressure tweezers or fingers to prevent or to allow, according to need, the flow of blood. Centrifugal circulation is naturally prevented by grasping the ends of this thread and pulling up the artery until it bends; by ceasing or slowing down the traction, the blood passes, or gushes out if the incised artery.”

“The highest thread or closer to the head has a prudential significance, since it is often necessary to tighten it after the incision of the artery has been made, to prevent the centripetal flow of arterial blood through nearby arterial anastomosis, higher than the incision point. The median thread is used to tighten the walls of the artery around the collar which is located behind the olive of the cannula of the haemodrometer (see figs. 1 and 2).”

“The incision of the artery, which can be longitudinal and linear, but which I prefer to make with scissors and therefore in a V-shape, open towards the heart, must therefore fall between the upper and median wires, because this serves to fix the artery on the cannula.”



“To establish the communication between the artery of the animal and the vein of the patient, I use my haemodrometer, reduced, as I have said, to half its length. One could not imagine a simpler and more appropriate instrument than this, because it is represented by an elastic rubber tube that is chosen, by calibre and wall thickness, according to the artery on which one has to experiment or operate. To fix it hermetically on both sides, when the velocity of the circulation is tested, or with one end in the artery and the other in the vein for the purpose of transfusion, it carries at both ends a cannula of metal or rather of glass, of the same shape and length as those of figures 1[a] and 2[a]; only the calibre varies according to the artery, and therefore to the elastic rubber tube, into which they are introduced beyond the collar of the olive, so that, in correspondence with this, the elastic wall can be tightened well on the contained cannula.”

“There are therefore two cannulas ending in a free olive, fixed and therefore hermetically communicating with each other, by means of an elastic rubber tube about 40 centimetres long.”

“Here, on the other hand, two of the largest double-ended olive cannulas can be seen in natural size. The finest, however, do not have a calibre below half of these; their length is almost always the same. The cannulas I used were made of glass and were pulled by the lamp, as is used in chemical laboratories; naturally, after breaking the tip, the edges of the opening were made rounded, by melting them by the lamp. Provided that the glass tube from which they are prepared has strong enough walls, I think they should be preferred to those of metal, since the latter are opaque, while the former allow one to see through whether the liquid is moving, whether there are air bubbles, etc., etc.”

“Recently I had several made of pachfond metal, some of which, at the suggestion of Prof. Gallozzi and as can be seen in figure 1a, the end of an olive is continued at a sharp point like a lancet, to introduce it into the vein without having to prepare it, in cases where it is urgent to make the transfusion with less loss of time.”

“Now I have devised another form of cannula, which we shall call venous because it is intended to be fixed in the vein, by which communication between the artery and the vein can be established even before the blood flows, because the cannula will have an upper opening intended to let out air or alkaline solution, and when the blood gushes out, with a simple device this will be closed and at the same time the one at the end of the olive, that is in the vein, will open.”

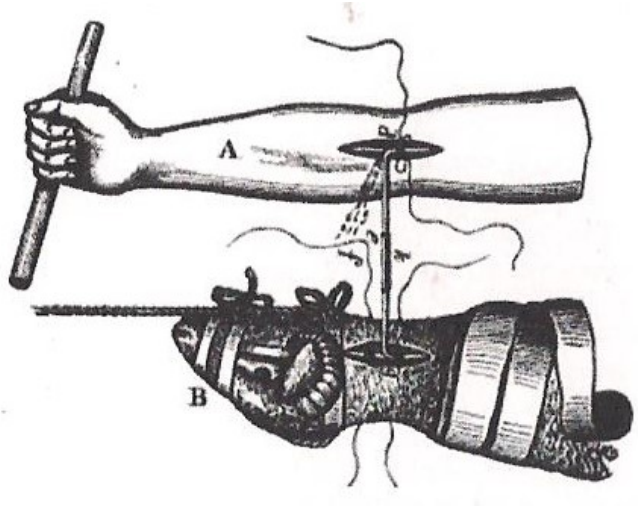
“This cannula has the opening of the olive to be introduced into the vein, semicircular in shape, because it is closed on one side by a half metal disc welded to its edge. In the wall of this cannula and about 15 millimetres from the extreme semicircular opening, there is an oblong rectangular window, two by three millimetres high and so long as to complete 180 degrees of the circumference of the cannula.”

“Inside the cannula and immediately behind the fixed half disk there is a groove in which the periphery of another movable metal half disk rotates. It is well understood that by turning this half disc in its groove you can bring it behind the fixed that will hide it, and then the cannula will be open; by continuing to turn the half mobile disc to the right or left, the opening will gradually narrower, until it will be hermetically closed once the half movable half disc has completed 180 degrees.”

“These rotational movements are impressed on the movable disc by means of a metal plate to which it is welded, and which ends with a button protruding from the rectangular opening described in the wall of the cannula. The flap that functions as a handle is thin, and slides, because it is slightly curved like a cylinder segment, along the inner surface of the cannula, while the button drags with it another rectangular flap that fits behind the edges of the opening and closes it entirely when the half movable disc is hidden behind the fixed one.”

“Before applying the long haemodrometer, in order to determine the velocity of the blood (3) or the one reduced to half length for transfusion, I have a rather concentrated solution of carbonate of soda pass through it for a few minutes, immersing one end in the bottle containing the solution, then absorbing at the other end and keeping the tube bent downwards so that the liquid comes out as if from a siphon. Since it is a transfusion from animal to human, I immerse the bottle of the solution in a water bath at 37 degrees centigrade. Finally, by compressing with pressure tweezers anywhere on the elastic rubber tube, I prevent the liquid from escaping further, while the haemodrometer remains full even when it is removed from the bottle. However, having to handle it, it is impossible to avoid some slight pressure on the elastic rubber tube, so that a few drops of water escape from the extreme olives, and the place of water is occupied by air bubbles. This does not always happen and especially if you take care to take the haemodrometer at both ends, where its walls are resistant due to the presence of glass or metal cannulas. However, even in these cases it is not possible to prevent a little air from entering, at one or both ends, when the pressure tweezers applied to prevent the solution from escaping is removed. At this point, of course, the elastic walls of the pipe (which under pressure touched each other) stretch, and therefore there is aspiration of liquid both here and there, the inevitable consequence of which is the entry of a little air from one and often from both olives. To avoid this inconvenience, which is very serious, since it is a matter of a blood transfusion in a man, I advise you to operate in the following way: as soon as the vein in the patient's arm is bare and isolated, and a silk thread has been passed under it, with which you must tighten around the olive tube to be inserted, the operator, assisted by two assistants, moves on to fix one end of the haemodrometer in the carotid artery of the lamb, naturally in the direction of the heart. An assistant pulling with some force the ends of the lower thread passed under the carotid artery prevents the centrifugal flow of blood; and the operator scissors the walls of the artery (making a V-shaped cut, open downwards or towards the heart) between the upper and median threads. He then grasps the tip of the V-shaped flap with tweezers held in his left hand, lifts it while taking the glass cannula of the haemodrometer between the index finger and thumb of the right hand behind the olive, the opposite end of which is immersed in the bottle of the solution. A second assistant raises the bottle a little, so that the solution gushes in a continuous column from the tube that the operator holds between his fingers. Then the assistant who pulls the artery, releasing the thread slightly, lets a little blood gush out, and at this moment the operator must direct the gushing tip of the tube against the gush of arterial blood to introduce the olive into the artery, which is immediately tightened with the middle thread around the collar of the olive itself and the artery is then immediately compressed, that is, pulled with the lower thread to prevent the further passage of blood (4). In this way it is certain that the blood column of the carotid artery continues with the column of soda carbonate solution, which prevents it from clotting. Once this is done, the table on which the lamb is fixed is brought closer to the patient’s bed, the operator cuts the vein with scissors as he did for the artery; he grasps and raises the flap with the tweezers of his left hand and takes with his right hand the still free end of the haemodrometer, pulling it from the bottle of solution, to bring it closer to the vein; then the assistant who holds the pulled artery, releases the thread, and consequently the blood passes from the carotid artery into the haemodrometer, pushes the column of carbonate solution forward and in less than a second it gushes out from the cannula that the operator holds in his right hand and near the opening of the vein. As soon as the blood appears, the olive is introduced into the vein (in the direction of the heart) the walls of which tighten around the collar of the olive as has been done for the artery. It is almost useless to say that

the vein must also be compressed upwards during the preparation, while in the act of incision and as long as the transfusion lasts it must be compressed downwards or towards the periphery. The upper pressure is removed as soon as the transfusion tube is inserted." (5)



Almost as a historical curiosity, which serves at the same time to illustrate the operation of direct transfusion from animal to man, I thought of having the united figure that I found in Paolo Manfredi's pamphlet (6) reproduced, which faithfully represents the reciprocal position of the animal and the arm, once communication has been established and at the moment when the blood passes from the carotid artery of the lamb into the vein of man.

And these were neither more nor less than the relations I established, with the difference, however, that I was able to avoid so many of the naiveties committed by Manfredi; so I did not need to wrap the lamb in a swaddling band, nor to fasten its head by means of the large rope, which I saw passing under the double muzzle; but I left his mouth open and his head free and protruding beyond the edge of the table, limiting myself to fixing him supine but a little on his side, by means of laces on all four legs, and to make him caress his muzzle, to keep him quiet, especially at the moment when the cannula had to be introduced and fixed in the artery, because once this was done the animal calms down, indeed, it even seems that the release of blood gives him a pleasant sensation.

However, to justify Manfredi and all those who practiced transfusion in the 17th century, I must recognize their need to secure the animal well so as not to allow it any movement, since they could not then have at their disposal, as we do, the elastic rubber tubes, to which the present factories, and in particular that of Vallach in Cassel, have imparted flexibility, combined with the robustness and elasticity of the arteries.

Replace with imagination the straight and rigid communication tube *d* and *g* of the figure, a supple and flexible tube and you will have the true illustration of my operation. What I must point out in this connection is the pulsation of the elastic communication tube, synchronous with that of the lamb's artery during the passage of blood.

This phenomenon, on the one hand, is really beautiful to look at, since it seems that the conducting tube is vivified, on the other hand it is very useful for the operation, since there is a certain proof that the blood goes into the vein and because it serves to calculate approximately, from the number of pulsations and the known velocity of the blood in the carotid artery, how much more or less is transfused.

By proposing and practicing the direct transfusion of blood from an animal to a man, I have never believed that I was doing anything new, but only of reviving a surgical practice desired by Hippocrates himself and performed, almost simultaneously, in the seventeenth century by so many surgeons, English, French, German and Italian, but which for over two centuries had been forgotten or abandoned, because it is judged severely by some scientific bodies and even prohibited by some governments.

Nor should this surprise us, when we consider that these direct blood transfusions were practiced precisely at that time when there was a fairly lively struggle was raging between anatomists and physiologists about the theory of the Arveo on the circulation of the blood, which means that the idea of circulation was not very clear, and therefore the necessary importance could not even be given to the possible passage of air in the veins of a man, while many of them still believed that the arteries were not blood vessels but air vessels, a belief that was not quickly destroyed, as is proved by the writings of some physiologists of the 1700s and best of all, those of Michele Rosa, who in 1788 instituted quite a few experiments to prove that the arteries contained little blood and much vapour.

And therefore, with such confused ideas about the true circulation, because they were ignorant if not of the existence at least of the shape of the capillaries and the size of the blood globules, those surgeons chose the lamb for the transfusion of blood into man, only because it is a tame and sweet animal, not because of the smallness of its blood cells; moreover, ignoring the dangerous effects of the entry of air (in continuous column or bubbles) into the veins, they established communication by means of three cannulas, one of which was fixed in the artery of the animal, the other in the vein, and a third served as a bridge between the one and the other.

These three cannulas were empty, or, better to say, filled with air, so that it had to be pushed forward into the man's vein by the arterial blood, when they removed the knot that tightened the artery below the point where the cannula was fixed.

This is evident from all the descriptions of transfusions practiced by the above-mentioned authors, from the figures and plates, and above all from the following passages by Lower, Denis, Manfredi, and Rosa, the latter of whom experimented towards the end of the eighteenth century.

[*NOTE: The next section is in English (and quotation marks) in the original paper – reproduced here as written - PL*]

"Then make a strong ligature on the upper part of the artery, not to be untied again: but an inch below, viz. towards the heart, make another ligature of a running knot, which may be loosened or fastened as there shall be occasion. Having made these two knots, draw two threads under the artery between the two ligatures; and then open the artery, and put in a quill, and tie the artery upon the quill very fast by those two threads, and stop the quill with a stick. After this, make bare the jugular vein in the other dog, about an Inch and a half long; and at each end make a ligature with a running knot, and in the space betwixt the two running knots draw under the vein two threads, as in the another: then make an incision in the vein, and put into it two quills, one into the descendent part of the vein, to receive the blood from the other dog, and carry it to the heart; and the other quill put it into the other part of the jugular vein, (which comes from the head) out of which, the second dog's own blood must run into the dishes. These two quills being put in and tied fast, stop them with a stick, till there be occasion to open them. ... ... After that unstop the quill that goes down into the first dog's jugular vein, and the other quill coming out of the other dog's artery, and by the help of two or three other quills, put into each other, according as there shall be occasion, insert them into one another. Then slip the running knots, and immediately the blood runs through the quills, as through an artery, very impetuously." (7)

[*NOTE: The next section is in French (and quotation marks) in the original paper*.]

"Then we strongly tied the artery of the female dog to the end of its pipe, and the vein of the dog to the two ends of the two pipes that we had introduced there, and after laying the dogs close to each other, so that the female dog's thigh responded to the dog's throat, we

made the first pipe enter the second, that is to say that of the female dog's artery, into that of the dog's vein which looked at the heart; and having loosened all three of our nooses, we saw the blood flow from the crural artery of the female dog into the jugular vein of the dog, while the third pipe poured into a dish about as much of this dog's blood as it receives." (8)

[*NOTE: The next section is in Latin (italics and quotation marks) in the original paper*.]

"*Et inde intrusi tubuli extremitate cum alio in Animantis ante parati Carotide praefixo, conjuncta, Arteriaeq. brutalis laxatis vinculis quod libuit sanguinis innocue communicavimus.*" (9) [I believe that this Latin text approximately translates to: "And from thence the extremity of the intruding tube was joined with another in the animal before the prepared carotid artery, the brutes bonds loosed we shared harmless blood at will." - PL]

"*From calf to lamb*. - The calf's carotid artery was already administered: the reason why the lamb was immediately arranged to transmit the blood to it. But the cut of the jugular had meanwhile been lost, it could no longer be found, and it was necessary to open a second one closer to the heart. The tube was vented in the air then slipped into the vein, the blood was let run from the carotid artery; the blood came in and ran in quickly, p. 289."

"The same on p. 290 writes: *From calf to lamb*. - Finally he was brought closer to the calf, the tube was applied and the blood was allowed to flow. The blood was flowing, the tube was full and distended and it seemed at first that it was flowing freely down the vein: they even thought they felt some movement in the precords, but then no doubt arose, it seemed and it didn't seem; we wanted to make sure and the machine became disconcerted: the tube melted, the feathers came out of the artery and vein; it was necessary to recompose the apparatus etc. etc. five minutes passed before the tubes were replaced. In the end, etc." (10)

If my scientific beliefs, based on the histological and chemical knowledge of blood, as well as on the good results obtained by transfusing into animals arterial blood of animals of other species (which, moreover, had been observed and obtained by other experimenters) and if finally the confidence in myself acquired, by long experience in haemodrometric and haemodynamometric research on live animals, made me propose the daring operation of direct transfusion from animal to man, practiced by Lower, Denis, Cassini, Manfredi, etc. however, they did not allow me to follow their defective and dangerous method (11), and therefore I did not establish the communication between artery and vein, by means of one or more empty tubes, in order to then give free flow to the blood of the former, which would have pushed the air contained in the tubes before it and into the vein; nor did I allow the contact of the blood to be transfused with atmospheric air, as they did, with which it could have been mixed, forming bubbles or foam, and with it lumps or clots, but, as can be seen from the minute description of my method of operation, I prevented all contact with the air by filling the communication tube with a harmless liquid which at the same time delays the coagulation of the blood.

In doing so, I have equipped the tube or system of tubes of communication between the artery of the animal and the vein of the patient with a safety valve; and by letting the blood gush before establishing communication with the vein, I also avoided letting the carbonate solution in. Further experiments, which I propose to carry out, will prove to me whether the passage of so small a quantity of this solution is dangerous or not; for me, judging *a priori*, I consider it indifferent.

Even our sick woman immediately felt, as we read in the authors who described the effects of the transfusion, the arrival of blood in the heart, showing a very particular agitation, which lasted until, judging by the number of beats of the lamb's heart and the elastic rubber

tube, I had transfused a sufficient quantity of blood (150-180 grams); I stopped its course by squeezing the elastic rubber tube between thumb and index finger near the vein, which was then compressed at the top to remove the cannula and medicate by bandaging, as is practiced, after bloodletting. Both times, shortly after the transfusion, the patient was seized by a cold shiver that began in the operated arm and specifically in the hand, a sensation that must certainly be ascribed to the cooling of the arm and shoulder left uncovered for the operation. This feeling, however, disappeared after some time, which was shorter the first time than the second time. What I especially noticed was the change in the rhythmic movements of the heart which instantly followed the transfusion of the blood, making the beats more robust and rarer, and the sounds more normal and almost physiological.

And so too were the pulsations of the radial, at first weak and very frequent, they became stronger, rarer and less rapid. In the first hours after the transfusion, a certain drowsiness was also observed that on the 15th passed into real sleep what did not happen after the transfusion of the 24th. – The improvement in the general state of the patient after the first transfusion began about six hours after the operation and continued progressively, so that on the third and fourth day it would have been quibbling folly to want to doubt the beneficial effects of the transfusion performed, especially since the patient did not use any medicine.

After the operation, she began to crave and tolerate broths that her stomach refused in the days before the transfusion. Later they passed on to soups, veal cutlets, and even salad and olives, which I myself saw the patient eating almost greedily. But since the patient was not under my care and I visited her after the two transfusions for scientific interest alone and for that concern that every operator feels for his work, and since finally the anaemic state of the patient was the direct effect of blood loss due to repeated haemorrhages from the exulcerated uterine mucosa and indirectly due to a disturbance of function in the digestion and blood producing organs, so I do not believe nor can I go further in the clinical report of this case.

I will only say that the second transfusion was carried out when it was observed that there was a pause and perhaps even a slight regression in the improvement, that had been obtained with the first transfusion, but the patient was still on day 24 in a better condition than on day 15, so that there was perfect agreement between the consultants whether or not it was not necessary to repeat the transfusion which, as has already been said, immediately produced a certain eagerness, followed by a sensation of cold. This time, however, the improvement was less evident and shorter. About two weeks later, the patient died as a result of peritonitis produced by the exulcerative process of the uterus, which had shown itself for a series of months to be refractory to any local and general therapeutic means.

Although these two transfusions in the same patient have not succeeded in saving her from death, yet they suffice to prove erroneous the opinion of those who maintain that the blood of an animal transfused into the vessels of an animal of another species acts like a poison.

Since blood consists of plasma and globules, and since these have different sizes in different species, it can be admitted that the blood of a given animal, e.g. of a frog or proteus injected even in small quantities into the veins of a mammal, e.g. of a lamb or a dog, can be harmful and even be the cause of death by simple mechanical fact, not by poisoning, for then any trauma would be a poison.

But when the globules of the transfused blood have dimensions equal in size or even smaller than those of the animal that receives it, all danger ceases, and as the blood of lambs or rams was not and is not poisonous to horses, calves and dogs, so I believe that it can be considered not at all dangerous even to humans. I am, however, far from believing that this blood of another species can always take the place of its own lost one, but I believe that its presence in the vessels, both mechanically and chemically, is so beneficial to the new body into which it is transfused, as to revive in it the principal organic functions, and especially those for the formation of blood, and thus give time and place to reproduce the missing blood and regain health. Yes, I do not think so bold, the opinion that if our patient had been subjected to a transfusion at a less advanced stage of the disease, the

improvement could have lasted and allowed for a more energetic local surgical treatment to lead her to recovery.

Consideration on different methods of transfusion

Blood transfusion is a therapeutic aid still in the process of experimentation, which is used only in extreme cases, that is, when the art is found to have exhausted all other means, and therefore it is always decided with an uncertain and anxious hand –

There is no doubt that in such cases the mind of every doctor-operator, who has physiological knowledge and knows how important a good quality and sufficient quantity of blood is, who knows that blood is blood in so far as it is contained in the vessels and these are vessels in so far as they contain it (12), must involuntarily run to the idea of making, to pass directly the arterial blood of a healthy man into that of the bloodless patient; except that this idea must be immediately renounced, both because it is difficult, indeed almost impossible, to find someone who lends himself to offer his artery for the operation, and because the surgeon could not accept the responsibility of exposing a healthy man to the danger of an arteriotomy, with the consequent necessary ligation, in the doubt of bringing relief to a dying person. And I confess that my conscience would not allow me to agree to lend myself to perform the operation in the possible, but rare, case of so much sacrifice to which a son could decide for his father or the latter for the son. It is a matter of mutilation to a healthy individual, which presents momentary dangers and who can also have them later and when he least expects it; therefore it should be prohibited by law. Therefore it is inevitable not to think about direct transfusion from man to man, from artery to artery or vein.

There remains the direct transfusion from man to man, from vein to vein. Here, however, many objections arise. First of all, it is necessary to consider venous blood, which is saturated as everyone knows with materials intended for elimination, which must occur from the lungs as regards the gaseous principles or the vapour state (*CO_2, NH_3, N, HO*), and for other organs of excretory secretion (kidneys, skin) for all solid and soluble bodies. In addition to this, a man could at most offer a vein of the arm or leg for transfusion, and therefore he would have the most venous, most charred blood in the body, because it is recovered from the muscles, nerves, bones and not mixed at all per kilo, as would be the case with a vein near the heart.

And we know from the experiments established in Ludwig's laboratory, that by having defibrinated venous blood pass through the blood vessels of an organ of secretion just removed from an animal and placed in all the most favourable conditions of temperature, humidity, etc., no trace of the specific normal principles of the organ can be obtained, but there is a simple exudation of water with salts, as when a solution of sodium chloride is injected instead of blood.

But even if venous blood was capable of sustaining replacement and strength, the question arises as to whether there is sufficient pressure in a vein of a human limb to push blood into a vein of another individual. For my part, I believe that out of a hundred attempts, in more than seventy or eighty, it would be almost impossible to pass the blood of a vein of one open limb into a closed vein of another, because of course this vein must not be crossed by one's own blood and therefore will have the walls sagging and leaning against each other. This represents for me such an obstacle as to prevent the exit, already ordinarily difficult in itself, of a strong jet of blood from the vein of the giver of the blood or to force it to make its way, by means of the innumerable venous anastomoses, into another adjacent vein of the same individual.

Finally, the dangers to which the person who has to give blood are exposed must not be overlooked, which, if they are not alarming, because they are not imminent, do not cease to be serious and easier to occur than by operating on the artery. - And these are: phlebitis which is easier to manifest than arteritis, and the consecutive suppuration of the wall of the vein where it was laid bare, incised and tied around the communication tube. In conclusion, therefore, I will say that the transfusion of blood from vein to vein, physiologically considered,

is an *inopportune* operation, perhaps *frustrating* for the quality of the blood, very *dangerous* for the generous or greedy for profit person that would give his vein, and *almost impossible* for hemodynamometric conditions. (13)

Now there remains nothing else but indirect transfusion, that is, the injection of beaten or defibrinated blood by means of syringes or with other similar devices. And this is the method used by most Italian and foreign surgeons from 1820 to the present day. (14)

But considering that for these transfusions venous blood is used naturally taken from a limb and therefore saturated with materials to be eliminated, that this blood to be defibrinated must remain for at least eight or ten minutes in contact with atmospheric air, (ordinarily colder) which must be beaten and deprived of a characteristic constituent principle, coagulating matter, which must come into contact with the always heterogeneous walls of different containers and devices, without questioning the sometimes mediocre and sometimes good results obtained by transfusions operated in this way, I cannot accept the assertion of those who want there to be no difference between the human venous blood thus treated (or rather mistreated) and that which flows in the vessels; but I think I am more in line with the truth by proposing to confess our ignorance and the defect of the physical and chemical means of recognizing these differences between a living blood, and one which, coming out of the vessels, has undergone so many modifications.

Blood is not only an animal tissue, but it is the protoplasm of the blood vessels that contain it; radical, its alterations must be very important once it abandons them, and it would be more profitable for science and practice to devise analytical means to determine these alterations or changes, the manner in which they occur, their progress with time, than to do everything to perpetuate the illusion. And since good results have also been obtained in man by injections of defibrinated animal blood, it is logical to expect very good results from direct transfusion, when my method is used, by which the danger of introducing air into the veins is eliminated.

REFERENCES

1. Trovandomi a Milano nel 1866 ed in procinto di partire pel campo colle Ambulanze Medico-Chirurgiche borghesi, avevo fermo divisamento di tener sempre fornita la mia Ambulanza di uno o più agnelli vivi, per servirmi del loro cuore e del loro sangue onde trasfonderlo a mezzo del mio emodrometro nelle vene di qualche soldato in pericolo di vita per grave emorragia. [*Finding myself in Milan in 1866 and about to leave for the camp with the bourgeois medical-surgical ambulances, I had a firm resolve to always keep my ambulance supplied with one or more live lambs, to use their hearts and their blood to transfuse it by means of my haemodrometer into the veins of some soldier in danger of life due to severe haemorrhage*.]
2. Nel caso che lungo il tratto isolato della carotide si scorgessero dei piccoli rami arteriosi bisognerà legarli con doppia legatura, l'una verso l'arteria e l'altra verso la periferia, per tagliarli poscia trasversalmente fra le due legature. [*If small arterial branches are seen along the isolated section of the carotid artery, they will need to be tied with a double ligature, one towards the artery and the other towards the periphery, to then cut them transversely between the two ligatures*.]
3. Vedi la mia *Guida allo studio della Fisiologia*. Parte 2a, pag. 78 e seguenti. [*See my Guide to the Study of Physiology. Part 2a, p. 78 et seq*.]
4. La prima trasfusione eseguita il mattino del giorno 15 novembre, ci aveva fatto conoscere gl'inconvenienti dell'introduzione del tubo di comunicazione nell'arteria dell'agnello, dopo di averne levato l'estremo dalla bottiglia e stringendolo in un punto perchè non uscisse la soluzione. Si ebbe qualche bollicina d'aria che si lasciò spinger fuori dal sangue prima di stabilire la comunicazione colla vena. E perciò alla seconda trasfusione, praticata nove giorni dopo nella stessa inferma, accettai con vero compiacimento la felice idea del dottor Frusci d'introdurre nell'arteria l'estremo della

cannula mentre ne zampillava la soluzione come si è descritto più sopra. [*The first transfusion performed on the morning of 15 November, had made us aware of the inconveniences of introducing the communication tube into the lamb's artery, after removing the end of it from the bottle and tightening it in one place so that the solution would not come out. There were some bubbles of air that were pushed out by the blood before establishing communication with the vein. And therefore at the second transfusion, performed nine days later in the same patient, I accepted with real satisfaction the happy idea of Dr. Frusci to introduce the end of the cannula into the artery while the solution gushed out as described above*.]

5. Come ognuno comprende, e più di tutti ne saran convinti i chirurgi, la comunicazione fra l'arteria dell'animale e la vena dell'infermo mediante il mio emodrometro si stabilisce in minor tempo di quello che occorre per leggere questa descrizione, e le cose vanno sempre bene seguendo il precetto festina lente, purchè non solo l'operatore ma ancora i suoi assistenti, che non devono essere meno di due ne più di tre, abbiano prontezza d'occhio e di mano. E qui non posso omettere una raccomandazione riguardante la costruzione e la scelta delle cannule, le quali non debbono avere un calibro troppo differente fra loro nè troppo angusto, specialmente in corrispondenza dei colletti dietro delle olive, poichè in tal caso, si possono formare delle bollicine. [*As everyone understands, and surgeons will be convinced more than anyone else, the communication between the animal's artery and the patient's vein by means of my haemodrometer is established in less time than it takes to read this description, and things always go well according to the precept festina lente, provided that not only the operator but also his assistants, who must not be less than two or more than three, have readiness by eye and hand. And here I cannot omit a recommendation concerning the construction and choice of cannulas, which must not have a caliber too different from each other nor too narrow, especially in correspondence with the collars behind the olives, since in this case, bubbles can form*.]
6. De Nova et inavdita Medico Chyrurgica Operatione Sangvinem transfvndente de individvo ad individvvm, privs in Brutis et deinde in Homine, Romae experta-Opuscvlvm singvlare Avctore Pavlo Manfredo Lvcense ex Lamaiore. Romae 1668. [I believe that this Latin text approximately translates to: *On the new and unheard-of medical surgical operation of transfusing blood from individual to individual, first in brutes and then in man, the experienced in Rome – A unique treatise by Paulo Manfredo Lucense from Lamaiore. Rome 1668*. - PL]
7. A method of transfusing blood; by Dr. Lower - The Philosophical Transactions. London 1812. [*Note: This year is incorrect – Lower published is paper in Philosophical Transactions in 1666 – PL*]
8. Extrait d'une lettre de M. Denis, professeur de philosophie et de mathematiques, à M. *** touching the transfusion du sang. De Paris le 9 Mars 1667.- Journal des Savans, de l'an 1667 Amster. 1685. [*Extract of a letter from M. Denis, professor of philosophy and mathematics, to M*** concerning blood transfusion*]
9. Paolo Manfredi, opera. cit. page 16.
10. Rosa Michele. *Lettere fisiologiche*. Napoli 1788.
11. È vero che i citati autori parlano di trasfusioni da lor praticate con felice successo; nè io ne dubito, essendo l'aria pericolosa come pericolosi riescono la mitraglia ed il fuoco di fila. E nella stessa guisa per cui non tutti i combattenti vanno a rimaner sul campo di battaglia, così non tutte le persone, cui penetri un po' d'aria nelle vene, sono soggette inevitabilmente a morire. È questione di eventualità. - Ancora non è stabilito quant'aria sia necessaria per uccidere un uomo od un animale. Certo è che un semplice soffio di aria nella vena del collo di un cavallo l'abbatte all'istante; nè si potrebbe altrimenti spiegare la morte istantanea di alcuni operati o feriti, o donne appena sgravate, se non ammettendo gli effetti micidiali di poche bolle d'aria penetrate per via dei vasi aperti nel loro circolo sanguigno. E qui conviene osservare che una sola bolla d'aria può bastare ad uccidere, se non direttamente, ma pur sempre all'istante. E come? -supponiamo che una bolla d'aria trascinata dalla corrente sanguigna giunga in una arteriuzza del midollo

allungato e non possa più procedere nei capillari, perchè le sue dimensioni non lo permettono, ed ecco intercettata così la circolazione nella rete capillare corrispondente, mentre il sangue spinto dalla forza del cuore si accumula dietro della bolla, cerca spingerla innanzi, esercitando così una pressione insolita sulle pareti dell'arteriola dietro della bolla. Finalmente la resistenza delle pareti viene vinta, cioè il sangue rompe il vaso e succede l'emorragia, la quale, abbenchè limitata a poche gocce di sangue, non può fare a meno di comprimere e lacerare il delicato parenchima del nodo vitale, e così, paralizzato il centro dei movimenti respiratorii, l'individuo spira. [*It is true that the cited authors speak of transfusions practiced by them with happy success; nor do I doubt it, the air is as dangerous as grapeshot and barrage are dangerous. And in the same way that not all fighters go to remain on the field of battle, so not all people, to whom a little air enters their veins, are inevitably liable to die. It is a matter of eventuality. - It is not yet established how much air is needed to kill a man or an animal. What is certain is that a simple breath of air in the vein of a horse's neck knocks it down instantly; nor could the instantaneous death of some who were operated on or injured, or newly relieved women, be otherwise explained than by admitting the deadly effects of a few air bubbles penetrated by the vessels opened in their bloodstream. And here it is worth observing that a single bubble of air can be enough to kill, if not directly, but still instantly. And how? - suppose that a bubble of air dragged by the blood current reaches an arteriole of the medulla oblongata and can no longer proceed in the capillaries, because its size does not allow it, and here the circulation in the corresponding capillary network is intercepted, while the blood pushed by the force of the heart accumulates behind the bubble, tries to push it forward, thus exerting unusual pressure on the walls of the arteriole behind the bubble. Finally the resistance of the walls is overcome, that is, the blood ruptures the vessel and haemorrhage follows, which, although limited to a few drops of blood, cannot help but compress and tear the delicate parenchyma of the vital node, and thus, paralyzing the centre of respiratory movements, the individual expires*.]

12. Per me non credo spingermi nell' esagerazione facendo un parallelo fra il sangue, la sostanza contrattile della fibra muscolare, il contenuto del tubulo nervoso, il protoplasma d'ogni cellula; e fra le pareti de' vasi e la membrana delle fibre, dei tubuli e delle cellule. [*For me, I do not think I go into exaggeration by making a parallel between the blood, the contractile substance of the muscle fibre, the contents of the nervous tubule, the protoplasm of each cell; and between the walls of the vessels and the membrane of the fibres, tubules and cells*.]
13. Lo stesso Lower, nel suo trattato “De trasfusione sanguinis” scrisse a pag. 197. *Et primum fistulis, hinc inde adaptatis e vena Iugulari hujus, in Iugularem alterius transmittere conatus sum; sed cum propter languidum sanguinis venosi motum, eum in fistula concrescere ṣtatim, et sibi ipsi viam obstruere viderem, etc*. [Lower himself, in his treatise "De trasfusione sanguinis" wrote on p. 197.] [*I believe that this Latin text approximately translates to: And first I tried to pass the tubes, adapted here and there from the vein of this jugular, into another jugular; but on account of the feeble movement of the venous blood, I would see it immediately congealing in a tube, and obstructing the way for itself, etc*. – PL]
14. Vedi *Archives de Physiologie normale et pathologique*, 1870. - *La transfusion du sang*, par Ladislas di Belina. [*See Archives de Physiologie normale et pathologique*, 1870. - *La transfusion du sang, by Ladislas de Belina*.]