DIE TRANSFUSION DES BLUTES – IN IHRER GESCHICHTLICHEN ENTWICKLUNG UND GEGENWARTIGEN BEDEUTUNG.

By: DR. LEONARD LANDOIS

A TRANSLATION BY PHIL LEAROYD

This paper by Dr. Leonard Landois titled 'The transfusion of blood – its historical development and current significance' was published in 1867 in the journal *Wiener medizinische wochenschrift* in thirteen separate parts, which can be read or downloaded from the following sites:

https://anno.onb.ac.at/cgi-content/anno-plus?aid=wmw&datum=1867&size=40

https://books.google.co.uk/books/about/Wiener_medizinische_Wochenschrift.html?id=5y7Hbt2RbCcC&redir_esc=y

The thirteen parts of this paper cover nine sections. The individual references for each of these parts are as follows:
Wiener medizinische Wochenschrift, Vol 17, No 30, pp 465-468 – Section I
https://anno.onb.ac.at/cgi-content/anno-plus?aid=wmw&datum=1867&page=251&size=40
Wiener medizinische Wochenschrift, Vol 17, No 31, pp 484-486 – Section II
https://anno.onb.ac.at/cgi-content/anno-plus?aid=wmw&datum=1867&page=260&size=40
Wiener medizinische Wochenschrift, Vol 17, No 32, pp 500-502 – Section II
https://anno.onb.ac.at/cgi-content/anno-plus?aid=wmw&datum=1867&page=268&size=40
Wiener medizinische Wochenschrift, Vol 17, No 35, pp 545-547 – Section III
https://anno.onb.ac.at/cgi-content/anno-plus?aid=wmw&datum=1867&page=295&size=40
Wiener medizinische Wochenschrift, Vol 17, No 36, pp 565-568 – Section III
https://anno.onb.ac.at/cgi-content/anno-plus?aid=wmw&datum=1867&page=305&size=40
Wiener medizinische Wochenschrift, Vol 17, No 37, pp 577-579 – Section IV
https://anno.onb.ac.at/cgi-content/anno-plus?aid=wmw&datum=1867&page=315&size=40
Wiener medizinische Wochenschrift, Vol 17, No 42, pp 657-660 – Section V
https://anno.onb.ac.at/cgi-content/anno-plus?aid=wmw&datum=1867&page=359&size=40
Wiener medizinische Wochenschrift, Vol 17, No 43, pp 675-677 – Section VI
https://anno.onb.ac.at/cgi-content/anno-plus?aid=wmw&datum=1867&page=368&size=40
Wiener medizinische Wochenschrift, Vol 17, No 47, pp 738-740 – Section VII
https://anno.onb.ac.at/cgi-content/anno-plus?aid=wmw&datum=1867&page=399&size=40
Wiener medizinische Wochenschrift, Vol 17, No 48, pp 753-755 – Section VII
https://anno.onb.ac.at/cgi-co2ntent/anno-plus?aid=wmw&datum=1867&page=407&size=40
Wiener medizinische Wochenschrift, Vol 17, No 49, pp 771-773 – Section VII
https://anno.onb.ac.at/cgi-content/anno-plus?aid=wmw&datum=1867&page=416&size=40
Wiener medizinische Wochenschrift, Vol 17, No 50, pp 790-792 – Section VIII
https://anno.onb.ac.at/cgi-content/anno-plus?aid=wmw&datum=1867&page=425&size=40
Wiener medizinische Wochenschrift, Vol 17, No 50, pp 790-792 – Section IX
https://anno.onb.ac.at/cgi-content/anno-plus?aid=wmw&datum=1867&page=503&size=40

In Part 1 (Section I, pp. 465-468) Landois provides an historical background to blood transfusion initially commenting on the fable of Medea, but then concentrating on the historical development of the discovery of the circulation of blood, stating that in his opinion blood transfusion could not effectively have occurred until it was discovered, and in doing so comments of the work of Galen, Vasalius, Michael Serveto, Andreas Caesalpinus and finally provides information on the work and life of William Harvey. Landois also gives some details

of the beginnings of the Royal Society in England, of which he also states “we will see that the transfusion of blood originated from the bosom of the Royal Society”.

Part 2 (Section II, pp. 484-486) lives up to its sub-title ‘The first transfusion experiments in England’ by firstly expanding on the role that the Royal Society played in promoting interest and research, initially in infusion experiments, that followed Harvey’s description of the circulation. The first infusions are credited to Christopher Wren but were then extended, especially by Timothy Clarke (spelt as ‘Clarck’ in the original publication). The early attempt at performing a blood transfusion by Dr Henshaw is mentioned before detailing Richard Lower’s experiments that were initially reported to the Society by Robert Boyle in 1666. A brief description of Lower’s transfusion technique between two dogs is provided.

Part 3 (Section II continued., pp. 500-502) - the concluding part of section II – continues the work of the Royal Society in promoting blood transfusion. Landois lists the 16 points made by Robert Boyle in his paper, published in the Society’s journal Philosophical Transactions – which reflect the limited knowledge regarding the role of blood within the body known at that time. After mentioning the research work of Thomas Coxe, Landois notes details of the first human transfusion (using lamb’s blood) made in England by Richard Lower and Edmund King on Arthur Coga, on the 23 November 1667, which, although repeated a few weeks later resulted in no improvement in the patient’s ‘mental confusion’.

Part 4 (Section III, pp. 545-547) is subtitled ‘The first transfusion experiments in France’. Initially Landois identifies that the reason why transfusion found so many opponents in France was due to the head of the Académie des Sciences, Gui Patin’s unwavering belief in the beneficial effects of bloodletting. Jean Baptiste Denis is identified to have first carried out extensive experiments on animals (dogs and calves) but then, together with the surgeon Emmerez, performed the first human transfusion (using sheep’s blood) on the 15 June 1667 on a 15/16-year-old boy who was suffering from a fever, as well as from the 20 bloodlettings that had been performed on him. The patient showed an ongoing improvement; not all of which can of course be attributed to the transfusion but is as likely as not to be due to the absence of bloodletting! The author then describes the transfusion of Denis’s second human recipient, a 45-year-old healthy palanquin bearer who was also transfused with sheep’s blood and who showed no ill effects.

From a German author’s viewpoint, Landois gives an interesting comparison between the English and French approach to the early development of transfusion, by comparing the work of members of the Royal Society (particularly Robert Boyle and Richard Lower) in England and the antagonism shown towards the work of Jean Baptiste Denis and Emmerez in France – and provides background information regarding both these situations.

Part 5 (Section III continued, pp. 565-568) - the concluding part of section III - that concentrates on the later transfusion experiments in France, while firstly commenting on the various people who supported Gui Patin in their opposition to transfusion – all the arguments of which lacked experimental content and were based only on ‘wit and scholastic subtlety’. Landois describes the transfusion of Baron Bond (the son of Sweden's first Minister of State), who was dying from ‘febrile diarrhoea’, which as expected, provided only a temporary relapse, and then concentrates on the transfusions of calf’s blood given to the madman Antoine Mauroy, his subsequent death and the judicial enquiry that exonerated Denis but resulted in the edict that no transfusions could be carried out on humans in the future in Paris unless given the Faculty’s consent.

Part 6 (Section IV, pp. 577-579) although subtitled ‘The first transfusion attempts in Italy, Germany and Holland’, the majority of the content of this section outlines the transfusion work performed in Italy, only briefly commenting on the lack of research performed in the other two countries. Riva is identified to have carried out the fist transfusions on humans in Italy, followed by Manfredi, whilst mentioning that Andreas Libavius thought about transfusion as early as 1615. The debated ‘transfusion’ of Pope Innocent VIII in 1492 is also mentioned. Kaufmann is stated as having been the first person to have performed a transfusion in Germany (though no reference is provided).

In Part 7 (Section V, pp. 657-660), Landois looks at the physiological effects related to blood transfusion, identifying the development of defibrinated blood use and the research

work performed in Germany. He mentions the investigations into transfusions from animals of the same and different species, the problems identified in 'over-transfusing' and the differing effects of using arterial c.f. venous blood being identified to be related to the its oxygen and carbon dioxide content. This section concludes with noting the investigations carried out in the possible transfusion treatment of gaseous poisonings and other types of intoxications.

Interestingly within this section, Landois credits Edward Doubleday rather than James Blundell with revitalising blood transfusion in England, as well as listing the names of a number of other people, though the references to their work are not provided.

Part 8 (Section VI, pp. 675-677) is subtitled 'Transfusion in acute anaemia, hydremia and chlorosis', in which Landois identifies that the treatment of anaemia, especially in post-delivery women, has had its greatest use. He then concentrates on his published research work with Eulenburg in 1866, regarding the physiological effects of anaemia and how transfusion is an effective treatment – warning against the dangers of using transfusion too late, i.e. as a 'last refuge'. Very little information is provided regarding the use of transfusion in the treatment of hydremic and chlorotic conditions.

Part 9 (Section VII, pp. 738-740) provides information regarding the use of transfusion with simultaneous depletion ('depletoric transfusion') in cases of gaseous and ('topical') substance poisonings, whereby the poison within the bloodstream is reduced by bloodletting and then replaced with fresh normal blood via transfusion. Carbon oxide gas poisoning is identified to be caused by CO forming a chemical bond with haemoglobin, making it impossible for it to absorb oxygen, the severity of the effects being related to the degree of exposure. Depletoric transfusion is also recommended in accidental overdose of chloroform or ether vapour poisoning during anaesthesia as well as opium, morphine, and strychnine poisoning.

Part 10 (Section VII continued, pp. 753-755) as the sub-title identifies extends the possible use of depletoric transfusions for the treatment of autochthonous intoxications, which Landois identifies to include asphyxia (especially in apparently dead newborn babies), cholemia, uraemia and septicaemia; though he identifies that it can only have a lasting effect if the abnormal blood condition is transient, otherwise it can only be regarded as a palliative treatment.

Part 11 (Section VII continued, pp. 771-773) is sub-titled 'the infusion-transfusion', by which Landois suggests that in some cases of poisoning, an antidote should be added to the transfused blood, otherwise its effect is diminished by the bloodletting when using depletoric transfusion. He extends this suggestion to also include such things as excitants, sedatives, ergotine and calabar extracts, but does at least identify that the chosen materials should be 'completely clear filtered liquids, which must also have the property of not causing any coagulation in the blood'. Although Landois identifies that Panum has proposed that 'blood does not serve as food for the body, but that it is only the general route through which the nourishing substances flow to all parts of the body', he then goes on to include his own questionable animal research into the use of transfusion as a food substitute (!).

Part 12 (Section VIII, pp. 790-792) is subtitled 'Practical execution of the transfusion' in which Landois states that defibrinated human blood should be used, transfused into a vein using a syringe. He then briefly discusses the potential problems of air intake (avoided using his 'air catcher' device) and phlebitis (avoided if the 'vein is treated fairly gently'). Few actual 'practical' steps are provided.

Part 13 (Section IX, pp. 943-945) is a comprehensive chart that summarises the authors / references, indications and outcomes for 145 blood transfusions that are broken down into three groups, i.e. in acute anaemia (mainly cases of metrorrhagia), in acute intoxications (poisoning by coal fumes and asphyxiation of newborns) and in diseases of various kinds. Landois identifies the success rates for each of these three groups to be 64.9%, 30.0% and 23.6% respectively.

I have produced a translation of this paper from German 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 have been maintained within the translation. The references in the original text are identified by asterisks and placed at the bottom of the relevant pages. I have sequentially numbered these and placed them at the end of the translated text for each part of the paper, reproduced as originally printed. I have also provided translations for some of the reference titles and the author's comments.

I have reproduced the author's spelling of the names of people and places, as well as the author's original English text, as originally printed. I have added alternative spelling options for some of the names of people and places, which I have placed in square brackets. The charts in section thirteen contain a number of obvious typographical errors (e.g. 'Sower' for Lower) that I have altered within the translation. The charts also contain a number shortened words / terms which I have also hopefully interpreted correctly. As a result, these charts are not an exact reproduction of the originals, but I believe them to contain a true representation of their content.

NOTE: Much of the material included in this publication also appears within the 'History of Transfusion' section (pages 1-26) of his book 'Die Transfusion des Blutes' published in 1875.
See:
https://openlibrary.org/books/OL24972761M/Die_Transfusion_des_Blutes
Also:
https://dlcs.io/pdf/wellcome/pdf-item/b21063023/0

LEONARD LANDOIS – BIOGRAPHICAL INFORMATION

Leonard Landois (1837-1902) was a German physiologist. He studied medicine at the University of Greifswald and later became a professor and director of the Institute of Physiology at Greifswald and a member of the German Academy of Sciences Leopoldina. Although his early work involved research in the field of parasitology, Landois was a pioneer in the study of blood transfusion. In 1874-5 he demonstrated inter-species incompatibility of blood by showing that the serum from one species of animal was capable of agglutinating or haemolysing the red cells of an animal of another species. He also linked this phenomenon with the appearance of black urine after a heterogeneous blood transfusion, establishing scientifically the dangers of transfusing blood of another species into humans. Extensive details of his in vitro inter-species experiments are included in a section of his 1875 book 'Die Transfusion des Blutes'.

Leonard Landois
(Photo credit: en.wikipedia.org)

PART 1 - PAGES 465-468

THE TRANSFUSION OF BLOOD
ITS HISTORICAL DEVELOPMENT AND CURRENT SIGNIFICANCE

By Dr. Leonard Landois
Private Lecturer and Assistant at the Anatomical-Physiological Institute at the University of Greifswald

I

The brilliant Dieffenbach (1) is right: "No operation is so well suited to arouse the curiosity and interest of people in general as transfusion; a thousand ideas and questions are linked to the mere idea of an exchange of blood between two individuals." The great interest which this operation has always aroused among all thinking physicians may justify it if we sketch in a few outlines its historical development, but the great importance which it has acquired, especially in recent times, primarily on the basis of physiological research, will make it appear harmless when we briefly present the current significance, indications and implementation of transfusion.

The transfusion of blood also has its fable story. Legend tells us that the Egyptian priests knew how to rejuvenate old age through blood. The sorceress Medea was taught this demonic art by them. Medea, the ancient poets tell us, (Ovid. Metamorph.) rejuvenated Jason's old father Aeson by draining his aged blood from the cut vessels in his neck and pouring into the wound the magic juice she had prepared. So much for the vague traditions of the legend, which seem to be based on the widely held view in antiquity that blood contains the actual vitalizing force for the entire body, as it were the soul (2). It was therefore easy for the view to take hold that the entire body could be given new strength

through an artificial revival of the aged blood, a view that could of course only find its justification as a poetic fable.

In the historical periods of antiquity there is no mention of the injection of blood into the veins of a man, and in general the idea of such an operation could not in any way take hold of the prevailing view of the movement of blood in the human body. According to Aristotle's views, the heart prepares the blood in its own cavities and through the veins it flows as a nutrient to all parts of the body and waters them, just as gardens are watered by constantly dividing streams of water (3). But the blood never flows back to the heart.

The heart is at the same time the source of warmth for the whole body, the seat of the sentient soul, the most important organ, as it were the fortress of the body, which contains within itself the impulse of its continual movements. At the same time as the blood, all parts of the body receive from the heart the power to move. This power, the breath of life, flows to the heart with every breath, through the trachea and the lungs, and from the lungs it passes through the veins leading from them to the heart into the cavity of the heart, from where it flows with the blood to all parts of the body (4).

The idea of transfusion was even less likely to appeal to the ancient physicians, since the two famous scholars of the Alexandrian school, Herophilus of Chalcedon and Erasistratus of Ceos (about 300 B.C.), gave general prevalence to the peculiar assumption in the doctrine of blood movement that the arteries only contain air which flows into them from the lungs when they breathe (5).

Even the reforms initiated by Claudius Galenus (131-201 AD) did not lead a step closer. Galen showed through experiment that the arteries contain blood. ("arteria, quacunque vulnerata, sanguinem egredi videmus .... Ubi funiculo dissectam artériam utrimque ligavimus, et quod in medio comprehensum fuerat, incidimus, sanguine plenam ipsam esse monstravimus.") The blood reaches the right heart through the hollow veins, where the warmth of the heart separates the useful parts from the useless parts of the blood. The unusable ones are carried through the pulmonary arteries into the lungs, through which they are excreted as soot (fuligo) during expiration. The usable parts enter the left heart through the holes in the septum. (“Quae in corde apparent foramina, ad ipsius potissimum medium septum, praedictae communicationis gratia exstiterunt.”) Here in the left heart the invigorating force is imparted to the blood by the pneuma absorbed into the lungs during inspiration, a small portion of which can also flow to the venous blood through the holes in the septum.

Of the three fundamental errors which, as Flourens (6) rightly says, concealed the great fact of the circulation of the blood, Galen had thus eliminated the one that the arteries contained air, but two still remained to be uncovered, namely that the septum of the heart has holes through which the blood from the right heart continually flows into the left, and that the blood flow in all veins has a centrifugal direction.

Vesalius clarified the second error by explicitly stating (7) that the substance of the septum was “so thick, compact and solid that he could never see how even the smallest amount of blood could pass through the substance of this septum”.

It was therefore necessary to seek a new way through which the blood had to pass from the right to the left heart, and the efforts of Michael Serveto [Servetus], that unfortunate researcher who, at the instigation of the fanatic Calvin, was publicly burned as a heretic in Geneva on 27 October 1553, succeeded in discovering the little circuit.

In his work Christianismi Restitutio 1553, says: "Fit autem communicatio haec (namely, of the cavities of both halves of the heart) non per parietem cordis medium, ut vulgo creditur, sed magno artificio a dextro cordis ventriculo, longo per pulmones ductu, agitatur sanguis subtilis; a pulmonibus praepatatur, flavus efficitur et a vena arteriosa (art. pulmonali) in arteriam venosam (ven. pulmonal) transfunditure."

Ten years later, the work of the selfish Realdo Columbo, the student and prosector of Vesalius, led to the same results, as did the investigations of the great defender of Aristotle, Andreas Caesalpinus, who first traced the flow of blood “ex dextro cordis ventriculo per pulmones in sinistrum”, with the word “Circulatio” (8).

In order to make the idea of transfusion possible, it was still necessary to discover the great circulatory system. It was of the utmost importance to William Harvey that he completed his medical studies in Padua (until 1604) – at a time when the famous anatomist Girolamo Fabrizio ab Aquapendente, the successor of Fallopia, had once again called attention to the venous valves. He had not discovered it, as is generally supposed, because as early as the middle of the 5th century AD the same Theodoretus, bishop of the city of Cyrus in Syria, mentions in his 3rd discourse on Providence: "Venas tenuissimis tunicis vestivit (Deus) et orificiis earum exilia opercula (valvulas) addidit." –

By considering the venous valves in particular, Harvey arrived at the removal of the third fundamental error, which concealed the correct conception of the whole circulation ratio, which found the centripetal movement of the blood-stream in the veins, and thus fully discovered the circulation of the blood. It is precisely this that makes the discovery great, that it was not achieved by chance, but according to plan, following logical deliberation and ingenious development. Circulatio Harveyana, res non casu, sed consilio inventa, says Timotheus Clarck, a compatriot and contemporary of Harvey, with justification.

As early as 1616, but certainly since 1619, Harvey presented his new doctrine in London (9), but it was not until 1628 that he appeared with his Exercitatio anatomica de motu cordis et sanguinis in animalibus, (Francofurti 1628; 4. pp. 72.) in front of the public. The work is dedicated to his royal lord Charles I., who made him his personal physician, as well as to the College of Physicians, in which he had so often demonstrated his experiments.

The time was not far off when that civil war broke out in England (1642) in which the people, so often disappointed, wanted to defend their parliamentary rights against King Charles I. with arms in hand. The king had to flee London and went to Oxford. Harvey accompanied him, as the two universities of Old England were generally devoted to the King's cause. Here in Oxford, around this time of the royal exile (1645), a society of learned men, with whom Harvey was also acquainted, was formed, whose endeavours were directed to enrich the fields of medicine and natural sciences through research and experimentation. The founding of this association was clearly inspired by Bishop John Wilkins.

It was called the "invisible" or "philosophical college" and the learned societies of Italy had served as a model for the founding of the association, such as the Academia de' Lincei founded by Cesi in 1603 (10).

When Oxford fell into the hands of the parliamentary troops under Oliver Cromwell, and King Charles I was executed by the sword under the windows of his own banquet hall in London, the company went to London (1648).

The researchers stuck to their original aspirations. When King Charles II ascended to the throne after the abolition of the interregnum, he, himself a friend of natural history, constituted the Society (1662), gave it privileges and rights, and gave it the name of the “Royal Society”, as which it still exists to this day, and has exercised the most advantageous influence on the development of natural and medical science, especially through its Philosophical Transactions, which have appeared since 1666. (The first editor of the negotiations was Heinrich [Henry] Oldenburg, a Bremen resident; the first volume appeared for 1665 and 1666 Numb. 1, 6 March, 1664/5). In the period from February 1671 to 1690 no writings appeared, but from 1691 until now without interruption.) - We will see that the transfusion of blood originated from the bosom of the Royal Society.

1. Operative Chirurgie, 1845, I, pag. 111
2. Vergleiche hierüber [Compare about]: Genesis 9, 4; - Levitie. 17, 11; - Deut. 12, 23; Anima est in sanguine. Anima ipsa est sanguis. – Joseph. Antiq. 3, 11, 2. – 1. 3. 8. – Philo. Opp. II. 356. – αἷμα εἶναι τὴν φυχήν. – Gal de Hippoer, dogm. 2 extr. – Ferner Plut. plae. philos. 4, 5. – Cicero Tuse. 1. 9. Nahers bei v. Bahr, Symbolik II. 247.
3. Dieser Vergleich auch bei Plato. [This comparison also applies to Plato]
4. cf. De partib. anim. II. III. IV. de respirat. 20. 21; de generat. anim. II, 6; de juven. et sen. III.
5. cf. Galeni de utilitate respirationis. Edit. Junta. Venet. 1597. p. 223... “arteriarum expletionis gratia respiramus velut Erasistratus putat?”

6. Histoire de la découv. de la Circul. du sang. Paris 1857. p. 14.
7. Andreae Vesalii Opera. omn. anatomic. Edit. Albin. 1725. T. I. pag. 519.
8. And. Cosalpini Quaest. peripat. Lib. V, p. 125 Venet. 1593.
9. Taylor, Orat. Harv. 1756.
10. Sie führte den Luchs im Siegel als Sinnbild scharfer Beobachtung. [She used the lynx in the seal as a symbol of keen observation.]

PART TWO – PAGES 484-486

THE TRANSFUSION OF BLOOD
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By Dr. Leonard Landois
Private Lecturer and Assistant at the Anatomical-Physiological Institute at the University of Greifswald

(Continued)

II

The first transfusion experiments in England

It is not surprising that the first attempts to carry out the transfusion originated from the country from which the discovery of the circulation had emerged. Harvey's discovery had caused a tremendous sensation in the entire medical world, and Haller is right when he asserts: novum inventum universam Europam medicam ad arma excitavit. It was natural that the very men to whom Harvey had so often demonstrated the blood-flow of living animals, should endeavour to extract new practical fruits from the physiological fact. At one of these demonstrations in the "invisible, philosophical" Society, the theologian Potter (about 1638) first suggested the idea of whether it was possible to replace the blood of one animal with the blood of another (1). This idea caused a sensation in the Society and a number of men were chosen to bring the question closer to its solution: the Coxe brothers, Wilkins, Hock and the famous physicist Robert Boyle.

At the same time as the transfusion, a second question of great practical value was suggested, namely, infusion. People rightly asked whether it might not be possible to inject various medicines directly into the veins and thus into the circulating blood, which until then had almost only been administered per os. So it happened that almost all researchers turned their studies to these two closely related operations, transfusion and infusion.

Dr. Christopher Wren, of the University of Oxford, afterwards Professor of Astronomy (2) and architect in London, first suggested the idea of infusion towards the end of 1656, and also carried it out at Oxford. He communicated his views to Wilkins and Robert Boyle (3); a cannula was used, which was inserted and integrated into the central end of an exposed and cut vein, and a syringe was used for instilling the substances to be introduced. In particular, Boyle ensured that a suitable apparatus was manufactured and carried out experiments on dogs. One of these dogs had an opium solution infused into the veins of the hind foot, and after it was administered to the brain, the dog fell into deep anaesthesia, but did not die. Another dog, which was taught a strong solution of Crocus Metallorum in the same way, died very quickly. The more detailed description of these experiments was given by Robert Boyle in his work, Usefulness of Experimental Philosophy. Part. 2. Essay, 2. p. 53-55.

The rumour of these experiments also reached the ears of the envoy residing in London, the French orator de Bourdeaux, who in 1657 carried out the first infusion in man with the assistance of Dr. Colladon, the Queen Mother’s personal physician. For the purpose of the experiment, an offender was taken, who was a lowly servant of the ambassador, and a solution of Crocus Metallorum was injected into his arm vein. However, when this

experiment revealed adverse effects on the organism of the person infused, further experiments on humans were not carried out (4).

Since then, extensive experiments have been carried out on animals both in Oxford and in London before the Royal Society, primarily by the general practitioner Dr. Timothy Clarck [Clarke], who continued the interesting experiments with great prudence and a lot of hard work.

As early as 1657, when Oliver Cromwell was solemnly elevated to the position of protector of England, T. Clarck [Clarke] had been carrying out both transfusion and infusion experiments (5), and had communicated and demonstrated them to the Royal Society before 1663. He had injected living animals with various medicines, even up to two pounds: Emetica, Cathartica, Diuretica, Cardiaca, and Opiates. However, the success of these infusion attempts was doubtful or inconsistent, as Clarck [Clarke] himself says: Agnosco tamen, me de hujusmodi experimentorum utilitate multum adhuc dubitare. However, the results of his transfusions were more favourable, especially those which he carried out on animals that had bled to death. Here we find the highly important and clearly pronounced word of the learned experimenter: Putem insuper, transfusionem sanguinis in magnis et subitaneis sanguinis profusionibus ad vires subito instaurandas, fortasse multum posse conducere. Tumet nobiscum vidisti, vir amicissime - he continues, calling the editor of the Philosophical Transactions, Heinrich [Henry] Oldenburg, as a witness, - animal large sanguinis profusione fere exsangue redditum, et convulsionibus lethalibus plane moribundum, sanguine alterius animalis, non ejusdem speciei, in illum transfuso, intra septem horae minuta ad pristinum et perfectum vigorem restitutum.

Clarck's [Clarke's] experiments also caused a sensation in the highest circles, and he performed a cathartic infusion into the veins of an animal in the Royal Palace in the presence of the Princeps Palatinus Rupertus. Around this time, a Dr. Henshaw was also involved in carrying out a transfusion. Nevertheless, there were still considerable difficulties associated with it, until in 1666 the famous London anatomist Richard Lower recommended an expedient method and, first in Oxford, then in London, at a public meeting at the Royal Society of Physicians in Grasham [Gresham] College, carried out the transfusion with good success (6). Robert Boyle took the most active part in these experiments, Rob. Boyle, descended from the Old English family of Corke [Cork], by nature a weak, delicately built man, had devoted himself with ardent zeal to the study of medicine and the natural sciences. It is said of him that he himself prepared medicines in his laboratory and distributed them to poor sick people (7). His name has also become immortal through the famous so-called "Boyle-Mariotte's Law," which he discovered.

This researcher tells us the method by which Richard Lower carried out his first transfusion attempts in an essay: The Method observed in Transfusing the Blood out of one animal into another. Philosopher. Transactions Vol. I. p. 353, December 17, 1666.

Two dogs are tied up next to each other, the common carotid of one is exposed for a large distance, cut, the peripheral end tied off and a cannula tied into the central part. A temporary knot around the arteries stops the blood from flowing out of this cannula. In the second dog, the external jugular vein on the adjacent side of the neck is exposed and cut. Then the cannula of the carotid artery of the dog is then inserted into the central end of the vein. The blood can be drained from the peripheral piece as desired.

Now the temporary knot of the arteries is loosened and the blood flows from the carotid artery into the vein of the other dog. In proportion as arterial blood flows in, blood is allowed to flow out of the animal from the peripheral end of the vein.

When carrying out these experiments, some precautionary measures must be taken into account.

First of all, it must be ensured that the joined vessels are not strained, as this can easily impair free circulation. Furthermore, one must ensure that the pulse of the carotid can also be felt in the constant jugular end. If this is missing, one can assume that the cannula has become blocked by clots, which must then be removed.

Furthermore, Boyle believes that it is best to take dogs of the same age, which if possible are fed at the same time and in the same way, so that a similarly mixed blood can be exchanged ('that both their blouds may be of a neer strength and temper').

After the operation is completed, the vein is tied off twice and the neck wound is sutured. (The dog that gives the blood is not taken into account.)

1. Vgl. Philosoph. transact. 18 May 1668.
2. Derselbe ist auch bekannt durch seine Vorschläge für Darstellung parabolischer Linsen. [He is also known for his proposals for the representation of parabolic lenses.]
3. An account of the Rise and attempts, of a way to conveigh liquors immediately into the mass of Blood. Phil. transact. Vol. I. 1665. N. 7. p. 128. - 4. Decemb.
4. Of Philosoph. transactions 1665 und 1668.
5. A letter etc. by Dr. T. Clarck concerning some anatomical inventions and observations particularly the origin of the Injection into veins, the Transfusion of Blood. Philos. Transact. 18. May 1668.
6. The success of the Experiment of transfusing the Blood of one animal into another. Philos. transact. vol I. 1666. N. 19. p. 352 (19. Novemb.)
7. Vgl. Haller's Bibliotheken

PART THREE – PAGES 500-502

THE TRANSFUSION OF BLOOD
ITS HISTORICAL DEVELOPMENT AND CURRENT SIGNIFICANCE

By Dr. Leonard Landois
Private Lecturer and Assistant at the Anatomical-Physiological Institute at the University of Greifswald
(Conclusion)

It is also interesting to note that in this way the blood of a very large dog was gradually chased through the veins of a small dog, until the large one had bled to death. When the little one was then released, he jumped from the table and shook himself as if he had merely fallen into the water.

But these experiments were not only carried out on dogs, but also on rabbits. Indeed, the blood of a rabbit had even been successfully transferred into the veins of a dog.

Boyle himself now holds out the prospect that all possible modifications should be made with the transfusion of animals: the blood should be exchanged between old and young animals, between sick and healthy, warm-blooded and cold-blooded, courageous and timid, tame and wild animals, etc.

Finally, Boyle adds a few more comments. In order to be sure that an animal has received completely new blood, one can let several others bleed into it one after the other. It would also be possible that the nature of an animal, if it were thoroughly impregnated with the blood of another animal, would change and perhaps even become similar to that of the blood-giving animal. Finally he concludes his communication with a statement that deserves to be shared in Extenso:

'The most probable use of this Experiment may be conjectured to be, that one animal may live with the blood of another; and consequently, that those animals, that want blood, or have corrupt blood, may be supplyed [supplied] from others with a sufficient quantily [quantity], and of such as is good, provided the Transfusion be often repeated, by reason of the quick expence [expense] that is made of the blood. 1. c. p. 358.' [385]

Robert Boyle devoted all his mental activity to the success of transfusion.

In a separate article he posed a whole series of problems which show how thoroughly he treated the question and how diverse his understanding of it was (1).

1. In the case of a complete transfusion, does one take into account a change in the natural disposition of the test animal, such as the way in which a wild dog becomes tame after ingesting the blood of a tame one?
2. Will an operated dog recognize his master again: - will he exercise his habits better or worse?
3. Can the peculiar characters of a dog's race be obscured if the blood of another race is repeatedly substituted for it?
4. Will a dog with foreign blood continue to maintain the habits it has learned, will it retrieve, dive for ducks, etc.?
5. Will a change in the pulse, urine, excrement and perspiration be noticeable in a dog whose blood has been replaced?
6. Will a dog lose its appetite if injected with chyle-rich blood from another dog in digestion? –
7. Will it even be possible to keep it alive at all by injecting chyle taken from the receptaculum chyli of another animal? –
8. Will a dog suffering from a blood disease be cured if its blood is replaced by healthy blood?
9. If an old dog receives the blood of a young one, will it become youthful again, and conversely, will a young one become old by the blood of old dogs?
10. Can a young dog of a small breed be made larger by giving it blood from a young dog of a large breed?
11. Can medicines be mixed into the transfused blood at the same time - and is the effect of the medicines added in this way different from those latter administered per os?
12. Does the blood injected from a dog that has been given a purgative also have a purgative effect on the other dog that has been given it? –
13. What are the results of the transfusion if the leaf exchange is carried out in different species, yes genera, even between cold-blooded animals (fish, turtle) and warm-blooded animals? –
14. Will the colour of the hair, or feathers, change if animals of different colours are used for the exchange of blood? –
15. If the substitution is repeatedly carried out in different breeds of dogs, will one perhaps notice a gradual transfer of the breeds? –
16. What effect does transfusion in pregnant animals have on the young, especially when transfusion is performed at different stages of pregnancy? -

Prof. Boyle, as can be seen from many of his communications, understood transfusion as the most complete substitution possible, complete exchange of blood; in the experiments, therefore, as a rule, the blood-shedding animal succumbed to death by bleeding after anaemic convulsions.

Of incomparably less importance are Boyle's experiments with regard to infusion. Thus he injected aqua fortis, vitriol oil, hydrochloric acid, etc., into the veins of various animals: the animals died rapidly under stormy phenomena, and their blood appeared dirty nut-brown and coagulated.

Of other researchers living at the same time who carried out experimental investigations in the same direction, we know Thomas Coxe, a member of the Royal Society, who transferred 14-16 ounces of blood from an old dog suffering from fatty scabies into a healthy one (2).

The result of this was that the healthy dog remained healthy, but the sick dog recovered quickly as a result of the extensive depletion. - The same researcher reports (3) that he let a pigeon bleed to death and then brought it back to life with the blood of another.

Furthermore, Edmund King (4) transfused from a calf into a sheep with happy success. He let the animal bleed almost completely to death and then saved them with a quick transfusion. This revealed that he was able to drain 60 ounces of blood from a calf until it

lost consciousness, and that anaemic convulsions occurred before the last 5 ounces expired.

The climax of transfusion in England, however, was reached by Richard Lower, for it was this famous London anatomist who, on 23 November 1667, together with Dr. Edmund King, who performed a transfusion on a human being, the first in England (5). Even before that, on 15 June of the same year, Denis had performed the first transfusion on a human in Paris.

The operation was carried out in London on a 32-year-old theologian Arthur Coga in the presence of many distinguished people in Aroundel [Arundel] House. The patient suffered from mental confusion, it is said of him “his brain was a little too warm”: Lower calls him hominem amabili vesania affectum. Before the operation he was given wine, during which he smoked and drank vermouth. First, a vein in the patient's arm was exposed and 6-7 ounces were drained from it as in a bloodletting. A long silver tube was then tied into the central end of the dissected carotid artery of a young lamb. Now the cannula was inserted into the venous wound of the patient and 9-10 ounces of carotid blood was allowed to flow in a free stream into the man’s vein towards the heart, so that one could clearly feel the pulsations of the carotid movement propagating through the long tube into the vein in the arm. The patient was "very well" during and after the operation, praised the operation very much and loved to talk about it with praise.

When asked why he gave himself lamb's blood, he said, "quia sanguis agni habet symbolicam quamdam facultatem cum sanguine Christi." After just 3-4 days the patient wanted the operation to be repeated, but his requests were only granted after a few weeks, when he was again drained 8 ounces of blood and 14 ounces of lamb's blood were given.

Both transfusions seem to have had no beneficial and changing influence on his intellectual activities, for it must seem doubtful that the man, proud of the new heroic operation performed on him, has since called himself the martyr of the philosophical faculty in London. Richard Lower also recommends the operation primarily for gout. –

The commission elected by the Royal Society of Physicians also achieved fairly favourable results in its numerous animal experiments, especially in the case of heavy blood losses. Only too much foreign blood injected would be detrimental to life, and a fox would die of lamb's blood under the greatest suffering. Lower also stated that dogs to which he had injected milk into their veins were in the greatest fear and their lives were in danger (6).

1. Tryals proposed by Mr. Boyle to Dr. Lower, to be made by him, for the improvement of Transfusing Blood of one living Animal into another, - Phil. Transact. Vol. I. for 1666 (16. Febr. 1666) p. 385.
2. An account of another Experiment of Transfusion. Philos. transact. 1667. N. 25. p. 451.
3. f. Dieffenbach. Operat. Chirurgie I. p. 111.
4. An account of an easier and safer way of transfusing Blood etc. Philos. transact. 1667. N. 25. p. 449.
5. An account of the Experiment of Transfusion, practiced upon a Man in London by Dr. Richard Lower and Dr. Edmund King. Philos transact. 9. Decemb. 1667. N. 30.
6. Rich. Lower, Tractatus de corde, item de motu et calore sanguinis et chyli in eum transitu. Londoni 1669.

PART FOUR - PAGES 545-547

THE TRANSFUSION OF BLOOD
ITS HISTORICAL DEVELOPMENT AND CURRENT SIGNIFICANCE

By Dr. Leonard Landois
Private Lecturer and Assistant at the Anatomical-Physiological Institute at the University of Greifswald

III
The first transfusion experiments in France.

While in England we saw almost all learned doctors working in a united effort to raise transfusion and infusion to the level of a physiologically tested, rational operation, in France we only meet one person who fights for the new healing method, fights against the majority of doctors and natural science scholars. It is Jean Baptiste Denis, professor of philosophy and mathematics at the Royal University of Paris. Even though he was unable to gain acceptance and recognition among doctors for transfusion, and even though, precisely because of his operations, the royal government even forbade the free execution of the operation by public decree, Denis still retains the fame, to having carried out the first transfusion on a human being that was ever performed.

The reason why transfusion found so many opponents in France can be found in the guiding principles in all of medicine that were spread from Paris at the time. In the "Académie des Sciences" founded by Cardinal Richelieu, the leading voice for medicine was the witty Gui-Patin [Guy Patin]. They had broken with the Arabs and turned again with all their zeal to the study of the ancients, the writings of the masters of ancient medicine: Hippocrates, Aristotle, Galenus [Galen]. People turned their backs on the impulses and aspirations of a new era that began to shine with the discovery of the circulation in England. People in Paris were reactionary, while in London everyone embraced the new physiological-empirical direction with zeal. Gui-Patin [Guy Patin] rejected the syrups and opiates of the Arabs - but he also rejected the cinchona bark that time had taught us to know, he rejected tea, the "impertinente nouveauté de siècle", he finally also rejected the new doctrine of the circulation that his colleague Riolan had already fought so desperately against in Paris (1).

Gui-Patin's [Guy Patin's] means were bloodletting and senna. He let children and old people bleed, yes, 32 times in one illness, he let himself be bled 7 times because of rheumatism; even 3-day-old infants were not spared. Nous guérissons beaucoup plus de malades avec une bonne lancette et une livre de séné, que ne pourraient faire les Arabes avec tous leurs sirops et leurs opiats, he writes in his letters (2).

It was all too clear that, with such guiding principles, Denis was unable to achieve general recognition for transfusion, the true antithesis of bloodletting. Gui-Patin [Guy Patin] and his comrades won and a vampirism was carried out in the hands of these "Grands-Saigueurs" that could hardly have been practiced by Leonardo Bottallo, Marcus and Broussais.

The first beginnings of transfusion in France are obscure; at any rate, they were insignificant and of doubtful value. Nevertheless, they wanted to claim priority for themselves. The French journals brought the news that a Benedictine Friar, or, according to others, a Don Robert de Gabets, had first proposed the transfusion to M. de Monmors [Montmor] about the year 1658.

Seen in the light alone (3), the French reports only date from March 1667, while the Royal Society of London had already called for transfusion in its public meeting of 17 May 1665 (following Wren's suggestion for infusion) (4) and had appointed that well-known transfusion committee. Furthermore, it is certain that Richard Lower had already published his method, which had proven itself on animals, in December 1666.

The truly classic age of transfusion in France begins with Denis, who carried out his first experiments on animals (5). He let 3 dogs bleed to death and then let calf's blood flow into their veins and they were very well afterwards. One of these, who had been very weakened by heavy blood loss the day before, showed a considerable increase in strength after the operation was completed. These experiments were repeated on 19 dogs and some calves; all survived the operation very well and had no subsequent illnesses. Denis transfused now from vein to vein, now from artery to vein.

Thus prepared by sufficient experiments, Denis decided to perform the first transfusion on a human being with the assistance of the surgeon Emmeriz [Emmerez] (6). It was a 15 or 16-year-old fever patient, on whom the doctors had performed 20 large bloodlettings in a

short time, in the manner of Gui-Patin [Guy Patin], for the purpose of withdrawing the fever-heated blood.

As a result of this intrusive treatment, a very considerable decline in strength had occurred; exquisite anaemia, great fatigue, apathy, decline in memory, and such a great somnolence that Denis had found the patient asleep even at breakfast. Denis, based on the assumption that the large blood losses had undermined the patient's constitution and that the little blood left, affected by the fever, was damaging the body, came up with the plan for a transfusion.

It was 5 a.m. on 15 June 1667, when Denis and his assistant Emmeriz [Emmerez] performed the transfusion. About three ounces of venous blood were previously drained from the patient which Denis considered particularly spoiled by its dark colour and viscosity, and about 9 ounces of blood were allowed to flow directly into the vein in the arm from the carotid artery of a lamb by means of a tube. Then bandage as if after a bloodletting and lie quietly in bed. The patient stated that he noticed heat along the vein in his arm during the operation. By 10 o'clock he could no longer be kept in bed, he got up, was quite lively, ate, drank and was in a friendly and cheerful mood.

At 4 o'clock in the afternoon a slight epistaxis of only a few drops occurred; at 9 o'clock in the evening he went to bed and slept well; he woke up again at 2 o'clock and rose from the bed feeling refreshed at 4 o'clock in the morning. The patient showed a much greater vivacity than before, his somnolence disappeared, his mental powers increased, he became strong and aroused general astonishment among all who knew him.

The indications according to which Denis considered transfusion necessary in this case deserve full recognition. But it is a mistake that Denis also considered animal blood to be the best for transfusion into humans, because, as he believed, animals did not waste their blood through debauchery or through passions, and furthermore the blood of animals could be prepared beforehand by feeding them, and because the flesh of mammals also serves as food for humans.

The view that the success of his treatment can be attributed to fermentation and the resulting development of vital spirits is also erroneous.

Nonetheless; - encouraged by the first happy success, Denis soon carried out the operation on a second man. This time it was more of an experiment than a real cure. The individual in question who presented himself for the operation was a Parisian palanquin bearer of about 45 years, to whom Denis had offered a good amount of money if he would have the transfusion carried out on him. Since the man was healthy and did not show any significant indisposition to the operation, it was decided to carry out a generous transfusion. Denis and his assistant Emmeriz [Emmerez] first had ten ounces of blood drained from the man's arm vein and then another twenty ounces flowed directly from the crural artery of a lamb through a tube to the person being operated on, in exactly the same manner as had been successfully done on the person who was first treated. During the operation the man always maintained his jovial sense of humour and was amazed at this strange operation as the sheep approached his arm. He also mentioned the feeling of heat in the arm while the arterial blood was flowing through it. Afterwards, the person who was operated on was advised to lie down in a quiet bed, but curiously he immediately cut up the lamb whose blood he had ingested and went home. On the way he met some merry friends, who squandered with him the gift of money he had received from Denis on wine at the first best inn he came across. None of this disturbed the favourable course of events; on the contrary, the state of his strength was to be called rather excellent. The next morning Denis found the man already wandering the streets of Paris again, and when Denis reproached him for his carelessness, he replied that he was well in every respect, that he could not stay in bed on that account, and that if Denis wished to repeat the operation again, he should take him back with him (7).

1. Opuscula anatomic. nov. Paris 1649.
2. Lettres de Gui-Patin. Tom. I. p. 400.
3. Philos. transact. 18. Mai 1668.

4. Philosoph. transact. 21. Oktob. 1667. N. 28.
5. Journal des Savans, Mars 1667; cf. An extract of a Letter of M. Denis, touching the transfusion of Blood of April 2. 1667. Philos. trans. Mai 6. 1667. N. 25. p. 453.
6. A Letter concerning a new way of curing sundry diseases by transfusion of Blood etc. by J. Denis at Paris. June 25. 1667. Philosoph. transact 1667. N. 27. Munday July 22.
7. Philosoph. transactions 1667. N. 27. - Dessgleichen: Lettre à M. de Montmort touchant deux experiences de la transfusion faites sur les hommes. Paris 1667. Journal des Savans. p. 44. 65.

PART FIVE - PAGES 565-568

THE TRANSFUSION OF BLOOD
ITS HISTORICAL DEVELOPMENT AND CURRENT SIGNIFICANCE

By Dr. Leonard Landois
Private Lecturer and Assistant at the Anatomical-Physiological Institute at the University of Greifswald

(Continuation)

III

The happy successes that Denis had achieved aroused a whole host of opponents and envious people in Paris who jointly strove to suspect the transfusion and to suppress it again. The most important of these were Guileaume Lamy, Magister Atrium [M.A.], and the Abbé Pierre Joseph Michon, called Bourdelot. The latter, both a doctor and clergyman, was considered an influential man (1); he had been for a time Queen Christina's personal physician.

He loved to gather famous men in his house for scientific meetings, at which he presided (2). The reasons that this man put forward against transfusion were, of course, of the weakest kind: - a child had died because the midwife had pushed the blood contained in the umbilical cord into the body cavity after birth; the transfused blood must also have an equally harmful effect. Lamy also had few weapons against transfusion other than wit and scholastic subtlety (3). The only thing worth noting about his omissions is that he claims that the diversity of the blood of various animal species is dangerous and that the introduction of excessive amounts of blood brings disadvantages for those undergoing surgery.

In addition to these, Gayant, Perrault (4) and Pequet, the discoverer of the thoracic duct, also argued against transfusion, basing their opposition partly on unfortunate experiments on animals (5). They were joined by Pierre Martin de la Martinière (6) and Pierre Petite (7), the latter of whom fully represents the point of view of Gui-Patin [Guy Patin] and the Paris therapists in that he tries to prove that bloodletting is necessary in the treatment of illnesses, but not the transfusion of blood. Finally, we will mention the objections of Gaspar de Gurye de Montpoly (8), whose opposition is also not supported by experimental investigations. For theoretical reasons, he believes that the combination of two different types of blood in the same body must bring dangers during transfusion. He further assumes that if too much foreign blood is injected, the life of the indwelling blood is overcome, threatening death to the transfused person. It is therefore advantageous if haematuria and epistaxis occur in transfused patients because this means that the excess injected is excreted and this therefore puts life out of danger.

Despite all this mass of opposition, J. B. Denis found little support. Gadroys (9) replied to the opponents of transfusion that foreign blood does not have a hostile effect in a body, since one can also see how foreign rice grafted onto a stem thrives and bears fruit.

Unconcerned about the many adversities that the many disputes with his opponents brought him, Denis remained true to his plan to carry out transfusions on humans as often as

the opportunity and indications presented themselves to him. The treatment he carried out on Baron Bond, the son of the King of Sweden's first Minister of State, caused a great sensation in Paris (10). The patient had been suffering from febrile diarrhoea for three weeks and had been treated by four doctors according to the school of the time, with bloodletting, purgants and clysters to the point of extreme exhaustion. To ensure that nothing was left untried, Denis was also brought in for a consultation. But only after all the treating doctors had given a unanimous written statement that the patient would certainly die in a few hours without further treatment, only then did Denis and his assistant Emmeriz [Emmerez] decide on the transfusion. The patient was already lying unconscious in agony with convulsions. The dying man was given six ounces of arterial calf's blood according to the previous method, whereupon there was immediate and undoubted improvement: consciousness returned, the convulsions subsided, the pulse increased and the patient appeared visibly strengthened. The operation was repeated the following morning, but the patient died that same day. The autopsy showed the first organs of the abdomen to be in such a pathologically degenerated state that death was inevitable under any circumstances. The heart was empty of blood.

Denis also managed to heal a woman who was paralyzed on one side by infusing sheep's blood.

The following case of the treatment of a mentally ill person by transfusion had a decisive influence on the fate of transfusion in France (11). The valet Ant. [Antoine] Mauroy, 34 years old, had fallen into violent madness as a result of an unhappy love affair 7-8 years ago, which recurred from time to time.

Later, when he had remained free for a long time, he married a young lady and lived in a place 12 miles from Paris. But suddenly, after 4 months, the old illness broke out again, the afflicted person tore off his clothes and, otherwise ignorant of the way, ran to Paris in the dark night. His wife searched for him in vain in all the surrounding villages. In Paris the unfortunate man wandered about without shelter because people were afraid that he would infect their houses. Then Monsieur de Montmors [Montmor] finally took pity on him, had him admitted and at the same time suggested a transfusion to Denis and Emmeriz [Emmerez]. Perhaps calf's blood could soothe his mental functions through its mildness and freshness. The madman was taken to a private house and the well-known, paid palanquin bearer, on whom Denis had previously carried out the transfusion, was appointed to guard him. He should persuade him as best he could. On 19 December 1667, at 6 o'clock in the morning, the operation was performed in the presence of many distinguished physicians. The patient was first drained of ten ounces of blood and then five or six ounces from the crural artery of a calf were poured into the vein in his arm. There was calming down and improvement. In order to completely restore the patient, a second operation was suggested, to which his wife, who had in the meantime found him again, also agreed. This second operation was carried out on the Wednesday before Christmas in the presence of physicians Bourdelot, Lallier, Dodar, de Bourges, Vaillant and others.

This time a more abundant amount of blood was allowed to flow. During the operation, the patient felt a feeling of heat in his arm in the course of the arterial blood flow in his veins; after this, the patient complained of pain in the kidney area, in addition to symptoms of oppression in the chest and irregularity in the action of the heart. On Saturday, the last day before Christmas, there was a nosebleed and the excretion of dark, sanguinulent urine. Nevertheless, the patient's improvement was unmistakable; he longed for the sacraments, was happy to see his wife again and thanked M. de Montmors [Montmor] for his kindness in having saved him from his deep misfortune. He was healthy and well, and the case caused a general sensation in Paris.

This conspicuous and brilliant success once again set in motion a whole host of envious people; some claimed that the person undergoing the operation had become even crazier after the transfusion than he had been before; others even said that he had died at the hands of the surgeons.

The man's healing lasted for two full months, but since then the illness, probably encouraged by a dissolute life, had reappeared in its old form. The unfortunate man's wife urged Denis and Emmeriz [Emmerez] to use the transfusion again. They agreed to do so.

The carotid artery of a calf had already been prepared and preparations were made to first draw blood from the veins of the patient's arm and leg. But since this did not succeed, the operation was abandoned, especially since the mere attempt to insert the cannula into the patient's arm vein caused the patient to make the most violent convulsive movements.

The following night - but not during the operation - the patient died, probably from poison which the wife had given to the patient. The autopsy that Denis had insisted on was refused. When the funeral had taken place, three doctors, who were envious of Denis, asked the woman to testify that her husband had died during the third transfusion, and they also bribed false witnesses to make similar statements.

Indeed, their impudence went so far that they provoked the woman to sue Denis so that he should support her for the rest of her life because he had killed her husband. - In the face of such intrigues, Denis thought it would be better to break his long-held silence and accuse both the deceased's wife of suspected poisoning and the three doctors for their shameful slander.

The judicial inquiry (12) found: that Denis and Emmeriz [Emmerez] had cured Ant. [Antoine] Mauroy of his madness twice by the transfusion and that the healing lasted for two full months after the second operation. From that time on, the man indulged in all sorts of excesses; his wife supported his passions, but secretly gave him arsenic. It is certain that she mixed a powder into the bread, that she prevented herself and strangers from eating the latter, and that later a cat that fed on the bread died. The woman also made death threats against her husband. The third time the transfusion was intended, but it was not carried out because no blood would flow from the patient's veins. The patient did not die until the following night.

The woman prevented the autopsy because she testified that her husband was already in the coffin, which was not true. The woman further testified in court that the three doctors had made promises to her and promised her money when she testified that her husband had died during the transfusion; one witness testified that one of the physicians had offered him twelve Louis d'ors if he would give the same false testimony. The court decided to hold the woman and the three doctors personally accountable, but at the same time it issued the serious edict that no transfusions could be carried out on humans in the future unless the doctors of the Paris faculty had given their consent.

This was crucial for the fate of transfusion in France. Denis could never count on approval for his favourite operation, because the faculty was led by his opponents, Bourdelot and his comrades. Thus, in Paris, transfusion was suppressed through intrigue and coterie.

Denis might well have angrily turned away from the dishonest conduct of his opponents; but what good did it do him to plead for himself and his operation at the faculties at Rheims and Montpelier, in vain, their hands were tied.

Nevertheless, transfusion remained a favourite operation for him and he continued to perform it on animals for a long time (13). This is how the transfusion trials in France, which had begun so promisingly, ended. –

It must, after all, seem striking why in England the transfusion was not carried out on a human sooner than in France, since it was known there for much longer and was tested much more thoroughly on animals.

But in England at that time the laws regarding dangerous cures were much stricter than in France. And we also know that at the beginning of 1667 Dr. Edmund King in London actually already had everything ready for a human transfusion (14). But chance didn't present him with a suitable case and so it happened that Denis beat him to the implementation.

1. cf. Hallers Bibliotheca med. pract. Tom III.
2. cf. Conversations de l'academie de M. l'Abbé Bourdelot recueillies par le S. Gallois. Paris 1675.

3. Guilielmi Lamy, Lettre à M. Moreau contre les prétendues utilités de la transfusion du sang. Paris 1668. Seconde lettre de M. Lamy pour confirmer les raisons qui'l a apportées dans sa premiere lettre contre la transfusion du sang. Paris 1668.
4. Claude Perrault, Ess. de physiol. Tom IV.
5. F. Haller, Biblioth. med. pract. III. p. 547.
6. Opuscules contre les circulateurs et transfusions du sang. 1668. Goulin.
7. Pseudonym: Eutyphrontis de nova curandorum morborum ratione per transfusionem sanguinis. Paris. 1668.
8. Lettre de M. Gurye de Montpoly à M. Bourdelot sur la transfus. du sang. Paris 1668. - cf. An account of more Tryals of Transfusion, accompanied with some considerations, cet. Phil. trans. Octob. 21. 1667. N. 28.
9. Lettre de M. Gadroys à M. l'Abbé Bourdelot pour servir de reponse à lettre écrite par M. Lamy contre la transfusion. Paris 1668.
10. cf. Philos. transact. 1667. Nr. 28 und pag. 562.
11. Lettre sur une Folie inveterée guérie par la transfusion. Paris. Journ. des Savans 1667. - An extract of a letter etc. touching a late cure of an inveterate Phrensy by the Transfusion of Bloud. Philos. transact. Febr. 10. 1667/8. p. 617 und an extract of a printed letter etc. Paris, Mai 15. 1668; Phil. transact. Jun. 15. 1668. N. 36. p. 710.
12. An extract of the sentence, given at the Chastelet [Châtelet], by the Lieutenant in Criminal Causes [Cases], April 17. 1668 in Paris. cf. Philos. transact. Dec. 13. 1669, N. 54. p. 1075.
13. cf. Dionis, Cours de Chirurgie p. 458. Duhamel, Histoire de l'Academie p. 21. 22.
14. cf. Philos. transact. Oktob. 21. 1667. N. 28.

PART SIX - PAGES 577-579

THE TRANSFUSION OF BLOOD
ITS HISTORICAL DEVELOPMENT AND CURRENT SIGNIFICANCE

By Dr. Leonard Landois
Private Lecturer and Assistant at the Anatomical-Physiological Institute at the University of Greifswald

IV
The first transfusion attempts in Italy, Germany and Holland.

At the time when, following the discovery of the circulation, transfusion was practised in England and France, the star of the Italian school, which had previously shone so gloriously, was already fading. So it came about that the new operation found imitators here, but no one who would have understood and appreciated it in its full scope. Here too, we often see transfusion and infusion treated together. While Fracassati was chiefly occupied with infusion experiments, Cassini carried out a complete substitution of the blood of one lamb by the blood of another lamb (1667) with the best success. Another experiment was made at Udine in the house of Signor Griffoni, in which the blood of a lamb was injected into a thirteen-year-old dog, which had already been deaf for three years, and which was then said to have regained its hearing (1). Riva (2) then carried out the first transfusions in humans, some of them successfully. He was followed by Paulus Manfredus [Paolo Manfredi] in Rome, who first performed the transfusion on dogs, but afterwards also on a person with a happy outcome (3).

In Manfredus [Manfredi] there is also the strange passage that Libavius actually said in his writing: “Defensio Syntagmatis Arcanorum chymicorum contra Heningum Schneumannum (actione 2. pg. 8.) Editio Francof. A. 1615” was the first to think of transfusion. Libavius says here: “Adsit juvenis robustus, sanus, sanguine spirituoso plenus:

Adest exhaustus viribus, tenuis, macilentus, vix animam trahens. Magister artis habat tubulos argenteos inter se congruentes, aperiat arteriam robusti et tubulum inserat muniatque; mox et aegroti arteriam findat et tubulum femineum infingat. Jam duos tubulos sibi mutuo applicet et ex sano sanguis arterialis calens et spirituosus saliet in aegrotum, unaque vitae fontem affert omnemque languorem pellet (4). Although we must assume that Libavius (in Halle) did not carry out the transfusion himself, it is still interesting to find a specific indication and a description of the method of direct blood transfer at such an early time (5).

Michael Lipari from Messina, a violent man who later lost his life and his head because of his participation in a rebellion, also carried out transfusion experiments on animals (6). - Bartholomaeus Santinelli was particularly zealous against transfusion in his writing: Confusio transfusionis, sive refutatio operationis transfundentis sanguinem de individuo ad individuum (Roma 1678). He refers to the unfortunate experiments that Hippolytus Magnani and the doctor Ventronus had carried out on animals and, and calls out to Seneca (where he speaks of the gladiatorial games), the indignant words: Homo, res sacra, jam per lusum et jocum occiditur!

Finally, it should not go unmentioned here that in Italy, even before the circulation was discovered, in the 15th century, according to the testimonies of Villari and Sismondi, a transfusion was carried out on Pope Innocence VIII (7). A Jewish doctor is said to have injected the blood of three boys into the veins of the Pope, who was suffering from great weakness. Nevertheless, he died on 25 April 1492, as did the three boys who provided the blood.

Of even less importance than the Italian efforts were the experiments on transfusion in Germany, which scarcely began to recover from the nameless misery of the Thirty Years' War, and where, at the beginning of the seventeenth century - which was at any rate of importance - there were still no anatomical chairs from which stimulation and instruction could have been given. Kaufmann in Küstrin was the first to carry out the transfusion in Germany; he allowed the blood of a lamb to flow into a patient suffering from leprosy. In another patient who suffered from a feeding rash, the condition actually worsened after the transfusion. Purman, who assisted in the operation, noted that the two people had hardly recovered from their sheep-like melancholy in a year and a day (8). Sigismund Elsholz, personal physician to the Elector of Brandenburg, emerged from the Italian school, a good botanist and anatomist, but became known primarily as an infuser, through his “Clysmiatria nova, addita inaudita sanguinis transfusione Col. ad Spream 1667,” raised the strange question, whether discordant spouses and siblings could not be reconciled naturally through repeated mutual exchanges of blood. Michael Crugener, on the other hand, rejects transfusion and infusion equally, without being able to refer to independent experiments. Michael Ettmüller, professor in Leipzig, from the school of van Helmot and Sylvius, one of the most famous physicians of his time despite his premature death at the age of 39, also disapproves of transfusion on the whole (9): it is not capable of rejuvenating life. Perhaps one could expect help from it after severe haemorrhages and in melancholy states.

In Holland (10) the transfusion also caused a sensation for a while. Animal experiments were apparently carried out, but without any significant results being obtained which could have been used for the practical execution of the operation on humans.

1. Giornale dei litterati apud Nic. Ang. Tinassi 1668. – Phil. Transact. 14. Dec 1668 p. 840. – Haller bibl. Med. pract. III.
2. Ephem. nat. cur. Dec. I. Ann. I.obs. 149.
3. Pauli Manfredi Lucensis, de nova et inaudita operatione sanguinem transfundente de individuo in individuum. Roma 1668. - Relazine delle esperienze fatte in Inghilterra, Francia ed Italia intorno alla transfusione del sangue. Roma 1675. Haller Bibl. I. 557.
4. Of the Antiquity of the transfusion of Bloud from one animal to another, Philos. transact. 13. Juli, 1668. p. 731.

5. Auch Marsilius Ficinus, Hier. Cardanus und Joh. Colle, (1628) Prof. zu Padua sollen schon den Gedanken an die Transfusion vor Harvey ausgesprochen haben. Vgl. H. Haeser, Geschichte der Medizin. Jena 1853, p. 632.
6. Disquisitio de corde hominis physiologica anatomica. Barcin 1694. Obs. 24. de transfus. sang. ex altero animali in alterum.
7. cf. Transfusion du sang. Union méd. 115 p. 32 1862.
8. cf. Dieffenbach, op. Chir. I. p. 114.
9. Tom. III. seiner gesammelten Schriften.
10. Ondervinding door de beroemdeste Geneesheeren van het leyden des bloods uyt een gedierte in het ander. Leeuwaarden 1668. - Recueil de quelques nouvelles observations de la transfusion du sang. xc. la Haye. 1668.

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THE TRANSFUSION OF BLOOD
ITS HISTORICAL DEVELOPMENT AND CURRENT SIGNIFICANCE

By Dr. Leonard Landois
Private Lecturer and Assistant at the Anatomical-Physiological Institute at the University of Greifswald

V

The physiological justification of the doctrine of blood transfusion; the more recent investigations.

The ban imposed on transfusion in Paris was not without consequences; physicians were afraid to carry out such a heroic operation and so it happened that transfusion was increasingly forgotten. It was only protected and cared for by physiologists, while infusion was used more generally in animals and humans. The physiological experiments carried out by Rosa (1783), Bichat and Portal (1800) and Blundell (1818) to clarify the effects of transfusions are of great interest, but they did not reveal any significant new facts. The same applies to the investigations of Viborg and Hertwig, which were undertaken to show how the blood of sick animals, injected into the veins of healthy ones, produced its effects. Of importance was the discovery of Dumas and Prévost (1) that defibrinated blood could be used in transfusion with the same success as fibrin-containing blood, which had hitherto been used exclusively in transfusion.

In England, Doubleday brought transfusion out of the darkness of almost complete oblivion back into the light, and repeatedly carried it out with favourable success in the case of women who had recently given birth who bled to death; his example was followed by Blundell, Cline, Uwins [Unwins], Waller, Davis, Pointes, Lambert, Graawes [Graves], Ralph, Jewels [Jewel], Boyle, Burton, Brown, Douglas, Fox, and others.

In Germany, Burdach, Dieffenbach (2), Joh. Müller (3) and Bischoff (4) worked partly at the sickbed, partly in the laboratory for the elucidation of the effects of transfusions. Dieffenbach performed the transfusion on a hydrophobic man. After a strong bloodletting, 3 cups of blood from a healthy man were transfused to him. “The condition initially improved, but soon the same terrible accidents returned. The next day, as the symptoms continued, the operation was repeated; soon afterwards he was able to drink water without reluctance; an hour later he had a violent fit of rage in which he died. The autopsy showed nothing abnormal at all, neither traces of hydrophobia nor of transfusion.” Dieffenbach also tried the operation on cholera patients, but unfortunately only on ice-cold, blue, pulse-less, almost dying individuals. In two of the three cases, the most unmistakable signs of improvement appeared after the operation, but death nevertheless followed. "What can be objected to

this operation," adds the ingenious surgeon, "is that little more could be expected from it in such an advanced disease with coagulation of the blood in the vessels."

The numerous transfusion experiments which Dieffenbach carried out on animals produced results which most closely approximated those obtained by Prévost and Dumas. He found - what was already known to the ancient transfusionists of England and France, - that mammals that had bled to death could be immediately brought back to life by transfused blood from animals of the same species; furthermore, that arterial blood abolished apparent death somewhat earlier than venous blood. If a larger amount of blood was injected than was previously drained, the animals became unwell. Defibrinated blood works just as well as blood containing fibrin; the same applies to blood, which is prevented from clotting by caustic soda (?). Foreign blood also awakened animals that had bled to death, but afterwards they always became very suffering: dizziness, difficult respiration, palpitations, skipped pulse, beating of the flanks, initially increased, later decreased temperature of the body, pale and sometimes spotted tongue, swelling of the abdomen and death. Blood urine only occurred after overfilling with a larger amount of related blood than was withdrawn (5). - Bischoff, who was concerned with the transfusion of mammalian blood to birds, believed he had to assume with caution that the blood of one species of animal acted like a poison on another. Dieffenbach had observed something similar when he said: Blood from birds, injected into a one ounce larger mammal, kills, but a bird, e.g. a pigeon, dies from a few drops of mammalian blood under the symptoms of prussic acid poisoning as it enters the circulatory system. Bischoff later found that death only occurred in his experiments when he used venous blood, but not when he used arterial blood. He was not yet able to give a sufficient explanation for this fact in view of the state of physiology at that time; he conjectured that the "animal dross" contained in the venous blood possessed the poisonous properties.

A significant advance in the theory of transfusion was brought about by the extensive investigations of Brown-Séquard (6). This researcher proved that the difference in the revival capacity of arterial and venous blood depended solely on the different gas contents of the same. Venous blood has the same reviving power if it is first made bright red by oxygen, conversely, arterial blood has a poisonous effect if it is made dark by treatment with carbonic acid. If venous blood is injected into the veins of animals that are still breathing, this also has no poisonous effect if the injection is so slow that it can be de-carbonized in the lungs; it only has a poisonous effect when it is instilled in such a rich measure that a quantity of it, without losing its venous character, passes through the pulmonary capillaries and is supplied in a large circulation to the vital nerve centres. Then death occurs with convulsions, which is to be attributed to the irritating property of carbonic acid. According to this, it is also obvious that it cannot be successful at all if one wanted to inject venous blood into an individual who is no longer breathing for resuscitation (as is attempted even in the case of humans). If the last spark of life were still slumbering, it would certainly be extinguished. –

Of great importance are also to be noted the excellent experiments of Panum (7) on the transfusion, transplantation or substitution of blood. This scholar first stated beyond any doubt that defibrinated blood possessed the same reviving power as fibrin-containing blood, and accordingly deserved preference in practice on account of the elimination of the danger of coagulation and thrombi formation.

In a second series of experiments, Panum found that the blood of an animal could be completely replaced by injected foreign blood from the same species. The newly absorbed blood continuously takes over all functions of the metabolism of respiration and nutrition, like the previously autochthonous blood, without any disturbance. The red blood cell content of the blood is not subject to any unusual fluctuations for a long time after the transfusion in the foreign animal's body, and furthermore, no abnormal excretory products are formed and, in particular, the export of urea and the perspiratio insensibilis prove to be unchanged.

In the third series of experiments, Panum studied the effect of the blood of a foreign species on the organism. Here it was shown that foreign blood is indeed able to bring about a temporary resuscitation, but it soon disintegrates in the foreign organism and is excreted in a dissolved state by the secretions and excretions. Denis (1667) had already made very

similar observations during the second transfusion of the mentally ill man mentioned above. When he had been given a copious transfusion of calf's blood, pain arose in the kidney region and dark urine was excreted. Denis repeatedly recorded epistaxis after injection of animal blood in humans. I too have convinced myself that after the injection of human blood and rabbit blood into dogs, there was a sanguinous excretion in the kidneys, stomach and intestinal tracts.

More recently, transfusion has been granted the opportunity to open up a wide field, the field of acute intoxications. While Dieffenbach, Panum and Blasius believed that transfusion was limited to the area of acute anaemia, more recent studies have pushed the barriers further. In January 1864, in a case of carbon oxide poisoning, transfusion was carried out for the first time in Traube's department in Berlin (8), but with unfavourable results. After repeated bloodletting, about 8 ounces of beaten human blood were injected into the right cephalic vein. The patient became more contemplative and reacted to skin stimuli. Death occurred in the evening. –

At the beginning of February 1864, the second transfusion for carbon oxide poisoning was carried out by Wagner and Möller (9) in Königsberg. The deeply anesthetized 13-year-old boy, who had already been treated with skin irritation and electricity, showed no improvement after the transfusion of 6 ounces of defibrinated human blood; rather, the collapse progressed and death followed after 2½ hours.

Furthermore, Kühne (10) published his experiments on the effect of transfusion in carbon oxide poisoning. He succeeded in resuscitating dogs by transfusion in those cases in which bloodletting and artificial respiration were no longer successful and in which the respiratory movements themselves had been completely interrupted for up to seven minutes.

Dr. Sommerbrodt (11) performed the third transfusion for carbon oxide poisoning in Breslau on 22 September 1864.

After the injection of 4 ounces of defibrinated human blood, the patient recovered considerably, but nevertheless died of pulmonary oedema on 25 September.

Mosler in Greifswald also saw only a temporary improvement in two cases of carbon oxide poisoning, without being able to avert death from the transfusion (12).

Finally, Badt and Martin succeeded in Berlin in permanently rescuing a man poisoned by carbon oxide gas by transfusion (13).

So transfusion had entered a new area of effectiveness and there was certainly no lack of scope for extensive investigations. On the one hand, practitioners, like Dieffenbach, tried to use transfusion in cases in which the blood mass had been put into an abnormal state due to pathological processes, which was detrimental to the entire organism. Thus, in individual cases, but only with temporary improvement, Neudorfer transfused in the case of pyemia, Weber and Blasius with unfortunate success, while Mosler with fortunate success in leukaemia.

On the other hand - and here I may be permitted to mention the name of my friend Eulenburg and my own name (14) - the effect of transfusion has been studied in a whole series of different acute intoxications: in poisoning by carbonic acid and lack of oxygen, by carbon oxide gas, chloroform, ether, morphine, opium, strychnine, phosphorus - and finally, the effect of transfusion in inanition. The details of this are set out below. -

1. Biblioth. univers. de Genevé. T. 17. Ann. Dwe chémie. T. 18. p. 294.
2. Die Transfusion. Berlin 1828. – Operative Chirurgie I. 110.
3. Handbuch der Physiologie I.
4. Müller’s Archiv. 1835, 1838.
5. Operat. Chir. I. P. 118.
6. Compt. rend. de la soc. de biologie 1849, 1850, 1851. Compt. rend. de l’Acad. 1851 1855, 1857. Journal de physiologie I. p. 95, 173, 666.
7. Virchow’s Archiv Bd. 27. p. 240.
8. H. Friedberg, Kohlendunstvergiftung. Berlin 1866. p. 166.
9. H. Friedberg, die Vergiftung mit Kohlendunat. Berlin 1866, p. 174.
10. Zentralblatt f, d. Mediz. Wissenschaften 1864. Nr. 9.

11. Friedberrg l. c. p. 175 und Wiener medizin. Presse.
12. Berliner klinische Wochenschrift. 1866.
13. Sitzungsberichte der berliner medizinischen Gesellschaft, 28. März 1866. Es wurde nicht defibrinirtes Blut angewandt.
14. Eulenburg und Landois cf. Comptes rendus 1865. N. 17. Zentralblatt f. d. medizinischen Wissenschaften 1865. N. 46. - Die Transfusion des Blutes. Berlin 1866 und berliner klinische Wochenschrift 1865 und 1866. - Zentralblatt f. d. mediz. Wiss. 1867 April.

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THE TRANSFUSION OF BLOOD
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By Dr. Leonard Landois
Private Lecturer and Assistant at the Anatomical-Physiological Institute at the University of Greifswald

VI

Transfusion in acute anaemia, hydremia and chlorosis

In England alone, an average of one woman who has recently given birth dies from bleeding every day (1); if we add to this the fatal loss of blood due to other internal causes or wounds, especially on the battlefields, we can easily see that transfusion opens up a field of activity in this direction alone, such as should hardly be expected. In acute anaemia, transfusion has its most immediate indication: the operation is intended to directly restore the blood that was lost to the body as a result of the accident that caused it. The statistics of transfusion also show that the operation has been used most frequently in cases of severe blood loss, with predominantly favourable results. Shortly after the discovery of the transfusion, T. Clarck [Clarke] had already promised a blessed future for the new operation in this direction: - and his word has been fulfilled.

In the experiments made by my friend A. Eulenburg and myself on the effect of the transfusion of blood in acute anaemia (2), we first sought to answer the following questions: 1. Is the peculiar restorative effect of transfusion in animals made anaemic connected with certain constituent parts of the form and mixture of the injected blood, and what are these constituents? and - 2. In what way does the effect of transfusion on the vital nerve centres manifest itself, and through which nerve pathways is the influence of the transfusion mediated? –

With regard to the first question, we could certainly agree with Panum's assertions that blood without fibrin has the same revitalizing power as blood containing fibrin, and that therefore fibrin does not participate in the restorative effect of the blood. Furthermore, the fact that serum does not have the revitalizing power was shown by the experiments in which animals that had succumbed to anaemic paralysis had serum shaken with oxygen injected into the veins without them recovering to life. These experiments, as well as those in which protein solutions, previously shaken with oxygen, were transfused instead of serum, showed at the same time that the hypothesis put forward by Goltz was invalid, namely that the main value of transfusion in cases of bleeding was simply based on the improvement of the mechanical circulation conditions. "The sudden fatal outcome after blood loss," says Goltz (3) – "is not caused so much by the cessation of nourishment, but by the fact that the movement of the blood stops, and the latter falters because the heart can no longer work successfully after the sudden reduction in the contents of the vessels. In such cases, the remnants of blood still present in the vessels would be able to sustain life for a while, at least provisionally, if only they were set in motion, if the mechanical movements for the circulation were established." According to this hypothesis, Goltz believes that a protein solution alone

is sufficient for resuscitation. However, this is not the case (4), - and so we are compelled to look for another agent which brings about resuscitation in the transfused blood, and find it in the red blood cells.

But the red blood cells are not able to develop a restorative effect under all circumstances, but only when they have taken in oxygen and when their haemoglobin has bound the oxygen. If, on the other hand, they have absorbed carbonic acid, death occurs under stormy phenomena.

Here, however, the condition of the person who has almost bled to death is to be observed: if he is already breathless, unconscious, in all circumstances only oxygenated blood can bring salvation. Conditions of so-called anaemic paralysis, then in all circumstances only oxygenated blood can bring salvation. If, on the other hand, the person who has nearly bled to death is still able to carry out breathing movements, albeit only weakly, then under that sole condition venous blood can also bring about complete restoration, namely if the injection into the vein is so slow that the blood in the lungs can be sufficiently de-carbonized. If, on the other hand, the injection is so rapid that a part of the venous blood as such passes through the lungs and is supplied through the arteries of the nervous centres, the greatest danger arises for the complete suppression of the still existing respiratory activity of the medulla oblongata. In this case, violent general convulsions are harbingers of certain death.

Under all circumstances, the beneficial effect of the transfusion is first manifested by the recurrence of the rhythmic breathing movements that have already been extinguished, or at least reduced to a minimum. This phenomenon led to the question of whether the stimulation of respiratory movements was caused by the injected blood in the centre, the elongated medulla, or by the peripheral fibres of the vagus nerve in the lungs. To decide this, both Nn. vagi were cut in bleeding animals, and the resuscitation transfusion was now carried out.

It was shown that the restoration was nevertheless successful, and we therefore believe ourselves justified in the conclusion that the respiratory nerves in their centre are restored by transfusion.

According to the facts described above, the theory of the transfusion effect in acute anaemia caused by bleeding may be developed in the following manner. In the normal state, the breathing movements in the prolonged medulla are produced by lack of oxygen. If one makes rich artificial respiration movements in animals, through which the blood is able to absorb a relatively large amount of oxygen, all spontaneous breathing movements cease, and apnea develops, as Hook discovered in 1667 (5). All beings are in the same state of apnea during intrauterine life as long as sufficient quantities of oxygen-containing blood flow to them from the placenta (6). In the same way, it can be expected that animals into which arterial blood is infused for a time into their large veins will develop apnea for the duration of the injection.

If the amount of blood cells is significantly reduced due to blood loss, an abnormal lack of oxygen occurs at the same time, as a result of which the medulla oblongata, which is more irritated than usual, triggers dypnoetic breathing movements. The greater irritation of the same is also reflected in the slowing of the pulse (vagal irritation), which occurs completely independently of breathing, and which, as I have shown, occurs even with sufficient artificial respiration (7). If the blood loss and with it the lack of oxygen reaches an excessive peak, the resulting increased irritation of the medulla oblongata causes violent general convulsions, the addictive seizures of Kussmaul and Tenner, which are finally followed by general paralysis and death if the lack of oxygen continues.

If, in this state of anaemic paralysis, characterized by the extinction of the cerebrospinal motor, sensitive and sensory functions when the cardiac action is close to extinction, oxygen-containing blood is again injected into the veins and fed through the heart to the centre of respiratory activity, medulla oblongata is returned from the state of paralytic overstimulation to the normal stimulation that serves to stimulate respiratory movements.

We have already noted that until now it was primarily acute anaemia for which transfusion was used in practice and here again primarily for bleeding in newly delivered patients.

However, some researchers have apparently gone too far if they want the use of transfusion to be limited to haemorrhages. Martin in his writing: "On the transfusion of bleeding in patients with newborn babies", Berlin 1859, presented the indications for these special cases in the following way: If signs of anaemia of a higher degree - general pallor of the skin, coldness of the extremities, small hardly distinguishable pulse, fainting fits, the re-emergence of the appropriate nutrients or medicines makes restoration impossible by means of the mouth and stomach, so I consider the time of the transfusion to have come and advise not to continue with this almost safe (!) operation." (L.c.p. 77.)

But transfusion is also absolutely indicated in the same way in the case of haemorrhages of other kinds, in the case of traumatic injuries, exhausting haemoptosis, haematemesis, bleeding of the intestines, the genital organs, stormy epitaxis, as well as in the haemorrhages of haemophiliacs.

But hydremia as a result of extremely debilitating illnesses, as well as severe degrees of chlorosis, can also be an indication for transfusion under certain circumstances, I believe that the easiest way to help patients after severe acute fever, especially typhus, over the often very dangerous periods of weakness is through a bold transfusion.

Above all, however, transfusion can become a necessity in hydremic and chlorotic conditions when persistent vomiting and exhausting diarrhoea increasingly impair the general diet and strong foods, iron preparations and roborants do not appeal to the organism.

It deserves special emphasis that in all these conditions the transfusion should not be postponed to the extreme, as an ultimatum refugium, since under persistent states of severe weakness the central nervous system must gradually become incapable of reacting properly to the stimulus given by the transfusion.

1. Graily Hewitt. Brit. med. Journ. 1863. p. 232.
2. Die Tranfusion des Blutes etc. Berlin 1866. p. 7.
3. Virchow's Archiv XXIX.
4. Aehnliche Versuche - jedoch ohne die hier discutirte Frage zu berücksichtigen, sind schon früher von Dumas, Prevost, Dieffenbach, Bischofh und Brown-Séquard, und zwar gleichfalls mit negativem Erfolge ausgeführt worden. [Similar attempts - but without taking the question discussed here into account - have already been carried out earlier by Dumas, Prevost, Dieffenbach, Bischofh and Brown-Séquard, and also with negative success.]
5. Philosoph. transact. 1667. Oktob. 21. N. 28. p. 539.
6. Aehnliche Verhältnisse bestehen bei den ausserhalb des mütterlichen Organismus sich im Eie entwickelnden Embryonen durch den Kreislauf auf Dottersack und Allantois. [Similar conditions exist in the embryos that develop in the egg outside the mother's organism through the circulation of the yolk sac and allantois.]
7. Centralblatt f. d. mediz. Wiss. 1865. N. 44.

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By Dr. Leonard Landois
Private Lecturer and Assistant at the Anatomical-Physiological Institute at the University of Greifswald

VII

Transfusion with simultaneous depletion in acute poisoning, or the substitution of normal blood in place of that impregnated with topical substances

The topical substances, which contain their detrimental influences on the organism, act in such a way that they are first absorbed into the blood and are carried within the circulatory system to those places on which their deleterious influences have an effect. Whether the poison is absorbed through the respiratory organs, through the digestive organs, or from a wound is completely irrelevant. It can therefore be described as rational when Roche and Sanson describe bloodletting as the sovereign remedy for acute intoxications. Vierordt was also able to state that death was delayed after bloodletting in the case of poisoning with strychnine. But bloodletting also has its dangerous sides. Apart from the weakening of the entire organism through the withdrawal of blood, which, as the case of strychnine poisoning by Duriau (1) shows, brings with it a strikingly slow convalescence, we know that as a result of the weakened circulation the elimination of the poison is delayed, and is even prevented. If, as is often the case, there is still unabsorbed poison in the body, then bloodletting also poses new dangers, as we know from Magendie's investigations that the absorption of poisons is accelerated after venesection.

We will therefore respond much better to the indications in acute intoxications if we remove the body the blood mass containing the poison and, in its place, introduce normal blood into the vessels by transfusion. This method of treatment for CO poisoning, proposed experimentally by Kühne (2) based on the work of other practitioners, has been elevated by us to a general method of treating indications (3). The large number of animal experiments we have carried out relate to poisoning by carbonic acid and oxygen deficiency (asphyxia), by carbon dioxide, chloroform, ether, morphine, opium, strychnine and phosphorus.

As regards poisoning by carbon oxide gas (coal vapours), we know that the harmful effect of this poison is that the CO forms a chemical bond with the haematoglobulin, and thus makes it impossible to absorb O into the blood. The O is expelled from its connection in the blood by the CO, whereby the latter enters into such a close connection with the blood cells that it cannot be separated from them again by the gas exchange of the respiratory activity. If only a small amount of CO has entered the blood, the organism is able to eliminate it again by oxidizing it by the O still present in the blood and converting it into CO2, and as such it finally escapes.

The cerebrospinal centres in particular suffer from the influence of CO: unconsciousness and coma occur, and the volitional organ is no longer able to function. But reflex movements are also impaired, breathing becomes less frequent and threatens to stop as soon as the medulla oblongata is drawn into the paralysis. The centre of the vasomotor nerves becomes paralyzed, as a result of which there is a dilation of paralytic vessels, a sharp drop in pressure in the arterial system and a serious disturbance of the entire circulation. The heart contractions are slowed down, but they are still relatively little disturbed as long as general paralysis does not occur.

In our experiments we allowed the animals to remain in an atmosphere containing $^{1}/_{12}$ - $^{1}/_{6}$ CO for as long as 2-8 minutes until they collapsed under the signs of general paralysis and became unable to breathe. None of the animals treated in this way recovered on their own in the open air, or with the use of extensive venesection, or with the initiation of artificial respiration, either by direct injection of air into the cut trachea, or by faradic stimulation of the phrenic nerves and “their comrades” on the neck. On the other hand, transfusion proved to be a reliable means of rescue. A considerable amount of blood was removed from the animals through bloodletting, which, as a result of the copious intake of CO, gave it a light cherry-red colour, and new, healthy, light red animal blood was then injected into them again. The more intense the poisoning was, the more complete the substitution was carried out and the success of this treatment must be viewed as consistently favourable, as Kühne had already found in his animal experiments.

These experiences made with experimental animals allow an unconditional transfer to humans, and blood substitution therefore deserves the strongest recommendation in cases of CO poisoning. The colour of the drained venous blood provides information about the extent to which the exchange is carried out. As long as the latter still has an unusually light

red colour, there is still insufficient substitution; furthermore, the symptoms of the poisoning themselves provide sufficient criteria for the extent of the substitution.

The treatment described has already been successful in humans, with both Badt and Martin (4) as well as Uterhart (5) succeeding in permanently rescuing people who had been suffocated by coal fumes.

Besides transfusion, which must necessarily occupy the first place, the use of means other than adjuvants naturally also has a legitimate position.

In our experiments to test the beneficial influence of transfusion in poisoning by chloroform and ether vapours, we found that the transfusion of O-rich blood, combined with depletion from the veins of a deeply anesthetized animal, is able to revive the respiratory movements that are close to extinction in the shortest possible time, and can make complete anaesthesia disappear in less than four minutes. We therefore have not the slightest hesitation in proposing depletoric transfusion in the event of accidents during chloroform or ether anaesthesia. Depending on the circumstances, it may also be necessary to use the method repeatedly and to combine it with other resuscitation attempts that have been proven to be appropriate.

In the case of the other poisonings we have studied, with opium, morphine, and strychnine, the depletoric transfusion proved to be the most powerful means at our disposal. In all these cases, where the poisoning was brought about partly by infusion into the veins, partly by hypodermatic application of the poisoning substance, it was possible to significantly shorten the duration of the poisoning time and the intensity of the symptoms of poisoning at non-lethal doses by a transfusion combined in the above manner, and even to partially preserve life and integrity of all functions at an otherwise lethal dose. Above all, it is to be taken to heart that in all intoxications the transfusion should not be postponed to the extreme, since under the constant influence of the poison the organism must always be in greater danger and a "too late" will then not be missed. The fact that the depletoric transfusion can no longer have a lasting effect and preserve life at the highest degrees of poisoning is self-evident in itself.

In view of the unanimously favourable results obtained by the depletoric transfusion in a number of the most diverse acute intoxications, we believe that we are justified in proposing the procedure for acute poisoning in general as a sovereign remedy, which corresponds best and most directly to the indicatio causalis. The operation will have to be continued depending on the degree and severity of the symptoms until it can be assumed that the poison that has entered the blood has been broken down or excreted in the body, or until the symptoms of poisoning have been reduced to modest limits.

A very special mention should be made here of those poisonings which can, as it were, form the transition to the chemical, and whose effect consists chiefly in the fact that they cause fatty degeneration of the liver, heart, kidneys, and muscles. We mean here primarily the poisoning by phosphorus, arsenic, antimony, as well as some acids etc. Among these, we have recently examined transfusion in acute phosphorus poisoning in more detail (6). Already Leyden, Munk and von Bamberger had pointed out the use of transfusion for this toxicity, but without testing it experimentally. We carried out our experiments on rabbits that had been poisoned either by oleum phosphoratum (internally or subcutaneously) or by phosphorus sulphur. If the poisoning was accomplished by a single lethal dose, the animals, left to their own devices, died after 12-24 hours with the characteristic changes described by Leyden and Munk and others. Treated with transfusion, on the other hand, the animals live for at least 2-6 days. If the poisoning occurred by repeated smaller doses from the stomach, the animals, without transfusion, usually died at the end of the second or during the third day with severe changes in all organs. When the depletoric transfusion was used and repeated at appropriate intervals, the animals were either preserved in their entirety, or lived at least twice or three times as long as the untreated. Killed earlier, they invariably showed far less advanced degenerative changes after the same period of poisoning, especially in the liver, heart and kidneys. Since, when the phosphorus is administered internally, it is absorbed through the absorption organs of the digestive tract, the transfusion naturally cannot prevent the P from passing through the liver, right heart and lungs once, and thus the development

of pathological changes in these organs, especially fatty degeneration; it can only largely eliminate P, which may still be contained in the larger circulatory system, as well as eliminating its harmful oxidation products and thus provide relatively healthier organs that are still intact as well as those that have already been affected. This also indicates the limits of its effect in this and the related intoxications, which must therefore be drawn more narrowly than in the case of many other poisonings.

1. Ann. d'hyg. 2. ser. XVI. 428. 1862
2. Siehe Absschnitt V.
3. cf. Husemann, kritische Blätter 1866. Nr. 43. p. 386.
4. Verhandl. d. Berliner mediz. Gesellschaft 1866. I.
5. Deutsche Klinik 1867. Nr. 14.
6. Centralbl. f. d. mediz. Wiss. 1867. Nr. 19. Eulenburg und Landois, die Transfus. bei akuter P-Vergiftung.

PART TEN - PAGES 753-755

THE TRANSFUSION OF BLOOD
ITS HISTORICAL DEVELOPMENT AND CURRENT SIGNIFICANCE

By Dr. Leonard Landois
Private Lecturer and Assistant at the Anatomical-Physiological Institute at the University of Greifswald

VII

Transfusion with simultaneous depletion in acute poisoning, or the substitution of normal blood in place of that impregnated with topical substances (Continued)

So far we have only spoken about those poisonings in which the toxic substance had to have entered the body from outside, but transfusion is of the same importance as in these cases

the autochthonous intoxications.

By this term I mean those poisonings in which, through abnormal functions or formation processes, different form or mixture components are introduced into the blood mass in the organism itself, which act on the body like a poison. On the one hand, I include asphyxia here, because as a result of the obstructed respiratory activity and the associated accumulation of CO_2 and reduction of O, an autochthonous mixture of blood is formed. I also include cholemia among the autochthonous intoxications, regardless of whether it is caused by blood icterus or absorption icterus, as well as uraemia and septicaemia. On the other hand, this is followed by leukaemia and melanaemia, which are caused by abnormal components in the blood.

Hydraemia and acytemia (chlorosis) can also be viewed from these points of view - but we found it advisable to treat them alongside acute anaemia.

In all autochthonous intoxications, depletoric transfusion can only have lasting success if the cause of the abnormal blood condition is transient. If this is not the case, its importance for the case in question is reduced to that of palliative treatment.

In the first place, as far as asphyxia is concerned, we shall here refrain from discussing anew the question, which has been most vividly discussed by physiologists, as to whether it is actually the increased CO_2 or the O deficiency, or finally the combination of the two that produces the toxic factor. We only want to mention here that our experiments on asphyctic animals show the effect of substitution in the most brilliant light. Rabbits whose external

jugular vein had previously been exposed were killed simply by asphyxiation and attempts were then made to resuscitate them. This showed that resuscitation by injecting arterialized blood after extensive bloodletting was still successful in all cases in which artificial respiration, initiated in various ways, was no longer able to have a revitalizing effect. The importance of our experiments for practice is self-evident.

We strongly recommend this method of treatment for all severe forms of asphyxia, especially to obstetricians in order to save seemingly dead children. In the latter case, an injection of half an ounce of fairly light-coloured blood is made into the umbilical vein and a corresponding amount of blood is allowed to flow out of the umbilical arteries (if anaemia is not present). This procedure can be repeated several times one after the other.

Following our suggestion, the assistant doctor at the local obstetric clinic, Dr. Bennecke tried transfusions in apparently severely dead newborns and he has already succeeded in achieving a favourable result in one case (1). We therefore once again recommend the method in question to all practitioners, especially at larger birthing institutes.

Of great importance for practice here is the fact highlighted by Bennecke that in births that involve asphyxia in the newborn, it is easy to obtain suitable blood without bloodletting.

After the placenta has been expelled, as large a quantity of bright red blood from the mother's placental vessels as is necessary still flows out of the vagina, which has been wiped-out as it were. Then you just need to catch it and collate it. This circumstance obviously particularly favours the acceleration of the operation, and most of it depends on the latter.

Also in cases of uremic intoxication (ammoniemia? Frerichs, acute brain anemia? Traube), depletoric transfusion deserves consideration.

But here too we can only speak of permanent effects if the causa movens is transitory; acute cases of nephritis should therefore usually be taken into account. In order to determine the beneficial influence in this direction, after opening the abdominal cavity, I placed a ligature around both ureters of a dog, which was pulled through the abdominal muscles in such a way that the passage in the ureters was interrupted.

After two days the signs of intoxication appeared, and I replaced the whole quantity of the animal's blood with the blood of another dog. From the drained blood I succeeded in producing an abundant quantity of urea. Then the ureteral loops, which were tightened on the outside of the abdomen, were cut loose and the urine was able to flow freely into the bladder again. The signs of intoxication disappeared, but unfortunately the animal did not recover and died on the fifth day of diffuse peritonitis. I have no doubt that continued experiments of a similar nature will produce completely satisfactory results.

In the same way, it can be expected that in severe forms of icterus caused by temporary impassability of the bile duct, depletoric transfusion will have good results. It therefore deserves recommendation here too.

Pyaemia and septicaemia also belong to this area as autochthonous intoxications. Neudorffer saw temporary improvement in pyaemic conditions after transfusion in five cases during the Franco-Italian campaign, and Lücke also believes he can recommend the same for septicaemia on theoretical grounds. But if it is not possible to eliminate the pyaemic or septicaemic herd in addition to the operation, one cannot expect lasting success from the option..

Finally, leukaemia and melanaemia must be mentioned, conditions in which autochthonous abnormal forms are introduced into the blood mass, which have a harmful effect. In the case of leukaemia the operation has already been carried out twice, once by Weber and Blasius with unfortunate success, the other time by Mosler with happy success.

Certainly, for most cases of leukaemia, the operation will only be able to provide palliative relief, since severe spleen hypertrophy and lymphatic neoplasms, which constantly supply masses of white blood cells to the blood, are unlikely to be eliminated by transfusion.

On the other hand, it cannot be denied that relatively mild cases of leukaemia can be cured by transfusion in such a way that the blood that is now instilled changes the organs that tend to produce abnormal new white blood cells to function normally.

Transfusion has also been suggested for diabetes mellitus, namely by Mosler (2).

According to the statements of Pettenkofer and Voit, the essence of sugar urinary dysentery consists in a disease of the blood, by virtue of which the blood cells are said to be unable to bind oxygen in sufficient quantities from the inhaled air.

The purpose of the transfusion here is to substitute a normal breathable blood in place of this blood that is incapable of respiration. Obviously, those cases of diabetes in which the disease is undoubtedly a nervous disease, a vasomatic neurosis, are to be excluded, but experience will best show what is to be expected here.

1. Berliner klinische Wochenschrift 1867, Nr. 14.
2. Die Transfusion bei Leukämie und Anämie. Berlin 1867.

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Private Lecturer and Assistant at the Anatomical-Physiological Institute at the University of Greifswald

VII

Transfusion with simultaneous depletion in acute poisoning, or the substitution of normal blood in place of that impregnated with topical substances (Conclusion)

The infusion-transfusion

At this point, I think it is necessary to point out the relationship between transfusion and the antidote method in the treatment of acute intoxications. It is really self-evident that in the case of poisoning, in addition to transfusion, antidotes should also be given their full scope, especially those which, from the first routes, render harmless the poison that has not yet been absorbed. The situation is different with those antidotes that only develop their effect within the circulation. If these are supplied to the poisoned person either from the digestive tract or hypodermically, it is evident that in the case of a substitution, the absorbed antidote is withdrawn from the body at the same time as the poison. In such cases, therefore, I recommend that the antidote be added to the blood to be transfused.

This has the advantage that the antidote must certainly take effect most energetically and quickly in this way. It goes without saying that for this infusion-transfusion one should only choose completely clear, filtered liquids, which must also have the property of not causing any coagulation in the blood (1). If the present case of illness requires that the substitution be repeated, an appropriate dose of antidote can always be added to the blood to be injected.

In the case of intoxications that are accompanied by significant states of depression, an excitant can be added to the blood to be transfused, whereas in those that are accompanied by symptoms of lively excitement, a sedative can be added.

I would also find it quite rational to carry out an infusion transfusion with ergotine or calabar extract in the case of carbon oxide poisoning in order to effectively counteract the paralytic vasodilatation associated with intoxication, which can very easily lead to paralysis of the entire circulatory system. Toxicology provides us with the indications for the individual antidotes that should be chosen for infusion-transfusion in the relevant intoxication cases. – In these brief outlines I wanted to indicate a method which will certainly be accompanied by favourable results in acute intoxications, and in which it would certainly be highly worthwhile to carry out animal experiments in various directions as preliminary studies.

I hereby leave the area of acute intoxications and their treatment by depletoric transfusion as well as by the infusion-transfusion that I have proposed, and finally I would like to mention the position that transfusion takes in relation to inanition states and lack of nutrition. Robert Boyle had already raised the question in his problems as to whether it might not be possible to feed an animal by repeated injections of chyle; but he himself did not attempt to solve this question through experiment.

Blundell and Panum took up the idea in a somewhat modified form; they tried to feed animals by injecting blood. However, the experiments produced a negative result and Panum came up with the proposition that the blood does not serve as food for the body at all, but that it is only the general route through which the nourishing substances flow to all parts of the body. However, Eulenburg and I repeated the experiments and succeeded in keeping a dog completely deprived of food for 24 days by regularly injecting blood into its veins at 48-hour intervals from the 6th day of fasting. The dog was of only small breed and the long life preservation is all the more admirable since the frequent operations had resulted in numerous festering wounds on the neck and inguinal areas, which alone were bound to have exhausted the animal. After death, the animal had lost 39% of its body weight. After each transfusion we found it relatively more alert and stronger than before.

The total amount of blood that was given to the animal amounted to about $^{1}/_{5}$ (!) of its body weight (at the beginning of the experiment). - Another similar dog, which had been comparatively starving without a transfusion, died on the 9th day and had lost 46% of its body weight.

In view of this favourable result, we have recommended nutritional transfusion even in those desperate human cases in which until then the practitioner had nothing other than nourishing enemas and nourishing baths. It is advisable to take the blood from a healthy, strong person a few hours after a large, appropriately mixed meal. In humans, however, repeating the transfusion is all the easier because there are a large number of sufficiently wide veins in the extremities on which the operation can be carried out. For more details on this information, I refer you to our writing cited above.

1. Dass unter diesen Voraussetzungen die Infusion eines Arzneimittels in die Venen von Menschen und Thieren völlig gefahrlos ist, beweisen die vielfältig hierüber angestellten Beobachtungen. Noch viel unbedenklicher muss es aber sein, wenn das Mittel durch gesundes Blut noch diluirt wird. [The numerous observations made on the subject prove that under these conditions the infusion of a drug into the veins of humans and animals is completely safe. But it must be even more harmless if the drug is diluted by healthy blood.]

PART TWLEVE - PAGES 790-792

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Private Lecturer and Assistant at the Anatomical-Physiological Institute at the University of Greifswald

VIII

Practical execution of the transfusion

For the transfusion we use human blood that has been defibrinated and arterialized by beating (1), which has been drained from the veins of a healthy person by venesection. The

use of fibrin-containing blood should be rejected because its ability to clot poses a great risk of embolism. The blood, defibrinated and arterialized by beating (with a fork), is filtered through a linen cloth and brought to blood temperature in a water bath.

For the injection, a glass syringe is used that can be easily guided with one hand (2). The simpler and more solid the syringe is constructed, the better it is. All devices of a different type that require you to hold the syringe with both hands should definitely be rejected.

If we disregard the direct transfer of blood from the artery to the veins of the patient, as practiced by the ancient transfusors, as a method which at present affords only historical interest, the transfusion may be carried out in the following various ways.

1. With exposure of the vein. The vein is exposed on its outer wall about a finger's width wide, incised, and while the filled syringe is guided with one hand, the other (left) ensures good coaptation of the vein wall to the cannula by simple finger pressure. This method will have to be used in the vast majority of cases, especially when a transfusion is required because of acute anaemia.

2. Transfusion from a simple bloodletting wound. If, as is the case with acute intoxications, blood is to be withdrawn from the patient before the transfusion, a somewhat large bloodletting wound is created in the vein, and it is then not difficult to penetrate the interior of the vessel with the cannula towards the end of the vein section, while the out-flowing blood stream still keeps the venous wound open. Riva already carried out his transfusions from the simple venesection wound in Rome in 1667. Elsner (3) states that Riva did his three transfusions “non bestiali more”, made “sed faciliori et humana methodo prosperoque eventu ... sine venae extractione vel excoriatione, sed solo congruo ac consueto phlebotomico, aliquantulum ampliori licet orificio.”

If transfusion is successful using this method, the risk of subsequent phlebitis is greatly reduced.

3. Subcutaneous transfusion can only be performed in the case of a swollen vein by inserting a trocar cannula (with a retractable stylet) through the skin into the vein, or by pushing a stiletto cannula with a lateral outflow opening across the skin and vein so that the outflow opening is within the venous tube.

This last method requires great dexterity and for this reason alone is less recommended.

Two dangers are associated with the execution of the transfusion, the entry of air into the veins and the subsequent phlebitis.

The entry of air into the vein, which results in instantaneous death, as Ritgen's case shows, can always be avoided by carefully filling the glass syringe. In order to make it completely impossible, Eulenburg and I indicated a special device, “the air catcher”.

It consists of a small glass drum to which the discharge tube of the syringe is inserted.

The opening necessary for this is close to the edge of one surface of the drum, whereas the cannula connected with the drum extends from the other surface of the drum close to the bottom of the edge. In this way, the lumen of the cannula is always below the level of the blood, even if some air bubbles from the syringe should have passed into the drum.

The much feared phlebitis is not a possibility if the vein is treated fairly gently. Of all the cases observed so far, it has never resulted in death, a sure proof that its dangers have been greatly overestimated.

Minor degrees of inflammation have been observed repeatedly after the transfusion, but it has always been possible to counteract it effectively by the anti-inflammatory apparatus.

It therefore follows that an artfully executed transfusion is as good as harmless.

Transfusion, therefore, deserves a far greater application than has hitherto been found among physicians. To neglect them would be to renounce one of the most beneficial and proven healing methods. -

1. Es ist geradezu unverständlich, wenn H. Demme (schweizerische Zeitrchr. f. Heilkunde I.) Thierblut, wegen der Kleinheit seiner Blutkörperchen, empfiehlt.
   [It is downright incomprehensible when H. Demme (schweizerische Zeitrchr. f. Heilkunde I.) recommends animal blood, on account of the smallness of its blood cells.]

2. Am besten ist die Spritze wie die Wundspritzen mit Ringen am hinteren Ende und am Stempel zu versehen. Transfusionsbestecke mit allem Zubehör verfertigt nach unserer Angabe Goldschmidt in Berlin, Instrumentenmacher (unter den Linden).
   [It is best to provide the syringe, with rings at the rear end and on the plunger, like the wound syringes. According to our information, transfusion sets with all accessories are manufactured by Goldschmidt in Berlin, an instrument maker (unter den Linden).]
3. Ephemerid. nat. cur. I. 1684. p. 286 obs. 149.

PART THIRTEEN - PAGES 943-945

TRANSFUSION STATISTICS

1. Transfusion in acute anaemia.

	Author - Citation	Indication	Outcome
1	Blundell (Routh's Table Med. Times 1849. 9. Nr. 5)	Metrorrhagia; respiratory. - 16 Unc. ven. blood	†
2	Blundell (Routh's Table Med. Times 1849. 9. Nr. 6)	Arterial rupture; respiratory. - 6 Unc	†
3	Blundell (Routh's Table Med. Times 1849. 9. Nr. 8)	Metrorrhagia, - Moribund, still respiratory. 3-4 Unc. ven.	†
4	Blundell and Doubleday (Routh Nr. 10)	Metrorrhagia, near death. 14 Unc. ven. Bl.	Favourable
5	Blundell and Uwins (Routh Nr. 13)	Metrorrhagia, - 12 Unc.	Favourable
6	Blundell and Waller (Diss. in de sang. in haemorrh. uter. transf. 1832)	Metrorrhagia, - Moribund. - 4 Unc.	Favourable
7	Blundell, Davis, Pointes, Lambert (Soden's Table [Lancet 1829] Nr. 10)	Metrorrhagia, - 8 Unc	Favourable
8	Doubleday (Routh Nr. 12)	Metrorrhagia, cold, without sensation	†
9	Waller and Doubleday (Diss. v. Waller)	Metrorrhagia, - 55 Drachm. ven. Bl.	Favourable
10	Waller (Diss.)	Metrorrhagia, cold, pulseless. - 8 Unc.	Favourable
11	Waller, Graaves (Soden Nr. 29)	Metrorrhagia, - 22 Unc.	Favourable
12	. Ralph (Soden Nr. 7)	Metrorrhagia, at abortion. - 4 Unc.	Favourable
13	Jewel and Boyle (Soden Nr. 16)	Metrorrhagia, - 4 Unc. Air injected!!	†
14	Burton, Brown (Froriep's Not. B. XVI)	Metrorrhagia, - 5 Unc.	Favourable
15	Douglas Fox (Routh Nr. 30)	Metrorrhagia, at abortion. - 4 Unc.	Favourable
16	Brigham (Routh 43)	Metrorrhagia, - 13 Unc.	Favourable
17	Philpott (Froriep's Not. 14.)	Burst varix. - 4 Unc	Favourable
18	Clement (Routh 18)	Metrorrhagia, abortion. - 15 Unc	Favourable
19	Howell, Davis, Doubleday (Routh 19)	Metrorrhagia, - 15 Unc.	Favourable

20	Bird (Lond. med. and surg. Journal. 1830)	Metrorrhagia, - 4 Unc.	Favourable
21	Banner (Routh 41)	Metrorrhagia, - 14 Unc.	Favourable
22	Bickersteth (Routh 27)	Metrorrhagia, - 12 Unc.	Favourable
23	Collins (Soden 27)	Metrorrhagia, - 10 Unc.	†
24	. Ingleby (Routh 40)	Metrorrhagia, - 4 Unc	Favourable
25	Crosse (Soden 35)	Metrorrhagia, cold, pulseless. − 10 Unc.	†
26	Turner (Schmidt's Jahrbücher XI)	Venous bleeding after amputation. femoris. - 5 Unc.	Favourable
27	Healey and Fraser (Routh 24)	Metrorrhagia, - 4 Unc	Favourable
28	Tweedy and Ashwell (Schmidt's Jahrb. 26)	Metrorrhagia, - over 7 Unc.	†
29	Lane (Routh 32)	Operation for a haemophiliac, - 17½ Unc.	Favourable
30	Olivier (Routh 31)	Metrorrhagia, Pulseless - 22 Unc.	Favourable
31	May (Routh 26)	Metrorrhagia, Near death. - 24½ Unc.	Doubtful, † on the 7th day,
32	Savy (Routh 29)	Metrorrhagia.	Favourable
33	Scott (Routh 36)	Bleeding after surgery.	†
34	Walton (Routh 42)	Bleeding after surgery collapse. 13 Unc.	Favourable
35	Soden (L. c.)	Metrorrhagia, in inverse, uteri. - 1 Unc.	Favourable
36	Schneemann (Rust. Mag. 37)	Metrorrhagia, Near death. - 8 Unc.	Favourable
37	Schneemann (Schmidt's Jb Bd. 80)	Metrorrhagia.	Favourable
38	Schneemann (Schmidt's Jb Bd. 80)	Metrorrhagia.	Favourable
39	Schneemann (Schmidt's Jb Bd. 80)	Metrorrhagia.	†
40	Schneemann (Schmidt's Jb Bd. 80)	Metrorrhagia.	†
41	Turner (Lancet 1853)	Metrorrhagia, - 13 Unc.	Doubtful – death, carbuncle day 10
42	Simon (Schütz de transf. Diss, in Bonn 1852)	Haemorrhage of the crural artery	†
43	Massen (Soden 32)	Metrorrhagia, - 9 Unc.	Favourable
44	Higginson (Liverpool med. Journal. 1857)	Metrorrhagia, - 12 Unc.	Favourable
45	Higginson (Liverpool med. Journal. 1857)	Metrorrhagia, - 7 Unc.	†
46	Higginson (Liverpool med. Journal. 1857)	Metrorrhagia, - 12 Unc.	†
47	Higginson (Liverpool med. Journal. 1857)	Metrorrhagia, - 6 Unc.	†
48	. Higginson (Liverpool med. Journal. 1857)	Metrorrhagia.	†
49	Wheatcroft (Lauc. 1857)	Metrorrhagia, - 2 Unc.	Favourable

50	Wheatcroft (Gaz. med. de Paris 1857)	Metrorrhagia, - 17 Unc.	Favourable
51	Simpson (Memoirs and observ. I.)	Metrorrhagia.	Favourable
52	. Hicks (Lancet 1863)	Metrorrhagia. Collapse. - 6 Unc.	†
53	Hicks (Lancet 1863)	Metrorrhagia, - 6 Unc.	†
54	Greenhalgh (Lancet 1863)	Metrorrhagia, - 2 Unc.	Favourable
55	. Zosenhanns (Würt. med. Corr. Bl. 1832)	Bleeding in Morbus maculosus. - 10 Unc.	Favourable
56	Kilian (Schütz Diss.)	Metrorrhagia, - 2½ Unc.	Favourable
57	Kilian (Schütz Diss.)	Metrorrhagia, - 2 Unc.	Favourable
58	Kilian (Schütz Diss.)	Metrorrhagia, - 3 Unc.	Favourable
59	Kilian (Schütz Diss.)	Metrorrhagia, - 5 Unc.	Favourable
60	Blasius (Deutsche Klinik 1863)	Laceration of the lower leg, cold, pulseless. - 4 Unc.	Favourable
61	Bayer (Jahrb. des ärzt. Ver. München II.)	Metrorrhagia, Acc. force.	†
62	Klett, Schrägle (Würt. Corr. Bl. 1834)	Metrorrhagia, - 2 Unc.	Favourable
63	Klett, Schrägle (Würt. Corr. Bl. 1834)	Metrorrhagia, - 3 Unc.	Favourable
64	Höring (Würt. Corr. Bl. 1834)	Metrorrhagia and Inanition	Favourable
65	. Berg (Würt. Corr. Bl. 1838)	Metrorrhagia, - 2½ Unc.	Favourable
66	Bliedung (Paffs Mitth. N. F. 1839)	Haemoptysis - 5 Unc. ven. Goat blood	Favourable
67	Neumann (Casper's Wochensch. 1842)	Metrorrhagia, - 2 Unc.	†
68	Abele (N. Zeitsch. f. Geburtsk. Bd. 14)	Metrorrhagia.	Favourable
69	Ritgen (N. Zeitsch. f. Geburtsk. Bd. 14)	Metrorrhagia, 2 Drachms. Air injected at the same time.	†
70	Neudörfer (Oesterr. Zeitach. f. p. Heilk. 1860)	Bleeding from an epithelioma. - 1½ Unc.	†
71	Martin (Die Transf. bei Blutungen Neuentbundener. Berlin 1859)	Metrorrhagia, - 5 Unc. fibrin-containing V. Bl.	Favourable
72	Martin (Monatschr. f. Geburtsk. 1861)	Metrorrhagia, - 10 Unc.	Favourable
73	Ersmarch (Virch. Ar. 27.)	Bleeding - exarticulatio fem, due to injury. Death prior to transfer.	†
74	Gudin (Kleinert Repert. d. Jour. 1831)	Metrorrhagia, pulseless; - 4 Unc.	Favourable
75	Roux (Routh 21)	Bleeding from a gunshot wound - 10 Unc.	†
76	Nélaton (L'Union 1850)	Metrorrhagia, - 12 Unc.	Doubtful
77	Marmonier (Canst. Jahrb. 1851.)	Metrorrhagia, - 8 Unc.	Favourable
78	Devay and Desgranges. (Gaz. de Paris 1852)	Metrorrhagia, - 6 Unc. Some air goes into the vein.	Favourable

79	Monneret (Schmidt's Jahrb. 75)	Anaemia after bleeding. 4 Drachms.	†
80	Thouvenet (Schmidt's Jahrb. 75)	Intestinal bleeding; - 6 Unc.	†
81	Wolf (Canst. Jb. 1842)	Metrorrhagia.	Favourable
82	Wolf (Canst. Jb. 1842)	Metrorrhagia.	†
83	Wolf (Canst. Jb. 1842)	Metrorrhagia (too late).	†
84	Wolf (Canst. Jb. 1842)	Metrorrhagia (too late).	†
85	Wolf (Canst. Jb. 1842)	Metrorrhagia (too late).	†
86	Michaux (Gaz. de Pa: 1859)	Bleeding.	Favourable
87	Fenger (Schmidt's Jahrb 84)	Spontaneous bleeding – 10 Unc.	†
88	Sacristan (Oppenheil Zeitsch. 29)	Bleeding from a varix	Favourable
89	Weickert (Deutsch Klinik 1862)	Metrorrhagia.	Favourable
90	Braun (Wien. med. Wochensch. 1863)	Metrorrhagia at abortion - 1 Unc.	Favourable
91	Thomas (Nederl. Tydoch. v. Geneesk. 1865)	Metrorrhagia.	Favourable
92	Heger (Virch. Arch. 30)	Metrorrhagia, - 4 Unc.	Favourable
93	Thorne (Lancet 1863)	Metrorrhagia.	Favourable
94	Thorne (Lancet 1863)	Metrorrhagia.	Favourable
95	Meyer (Baierisch. arzt. Intelligenzbl. 1866)	Metrorrhagia.	Favourable
96	Mosler (Die transfusion bei Leukamie und Anämie Berlin 1867)	Metrorrhagia.	Favourable
97	.? (Routh 20)	Bleeding after fractured fibia - 18 Unc.	†

SUMMARY - 97:

{ With menorrhagia - 78
- { Doubtful - 3 }
- { Favourable - 53 } Doubtful - 3
- { † - 22 } Favourable - 63

{ With other bleeding - 19
- { Favourable - 10 } Death - 31
- { † - 9 }

2. Transfusion in acute intoxications

	Author - Citation	**Indication**	**Outcome**
98 (1)	Dieffenbach (die Transfusion)	Asphyxia of a newborn. - 2 Unc. venous blood.	†
99 (2)	Blasius (deutsche Klinik 1863)	Asphyxia in a child delivered by caesarean. - 2 Unc. venous bld.	†
100 (3)	Traube's Klinik (Friedberg Verg., dur. Kohlendunst. Berlin 1866)	Poisoning by coal fumes. - Substitution of 14 Unc.	†
101 (4)	Möller (Friedberg Verg., dur. Kohlendunst. Berlin 1866)	Poisoning by coal fumes. - 6 Unc. after a bloodletting.	†
102	Sommerbrodt (Friedberg Verg., dur.	Poisoning by coal fumes. - 4	†

(5)	Kohlendunst. Berlin 1866)	Unc. after a bloodletting.	
103 (6)	Mosler (L. c.)	Poisoning by coal fumes. Transfusion after bloodletting.	†
104 (7)	Mosler (L. c.)	Poisoning by coal fumes. Transfusion after bloodletting.	†
105 (8)	Badt and Martin (Verb. d. Berl. med. Ges. I. Berlin 1866)	Poisoning by coal fumes. Transfer after bloodletting.	Favourable
106 (9)	Uterhart (Deutsche Klinik 1867)	Poisoning by coal fumes. Transfer after bloodletting.	Favourable
107 (10)	Bennecke (Berliner klinische Wochensch. 1867)	Newborn asphyxia. Arterialized blood into the umbilical vein.	Favourable

SUMMARY - 10 { CO - 78 { Favourable - 2 } { † - 5 } Favourable - 3
{ Asphyxia - 3 { Favourable - 1 } Death - 7
{ † - 2 }

3. Transfusion for diseases of various kinds.

	Author - Citation	**Indication**	**Outcome**
108 (1)	Denis 1667 (Citation – see above)	Exhaustion after intermittent bloodletting. Animal blood.	Favourable
109 (2)	Denis 1667 (Citation – see above)	Hemiplegia. Animal blood.	Favourable
110 (3)	Denis 1667	Febrile diarrhoea. Animal blood.	†
111 (4)	Denis 1667	Mental illness. Animal blood.	Favourable
112 (5)	Lower and King (Citation - Lower)	Mental illness. Animal blood.	Doubtful
113 (6)	Riva (Eptem. nat. eur. I. Dec. I.) 1684	Phthisis. Animal blood.	Improvement; doubtful.
114 (7)	Riva (Eptem. nat. eur. I. Dec. I.) 1684	Intermittently quotidian. Animal blood.	Favourable
115 (8)	Riva (Eptem. nat. eur. I. Dec. I.) 1684	Illness? - Animal blood.	Doubtful
116 (9)	Manfredi (Citation above)	Exhaustion. Animal blood.	Favourable
117 (10)	Kaufmann (Citation above)	Eating rash. Animal blood.	Doubtful
118 (11)	Kaufmann (Citation above)	Leprosy. Animal blood.	Doubtful
119 (12)	Blundell, Cline (Routh. No. 9)	Death by Cancer - 14 Unc. Human blood.	†
120 (13)	Brown (Soden 25)	Epilepsy during birth. - 4 Unc.	Favourable
121 (14)	Gritchard, Clarke (in case of death)	Phthisis due to digestive disorders. - 16 Unc.	Favourable
122 (15)	Higginson (Liverpool med. and surg. Jour. 1857)	Exhaustion from suckling.	Favourable
123 (16)	Neudörfer (L. C.)	Exhaustion from purulent fever - 4 Unc.	†
124 (17)	Neudörfer (L. C.)	Exhaustion from purulent fever - 4 Unc.	†
125 (18)	Neudörfer (L. C.)	Exhaustion from purulent fever - 4 Unc.	†

126 (19)	Neudörfer (L. C.)	Exhaustion from purulent fever - 4 Unc.	†
127 (20)	Neudörfer (L. C.)	Exhaustion from purulent fever - 4 Unc.	†
128 (21)	Neudörfer (L. C.)	Tuberculosis. – 2 Unc.	†
129 (22)	Esmarch (Dressen Diss. de transf. sang. Kiel 1861)	Exhaustion from suppuration. - 14 Unc.	†
130 (23)	Golli (Ann. univers. de med. 1852)	Chlorosis after 300 bloodlettings - 2 drachms.	Doubtful
131 (24)	Blundell (Routh 7)	Puerperal fever. - 6 Unc.	†
132 (25)	Wolton (Routh)	Cholera, Collapse. - 30 Unc	†
133 (26)	Stokes (Soden)	Typhus, Collapse. - 5 Unc.	†
134 (27)	Dieffenbach (L. c.)	Hydrophobia.	†
135 (28)	Dieffenbach (L. c.)	Cholera, Collapse. - 5 Unc.	†
136 (29)	Dieffenbach (L. c.)	Cholera, Collapse. - 3 Unc	†
137 (30)	Dieffenbach (L. c.)	Cholera, Collapse. - 5 Unc	†
138 (31)	Larzeu (Ganum)	Pyaemia with chancroid.	†
139 (32)	Blasius, Weber (L. c.)	Leukaemia. - 4 Unc.	†
140 (33)	Mosler, Groke, Landois (L. c.)	Leukaemia after phlebotomy - venous blood.	Favourable
141 (34)	Dieffenbach	Melancholy.	Unfavourable
142 (35)	Dieffenbach	Erotomania.	Unfavourable
143 (36)	Golli (L. c.)	Nonsense. - 2 Dr.	Doubtful
144 (37)	Nussbaum (Aerztl. Intell. Bair. 1862)	Joint inflammation.	Favourable
145 (38)	Dennis (L. c.)	In a healthy person - animal blood.	Favourable

SUMMARY – 38 { Doubtful - 8
{ Favourable - 9
{ Unfavourable - 20
{ On a healthy person - 1

TOTAL OVERVIEW: 145 { Favourable – 76 52.4%
{ Unfavourable – 58 40.0%
{ Doubtful – 11 7.6%