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TRANSFUSION.

In the following pages we have endeavored to give, as briefly as possible, a succinct report upon the subject of transfusion, according to the accepted views of the experimentalists up to the present day. We have also annexed a list of more than seventy authors and operators who have published works or essays on the subject for the benefit of those who may wish to investigate more fully the theory and practice of transfusion.

Like many other grand conceptions of the human mind, transfusion has been made known–then despised and forgotten. It is not an invention of modern times, but yet the honor of making known its importance in the science of medicine, belongs to the labors and discoveries of the present century.

It was known to the ancients, as we may learn from the metamorphoses of Ovid and other writings of antiquity.

We regret to say that both Pliny and Celsus condemned it. During mediæval times but little appears to have been known of it, and it is not until about the middle of the 17th century that its true history commences.

To the English Faculty belongs the glory of reviving the practice, or rather of putting in practice the theory derived from the ancients.

Christopher Wren, a Professor of Anatomy, at Oxford, lectured upon the theory of transfusion as early as 1656, and several experimentalists in different countries of Europe soon after demonstrated its importance by their experiments.

Jean Dennys, of the Faculty of Montpellier, in France, succeeded in practicing it upon man, on the 15th of June, 1667. To this physician belongs the honor of being the first in modern times to practice transfusion upon man. The scientific men throughout Europe became profoundly excited at this success, and many openly declared that the secret of life, and even the fountain of eternal youth, had been dis-

covered: but their bright hopes were soon bitterly crushed. This famous experiment of Dennys was practiced upon a young man reduced by severe fever. Three ounces of blood were removed from the patient and replaced by eight ounces, taken from a calf. Recovery immediately followed. Other successful cases were soon recorded by different expermentalists.

Dennys success, however, which for the moment gained an immense reputation, also made him the object of envy and jealousy among his professional brethren.

Two parties at once sprang up in Paris: one in favor of the operation; the other as bitterly hostile.

The Faculty of Paris soon became openly antagonistic to Dennys and his views. He was attacked in the vilest manner by some of his opponents, and even denounced as an executioner. In less than a year after his first success, Dennys had the misfortune to operate on a fool, in hope of restoring reason by the introduction of healthy blood.

Two operations had been performed on the lunatic and several months had passed since the last transfusion, when the patient was attacked with tremblings, and the enemies of the theory at once denounced the practice.

Complaint was made to the legal authorities, and on the 17th of April, 1668, the famous decree of Chatelet was issued, which forbade the operation of transfusion under pain of imprisonment.

During this short year of experiment in the art of transfusion, several successful and legitimate cases were recorded, but the inventive spirit of the innovators had been let loose without restraint, and they fondly hoped to prove that the secret of the prolongation of life had been discovered. They believed that the practice would restore youth to old age, mildness of temper to the irascible, reason to the demented, and also remove various maladies, like cancer, consumption, palsy, etc. Although the operation was successfully performed in Italy, England and Germany, the Chatelet sentence cast a stigma over the practice, and it soon became forgotten, except to the occasional experimentalist.

A few years afterward, the Court of Rome forbade the act in

Italy, and from this time up to the period of 1818, the art of transfusion was mentioned only in the works of a few daring authors, who boldly declared their faith in its utility, and advised its use.

In 1818, an English surgeon by the name of Blundell, becoming shocked by the death of a young woman, from puerperal hemorrhage, determined to investigate the theory of transfusion.

Shortly after, he published the result of his investigations and experiments, including an account of his operation of transfusion from man to man. This memoir again forcibly brought the subject of transfusion to the public notice and its true scientific history may be said to date from this period. Several other papers were soon after published in Germany and Switzerland on the subject, demonstrating the practicability of the operation. France, however, hesitated in receiving the new proofs of the doctrine, although Milne Edwards, in his thesis in 1823, demonstrated its utility in treating hemorrhage. A few unsuccessful attempts again influenced the French Faculty to oppose the practice.

In 1850, Nelaton succeeded in a case, and perceiving its value in the curative art, at once boldly and determinedly maintained its great worth.

Not long after, Claude Bernard, Brown Sequard, Longet and other experimentalists, by their researches proved the practicability of the operation, and established its position in the practice of medicine and surgery beyond a doubt. Since the experiments of Blundell, in 1818, over 200 cases have been recorded, with more than 120 successes. Some of the operations mentioned as failures, do not fairly represent the value of transfusion, as they were attempted for the cure of cancer, cholera, pyemia, phthisis, etc.

A number of the reported failures were in reality cases which were restored for a time and afterwards succumbed to other diseases. In connection with the exhausting hæmorrhages of childbirth, there are nearly 100 cases recorded, with more than 60 successes.

Out of 24 cases of traumatic hemorrhage, 14 cures have been reported.

There is not sufficient space in this brief paper to enumerate the various and interesting experiments of the physiologists in connection with the effects of transfusion. We will, however, give a general outline of them, and mention the accidents and diseases in which transfusion is especially recommended.

In all cases of exhausting hemorrhage, whether traumatic or otherwise, transfusion offers the easiest and surest method of restoration. It is simply replacing what has been lost.

We do not want stimulants, electricity, and the application of heat in these cases, but rather the restoration of the blood corpuscles. In anemia, where the organism has lost gradually its faculty of making healthy blood and repairing the loss of tissue and substance, transfusion is advised by the distinguished authority, Prof. Polli. It is also evident that in some cases of self limited diseases, where the powers of digestion and assimilation are temporarily suspended, moderate transfusion of strong, healthy blood may be injected into the veins or under the skin of the patient, and life sustained until the stages of disease are passed by and nature makes an effort to recuperate its dormant forces. In tetanus it offers a gleam of hope, especially as statistics seem to indicate that if life be prolonged to the tenth day, recovery may be expected.

In the asphyxia of the newly born child, where ordinary remedies fail, the operation may prove successful, as has been shown by Belina, who took some of the blood of the placenta of the mother and successfully injected it into the umbilical vein of the child, thereby restoring the suspended functions.

In cases of poisoning by noxious gases, chloroform, opium and any of the alkaloids, transfusion offers a new and logical method of treatment.

Eulenburg and Landois, by numerous experiments with poisoned animals have shown that by removing the affected blood of these animals and replacing a portion of it by pure and healthy blood, the influence of the poison can be obverted and the animals restored to health. Von Belina suffocated animals with common illuminating gas and recalled some of them to life by transfusion, while those not operated upon, died.

In cholera it has not met with the hoped for success, but occasional cures have been reported.

In nervous shock or collapse, and exposure to cold, it may be used to excite the circulation and restore animal heat.

Several cases of epilepsy have been noted among the cures produced by this operation, and the experiment in this class of disorders is worthy of being repeated. Sequard has shown that in cases of poisoning and asphyxia from blows on the head, as well as those in the agony of death, the faculties may sometimes be temporarily restored by transfusion.

Therefore by this operation justice may recall the victim to life for an instant in order to reveal the author of the crime.

The operation of transfusion has been divided into two distinctions, known as mediate and intermediate, and for the purpose a number of instruments have been invented. We will not attempt to describe them but will state that the greater number of successes have been obtained by the simplest means, and a glass syringe with a fine point is all the instrument an operator of ordinary skill and sagacity requires. The instruments for direct transfusion, that is from man to man, are complex, and their use requires a certain degree of manipulation, which every practitioner does not possess in time of emergency.

What kind of blood is the best for transfusion, and what animal should be selected if a healthy man is not accessible? A vast number of experiments show that the blood of the same species should be used in transfusion, though there are instances where it has succeeded in species widely different, as for instance, the experiment of Diffenbach, where the blood of man was used in restoring a cat. The most successful operations have been made with the blood of the same species, man to man, dog to dog, rabbit to rabbit, etc.

The early operators used arterial blood, but the modern experimentalists prefer venous, as the carbonic acid it contains, has a stimulating effect and causes the muscular fibres of the heart to contract. Still there is no serious objection to the use of arterial blood.

To our distinguished physiologist, Brown Sequard, we owe much of the present knowledge of the theory and practice of transfusion. During a period of years, especially extending from 1855 to 1857, he instituted numerous experiments upon

the subject of oxygenated blood for the purpose of transfusion. The idea however, originated with Bischoff in 1835 and 1838.

Sequard, with his researches, firmly established the theory of Bischoff, that venous blood defibrinated by means of being beaten with a bundle of twigs is safer than arterial or freshly drawn venous blood. This process of agitation oxygenates the blood, and as its vivifying power lies in the red globules, the more highly charged they are with oxygen, the more their vital properties are increased.

Sequard's conclusions were as follows: "Defibrinated blood has always acted as powerfully as natural blood,—that the presence of the fibrine not only is not necessary, but seems to be quite useless—that defibrination by agitation or whipping does not alter the globules,—that defibrinated blood of one species can be introduced without danger into the veins of an animal of another species, and that the defibrinated blood of any of the mammalia can be employed in transfusion with man."

In 1863, Panum, by a series of experiments, also confirmed the opinions of Bischoff and Sequard, and proved that defibrinated blood possessed sufficient revivifying force and performed the functions of normal blood.

Many of the ablest of the experimentalists, like Muller, Difenbach, Polli, Belina, and Neudorfer, advise the use of defibrinated blood. Others, however, believe the best medium to be the venous blood, and therefore urge direct transfusion from man to man, or the selected animal to man. Prof. Behier, in a late clinical lecture at the Hotel Dieu, commenting upon a successful operation with a case of anemia, where death was certain, advocates the use of venous blood, introduced without defibrination, and slowly, by continued and regular movement. In this case he injected 3 1-2 ounces of blood during the space of three minutes. This slow injection is enjoined by all operators, no matter what quantity of blood is used, as a too sudden, or too copious injection is liable to be followed by syncope or pulmonary congestion. Syncope is produced by too great distention of the right ventricle, which paralyses its walls, hence the first indication of faintness should stay the hand of the operator. A slight cough also, often gives warning in time of the commencing pulmonary congestion.

The improvement in this case of anemia of Behier, was very marked. Prior to the transfusion the number of red globules per cubic millimetre, was found to be 850,000, while four hours after the operation, the number rose to 1,110,000.

Experiments with the serum of blood, even in the able hands of Dumas and Prevost, Bischoff and Sequard, have resulted fatally, while success has attended the use of oxygenated or defibrinated blood; thus proving that the vivifying power lies in the blood corpuscles.

Fibrine does not seem to be an essential part of the blood, and as it is reproduced in about 48 hours, its absence for that time appears of little consequence.

The difficulty of maintaining the blood to be injected at the normal temperature of nearly 100 degree Fahrenheit, has been an obstacle in the practice of transfusion.

But a number of the experimentalists have shown that cold blood may be injected with safety. And it is the belief of Bechamp, Estor, Marmonier and others, that when venous blood is used without being defibrinated, it should be immediately cooled, as by the effect of cold the production of fibrine is retarded—fibrine being regarded as the product of fermentation post-mortem. Orè gives an illustration for these views, the fact of a successful transfusion with an animal with its own blood, which had been exposed to the action of a freezing mixture, for twenty minutes. Therefore, in cases of emergency, where time is of great importance, we see no objection to the use of venous blood received into cooling vessels, and then slowly injected before coagulation commences, provided the quantity injected at once be not too great. Coagulation may be expected in four or five minutes after venesection, though it sometimes takes place much later and depends greatly upon the degree of temperature.

But as greater safety seems to attend the use of defibrinated blood, we should counsel its use, and also advise that its temperature be raised to nearly the normal degree, especially if the amount required by the patient be large. We are led to this view by the observations of naturalists upon the change of the actual temperature of animals. And it is shown by the researches of Liebermeister, Howarth, Hueter and others, that

the normal temperature of warm blooded animals remains constant, and that if this temperature becomes reduced more than 5 or 6 degrees below its natural standard, death inevitably results. Those birds whose natural temperature is about 110 Fahrenheit, die if their blood be cooled down to 100 degrees, and the mammalians, whose natural degree is about 100, die when the temperature be reduced below 94 or 95 Fahrenheit. It appears that the fluctuations of the temperature of the blood of man which are called forth by different means and conditions of ordinary life, are comparatively insignificant and only within the range of a few degrees. Also that the tendency of the system is invariably to return to its standard temperature, which if increased or diminished beyond certain limits, is incompatible with life. Still there seems to be some strange exceptions to this physiological law in hybernating animals so far as the reduction of temperature is concerned.

The introduction of air in the veins is to be dreaded, and it is not to be denied that this accident is a serious one. It may happen to the most skilful operator, as to the celebrated Dupuytren. Care therefore must be observed with the instrument, and particularly with the aperture in the vein after the transfusion is ended. It is shown by numerous observers, that small quantities of air may be admitted into the veins without injury to the system, especially when introduced into the veins of the extremities.

Although atmospheric air may have deleterious effects when admitted into the circulation, other gases may be introduced without fatal results. Demarkuay and Lecompte have injected considerable quantities of oxygen into the vena cava and vena porta without bad effects. Other experimentalists have introduced, without injury, into the veins of animals, nitrogen, hydrogen, and carbonic acid gases, in equal or superior quantities to that of atmospheric air which has generally proved fatal. The quantity of air sufficient to cause death in man, is not accurately known. Ore, however, has determined that with some of the animals of medium hight, the introduction of 50 cubic centimetres of air may be tolerated, but a quantity greater than that generally causes death in two or three minutes.

In case healthy blood is not accessible, it may be asked what may be used instead, and what is the nearest analogue to blood. Neudorfer recommends a special liquid composed of albumine, glycerine, and carb. of soda, and as an illustration of its virtues, Richardson kept a monkey alive several weeks by a daily injection. We believe milk to be the best substitute for blood, and our views are greatly strengthened, by the three remarkable cures of cholera last year, by Dr. Hodder, of Toronto, who transfused into the veins of the patients, milk taken warm from the cow.

The experimentalist Donne injected milk into the veins of rabbits and dogs, and found that it did not kill them.

The opinion of this observer, and also Wagner, Gulliver and others, that the white corpuscles of milk were capable of being transformed into red blood corpuscles, is entitled to great consideration.

The globules of milk are so fine that they cannot be separated from the other liquid portion, even by the finest filtering paper, therefore they will probably be absorbed by the capillaries, when injected under the skin instead of the veins. We also believe that it is not imperative to use milk warm from the cow, but that some time may be safely allowed to elapse before its use after it has been drawn from the animal.

What is the quantity of blood required for successful transfusion?

The logical conclusion would be to restore the exact amount lost in a case of hemorrhage, but the experiments show that relative small quanties of transfused blood, produce remarkable results. Sequard says that even two ounces will often restore animation.

For ordinary purposes, 2 to 8 ounces may be considered sufficient for a single operation, but the quantity may be renewed, according to the requirements of the case. One thousand grammes, or over two and a half troy pounds, have been successfully used.

Nussbaum succeeded with over a pound of defibrinated blood, injected into the cephalic vein with a glass syringe. Esmarch passed successfully into the femoral vein, 14 fluid oz., of defibrinated calf blood.

The main difficulty in the use of venous blood, is its coagulability and formation of clots. This may be prevented by the use of some of the salts of soda and potassa, but it is not advised for various reasons. They alter the composition of the blood, diminish its plasticity and increase the tendency to hemorrhage.

When venous blood is used for mediate transfusion, it should be received in a tall vase, and drawn into the syringe as soon as possible. The vase should be placed in a cooling mixture for the purpose of retarding coagulation.

When it is determined to use defibrinated blood, the blood may be primarily received into a bowl, and after being defibrinated and filtered, may be placed at leisure in the instrument used for injecting the blood. If a large quantity is to be used, it should be heated to near the normal degree, and always filtered before use. The blood of a man is preferred to that of woman, as it is richer in globules, and the blood of a heifer to that of a sheep, as the former is less liable to phthisis. The man selected should be less than 40 years of age, and free from any taint or suspicion of constitutional disease, like cancer, phthisis, scrofula, etc.

Several surgeons like Nussbaum and Vincent, have used their own blood..

The veins of the extremities are generally selected, for those of the neck and shoulder are more liable to admission of air.

The median-cephalic, or basilic vein in the bend of the arm, are usually chosen, and it should be exposed by a dissection before it is opened for the introduction of the syringe, then it may be compressed above, either by forceps or ligature, immediately before and after the transfusion.

When the pulse begins to exhibit returning strength, the injection should be relaxed.

During the period of the operation, the thoracic walls should be alternately pressed and relaxed with moderation, so as to establish a slight degree of artificial respiration.

It may be asked what indications are required before the operation should be resolved upon? The surgeon must be guided by the circumstances of the case, and his own intelli-

gence. But the usual phenomena of fatal hemorrhage are as follows: extreme feebleness and palor, frequent faintings, respiration irregular, pulse 120 to 140, or imperceptible, cold sweats, and general coldness, intelligence impaired, sense of vision imperfect, vertigo and vomitings.

Even if respiration has ceased, the operation should not be abandoned, as animals have been recalled to life by transfusion several minutes after they have stopped breathing.

From the great amount of evidence offered, we feel authorized in sustaining the theory and practice of transfusion. Often in the practice of the physician, it will afford the means for successfully resisting the effects of disease, and sometimes it will offer to the surgeon the only chance of preserving life. It has been proven that several methods may be used in safety, either with venous, arterial or defibrinated blood, but that the last is the safest and the easiest.

It is not only shown that blood may be injected into the veins for various purposes, but also that defibrinated blood, with its analogue, milk, may be used subcutaneously in small, but sufficient quantities to sustain life for a definite period of time.

List of some of the Works and Essays on Transfusion.

	Year.
Robert des Gabets. Journal des Savants	1667, p. 96.
Chris. Wren and Richard Sower. Journal des Savants,	1667, p. 21.
Robert Boyle. Philos Transact,	1665, tom. 1, p. 129.
Fracassati et Malpighi. Tetras anatom Bologne,	1665.
Denys. Journal des Savants,	1667, p. 134.
Paul Scheele. die Transfusion des Blutes, Kopenhagen,	1802.
Bichat. Rech. physiolog.	1813, p. 167.
Hufeland. Dissert in de usu Transfusionis,	1815.
Blundel. Medico chirurgic Trads. tom. iv,	1818.
Blundel. Researches physiological and Pathological on Transfusion of Blood. London,	1824
Blundell. Vorlesingen über Geburtshülfe von Thom Castle deutsch von Ludw. Colman Leipzig.	1839.
Prevost and Dumas. Bibliotheque universelle de Geneve tom, xvii,	1821.
Magendie. Journal de Physiologie tom ii,	1822.
Magendie. Lecons sur les phenomenes physiques de la vie, Vol. iv,	1842.
Milne Edwards. These de Paris, No. 73,	1823.
Milne Edwards. Lecons sur la physiologie et l'anatomie comp. tom. i,	1857.
Milne Edwards. Comptes rendu de l'Academie des Sciences tom. xlv,	1857.
Tietzel. Diss in de Transfusione sanguinis Berol,	1824.
Dieffenbach. die Transfusion des Blutes, Berlin,	1828.
Deffenbach. Rusts Magazin fur die gesamnite, Heilkunde tom. xxx, et Archives generale de medicine tom. xxii,	1830.
Diffenbach. in Rusts Chirurgie Bd. ix,	1845.
Marcinkowski. Hamb Zeitschrift f. d. ges Medic von Dieffenbach etc., Bd. 1,	1830.
Richerand. Traite de Physiologie tom. i,	1833.
Bischoff. Mullers Archiv Bd. ii,	1835.
" " " " v,	1838.
Burdach. Traite de Physiologie, tom. vi,	1839.
Carri. These de Paris, No. 214,	1844.
Routh. Statistische etc uber Transfusion, des Blutes Medical Times, Aug.,	1849.
Comptes rendus de la Soc. de Biol, Vol. i,	1849.
" " " " " ii,	1850.
" " " " " iii,	1851.

Comptes rendus de l'Academie des Sciences, Vol. xxxii, 1851.
Achille Perier. These de Paris, No. 195, 1851.
Giovanni Polli. Gazette d Omodie and Archives generales de Med., 1851.
Berard. Traite de Physiologie, tom. iii, 1851.
New York Med. Times, Pag. 355, 1852.
Soden. Tabelle in den London Med. Chis. Trans, Vol. xxxv, 1852.
Etienne Passement. These de Paris, No. 172, 1852.
Devay and Desgranges Gaz. Med. de Paris, 1852.
Northern Lancet, 1853.
Durant. These de Montpelier, No. 8, 1854.
Comptes rendus le l'Acad. des Sciences, Vol. xli, 1855.
" " " " xlv, 1857.
Gerard Tenlon. Gazette Med. de Paris, 1857.
Brown Sequard. Journal de Physiologie, tom. i, 1858.
" " " " " ii, 1859.
" " " " " iii, 1860.
" " " " " iv, 1861.
" " " " " v, 1862.
Ed. Martin. uber die Transfusion bei Bhetungen Neuentbrendener. Berlin, 1859.
Ch. Waller. On Transfusion of Blood in obstetrics. Trans. of London, 1860.
Neudoerfer and Demme. Oesterr Zeitsch pact. Heilkunde, No. 8 and 9, 1860.
Neudoerfer and Demme. Schweiz-Zeitsch, b. Heilkunde, 1762.
Panum. Experimentelle, Untersuchungen uber die Transfusion, etc., etc., in Virchows Archiv. Bd. xxvii, 1863.
Orè. Etudes Historiques et Phys. Bordeaux, 1863.
" Recherches experimentelles, Bordeaux, 1865.
Courtois. These de Strasburg, No. 686, 1863.
Guil Boldt. de Transfusions Diss Berol, 1863.
Blasius. Statistik de Trans. des Blutes, 1863.
Graily Hewit. British Med. Journal, 1863.
" " Apparatus for the performance of Transfusion of Blood in obstetrical transac of London, Vol. vi 1865.
Morely. These de Paris, No. 73, 1864.
Moncocq. " " " 185, 1864.
Aveling. On Immediate Transfusion in obstetrical Trans. of London, Vol. vi, 1865.
Goulard. Theses de Paris, No. 319, 1865.
Eulemburg and Landois. die Transfusion des Blutes. Berlin, 1866.
Badt and Martin. Verhandlungen des Berliner Med. Gesellschaft. Berlin, 1867.

Mosler. Ueber Trans. Defibrinirten Blutes bei Leukaemie and Anaemie. Berlin, 1867.
Branton—Hicks. Guys Hospt. Reports, tom. xiv, 1869.
Longet. Traite de Physiologie, tom. ii. 1869.
Von Belina. Die Transfusion des Blutes in Physiologischer und Medicinisher, Beziehung. Heidleberg, 1869.
Chas. Marmonier. Transfusion du Sang. Paris, 1869.
Belina Tableau Statistique de 175 Operations de la Transfusion du Sang Pratiques Depuis 1819, jusqu'a nos Jour. dan les Archives de Physiologie, 1870.
Von Belina. Transfusion dan Sang Defibrine—Nonveau Procede Practique. Paris, 1871.
Dr. Madge to Brit. Association on Transfusion, 1873.