EARLY IMAGES OF EQUIPMENT AND TECHNIQUES USED FOR INFUSION AND BLOOD TRANSFUSION

Phil Learoyd

This collection of early images of equipment and techniques are ones that were published by different authors between 1667 and 1892. The images are presented according to their published date order.

*These publications, i.e. the books by Belina-Swiontkowski (1869), Jullien (1875) and Roussel (1877) also contain images of equipment devised by other people.

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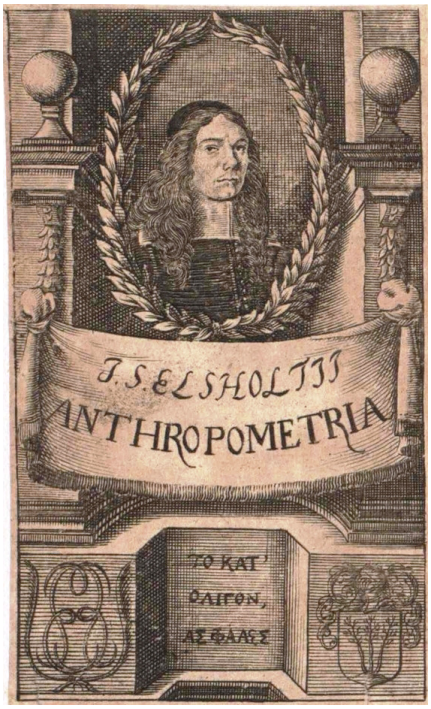
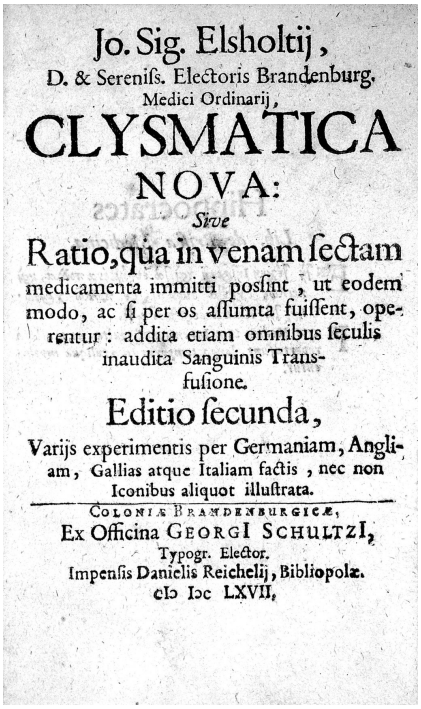
CLYSMATICA NOVA (1667) BY JOHANN SIGISMUND ELSHOLTZ

Johann Sigismund Elsholtz was born in Frankfurt in 1623, studied in Wittenberg and Konigsberg, travelled in Holland, France, and Italy, and obtained his doctorate in Padua in 1653, after which he returned to Berlin and became a state physician. His book *Clysmatica Nova* was first published in 1665 with a revised second edition, which was the first version to include illustrations, published in 1667; the same year that the first human blood transfusion was performed by Jean-Baptiste Denis in Paris. The images in the book illustrate different infusion experiments that were performed by Elsholtz.



Engraving of Johann Sigismund Elsholtz (1623-1688) taken from the frontispiece of his Anthropometria (Frankfurt, 1663)
(Image credit: Picryl.com)


Jo. Sig. Elsholtij,
D. & Serenis. Electoris Brandenburg.
Medici Ordinarij,
CLYSMATICA
NOVA:
Sive
Ratio, qua in venam sectam
medicamenta immitti possint, ut eodem
modo, ac si per os assumta fuissent, ope-
rentur: addita etiam omnibus seculis
inaudita Sanguinis Trans-
fusione.
Editio secunda,
Varijs experimentis per Germaniam, Angli-
am, Gallias atque Italiam factis, nec non
Iconibus aliquot illustrata.
COLONIÆ BRANDENBURGICÆ,
Ex Officina GEORGI SCHULTZI,
Typogr. Elector.
Impensis Danielis Reichelij, Bibliopolæ.
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Title page of the revised second (first illustrated) edition of Clysmatica Nova (Berlin, 1667)
(Image credit: Wellcome Collection)

In the book Elsholtz describes his own detailed experimental work on 'infusion therapy' in both animals and humans and extensively discusses the contemporary problems related to blood transfusion. Whilst accepting the use of animal donor blood for transfusion to humans he also argues for 'robust young men' as blood donors for the 'feeble old or people weakened by disease'. He speculates that transfusion could modify a person's temperament, suggesting that a blood transfusion between husband and wife could lead to a more harmonious marriage.

Within the book he acknowledges William Harvey's publication of the circulation of blood in 1628 as one of the 'discoveries of the century' and includes a summary of intravenous injection and transfusion work performed by Italian, English and French researchers. The presence of the equipment and cannulas on the tables as well as the illustrations of the vascular systems in the images confirm that they are designed to illustrate the technical aspects of the infusion / transfusion processes. Some of the images cleverly identify the role of the surgeon/operator by illustrating only the hands, making the images less cluttered. There is an obvious practicality to the images though his description of the animal experiments and his illustrations of them are somewhat gruesome.

The first engraving (Fig. I) illustrates his method of injecting a drug into a dog using a 'small metal syringe'. Elsholtz describes six experiments of this type performed on dogs and identifies the necessary equipment for performing these experiments on animals as being '… *a table, knife, lancet, syringe, tubes, and the liquid to be injected; also a sponge, cold water, bandages, and needle and thread*' – all of which can be seen in the engraving; and comments that the needle of the syringe should be straight, not curved, as this aids the injection.

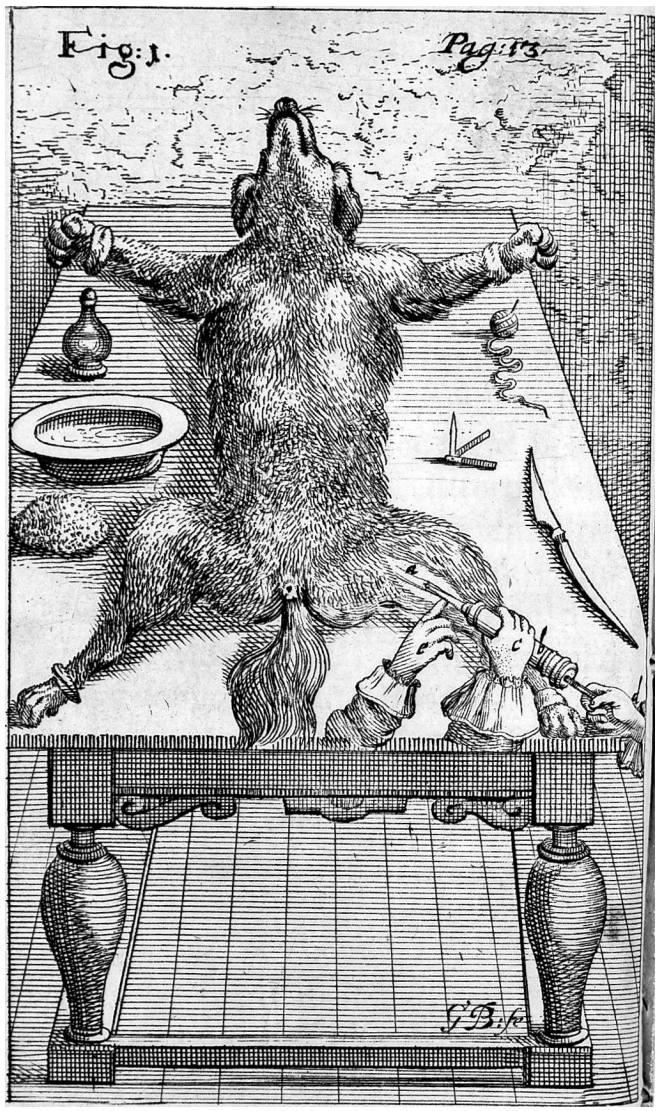


Fig I – Clysmatica Nova (Elsholtz, 1667)
(Image credit: Wellcome Collection)

Fig. I: Illustration from Elsholtz' Clysmatica Nova (1667) showing his method of intravenous injection ('simple infusion') of drugs into dogs. Explanation given of the letters used: *a*, crural vein exposed in dog; *b*, syringe filled with medicated liquid and inserted in opened vein; *c*, right hand of surgeon holding piston; *d*, left hand of surgeon pushing plunger; *e*, hand of attendant compressing vein with finger.

The second engraving (Fig. II) illustrates his method of injecting a drug into a man. Elsholtz identifies that fewer instruments are required when working with men, '… *merely a lancet, syringe, tubes, liquid, and bandages*'. He states that this experiment was performed on three male volunteers – two of which are illustrated in the engraving, i.e. phlebotomy and subsequent injection into the opened '*median vein of*

the left arm' of one man and the injection of another man into the '… *crural vein near to an old ulcer on his left leg*'. Interestingly, although the text identifies that this image illustrates an injection of aqua plantaginis as a form of treatment for the ulcer, it is the same basic syringe technique that was eventually used by James Blundell and Charles Waller to perform human-to-human transfusions in the early part of the nineteenth century.

Fig II – Clysmatica Nova (Elsholtz, 1667)
(Image credit: Wellcome Collection)

Fig. II: Illustration from Elsholtz' Clysmatica (1667), showing his method of intravenous injection of drugs into humans. Explanation given of the letters used: *a*, inner branch of crural vein opened by lancet; *b*, syringe filled and inserted in vein; *c*, left hand of surgeon compressing skin; *d*, right hand of sturgeon holding piston; *e*, hand of assistant pushing plunger; *f*, ligature removed after dissection. In arm: *g*, median opened; *h*, syringe inserted; *i*, left hand of surgeon; *k*. right hand of surgeon; *l*, hand of assistant.

The third engraving (Fig. III) illustrates his experiment of the transfusion of blood from one animal to another. He recounts Lower's experiments which convinced him that blood could pass from the artery of one dog into the vein of another and that it did not coagulate in the small intervening space, '…*which was about three fingers long*'. The illustration depicts his experiment of the direct transfusion from the crural artery of

one dog into the jugular vein of another. He notes that if a pipe made from a medium-sized goose quill (depicted in Fig. III by the letter *o*) is inserted between the first and second tubes its transparency '… *enables one to see more quickly if the blood is flowing properly*'.

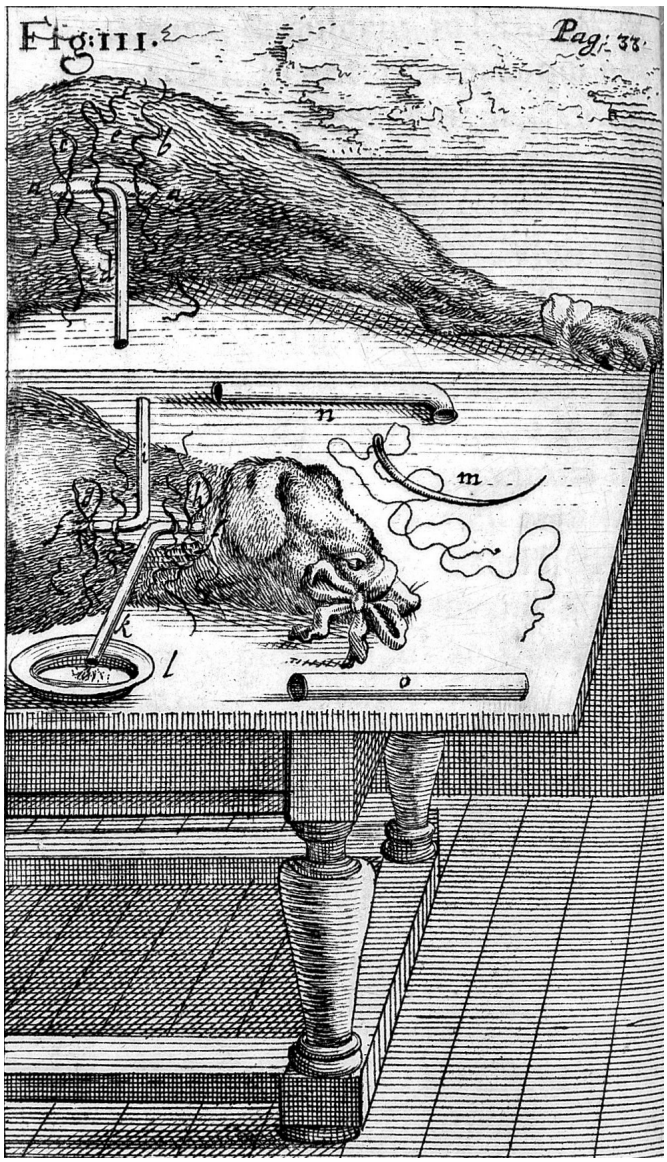
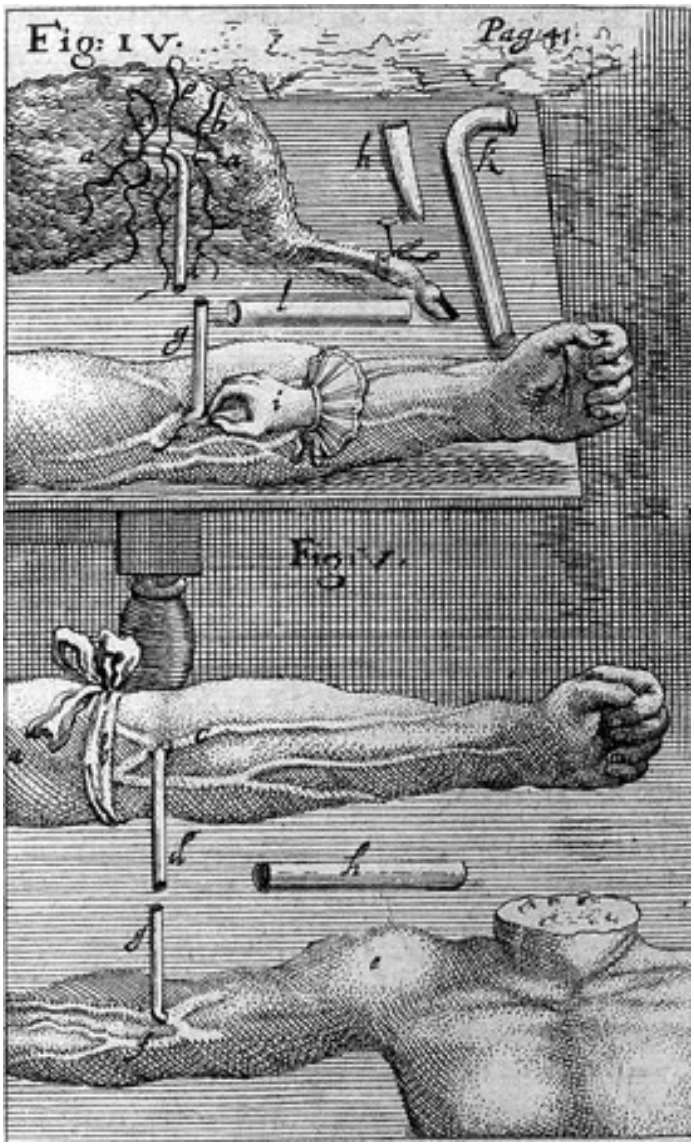


Fig III – Clysmatica Nova (Elsholtz, 1667)
(Image credit: Wellcome Collection)

Figure III: Illustration from Elsholtz' Clysmatica Nova (1667) showing the transfusion of blood from one animal to another. Explanation given of the letters used: *aa*, crural artery exposed in dog; *b*, tight ligature; *c*, loose ligature or with loop; *d*, first silver tube inserted in opened artery; *e*, ligature binding artery about tube; *ff*, jugular vein exposed in other dog; *g*, lower loose ligature; *h*, upper loose ligature; *i*, second silver tube with its tight ligature; *k*, third silver tube with its tight ligature; *l,* basin to receive blood; *m*, curved needle threaded; *n*, form of silver tube with rim for use with animals; *o*, pipe of medium-sized goose quill inserted between first and second tubes. Note: Tube *n* is shown in adequate size; tubes *d*, *i*, and *k* are proportionately smaller.

Elsholtz describes the animal-to-human blood transfusion technique performed in France (i.e. by Jean-Baptiste Denis) of injecting the blood of a lamb into the veins of two men. He states that Fig. IV '… *shows an example of this*' – though he does not

identify that he has performed an equivalent experiment himself and comments that '… *transfusion of blood, which some believe impossible, which very many consider most dangerous, and the majority think useless*'. This engraving illustrates the method of blood transfusion from an animal (a lamb, recognisable by its hoof) to a man (Fig. IV) and from one human to another (Fig. V). Even though he presents a number of arguments, predominant at the time, that animal blood is preferable to human blood for transfusion purposes, he also states that '… *the type of man to give part of his blood to a weaker person must be strong, young, and plethoric*'. Even though Elsholtz does not identify that he has performed a blood transfusion some authors have interpreted the text, and the presence of these illustrations to argue that he did.



Figs IV and V – Clysmatica Nova (Elsholtz, 1667)
(Image credit: Wellcome Collection)

Figure IV (upper half of the image): Illustration from Elsholtz' Clysmatica Nova (1667) of the transfusion of blood from an animal to a man. Explanation given of the letters used: *aa*, crural artery exposed In lamb; *b*, tight ligature; *c*, loose ligature; *d*, first silver tube inserted in artery; *e*, ligature holding artery about tube; *f*, median opened; *g*, other silver tube inserted in vein; *h*, stopper for tube, made from quill; *i*, hand of surgeon compressing skin; *k*, form of silver tube without rim for use with man; *l*, pipe made of quill inserted in each tube. Note: Tube *k* is shown in adequate size; but the proportions of tubes *d* and *g* are diminished.

Figure V (lower half of the image): Illustration from Elsholtz' Clysmatica Nova (1667) of the transfusion of blood from one man to another. Explanation given of the letters used: *a*, forearm giving blood; *b*, ligature around it; *c*, its median opened; *d*, silver tube inserted, and curved toward hand; *e*, forearm receiving blood; *f*, its median opened: *g*, silver tube inserted and curved toward heart: *h*, pipe male of quill to connect tubes. Notes: The hand of the surgeon compressing the skin has been purposely omitted since it is sufficiently clear from Figure IV, letter *I*, and the illustrator has shown tubes *d* and *g* in small size, observing the proportions; the proper size of the others is apparent from Figure IV, letter *k*.

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https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1658688/

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Note: A review of the 1667 edition of the book Clysmatica Nova was published in *Philosophical Transactions* in 1670 (volume 5, Issue 58) – see:
https://royalsocietypublishing.org/doi/10.1098/rstl.1670.0071

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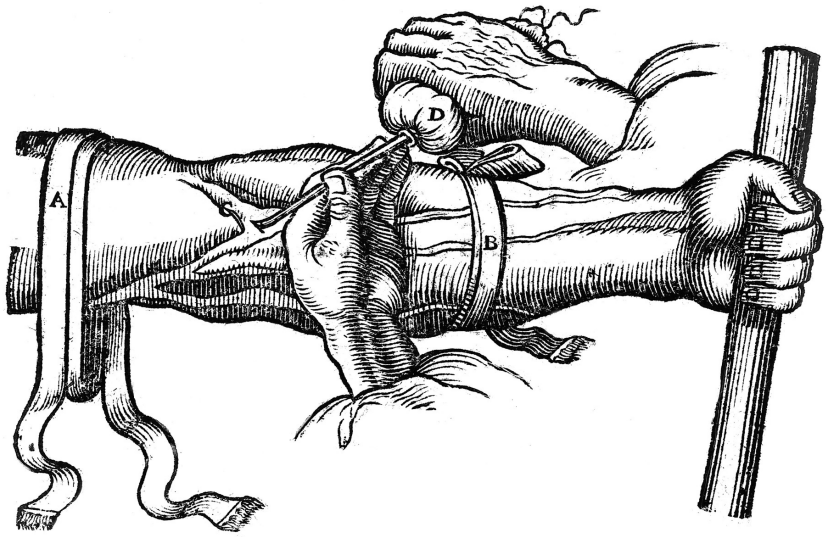
CHIRURGIA INFUSORIA PLACIDIS CL. VIORUM DUBLIS IMPUGNATA, CUM MODESTA, AD EADEM, RESPONSIONE (1667) BY JOHANN DANIEL MAJOR

In his book *Chirurgia infusoria placidis cl. virorum dubiis impugnata, cum modesta, ad eadem, responsione*, published in 1667, Johann Daniel Major describes his method for injecting solutions into a human vein and includes a graphic illustration of him performing this on a man's left arm.



Injecting a solution using a bladder – Chirurgia infusoria (Major, 1667)
(Image credit: Wellcome Collection)

The book *Chirurgia infusoria* is written in Latin and published using Major's latinised name of 'D. Joh Danielis Majoris'. The content has subsequently been interpreted by various authors in different ways, but there appears to be agreement that the description of his infusion of substances into the veins of a human dates from 1662. Christopher Wren is stated to have injected wine and beer into the veins of animals in Oxford in 1656 and is credited by Thomas Sprat in his 'History of the Royal Society' with this, stating that Wren was '… *the first author of the noble anatomical experiment of injecting liquors into the veins of animals. Hence arose many new experiments, and chiefly that of transfusing blood*.' Johann Daniel Major however is believed to be the first person to inject medications into the vein of a human, describing and illustrating the technique in this book. He is also reported by Maluf to have injected blood using a silver cylinder which had a cannula-like spout at the bottom. Within the book Major reviews the infusion work performed by other investigators and includes their letters written to him. He compares his own research with others and argues the merit and originality of his own work. Paul Scheel comments on Major's work in his 1802 book *Die transfusion des blutes und einspreutzung der arzeneyen in die adern* ['Transfusion of blood and the application of medicines into the veins'].

Johann Daniel Major was born in Breslau, Germany in 1634. He studied at the University of Wittenberg from 1654, graduating with a degree in medicine in 1658. He then travelled to Italy, gaining a second degree (by dissertation) in Padua in 1660. He practiced medicine in Wittenberg between 1661 and 1663 before moving to Hamburg, where he was a 'plague physician' and where he wrote his medical

publications. He was appointed Professor of Medicine at Kiel in 1665. He died in Stockholm, Sweden in 1693.


D. JOH. DANIELIS MAJORIS
CHIRURGIA
INFUSORIA,
placidis CL: VIRORUM DUBIIS impugnata, cum modestâ, ad Eadem, Responsione.
KILONI,
Sumptibus Joh: Lüdervvald, Bibliopolæ Magdeburg.
Imprimeb: Joach: Reumannus, Acad. Typogr. 1667.

Frontispiece of Chirurgia Infusoria
(Image credit: woodlibrarymuseum.org)


HESPERIUS.

Johann Daniel Major
(Image credit: The University of Iowa)

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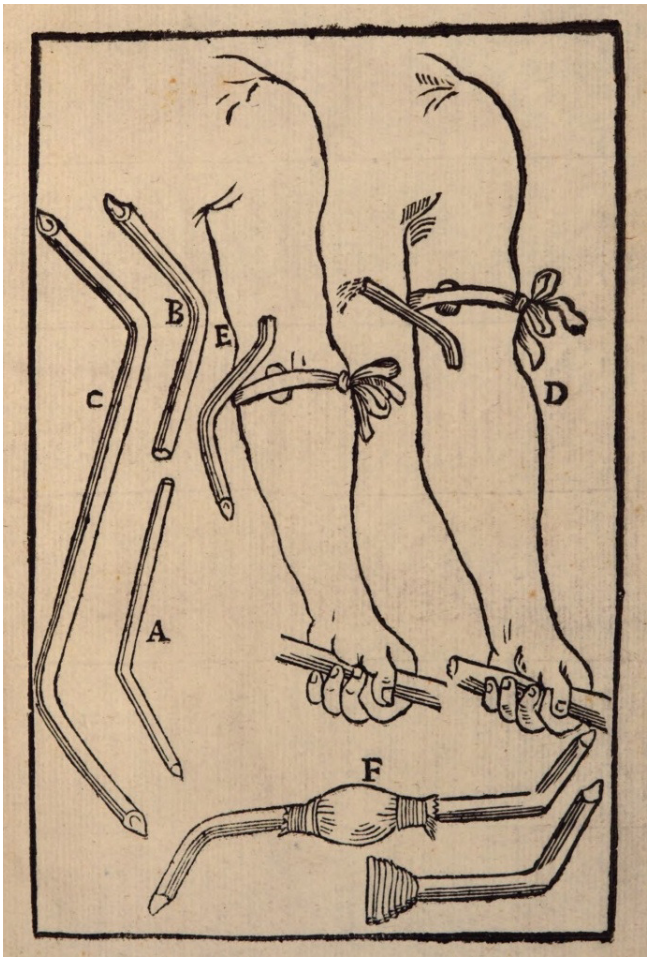
RELAZIONE DELL'ESPERIENZE FATTE IN INGHILTERRA, FRANCIS ED ITALIA. INTORNO ALLA CELEBRE, E FAMOSA TRASFUSIONE DEL SANGUE PER TUTTO MAGGIO 1668 (1668) BY EMILIO MARIA MANOLESSI

The book '*Report of the experiences made in England, Francis and Italy. Around the famous, and famous blood transfusion throughout May 1668*' contains only one (untitled) image of the transfusion equipment used in Italy at this time, which shows a combination of cannula pipes that are referred to only in the text (pages 54-56). This indentifies that a 'very clean' glass tube, curved towards the two sharpened ends, was used for the direct transfusion between the artery of the donor animal and vein of the recipient. This is stated to have enabled the blood flow to be easily observed, though comment is also made regarding their fragility and the possibility of breakage during the procedure. As an alternative option, two glass tubes were also used whose larger and smaller ends could be slotted together (i.e. A and B c.f. C in the image) or that could be bound together (i.e. F in the image), a process which is stated to be the same as '…*the custom of France*.' Though the text recommends the use of a single tube as this does '…*not exhale the spirits of the blood*.'



Glass tubes used for direct transfusion (Manolessi, 1668)
(Image credit: hathitrust.org)

This book, published by V.M. Davia in Bologna in May 1668, attempts to summarise the work that had already been performed on blood transfusion up to that date in England, France and Italy. The work of Denis and Emmerez in Paris during 1667 is identified first by means of the correspondence published in the *Journal des Sçavants* during the period 9th March to the 8th August 1667 between Jean-Baptiste

Denis and Monsieur de Montmor and Abbott Boudelot, as well as the letters between G. Lamy and Monsieur Moreau. The research performed by Richard Lower and Edmund King in London is identified by means of the reports published in the *Philosophical Transactions* in 1667 by Thomas Coxe and Edmund King. The work of Andreas Libavius and Claude Tardy is also mentioned in the text as predating the work performed by Lower in England and Denis in France, a claim that is disputed in an article published in the *Philosophical Transactions of the Royal Society* of 1668 titled 'On the antiquity of the transfusion of blood from one animal to another'. The book identifies the work performed in Italy by G. Montanari in Bologna in 1667 and the lamb-to-lamb and a lamb-to-dog transfusions performed at the home of a Mr Cassini in 1667. An extract of the report of these transfusions was published in the *Giornale de'Letterati* and subsequently in the *Philosophical Transactions of the Royal Society* in 1668.

RELAZIONE
DELL' ESPERIENZE
Fatte in Inghilterra, Francia, ed Italia
Intorno alla celebre, e famosa
TRASFVSIONE DEL SANGVE
PER TVTTO MAGGIO 1668.
In cui, oltre all' oppugnationi, e difese, si vede la sanità restituita ad alcuni infermi, e particolarmente à vn pazzo.
La maniera di facilmente prattticarla ne gli Huomini, e la minuta descrizione di essa,
Con nuoua Esperienza in vn Cane vecchio, e sordo restituito alla forza, & vdito.
DEDICATA
ALL' ILLVSTRISSIMO SIGNORE
VIRGILIO MARIA
DAVIA.
In BOLOGNA, Per Manolessi. M.DC.LXVIII.
Con licenza de' Superiori.

Title page of Manolessi's book (1668)
(Image credit: hathitrust.org)

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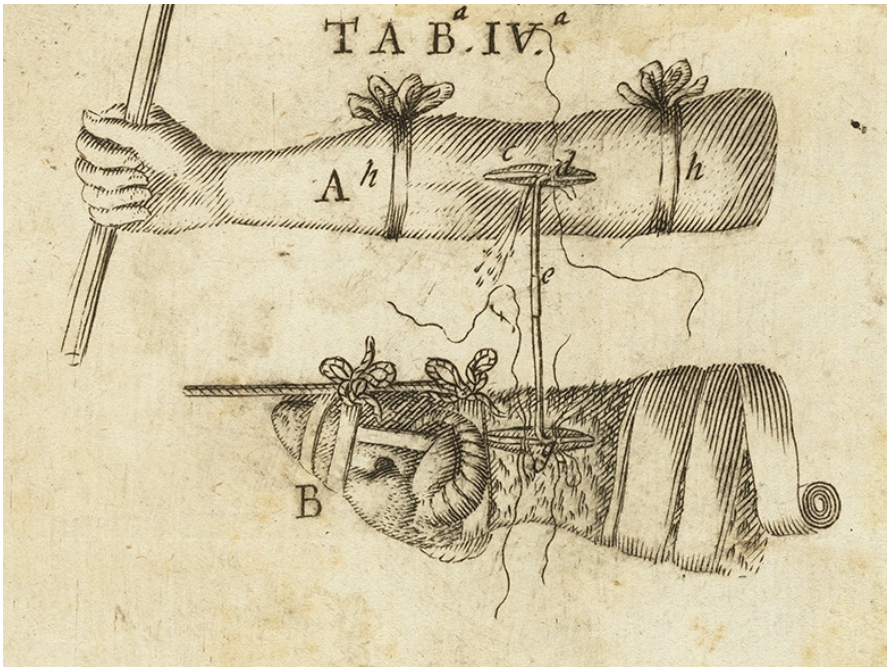
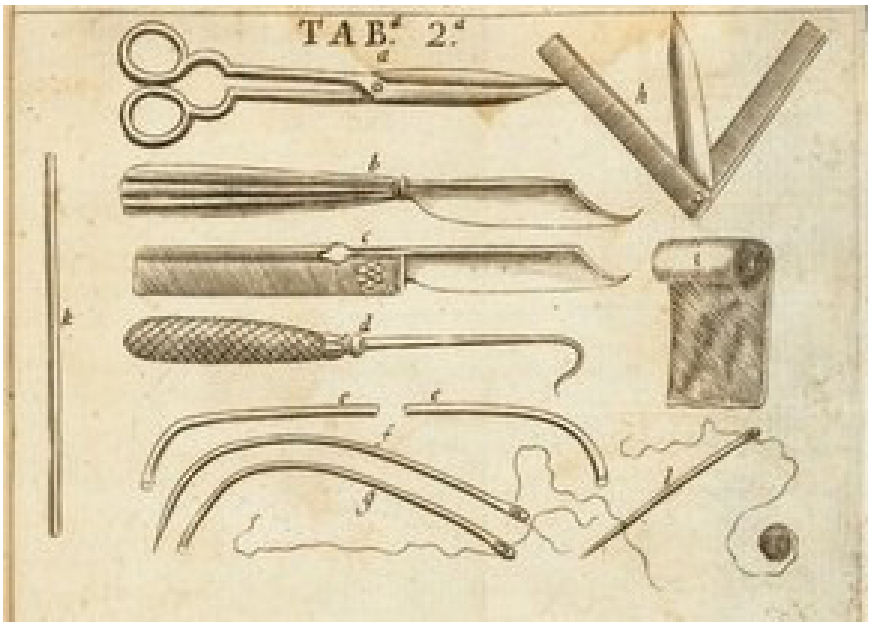
https://royalsocietypublishing.org/doi/10.1098/rstl.1668.0058

RAGGUAGLIO DEGL'ESPERIMENTI FATTI SOTTO LA DIRETTIONE DI PAOLO MANFREDI, CIRCA LA NUOVA OPERATIONE DELLA TRASFUSIONE DEL SANGUE DA INDIVIDUO AD INDIVIDUO & IN BRUTI & IN HUOMINI (1668) BY PAOLO MANFREDI

In 1668 Paolo Manfredi (1640-1716) published a report '*Summary of the experiments carried out under the direction of Paolo Manfredi, regarding the new operation of transfusion of blood from individual to individual and in animals and humans*' that contains an image of a direct blood transfusion from a sheep to a man and one of the equipment needed to perform the operation..

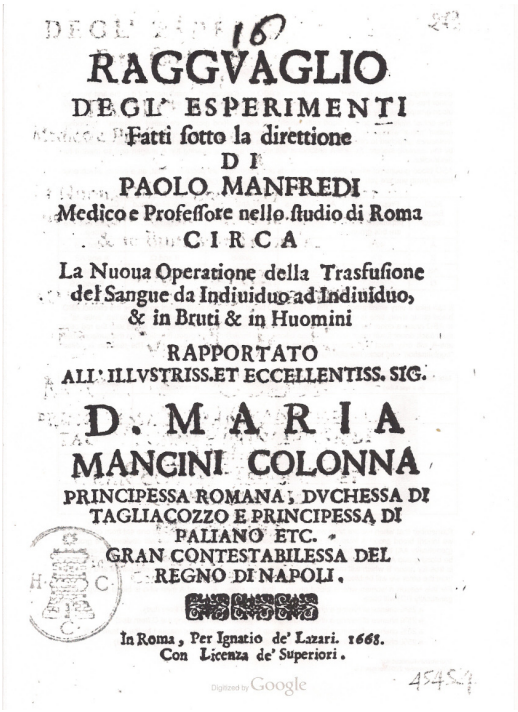


Direct blood transfusion from a sheep to a man (Manfredi, 1668)
(Image credit: Wellcome Collection)



Equipment needed to perform a direct blood transfusion (Manfredi, 1668)
(Image credit: Wellcome Collection)

Manfredi is reported to have transfused the blood of a lamb into a labourer called Angelo da Udine on the 5th January 1668 at his home in front of a large audience. Instead of the silver tubes previously used by Richard Lower and Jean-Baptiste Denis for the direct transfusion of blood, Manfredi used glass tubes that allowed him to be able to see and control the flow of blood. Immediately after this he published two reports in 1668: *De nova et inaudita medico-chyrurgica operatione sanguinem transfundente de individuo ad indiviuum* and *Ragguaglio degl'esperimenti fatti sotto la direttione di Paolo Manfredi, circa la nuova operatione della transfusione del sangue da Individo ad Individo et in bruti et in huomini*. Both publications were intended to counter the accusations, controversy and debate that transfusion experiments had raised in Rome, like other places in Europe, in 1668. The publications on the one hand appear to have been written to confirm the success of the operation of transfusion whilst also attempting to answer the medical, philosophical and even theological objections that the introduction of animal blood into a man raised. He appears to have advocated animal-to-human transfusions due to the practical difficulties that arterial blood transfer from a human raised whilst at the same time rejecting the idea that the introduction of animal blood could in any way modify the human nature of the recipient – a view widely held at that time.



RAGGVAGLIO
DEGL' ESPERIMENTI
Fatti sotto la direttione
DI
PAOLO MANFREDI
Medico e Professore nello studio di Roma
CIRCA
La Nuoua Operatione della Trasfusione
del Sangue da Indiuiduo ad Indiuiduo,
& in Bruti & in Huomini
RAPPORTATO
ALL' ILLVSTRISS. ET ECCELLENTISS. SIG.
D. MARIA
MANCINI COLONNA
PRINCIPESSA ROMANA, DVCHESSA DI
TAGLIACOZZO E PRINCIPESSA DI
PALIANO ETC.
GRAN CONTESTABILESSA DEL
REGNO DI NAPOLI.
In Roma, Per Ignatio de' Lazari. 1668.
Con Licenza de' Superiori.

Title page of Paolo Manfredi's book (1668)
(Image credit: books.google.co.uk)

At the time that the transfusion experiments were made Manfredi was an 'Ordinary Reader' of theoretical medicine, but by 1676 (when records are available) he had entered the Medical College and by 1682 (again, when records are available) he is identified as being the Dean of the College of Medicine in Rome. During this period he taught anatomy and surgery and published other works on the anatomy of the eye and ear. In 1704 he resigned from the College but is known to have held the office of Archivist (1709) and Chamberlain (1713).

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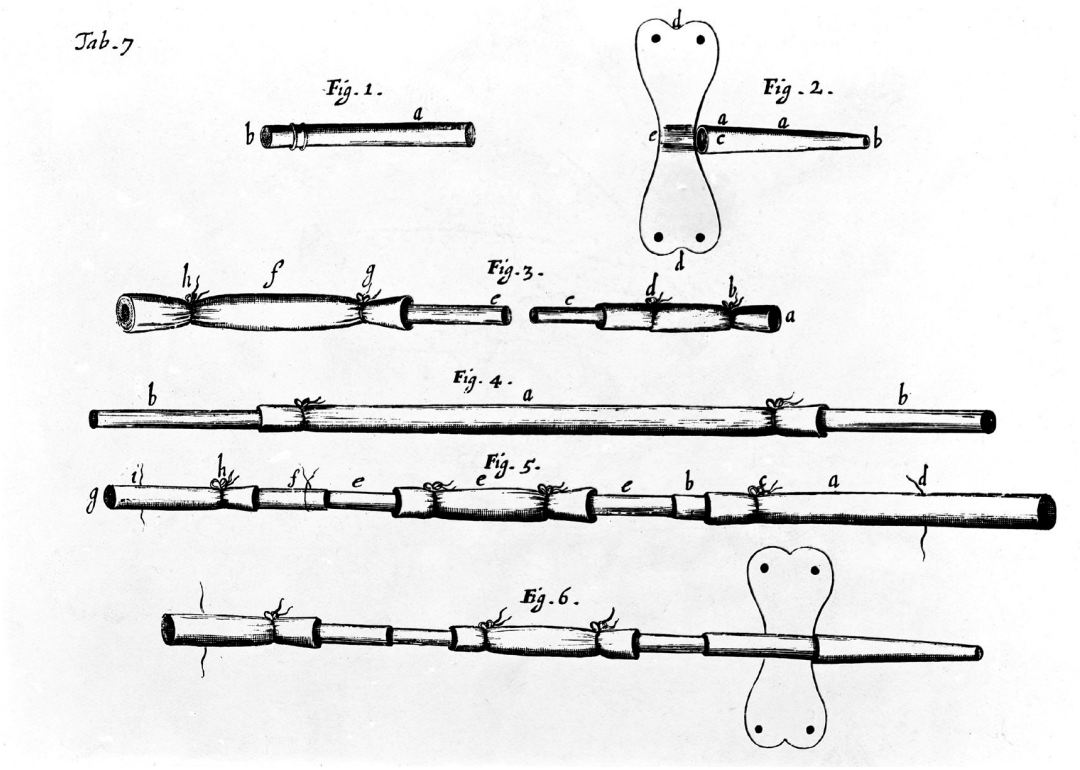
https://www.sciencedirect.com/journal/transfusion-medicine-reviews/vol/32/issue/1

TRACTATUS DE CORDE – DE TRANSFUSIONE SANGUINIS EX ANIMALI ALIO IN ALIUD (1669) BY RICHARD LOWER

Richard Lower's book *Tractatus de corde. Item de motu & colore sanguinis et chyli in eum transitu* summarises his cardiovascular and gastrointestinal research, containing descriptions of his experimental methods, clinical observations about heart disease, the behaviour of the pericardium and the nature and function of heart muscle. It also documents his observations regarding the change in the colour of arterial blood as it passes through the lungs compared with venous blood. The fourth of the five chapters is titled *De transfusione sanguinis ex animali alio in aliud* [Concerning the transfusion of blood from one animal to another]. In this chapter he provides evidence for being the first person to perform a dog-to-dog blood transfusion in the form of an exchange of letters between Robert Boyle (representing the Royal Society) and himself, as well as providing information regarding the method employed. Lower identifies that he originally used quills (possibly from geese) as the tubes that provided the closed/direct arterial-venous connections between the two animals, which he describes as being fragile and difficult to fix securely into blood vessels, invariably resulting in them having to be held in place by hand. In the text Lower mentions that he has developed silver pipes that are more robust and which can be more easily anchored in place by ligatures, stating *'… so that the vessels might be tied with the greater security one of the ends is surrounded with two little rings jutting out somewhat above the surface'*. He provides an illustration of these pipes, describing how they are anchored in place by ligatures and how they are joined together by pieces of ox or horse artery (to provide flexibility).



Richard Lower's cannulae - *Tractatus de corde*, 1669.
(Image credit: Wellcome Collection)

Detailed information on each item within the illustration is included within the text and can be translated as follows:

Fig 1:
a. The silver pipe.
b. That part which is to be inserted into the vein or artery with its two circular rings where the ligature might be tied with the greater security.

Fig 2: Is a silver pipe made to convey blood into a human arm
aa. The silver pipe.
b. Its lesser part to be inserted into the vein of the arm.
c. Its greater part where it receives the blood.
dd. Its two branches perforated on both sides for passing a ligature through to fasten the plate to the arm.
e. A sinus excavated in the middle between both branches, if it might more commodiously receive the pipe which so compresses the vein that lies under it, that no blood can flow out of it and may be fitly compared to the pit in the middle of a man's upper lip.

Fig 3: Shows the pipes as they are fitted to the artery and the vein before the operation is to be performed, where
a. Is the emittent cervical artery.
b. The same artery tied tight, but as a slip knot.
c. The pipe conveyed into the artery for transmitting the blood.
d. The place where the artery is tied tight upon the pipe between the rings.
e. The pipe for receiving the blood and conveying it into the jugular vein.
f. The jugular vein.
g. The place where the vein is tied tight upon the pipe.
h. A ligature on the vein, but with a loose knot.

Fig 4: Shows the cervical artery taken from an ox or horse and fitted to the silver pipe at both ends
a. The cervical artery
bb. The pipes fitted to the artery

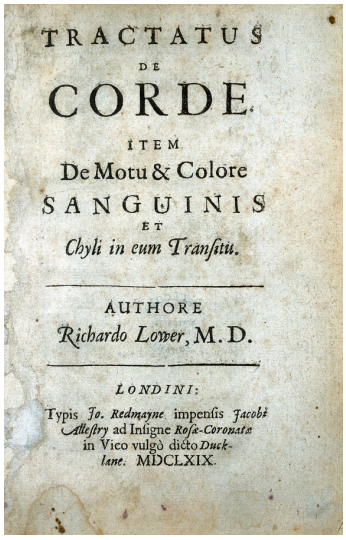
Fig 5: Exhibits the whole apparatus for transfusing the blood out of one animal into another, where
a. The jugular vein towards the heart of the animal into which the blood is to be transmitted.
b. The silver pipe conveyed into the jugular vein.
c. The vein tied upon the pipe with a close knot.
d. A ligature on the vein beyond the pipe with a very loose knot.
eee. The intermediate pipes and cervical artery which convey the blood from the immittent pipe into the recipient.
f. The pipe receiving the blood from the artery.
g. The artery of the animal which emits the blood.
h. The place where the artery is firmly tied upon the included pipe.
i. The place where it is tied beyond the pipe with a knot to be loose as occasion

Fig 6: Shows the same apparatus for transfusing blood from a brute into a man the use of which may be sufficiently understood from the foregoing.

A review of the book *Tractatus de Corde* is printed in the *Philosophical Transactions of the Royal Society*, in which the only comments regarding the content of chapter 4 of the book by the reviewer (the Journal's Editor, Henry Oldenburg) include the issue of the priority of the work compared with that performed by Jean-Baptiste Denis and the fact that Lower incorrectly calls the 'Philosophical Transactions' to be 'Transactions of the Society'.

Richard Lower was born in Cornwall in 1631. He was educated at Westminster School and enrolled at Christ Church College Oxford in 1649, obtaining a Bachelor's degree in 1652 and a Master's degree in 1655. He was then involved in research work with Professor Thomas Willis, studying the effects of different agents injected

intravenously in animals and performing detailed anatomical dissections of the heart and circulatory system. Willis described Richard Lower as being '…*a doctor of outstanding learning and an anatomist of supreme skill*.' He completed his medical degree whilst in Oxford in 1660 and then moved to London where his growing full-time medical practice took him away from research. He died in London in 1691, probably of pneumonia.


TRACTATUS
DE
CORDE.
ITEM
De Motu & Colore
SANGUINIS
ET
Chyli in eum Tranſitu.
AUTHORE
Richardo Lower, M.D.
LONDINI:
Typis Jo. Redmayne impenſis Jacobi Alleſtry ad Inſigne Roſæ-Coronatæ in Vico vulgò dicto Duck-lane. MDCLXIX.

Title page of Tractatus de corde (1669)
(Image credit: Wellcome Collection)

Richard Lower (1631-1691)
(Image credit: en.wikipedia.org)

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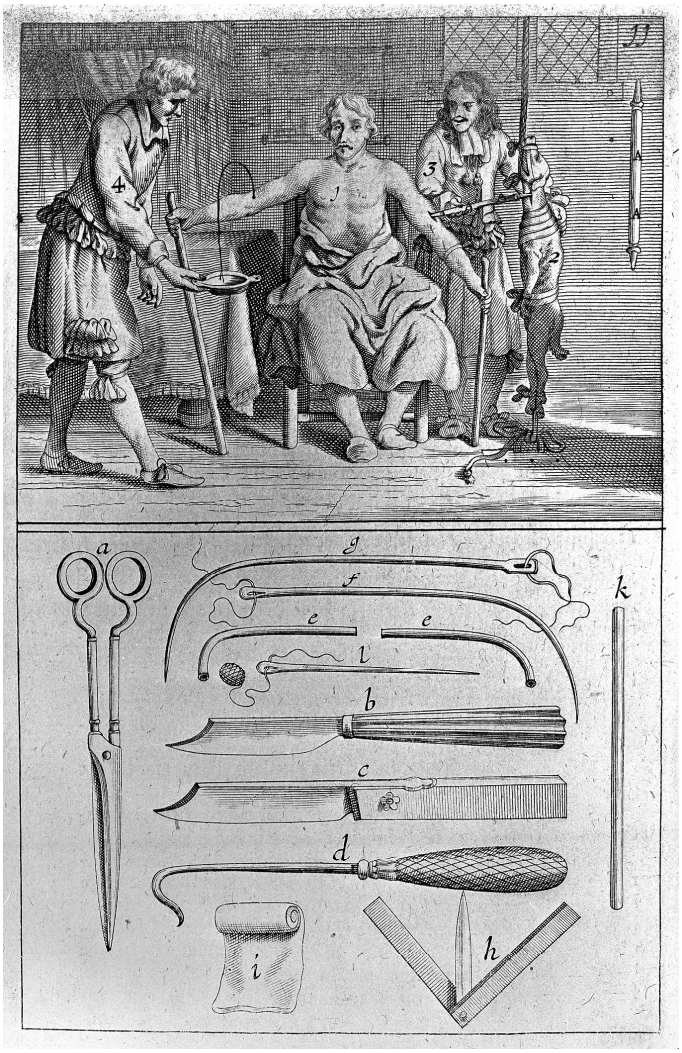
ARMAMENTARIUM CHIRURGICUM (1671) BY JOHANNES SCULTETUS

The surgical manual *Armamentarium Chirurgicum* by the German surgeon Johannes Schultheiss (1595-1645) was originally published in 1655, ten years after his death, using his Latinised name of Johannes Scultetus. This was the first complete detailed textbook of surgery. It was originally written in Latin but was soon translated into German, English and French. An appendix to a later 1671 edition of the book printed in Amsterdam by Jean-Baptiste van Lamzweerde, i.e. four years after the first human blood transfusion was performed by Jean-Baptiste Denis, includes an image demonstrating a blood transfusion.



Blood Transfusion (Scultetus, 1671)
(Image credit: Wellcome Collection)

The first image illustrates a somewhat stylised animal-to-human transfusion [the strongly bound animal has been identified by many later authors as being a dog]. The patient is illustrated as being bled by one of the two attendants at the same time as being transfused, phlebotomy being a common practice when some of the earlier transfusions were performed, but this may also be an acknowledgement to the fact that by the time that this edition of the book was published blood transfusion had fallen into disrepute in France. This image was published together with a second that depicts the surgical equipment necessary for performing the transfusion. The fact that these illustrations are included at all is interesting in that the publisher of the

1671 edition Jean-Baptiste van Lamzweerde, a brilliant doctor in his own right, was known to have supported Galen's theories.

Johannes Schultheiss was one of the first academically trained physicians and surgeons in Germany in the 17th century. Under the guidance of his mentor, the famous Belgium physician Adriaan van de Spieghel, Professor of Anatomy, he graduated from the University of Padua in 1623 with degrees in philosophy, medicine and surgery. After graduating Scultetus initially went to Venice and established a private practice, but in 1625 he became the official physician of his German home town of Ulm. He worked on the manuscript of his book for 22 years until his untimely death from a stroke in 1645. His nephew, Johannes Scultetus the Younger, who followed in his uncle's footsteps, having graduated from the University of Padua and becoming the town physician in Ulm, published the first edition of the textbook in 1655. Given that the edition of his book where the image of blood transfusion is included occurred twenty-six years after his death indentifies that it was not in fact the original author's work.

German edition of *Armamentarium Chirurgicum* (1666)
(Image credit: journalacs.org)

Frontispiece of *Armamentarium Chirurgicum* (1657)
(Image credit: Wellcome Collection)

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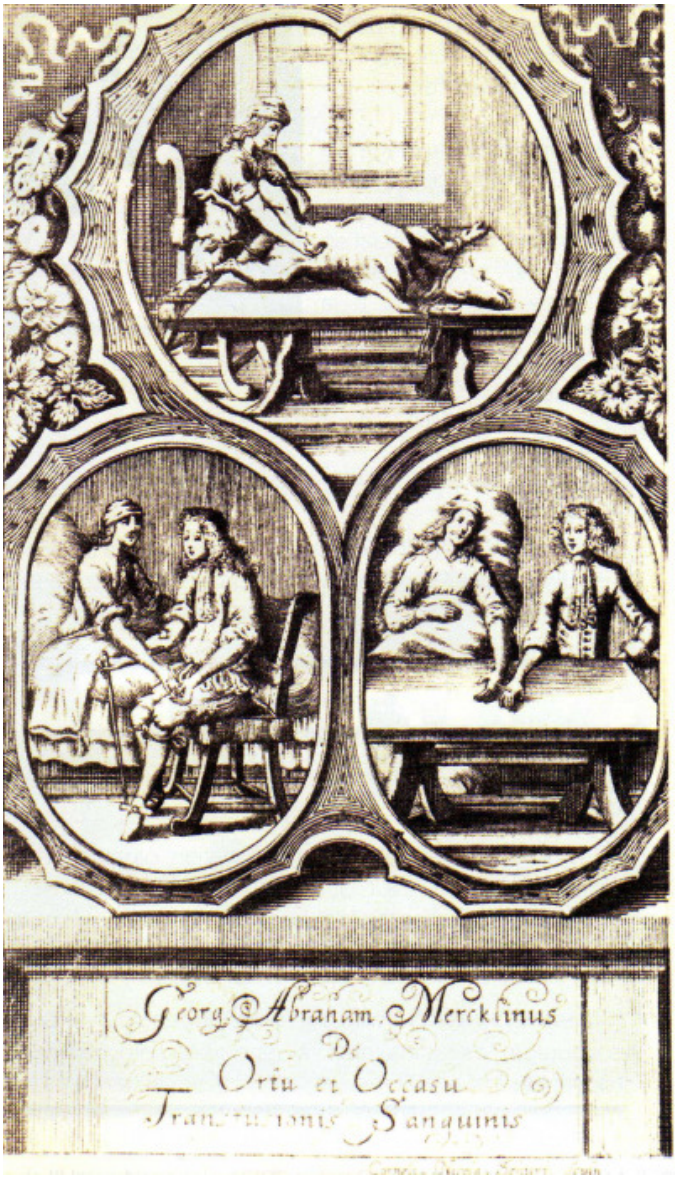
TRACTATIO MEDICA DE ORTU & OCCASU TRANSFUSIONS SANGUINIS (1679) BY GEORG ABRAHAM MERCKLIN

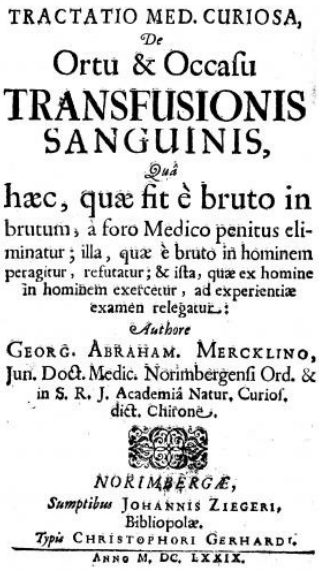


Frontispiece of Tractatio Medica De Ortu & Occasu Transfusionis Sanguinis (Mercklin, 1679)
(Image credit: Wellcome Collection)

This image depicting three scenes of early transfusion is the frontispiece of the book *Tractatio Medica De Ortu & Occasu Transfusionis Sanguinis* by Georg Abraham Mercklin, printed in Nuremberg in 1679 and is the work of the engraver Cornelius Nicolaus Schurtz. The upper image appears to show a calf (or sheep) blood transfusion to a man, whilst the two bottom images show the blood of a healthy man being transfused to a sick man, in the left image into the arm and in the right image into the back of the hand.

In this early treatise on blood transfusion Mercklin recognises and describes what would now be understood to be transfusion reactions and as such opposes the wisdom of performing blood transfusions whether they were done using animal donor blood, usually from a sheep, or human blood. He points out the technical difficulties, dangers and drawbacks as he sees them by the discussion of case histories.

Given that the author appears to find blood transfusion unnecessary and even revolting it has been suggested that the artistic representations depicted in this frontispiece are designed to be deliberately shocking. The top image appears to show a man in good health sitting at a table with the animal depicted as being ill or dead, possibly suggesting that the blood flow is actually from the man to the animal. There is also an obvious unnaturalness suggested by the positioning of the man and the animal in this image. Similarly there is also some ambiguity in the two lower images. These appear to depict male recipients as well as donors whose facial expressions, contact and body positions are also somewhat ambiguous for the period. In addition, none of the three illustrations include a surgeon or illustration of the instruments necessary to perform a transfusion, supporting the author's narrative that blood transfusions are cruel and potentially dangerous. It is possibly relevant therefore that *De ortu et occasu transfusionis sanguinis* translates to 'On the rise and fall of blood transfusion'.


TRACTATIO MED. CURIOSA,
De
Ortu & Occaſu
TRANSFUSIONIS
SANGUINIS,
Quâ
hæc, quæ fit è bruto in
brutum, à foro Medico penitus eli-
minatur; illa, quæ è bruto in hominem
peragitur, refutatur; & iſta, quæ ex homine
in hominem exercetur, ad experientiæ
examen relegatur:
Authore
GEORG. ABRAHAM. MERCKLINO,
Jun. Doct. Medic. Norimbergenſi Ord. &
in S. R. J. Academiâ Natur. Curioſ.
dict. Chirone.
NORIMBERGÆ,
Sumptibus JOHANNIS ZIEGERI,
Bibliopolæ.
Typis CHRISTOPHORI GERHARDI.
ANNO M. DC. LXXIX.

Title page of *Tractatio Med. curiosa de Ortu et Occasu Transfusions Sanguinis*
(Image credit: books google.com)

Georg Abraham Mercklin - Line engraving by E. Nunzer after J.M. Krieger
(Image credit: Wellcome Collection)

Georg Abraham Mercklin was born in 1644 in Weissenburg, Germany, the son of the physician of the same name (1613-1683). He studied medicine at the University of Altdorf and on completing his degree he lived in Nuremberg from 1670 as a general practitioner. He wrote several medical papers as well as the book *Tractatio medica de ortu & occasu transfusions sanguinis*. He was a member of the German Academy of Sciences Leopoldia. He died in Nuremberg in 1702.

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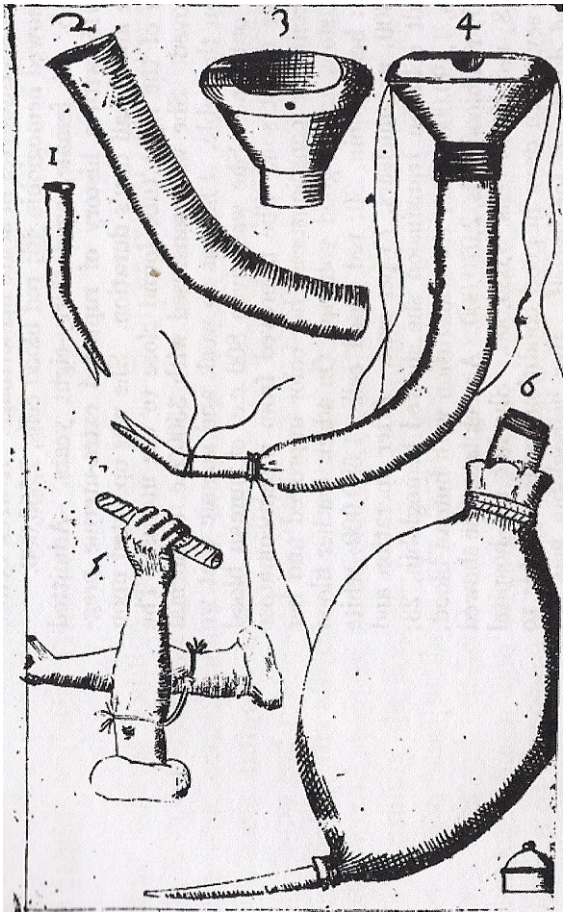
STADERA MEDICA NELLA QUALE OLTRE LA MEDICINA INFUSORIA ED ALTRE NOVITÀ SI BILANCIANO LE RAGIONI FAVOREVOLI E CONTRARIE ALLA TRASFUSIONE DEL SANGUE (1680) BY FRANCESCO FOLLI

Although in the introduction to his book *Stadera Medica* Francesco Folli (1624-1685) claims to be 'the discoverer of blood transfusion' he also states that his 'speculations carried into practice so far as this is possible on paper' and concludes by saying that 'he himself had never attempted' a transfusion. It appears therefore that although he may have performed intravenous infusion experiments he did not actually perform a blood transfusion. Much of the confusion regarding his claim comes from the translation as to whether he 'demonstrated' or 'manifested' (i.e. translated from the word manifestata) a transfusion to Duke Ferdinand II of Tuscany in 1654. This taken together with a drawing in the book showing a direct human-to-human transfusion has been interpreted to indicate that he actually carried out a transfusion. This belief is in fact helped by his remarkably accurate description of the apparatus necessary to carry out a direct blood transfusion, which he illustrates and describes in his book.



'Tabula' taken from 'Stadera Medica' (Folli, 1680)
(Image credit: Google.Books.com)

Folli describes a cannula of gold, silver or crow quill, bent so that it could be inserted into the vein of the recipient (Fig.1) which could be attached to a tube made from the intestine of a hare, cat or dog (Fig.2). The other end of this tube was then to be connected to a small funnel of ivory or bone (Fig.3) that was attached to the donor's arm so as to collect blood from a cut vein, the whole apparatus being held together by ligatures (Fig.4). Even though the text indicates that Folli was aware of the need to avoid introducing air into the recipient's circulation and the problems caused by blood clotting, this apparatus appears prone to both of these problems. However he

also illustrates a direct transfusion (Fig.5) from the arm of one man into that of another using two cannulas joined together with an artery from a goat or other animal, which has been soaked in brandy or fat in order to keep it supple, enabling the blood to be pushed through by a milking-type action. In another section of the book he also describes an apparatus made from a dove's quill, used as a cannula, fixed to the bladder of a lamb or dog (Fig.6) that can be squeezed so as to infuse drugs directly into a vein. Folli states that this avoids the drug being affected by gastric juices if it were to be taken by mouth and that he has actually performed experiments using this apparatus. Note: This piece of apparatus is also included (bottom left) in the line drawing of Folli in his book – see below.

Within the text, he also identifies that transfusion should be used for rejuvenating the elderly (rather than the treatment of disease or blood loss), which he envisaged would be achieved by the gradual exchange replacement of an elderly person's blood with a series of transfusions from a number of young blood donors. He calculated that the volume of blood required to do this would require at least twenty young donors in daily doses and as such transfusion could only be afforded by 'princes or rich men'.

Note: The translation of the title of the book equates to 'Medical steelyard in which in addition to infusion medicine and other innovations, the reasons for and against blood transfusion are balanced', though this has also been translated to be 'Medical balance in which, besides infusion medicine and other novelties, the reasons for and against blood transfusions are weighed', i.e. the word *Stadera* translates as 'steelyard balance'.


STADERA MEDICA
Nella quale oltre
LA MEDICINA INFVSORIA,
ED ALTRE NOVITA'
SI BILANCIANO LE RAGIONI
FAVOREVOLI,
E LE CONTRARIE ALLA
TRASFVSION DEL SANGVE
Già inuentata da
FRANCESCO FOLLI,
ET ORA DAL MEDESIMO DESCRITTA,
E DEDICATA
AL SER.mo PRINCIPE
FRANCESCO MARIA
DI TOSCANA
IN FIRENZE

Title page of *Stadera Medica* by Francesco Folli
(Image credit: Wood library museum.org)

Francesco Folli – line drawing from *Stadera Medica*
(Image credit: Himetop-Wikidot)

Francesco Folli was born in Poppi, Tuscany, in 1624 and obtained a doctorate in philosophy and medicine at the University of Pisa in 1648. He initially started his medical practice in Poppi but then moved to Bibbiena, becoming a member of the 'Experimental Academy' of Ferdinand II, Grand Duke of Tuscany, in front of whom he says he 'demonstrated' blood transfusion in 1654. After this however he appears,

somewhat mysteriously, to have moved out of Tuscany and the Duke's influence to Citerna, Umbria. After a lapse of over twenty years and apparently ignorant of the transfusion experiments performed by Lower in England and Denis in France that had taken place during that period, he decided in 1680 to publish his book in which he claims to have discovered transfusion.

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GROSSER UND GANTZ NEUGEWUNDENER LORBEER-KRANTZ, ODER WUND ARTZNEY… (1705) BY MATTHAUS GOTTFRIED PURMANN

Blood transfusion from a lamb to a man (Purmann, 1705)
(Image credit: Wellcome Collection)

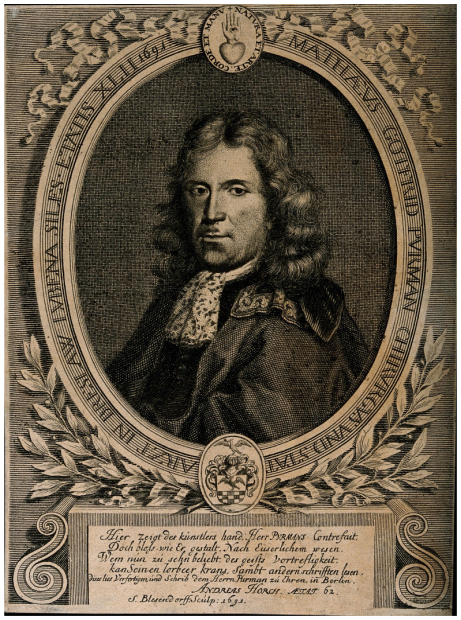
This engraving, which shows the transfusion of blood from a lamb to a man, appeared in the book *Grosser und gantz neugewundener Lorbeer-Krantz, oder Wund Artzney* … by Matthäus Gottfried Purmann (1649-1711) that was first published in Frankfurt and Leipzig in 1705.

Purmann not only used different sized tubes to potentially alter the rate at which the blood flowed through them but also believed that one of the reasons why the blood clotted was the loss of heat as it passed through the cannula joining the donor and recipient. To counteract this, he devised *'… a tube surrounded with a linen cover, in which warm water is held, to hinder the blood from coagulating which passes through the tube; this must have on each side a fine silver pipe, one of which must be put into the vein of the man, and the other into the vein of the beast*'. These fine (straight) silver pipes and the jacketed cannula (item *C*) are also included in the engraving.

Purmann was the first doctor in Germany to perform animal-to-human transfusions starting in 1668 (the year after Jean-Baptiste Denis in Paris) and he performed several transfusions using lamb's blood during the next ten years, by which time the practice had been prohibited in France. However, many of his experiments resulted in failure leading him to conclude that animal blood transfusions to humans were dangerous and he abandoned the practice, which may possibly be the reason why he did not publish his findings until much later. The engraving is designed to illustrate the procedure by showing the veins involved together with what appear to be different sized cannulas as well as other equipment. However, it appears strange in that the hardly-tethered donor lamb seems resigned to its fate, evoking the idea of

sacrifice, whilst the recipient appears distant and melancholy – an image which does not evoke the belief of the time that transfusion was able to change the character and revitalise the sick.

Purmann (1649-1711) was born in the Silesian town of Lüben. After an apprenticeship as a wound surgeon he joined the Brandenburg military service and became a regimental field worker in 1675. On his release from military service in 1679 he became a surgeon in Halberstadt and then moved to Wroclaw where, even though he did not have a medical degree he became the city doctor in 1690, presumably based on the fact that he had acquired extensive practical experience of treating injuries (i.e. a 'barber surgeon'). He was the author of a number of published books on surgery.



Matthäus Gottfried Purmann
- Line engraving by S. Blesend
(Image credit: Wellcome Collection)

Title page of Grosser und gantz neugewundener Lorbeer-Krantz, oder Wund Artzney (1705)
(Image credit: Wellcome Collection)

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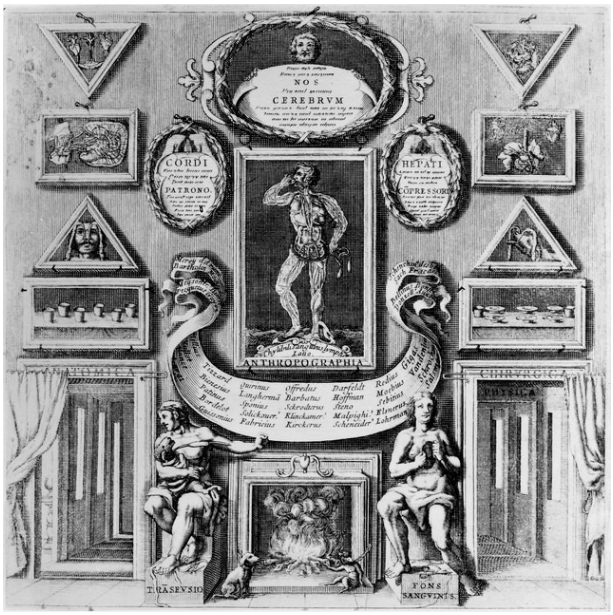
Accessed: 9 August 2020

https://link.springer.com/article/10.1007/BF02428385?error=cookies_not_supported&error=cookies_not_supported&code=ed5fea24-978a-4bda-9f51-f26e9404587b
Accessed: 9 August 2020

TABULAE ANATOMICAE (1741) BY PIETRO BERRETTINI DA CORTONA

Pietro Berrettini da Cortona's *Tabulae Anatomicae* was published by Gaetano Petrioli in Rome in 1741. On the lower left of the frontispiece of this book there is a statue-like figure who is sitting on a pedestal which is inscribed with the word Trasfusio.



Frontispiece of Tabulae Anatomicae (1741)
(Image credit: Wellcome Collection)

Tabulae Anatomicae (1741)
(Image credit: Wellcome Collection)

This image depicts a man holding a bound lamb in his right arm whilst the lamb's blood is being infused into his left arm. It appears highly likely that this part of the fresco was not original and was added as part of the 1741 publication because Pietro's original anatomical tables appear to have actually been produced before 1628, a date much earlier than the first animal-to-human transfusion experiments. Although this appears to be a symbolic illustration showing the man looking away from the animal, some surgical equipment can also be seen at the bottom of the pedestal. Pietro da Cortona's *Tabulae anatomicae* was one of the most artistic anatomical atlases ever produced but was not published until more than 70 years after the artist's death.

Gaetano Petrioli was a professor of medicine and surgery who edited and promoted various anatomical publications. The art work of Pietro da Cortona was still admired in the eighteenth century so the inclusion of his name would have added greater prestige to a publication. A second edition was published in Rome in 1788 though this does not contain Petrioli's text and figures.

Pietro Berrettini was born in Cortona in Tuscany in 1596 and became known simply as 'Pietro da Cortona'. He worked mainly in Rome and Florence as a very successful baroque painter and architect as well as an important interior designer. He died in Rome in 1669 when 72 years old.

Pietro Berrettini da Cortona
(Image credit: en.wikipedia.org)

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Accessed: 9 August 2020

A GENERAL SYSTEM OF SURGERY IN THREE PARTS (1743) BY LORENZ HEISTER

The 'three parts' identified in the title of the English translation of Lorenz Heister's encyclopaedic book on surgery are:

1. Of wounds, fractures, luxations*, tumours, and ulcers, of all kinds
2. Of general operations practicable in several different parts of the body
3. Of the several bandages applied in all operations and disorders

* Dislocations of the bone at the joint

A major section of the second part of the book involves an extensive description of phlebotomy or 'Bleeding' by the opening of a vein, a very common practice of the 18th century. Detailed instructions of how to perform this process on many different parts of the body is provided. It is within this section of his book that Heister includes a chapter (XIV) titled 'Of injecting liquors into the veins, and of transfusing the blood of one animal into another'. This section includes an image (Plate XI) illustrating aspects of venous access, treating aneurisms, injecting liquors into the vein and blood transfusion, together with an explanation of the figures included within it.

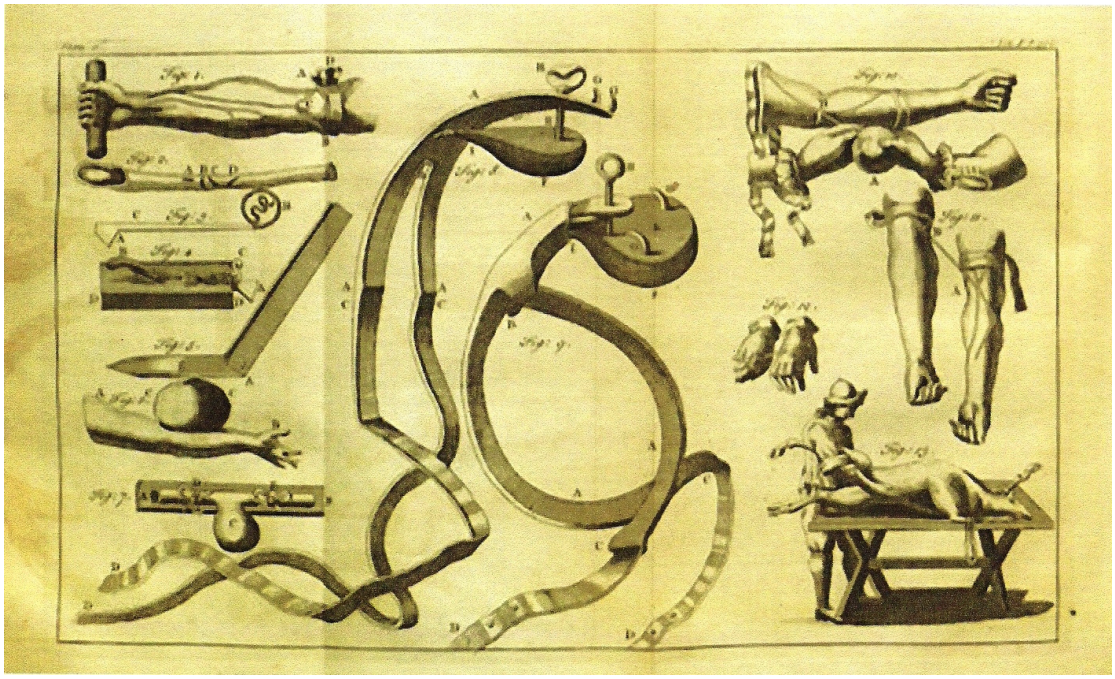


Plate XI – A general system of surgery in three parts (4th Edition) Part 2, Chapter XIV.
(Heister, 1750)
(Image credit: babel.hathitrust.org)

Fig.1. Represents an arm in which the vein is to be opened; *A* denotes the Cephalic vein, *B* the Basilic, and *C* the Median vein; *D* the ligature fixed above the elbow to make the veins swell.

Fig.2. Represents the several forms of incising a vein with a lancet; *A* shows a longitudinal incision, *B* a transverse one, and *C*, *D*, oblique ones.

Fig.3. Exhibits the ancient German Phlebotomus or Fleam for opening a vein, *A* the sharp point to be fixed on the vein, *B* the handle to be held in one hand, whilst part *C* is struck be fillip of the finger of the other hand, so as to drive the point *A* into the vein.

Fig.4. Is a Spring Fleam, now in use with some. The part *A* being fixed on the vein and the part *C* being elevated depresses the spring by the end *B*, which by its reaction or elasticity strikes the end *C* upon the Fleam *A*, so as to drive it into the vein. *DD* is a hollow case of brass or silver, in which the spring part of the instrument *B* is included.

Fig.5. Represents the French Phlebotomus, or Lancet, bent so as to form an obtuse angle, as it should be for the more convenient holding it in Bleeding.
Fig.6. Is the great aneurism as big as one's head, observed by Purmannus [i.e. Matthaus Gottfried Purmann] in an arm near the joint or bend of it.
Fig.7. Shows the manner of applying the ligatures above and below an aneurism, in the operation for that disorder. *AB* the artery, *C* the aneurism, *D* the upper ligature, *E* the lower ligature.
Fig.8. Exhibits an instrument contrived both for the prevention and cure of aneurisms. *AAA* denotes the plate of iron or steel in form to the flexure of the arm. *B* its fissure. *CC* ligatures fastened to the ends *AA*, and extended to *DD*. *E* denotes a moveable steel plate joined by the hinge *I*, and covered with a cushion of cotton or silk at *F*, to be fixed upon the aneurism. *GG* are two small hooks by which the instrument is fastened upon the arm by the ligature *CC DD*. *H* is a screw by which the plate and cushion *EF* are pressed down upon the tumour.
Fig.9. Represents an instrument of the same kind with the former, but of a different shape. Here the plate and cushion EF are larger, for bigger aneurisms than the former. Its parts and explanatory letters correspond to those of the preceding figure.
Fig.10. Shows the apparatus with a bladder and tube for injection of liquors into the veins; *A* the bladder and tube, *B* a vein of the arm opened, in which the tube is inserted.
Fig.11 & 12. Exhibit the transfusion of blood from the veins of one man into those of another; *B* denotes the recipient, and *A* the emittent arm.
Fig.13. Shows the transfusion of blood from the crucial artery or vein of an animal into the arm of a man, by the intervention of the tube *A*.
[Note: This illustration is similar to the one used by Georg Abraham Mercklin in 1679]

Chapter XIV starts with a comment that the chapter is included within the book 'as a branch of surgery' because it involves the opening of a vein. Heister then states:

'The generality of physicians, not without reason, attribute most disorders of the body to some vice in the blood, and therefore what method can be more ready to remove or correct that vice than injecting a proper medicine into the veins to mix with the blood itself, or the transfusing [of] the found blood of one man or animal into the veins of another, instead of that which is diseased. For by this means the action of a medicine on the blood will be immediate and entire, without being impaired or changed by passing the stomach and intestines, and mixing with various juices before it arrives to the veins.'

Of injecting liquors Heister states:

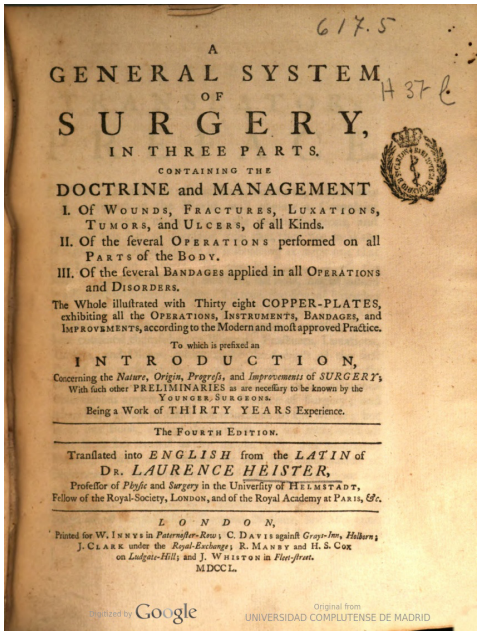
'First a vein is to be opened, usually in the arm, by your Lancet, as in Bleeding; and having introduced a small pipe of a syringe, or a very small clyster-pipe with a bladder (Table XI, Fig.10) the container liquor is injected or forced into the vein upwards towards the heart; which done you are to dress the orifice, and make your deligation upon the arm in the same manner as after phlebotomy.'

Of blood transfusion Heister states:

'For the transfusion of blood into the veins, you are first to open a vein in the patient's arm or hand, as at Fig.11 and 12, Table XI and then thrust gently upward into it a small tube of silver, brass or ivory. The same is also to be done with the found person (i.e. the donor); only the tube must here be inserted downward towards the small end of the vein. This done, the smallest of the tubes is to be inserted into the larger one, by which means as much blood will pass from the found person into the patient as may be thought proper, and then the incised veins are to be dressed or bound up as in Bleeding; but if the patient does not recover after one transfusion, the operation should be repeated again at convenient intervals. But before the patient

receives the blood of the found person, he ought to be bled proportionately, so that the new blood last received may have the freer circulation. Sometimes a vein is opened in each arm of the patient at the same time that as much of the vitiated blood may flow out of one orifice as he receives of the found by the other.' … 'If the blood is to be transfused out of some animal into the patient then a calf or a lamb, for example, are to be secured by ligatures and one of their veins or arteries opened either in the neck, leg or thigh, and the rest of the operation managed as before (see Table XI, Fig.13).' … 'Lastly where tubes of metal or bone are found painful and less convenient, for want of being flexible, operators contrive to fasten an intermediate flexible pipe betwixt the two others, such as part of the carotid artery, or the ureter from an ox, calf or lamb, or the windpipe of a capon, duck, etc., by which means the process becomes much facilitated both to the operator and the patients.' The description that the patient should be bled whilst being transfused resembles that illustrated by Johannes Scultetus in 1671.

Whilst Heister was noted for having performed a large number of different surgical procedures, many of which he demonstrated publically, at no time in this section of the book does Heister identify that he has actually performed a blood transfusion himself.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A
GENERAL SYSTEM
OF
SURGERY,
IN THREE PARTS.
CONTAINING THE
DOCTRINE and MANAGEMENT
I. Of Wounds, Fractures, Luxations, Tumors, and Ulcers, of all Kinds.
II. Of the feveral Operations performed on all Parts of the Body.
III. Of the feveral Bandages applied in all Operations and Disorders.
The Whole illuftrated with Thirty eight COPPER-PLATES, exhibiting all the Operations, Instruments, Bandages, and Improvements, according to the Modern and moft approved Practice.
To which is prefixed an
INTRODUCTION,
Concerning the *Nature*, *Origin*, *Progrefs*, and *Improvements* of *SURGERY*; With fuch other PRELIMINARIES as are neceffary to be known by the Younger Surgeons.
Being a Work of THIRTY YEARS Experience.
The Fourth Edition.
Tranflated into *ENGLISH* from the *LATIN* of
Dr. *LAURENCE HEISTER*,
Profeffor of *Phyfic* and *Surgery* in the Univerfity of Helmstadt, Fellow of the Royal-Society, London, and of the Royal Academy at Paris, *&c.*
LONDON,
Printed for W. Innys in *Paternoſter-Row*; C. Davis againſt *Gray's-Inn*, *Holborn*; J. Clark under the *Royal-Exchange*; R. Manby and H. S. Cox on *Ludgate-Hill*; and J. Whiston in *Fleet-ſtreet*.
MDCCL.

Title page: A General System of Surgery by Lorenz Heister (1743 – 4th Edition)
(Image credit: babel.hathitrust.org)


D. LAVRENTIVS HEISTERVS

Lorentz Heister – Portrait by J.J. Haid
(Image credit: Wellcome Collection)

Lorenz Heister was born in Frankfurt in 1683. He initially studied in the Universities of Giessen and Wetzlar between 1702 and 1706, after which he moved to Leiden, Amsterdam, obtaining his M.D. in 1708. In 1709 Heister joined the Dutch army as a field surgeon subsequently caring for the wounded in the battles of Oudenarde (Belgium) and Malplaquet (France). In 1710, at the age of 27, he was appointed Professor of Anatomy and Surgery at the University of Altdorf, near Nuremberg, when he started working on his book, the first edition being published in 1718. Although he lectured and wrote in Latin, the common language of science at that time, Heister decided to write his book in German and because of this and the fact that it contains a large number of illustrations of operations and instruments, it quickly became the most important surgical textbook in Europe. The book was translated

into French, Italian, Spanish and Latin. An English translation was produced from the Latin version in 1743, which included the title 'A general system of surgery in three parts'. Heister is also the author of other works on surgery and anatomy. He died in 1758 in Helmstadt, near Wurzburg.

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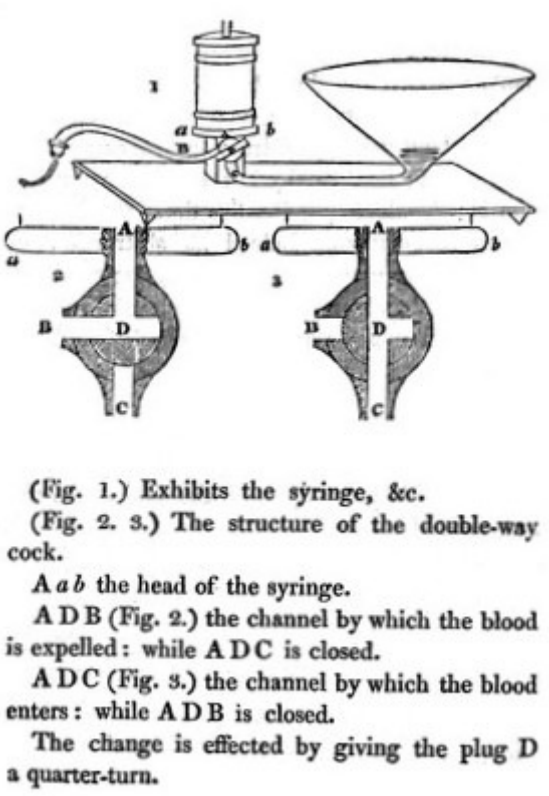
EXPERIMENTS ON THE TRANSFUSION OF BLOOD BY SYRINGE (1818); SOME REMARKS ON THE OPERATION OF TRANSFUSION (1825); OBSERVATIONS ON TRANSFUSION OF BLOOD WITH A DESCRIPTION OF HIS GRAVITATOR (1829) BY JAMES BLUNDELL

Having originally used a cannula to directly transfuse arterial blood from one animal into the vein of another, James Blundell devised a syringe, an Impellor and a Gravitator to perform indirect transfusions in both animals (usually dogs) and humans.

Blundell's first paper on the subject of transfusion that contains a diagram of one of his instruments was published in 1818 and titled *Experiments on the transfusion of blood by syringe*. This paper summarises the outcomes of a variety of different experiments that he performed on dogs and describes and illustrates the syringe he devised to experiment with the indirect transfer of blood from the donor to the recipient animal.



Blundell's Syringe (1818)
(Image credit: Wellcome Collection)

The syringe has a three-way valve device which allows (donor) blood to be sucked from a collection funnel and then by turning the valve, to push the blood via a tube into the recipient's vein. He used this same syringe device for the first time to transfuse a man later that same year and published the details of the operation in 1819 in a paper titled *Some account of a case of obstinate vomiting, in which an attempt was made to prolong life by the injection of blood into the veins*. Blundell described the syringe (somewhat confusingly) in the 1818 paper as follows:

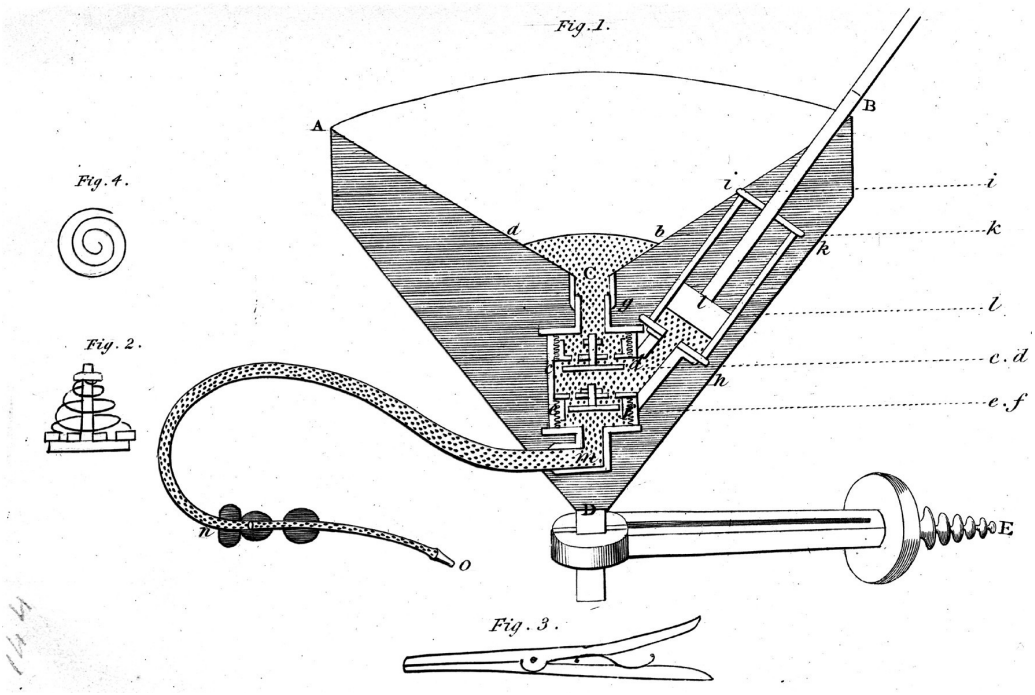
'The syringe is constructed in the usual manner; the cup, which is designed to collect the blood, is funnel-shaped; but the tubular part is a little more complicated. It consists of two pipes, with a double-way cock. Of these pipes, one is intended to discharge the contents of

the syringe; and is connected by one extremity to the nozzle, and by the other, when the instrument is in action, to the tubule which his inserted into the vein. To this venous tube it fixes by sliding over the end, so that the two may be easily disunited; but it is connected to the syringe itself by means of a screw upon the side of the nozzle, in such a manner as to lie at right angles with it. The other pipe, which is designed to conduct the blood from the cup to the syringe, is united at one extremity to the nozzle, and at the other to the bottom of the cup, the point of which opens into it. Of course this pipe is formed with a rectangular curve at either end, so as to give an upright position to the cup. The two-way cock, which completes the instrument, forms a part of the nozzle; and making a quarter turn, throws upon the tube which discharges, and closes that which admits the blood, or the contrary, according to the position in which it is placed.'

Blundell included a section titled 'Some remarks on the operation of transfusion' within the book *Researches physiological and pathological: instituted principally with a view to the improvement of medical and surgical practice*, published in 1825. As well as describing some of his research experiments and clinical cases, he identifies that as well as a tube for the direct transfusion of blood he has used two types of equipment for performing indirect blood transfusions. The first of these is a piece of equipment that he describes as an 'Impellor', which is essentially is a water-jacketed funnel with a piston-type pump. Blundell describes in some detail how this piece of equipment is employed and notes that 'these instruments are now manufactured by Laundy of St Thomas's Street, Southwark.' Essentially the outer funnel is attached by a screw to a chair that is also used by the blood donor to sit on. This funnel incorporates a piston operated valve and pump mechanism. This funnel is filled with 'tepid' water and an inner funnel is then carefully fitted over the valve mechanism ensuring that it is air-tight – the outer water-filled jacket therefore keeping the mechanism warm. This inner vessel is then also filled with 'milk-warm' water which is pumped through the connecting tube to expel the air from the equipment. The donor is then bled from an arm and the venous blood collected in the inner jacketed funnel is thereby gently pumped into the patient.

Blundell's Impellor fixed to the back of a chair (1825)
(Image credit: ncbi.nlm.nih.gov)

There is also a cut-through diagram of the Impellor showing its workings by means of two pressure valves, together with an extensive explanation of the equipment.

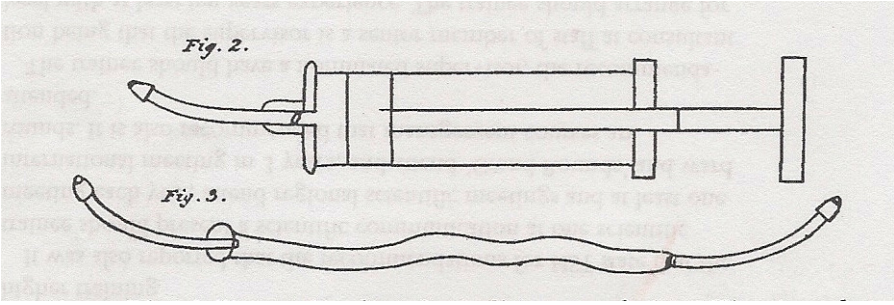


Cut-through diagram of Blundell's Impellor (1825)
(Image credit: Wellcome Collection)

Fig.1. Perpendicular section of the Impellor
A.C.B. The inner cup
A.D.B. The outer cup full of water
D.E. The vice
a.b. A line on the inner cup above which the blood should not be suffered to rise
c.d. The upper valve, armed with two or three folds of soft alum leather
e.f. The under valve, *idem*
g.h.i.k. The syringe
l. The plug
B. A mark on the piston-rod indicating the elevation to which the plug l has to be raised
The space covered with dots represents that portion of the instrument which is filled with blood. The space covered with lines represents that portion of the instrument which is full of water
m.n. The flexible tube
n.o. The venous tubule
When the piston of the syringe is raised, the blood is drawn from the cup A.C.B. down pipe C. through the upper valve *c.d.* into the syringe; the reflux from that part of the equipment which lies below the under valve *e.f.* is prevented from the closure of the valve. When the piston is depressed the blood is expelled through the valve *e.f.* along the pipes *m.n.o.*; the reflux into the cup A.C.B. is prevented by the closure of the valve *c.d.* Except the plug joint at *n.* all the joints at which air might enter and mix with the blood, are covered with water, by which means the instrument is rendered air secure. With a view of avoiding complexity, the springs which raise the valves are not represented.
Fig.2. The valve with the springs mounted.
Fig.3. Spring forceps
Fig.4. The curve of the wire forming the spring which raises the valves

The second piece of equipment devised by Blundell and illustrated in his 1825 book he describes as an 'injection syringe' that is 'capable of containing three or four ounces of blood, with a nozzle capable of uniting in the way of a plug with either of

the venous tubules.' The syringe is therefore different from the one he described in 1818 and could be used to connect with a tubule in the donor vein or for sucking-up blood from a vessel 'such as a tumbler', inverted and the plunger gently depressed so as to remove any air, and then quickly 'plugged into' the venous tubule already in the arm of the recipient. The syringe is illustrated in the book (Fig.2) together with a 'tube for transfusion from arteries to veins direct' (Fig.3), i.e. effectively a cannula for direct transfusion from the artery or vein of the donor into the vein of the recipient.



Blundell's syringe and tube for transfusion (1825)
(Image credit: archive.org)

In 1829 Blundell published a paper titled *Observations on transfusion of blood with a description of his Gravitator*, which provides two images of this piece of equipment that is essentially a funnel connected via a pipe to the vein of the patient and is therefore a much simpler design that his Impellor. Venous blood from the donor is collected into a funnel and is via a simple stop-cock allowed to flow down a tube, which is strapped to the patient's arm, and into the vein of the patient. The blood is therefore transfused to the patient by gravity – essentially the same technique that was much later used to transfuse anticoagulated stored blood. The two images of the Gravitator presented in this paper are stated to illustrate 'the whole apparatus connected for use and in action' and to represent 'the several parts of the apparatus'.

James Blundell's Gravitator being used (1829)
(Image credit: Wellcome Collection)

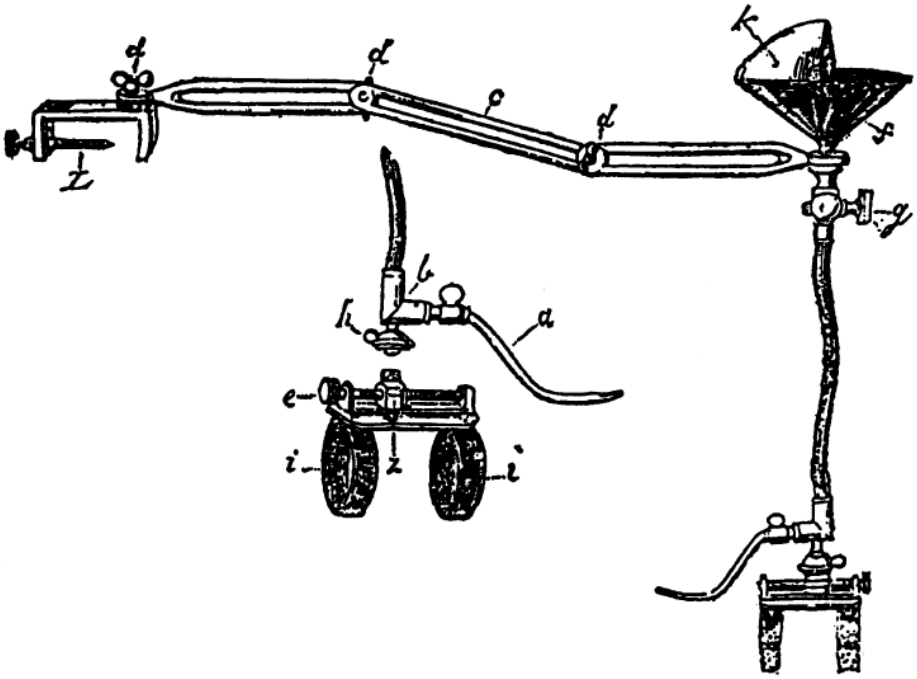


Diagram of the parts of Blundell's Gravitator (1829)
(Image credit: fdocuments.in)

Blundell provides quite extensive instructions on how to use the Gravitator in his 1829 paper, which involves filling the vessel and tube with warm water with the stop-cock (*g*) closed, carefully placing the bracelet on the patient's arm in such a way that the tubule (*a*) can be connected, having already been placed into a vein, and having flushed through some of the water (to remove any air), the donor's blood is allowed to run freely into the vessel and a small amount transfused at any one time, controlled by the stop-cocks. The original description by Blundell should be read to fully appreciate the complexity of the operation.

Blundell's syringe – Savigny & Co. London
(Image credit: Wellcome Collection)

Having devised these complex pieces of equipment he finally devised and used a metal syringe with a two-way valve and a glass collecting vessel, whereby the venous blood of the donor could be collected into the vessel, drawn into the syringe and by changing a valve infused into the recipient's vein. This much simpler instrument was made and marketed by Savigny & Co., London.

Dr James Blundell (1790-1877) was one of the outstanding obstetricians of his day who re-awakened interest in the use of blood transfusion following an extensive series of experiments on animals. Blundell initially became interested in transfusion as a method of treating post-partum haemorrhage, being *'… appalled at my own helplessness at combating fatal haemorrhage during delivery*.' He advocated the use of human rather than animal donor blood, though his reason for doing so at the time was somewhat less than scientific, stating: *'What is to be done in an emergency? A dog might come when you whistled but the animal is small; a calf might appear fitter for the purpose, but then it cannot be taught to walk properly up the stairs.'*

James Blundell and his colleague Henry Cline performed the first human-to-human transfusion on the 26th September 1818 in London using an ox-ureter (as tubing) and crow quills (as needles). Blundell argued that transfusion should be used for the treatment of desperately ill patients and performed ten transfusions between 1818 and 1829 with no more than four being successful (though two of the patients were already dead before the transfusion commenced!).

He subsequently described a transfusion (using a syringe) on a woman who was dying from post-partum haemorrhage in the *Lancet* in 1829. Following the transfusion the patient recovered and Blundell states that she '*... expresses herself very strongly on the benefits resulting from the injection of the blood; her observations are equivalent to this – that she felt as if life were infused into her body*.' Blundell however also reported that some of his patients *'... suffered fever, backache and passed dark urine*', i.e. what would now be recognised as a haemolytic transfusion reaction.

James Blundell M.D.
(Image credit: Wellcome Collection


THE LANCET.

First page of Blundell's 1829 paper
(Image credit: en.wikipedia.org)

James Blundell was born in Holborn, London, in 1790. He graduated from the University of Edinburgh Medical School with an MD in 1813 and began his medical career in London, lecturing on midwifery and physiology. On the death in 1818 of his uncle Dr John Haighton he succeeded him to the chair of obstetrics and physiology

at the combined schools of St. Thomas and Guy's Hospital where his lectures attracted large audiences. The publication of these lectures led to a breach between Blundell and the hospital and he left Guy's in 1834 following a dispute with the hospital treasurer. He continued his private practice, living with his grand niece Mary Noyes, retiring from practice in 1847. He never married and died in 1878, aged 87, his estate at that time being valued at £350,000.

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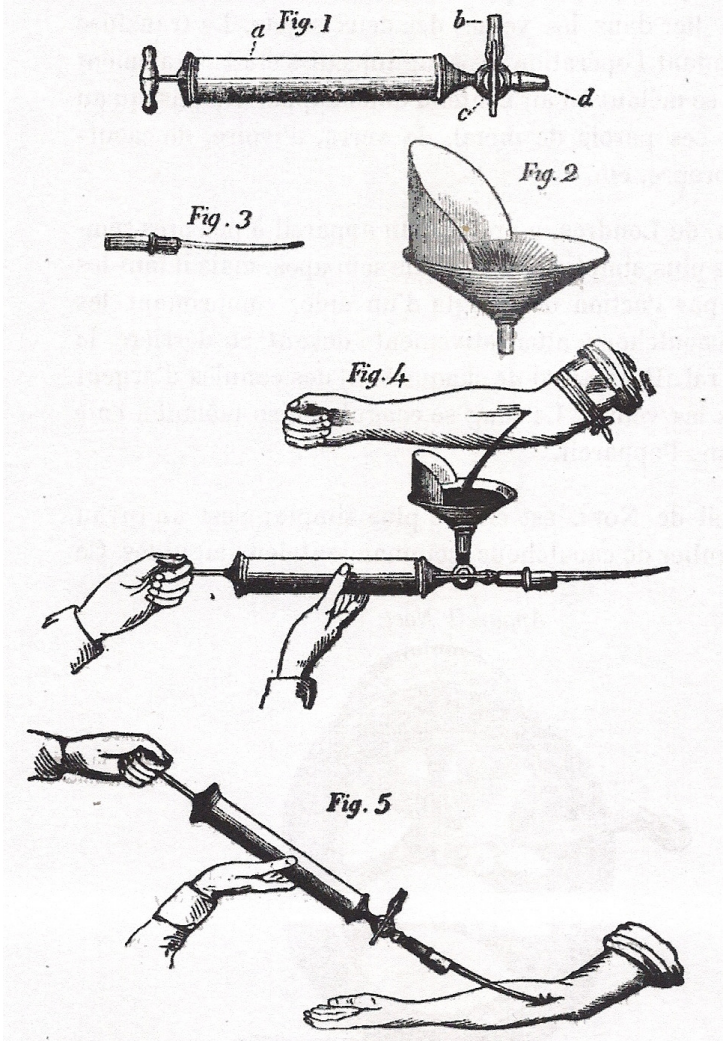
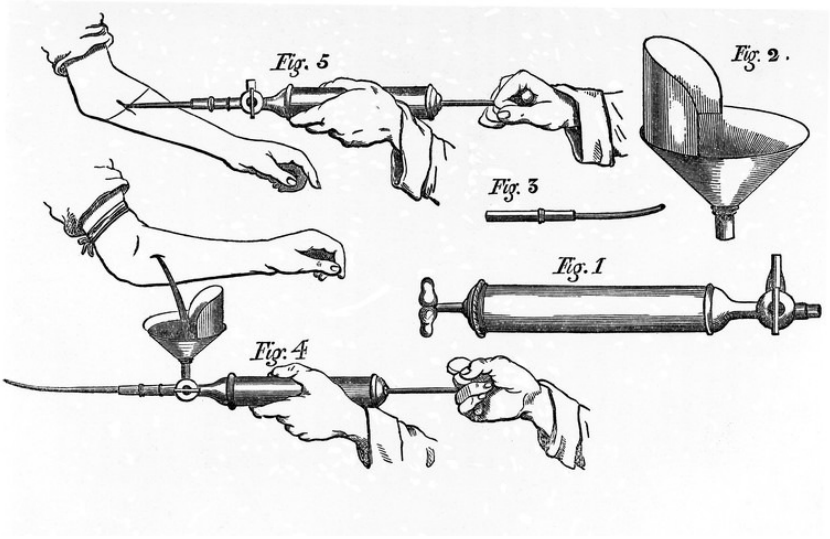
A DISSERTATION ON THE TRANSFUSION OF BLOOD IN THE MORE DANGEROUS VARIETIES OF UTERINE HAEMORRHAGE (1832); ON TRANSFUSION OF BLOOD: ITS HISTORY AND APPLICATION IN CASES OF SEVERE HAEMORRHAGE (1859) BY CHARLES WALLER

An image of Charles Waller's transfusion syringe was first published in 1832. It was included in: *A dissertation on the transfusion of blood in the more dangerous varieties of uterine haemorrhage*, which is a section of the 7th edition of the book: *An introduction to the practice of midwifery* that Waller re-wrote (the book having been originally written by Dr Thomas Denman). It is reproduced on page 415 of the book but as he states in the text 'The annexed sketch illustrates the mode of performing the operation [of transfusion], but the artist has unfortunately drawn the figures left handed; if this be recollected, the plate will convey a very tolerable idea of the subject'. In addition, the printed description of the images in the figure is also incomplete.



Charles Waller's Syringe (1832)
(Image credit: archive.org)

The same illustration, now reproduced right-handed, is included in Waller's 1859 paper titled: *On transfusion of blood: its history and application in cases of severe haemorrhage* that was published in the *Transactions of the Obstetrical Society of London* in 1859. Waller includes the following description of the image, though the letters used in the description are not reproduced in this image.



Charles Waller's Syringe (1859)
(Image credit: Wellcome Collection)

Fig.1. The syringe capable of receiving two ounces of blood: *a*, the barrel; *b*, the part upon which the funnel is received; it is hollow, communicating with the interior of the barrel of the syringe; *c*, the stop-cock; *d*, the extremity of the instrument, to which the silver pipe is affixed when the operation is about to be performed.
Fig.2. The funnel, composed of two portions; the part standing up is removable at pleasure, rendering the instrument more portable.
Fig.3. The silver tubule, bevelled at the point, to allow of its more easy introduction into the vein. The operator should be furnished with two or more of these tubes of different calibres.
Fig.4. Represents the mode in which the blood is received into the syringe, and
Fig.5. The manner in which the injection takes place; the tubule having been inserted into the vein at the bend of the arm.
In addition to the above, a common probe is required, the blunt end of which should be passed under the vein at the lower part of the incision, upon which pressure should be made by the finger of an assistant, to prevent any oozing of blood.

Charles Waller (1798-1862) was a vocal and loyal supporter of James Blundell's work to get blood transfusion accepted as a form of treatment for uterine haemorrhage. He began his medical career when 23 years old at Guy's and St Thomas' Hospitals, later specialising in midwifery and subsequently becoming Physician-Accoucheur and Lecturer in Midwifery at St Thomas's Hospital, London. He was a prolific writer of papers on the use of transfusion, some of which he re-published in different journals.

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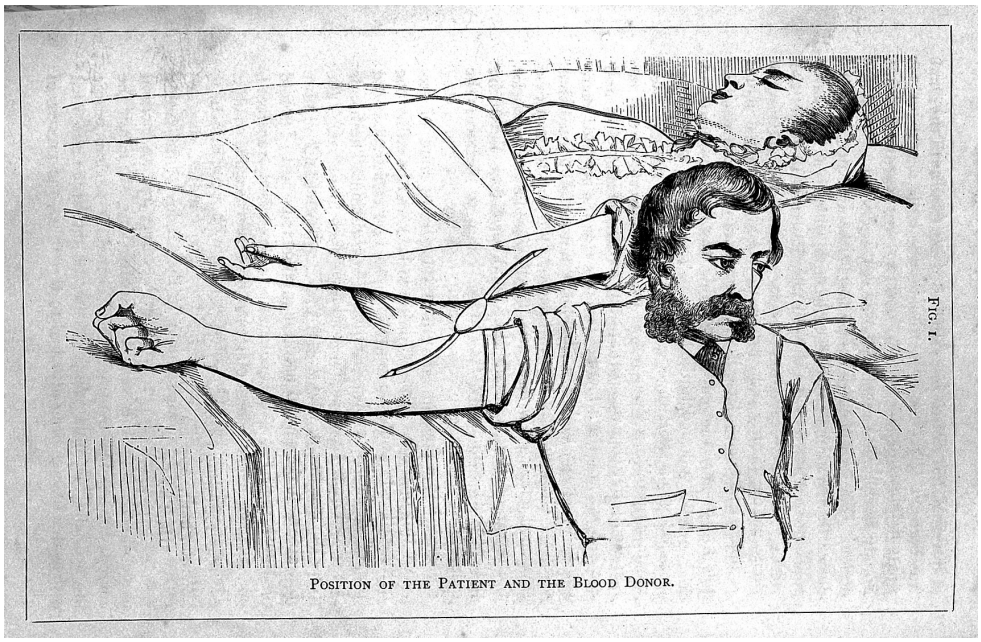
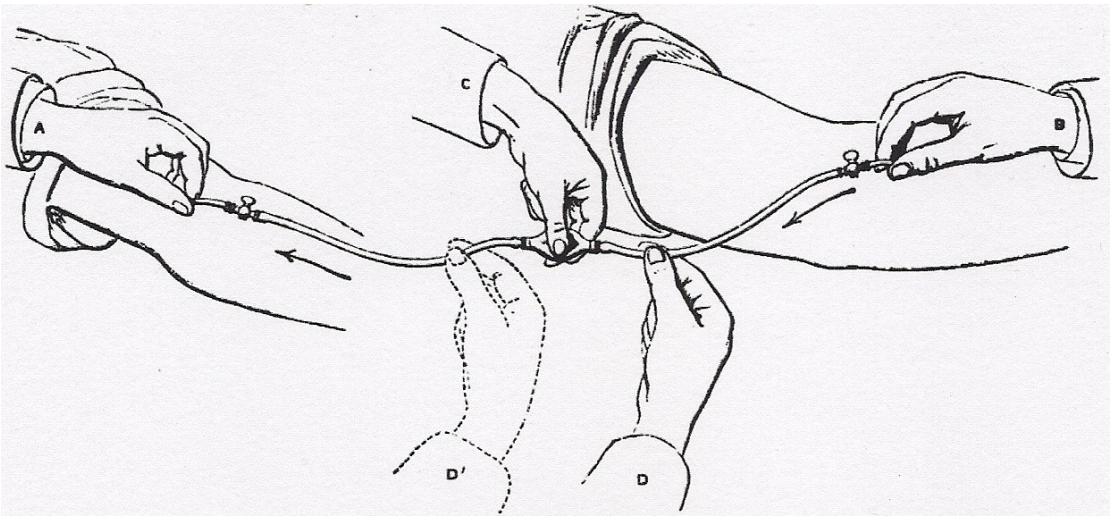
ON IMMEDIATE TRANSFUSION (1865); A SUCCESSFUL CASE OF IMMEDIATE TRANSFUSION (1872); IMMEDIATE TRANSFUSION IN ENGLAND: SEVEN CASES, AND THE AUTHOR'S METHOD OF OPERATING (1873) BY JAMES HOBSON AVELING

Aveling's first paper called: *On immediate transfusion* was published in *Transactions of the Obstetrical Society of London* in 1865, when he was working as a Senior Medical Officer to the Sheffield Hospital for Women. In the paper he first discusses the problem of blood flow when the veins of a donor and patient are connected by a tube as the venous circulation is not sufficiently strong enough to ensure continuous passage of the blood and argues that it is this poor blood flow that results in it coagulating. He then describes his transfusion instrument as follows: *'It consists of two small silver tubes to enter the vessels and of an india-rubber pipe by which they are united, and which has in its centre an elastic receptacle, holding about two drachms. It is without valves, and is simply a continuous pipe with an expanded portion in the middle*'. After connecting the pipe to the donor vein, the tube is first filled with donor blood, whilst at the same time expelling the air from it by holding the tube vertically. It is then connected to the pipe in the recipient's vein. By alternatively compressing the pipe on different sides of the central bulb it acts as a pump, though he notes that this should be performed slowly and that the pipes in the donor and recipient veins should be held in place between the finger and thumb of an assistant. As well as this description the article also contains a somewhat stylised illustration, especially given that Aveling states that he has only experimented with the instrument on horses and has not up to that time used it for a human transfusion.



Direct Transfusion – Aveling (1865)
(Image credit: remedianetwork.net)

In 1872 Aveling (1828-1892) published a paper in the *Lancet* which identified that he had successfully transfused a twenty-one year old woman with post-partum haemorrhage using his instrument. A paper on immediate transfusion published in 1873 includes details of four historic cases, two recent cases performed by other surgeons who had used his transfusion apparatus and one of his own – all being performed on women suffering from post-partum haemorrhage. This paper also includes the same image as the one published in 1865 together with another drawing that provides details of the transfusion method.

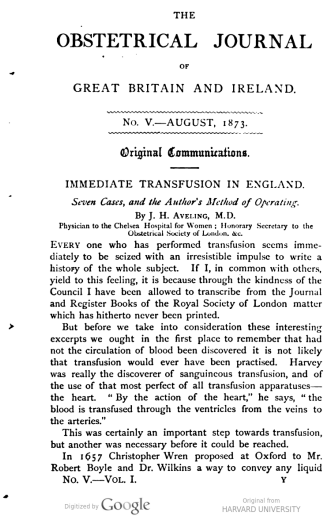


Direct transfusion technique using Aveling's equipment (1873)
(Image credit: Wellcome Collection)

B represents the hand of an assistant holding the efferent tube and the lips of the small wound together, and *A* shows the afferent tube secured in the same manner. The india-rubber portion of the apparatus, filled with water, and kept so by turning the cock at each end of it, is now fitted into the two tubes. The cocks are then turned straight, and the operation commenced by compressing the india-rubber tube on the efferent side *D*, and squeezing the bulb *C*; this forces two drahms of water into the afferent vein. Next shift the hand *D* to *D'* and compress the tube and compress the tube on the afferent side, then allow the bulb to expand slowly, when blood will be drawn into it from the efferent vein.

This operational method differs from his original description in that it identifies that the rubber tubing is first filled with water to avoid the donor blood coming into contact with air, which is the same reasoning used by Roussel in 1876. In 1874 Aveling described another transfusion using his equipment but inexplicably chose to use a lamb instead of a human blood donor. Even though the use of animal blood donors was popular in Europe in the 1870's, this report made him the first doctor to perform an animal-to-human immediate transfusion in England.

James Hobson Aveling (1828-1892)
(Image credit: cambridge.org)



THE
OBSTETRICAL JOURNAL
OF
GREAT BRITAIN AND IRELAND.

No. V.—AUGUST, 1873.

Original Communications.

IMMEDIATE TRANSFUSION IN ENGLAND.

Seven Cases, and the Author's Method of Operating.

By J. H. Aveling, M.D.
Physician to the Chelsea Hospital for Women; Honorary Secretary to the Obstetrical Society of London, &c.

EVERY one who has performed transfusion seems immediately to be seized with an irresistible impulse to write a history of the whole subject. If I, in common with others, yield to this feeling, it is because through the kindness of the Council I have been allowed to transcribe from the Journal and Register Books of the Royal Society of London matter which has hitherto never been printed.

But before we take into consideration these interesting excerpts we ought in the first place to remember that had not the circulation of blood been discovered it is not likely that transfusion would ever have been practised. Harvey was really the discoverer of sanguineous transfusion, and of the use of that most perfect of all transfusion apparatuses—the heart. "By the action of the heart," he says, "the blood is transfused through the ventricles from the veins to the arteries."

This was certainly an important step towards transfusion, but another was necessary before it could be reached.

In 1657 Christopher Wren proposed at Oxford to Mr. Robert Boyle and Dr. Wilkins a way to convey any liquid

Title page of Aveling's 1873 paper
(Image credit: babel.hathitrust.org)

James Hobson Aveling was born in Cambridgeshire in 1828, graduated in Aberdeen in 1856 and then settled in Sheffield into general practice and where nine years later he founded the Sheffield Hospital for Women. In 1868 he moved to London where, together with Dr. Chambers, he started a small hospital for women in Chelsea, which was to become the Chelsea Hospital for Women and where Aveling became the senior physician. He edited the *Obstetrical Journal* for many years during which time he actively advocated the recognition of midwives by the State. He died in December 1892 of typhoid fever.

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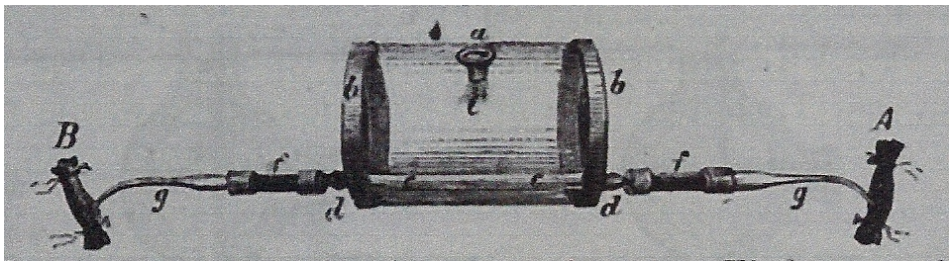
DIE TRANSFUSION DES BLUTES IN PHYSIOLOGISCHER UND MEDICINISCHER BEZIEHUNG (1869) BY LADISLAO VON BELINA-SWIONTKOWSKI

Belina-Swiontkowski's book *Die transfusion des blutes in physiologischer und medicinischer beziehung*, printed in Heidelberg in 1869 is a review of transfusion to that date. He starts with a section on the history of blood transfusion (pages 3-18) followed by a series of charts summarising the information for 155 blood transfusions that were published between 1819 and 1868 inclusive. These are broken down into three categories, i.e. transfusion given for uterine bleeding following childbirth (83 cases), for traumatic and neoplastic bleeding (21 cases) and for 'blood anomalies' (51 cases). Of these 155 collected cases he states that 75 had a good result, 3 had transitory good results, 5 doubtful and 72 had no effect; in only 2 cases was animal blood used and these were both classed as 'doubtfully successful'.

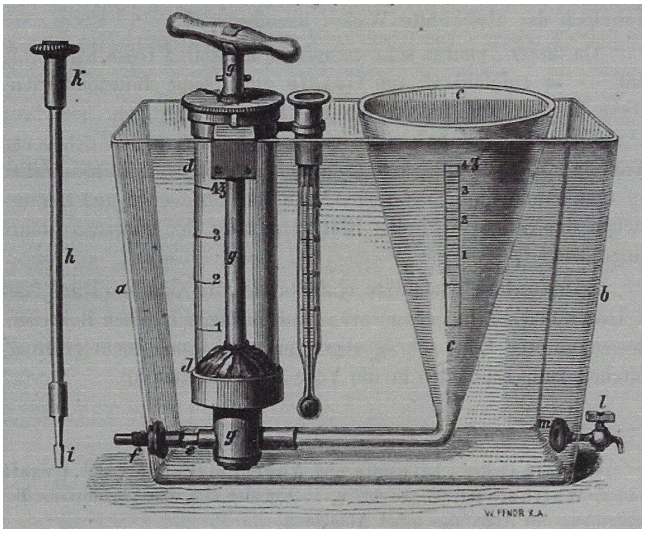
As well as sections on the physiological basis for transfusion and the medical applications of transfusion the book also includes an extensive section on transfusion techniques. Belina also describes and illustrates seventeen different types of blood transfusion equipment developed and used by the people who performed the 155 cases of transfusion listed in the book, including one developed by himself and Dr Helmholtz. In this respect, this book is similar to two other books of that same period, i.e. by Louis Jullien (1875) and Joseph Roussel (1876). Belina-Swiontkowski also published the book *De la transfusion du sang défibriné* in 1871. His surname has been given various interpretations including Ladislao de Belina and L. Belina-Kwiatkowski as well as L. von Belina-Swiontkowski.

Instead of a simple cannula, Karl Ferdinand von Graefe (1787-1840), a German surgeon from Warsaw, devised a somewhat complicated apparatus for direct transfusion that consists of a glass cylinder with a brass surround *bb* and a tubule *a*, which allows it to be filled with warm water. A glass tube *cc* passes through the middle of this cylinder, the ends of which *dd* are connected to rubber tubes *ff* and these again are connected to silver tubes *gg*, the curved ends of which are tied into the corresponding blood vessels *A* and *B* of the donor and recipient. The ides of keeping the blood warm as it passed from the donor to the recipient was believed at that time to slow the clotting process.



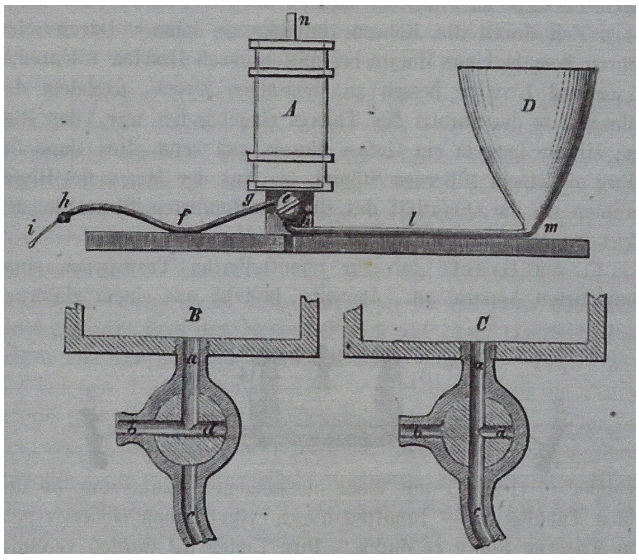
von Graefe's direct transfusion apparatus (Belina-Swiontkowski, 1869)
(Image credit: Wellcome Collection)

Karl von Graefe also devised what is essentially a modification of Blundell's' syringe, which consists of a graduated collection vessel (enabling the amount of transfused blood to be measured) that is connected to a syringe and then to a tube. The collection vessel and syringe are inside a glass bath that is filled with warm water – the temperature of which can be monitored with a thermometer.



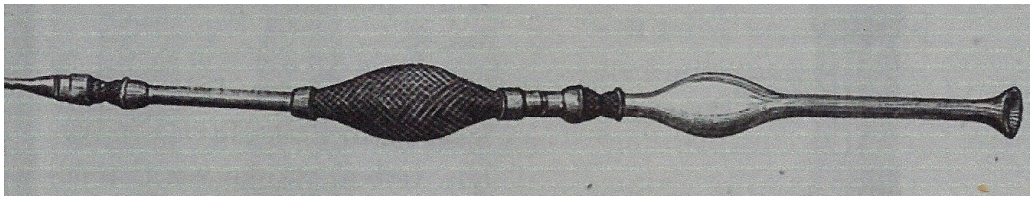
von Graefe's indirect transfusion apparatus (Belina-Swiontkowski, 1869)
(Image credit: Wellcome Collection)

An image of James Blundell's syringe for indirect transfusion is included within the book, which is a similar illustration as that presented in his original paper published in 1818 titled *Experiments on the transfusion of blood by syringe*, but it is a somewhat clearer version with regard to the valve settings. The image legend states that the reservoir *D* is connected via a tube to the valve that allows the syringe *A* to pull blood from the reservoir into the syringe (setting C) or push blood from the syringe into the patient (setting B) via tube *f*.



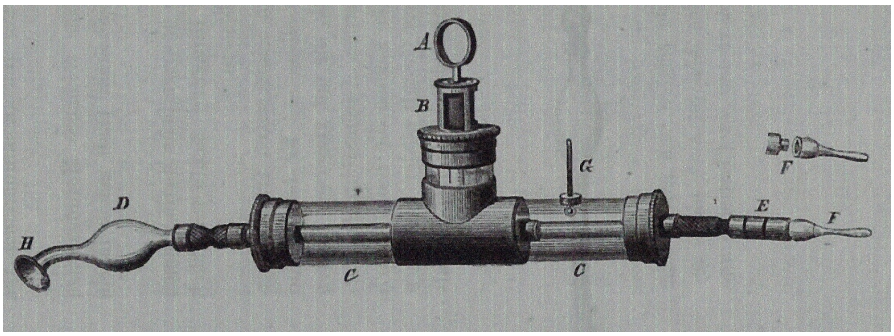
James Blundell's syringe for indirect transfusion (Belina-Swiontkowski, 1869)
(Image credit: Wellcome Collection)

In 1853 Mathieu constructed his first transfusion apparatus which consisted of a vulcanized rubber balloon connected with a glass tube and a corresponding ivory 'discharge tube'. Due to their elasticity the balloon can automatically assume its former shape by itself after squeezing and with appropriately designed ball valves it acts as both a suction and drainage pump. This apparatus is therefore essentially similar to that devised by James Hobson Aveling in 1865.



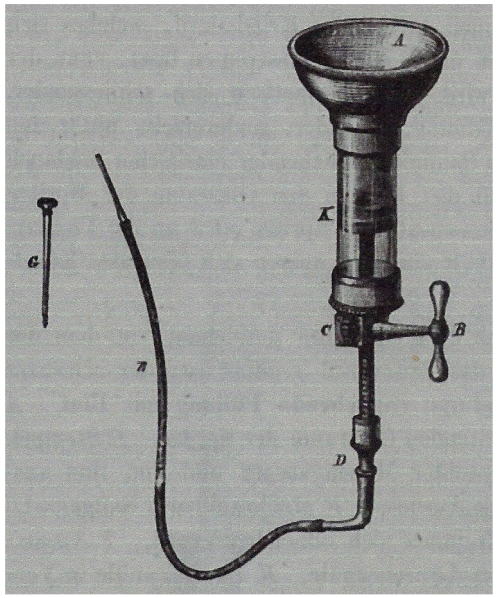
Mathieu's transfusion apparatus – 1853 (Belina-Swiontkowski, 1869)
(Image credit: Wellcome Collection)

Mathieu's second device is a development of his first in that a suction pump *B* is moved by means of a plunger *A*; *D* is the intake reservoir with its inlet opening *H*; *F* is an ivory outflow pipe; *CC* is a glass cylinder that is filled with warm water, the temperature of which is monitored by a thermometer *G*. The cylinder contains glass tubes that connect the reservoir *D* with the pump *B* and the pump with the outflow tube that was presumably placed into an already open vein.



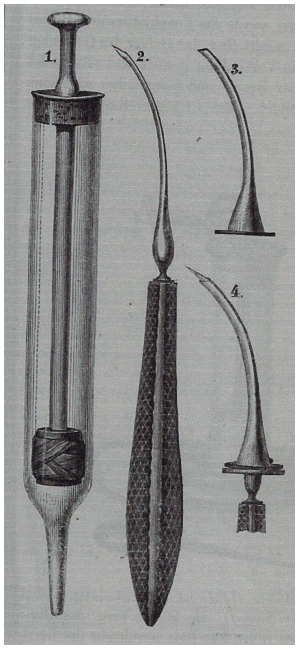
Mathieu's transfusion equipment – 1853 (Belina-Swiontkowski, 1869)
(Image credit: Wellcome Collection)

Mathieu's apparatus designed in 1866 involves a reservoir for collecting the donor blood and a syringe pump with a handle that pulls the blood from the reservoir into the rubber tube and then pushes it into the vein of the patient. Note: Moncoq claims that he designed this apparatus not Mathieu – see Moncoq 1874.



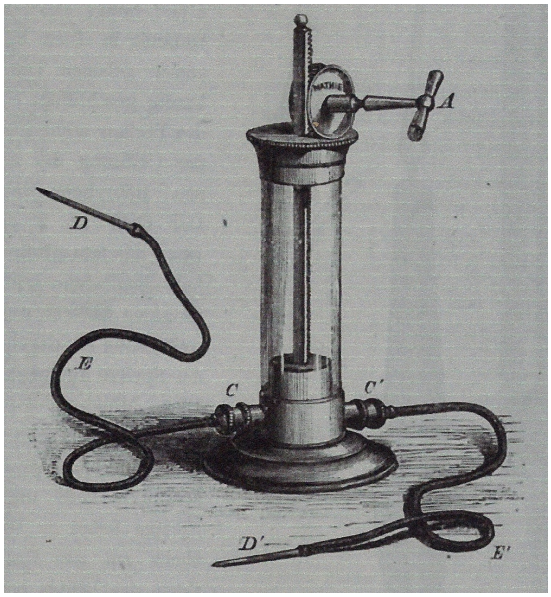
Apparatus attributed to Mathieu – 1866 (Belina-Swiontkowski, 1869)
(Image credit: Wellcome Collection)

Professor E. Martin's all-glass tube that holds two ounces of blood has a glass plunger that can be inserted into it, the end of which is stated by von Belina-Swiontkowski to have been wrapped in cotton thread that was replaced after use. The illustration also includes an instrument (item number 2) that is stated to have been used to expose the patient's vein into which the blood is then infused via a curved tube (item number 3). The glass container is said to be seven inches long and was presumably filled with untreated blood directly from the donor or more likely with defibrinated donor blood.



Indirect transfusion equipment devised by Martin (Belina-Swiontkowski, 1869)
(Image credit: Wellcome Collection)

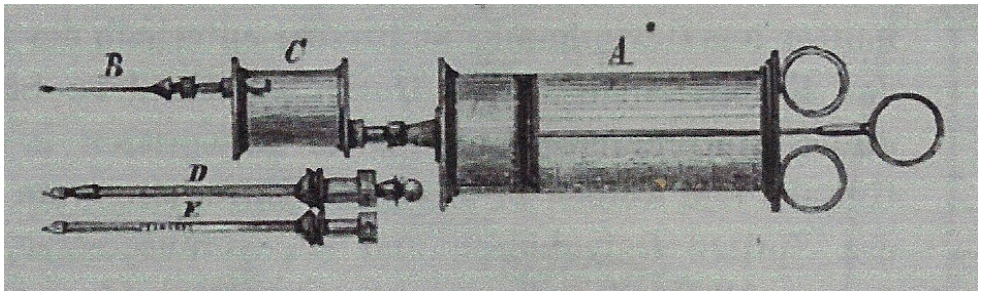
Dr Moncoq's direct transfusion device of 1862 is a ratchet wheel operated glass-metal syringe with thin rubber pipes between valves CC/ and small silver tubes DD/ that are inserted into the donor and recipient's veins.



Direct transfusion equipment devised by Moncoq – 1862 (Belina-Swiontkowski, 1869)
(Image credit: Wellcome Collection)

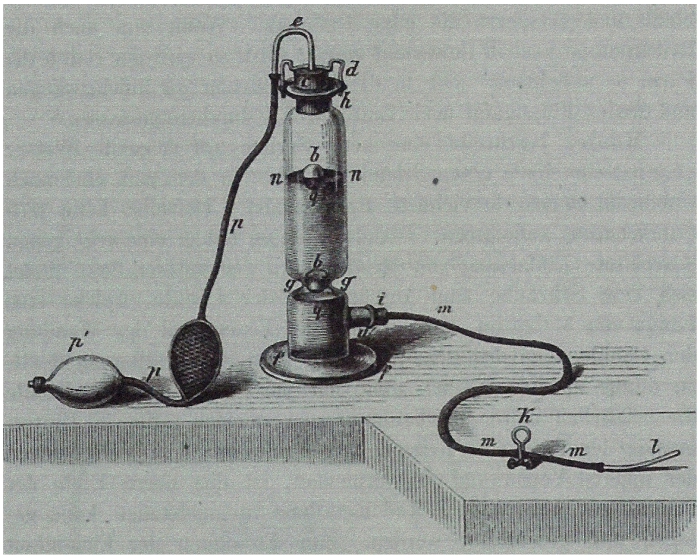
By alternatively opening and closing the valves, blood can be drawn from the donor and then pumped into the patient. Each of the rubber tubes is stated to be 10 cm. in length and very narrow. Moncoq believed that the narrow rubber pipes together with the pumping action of the syringe would prevent coagulation of the donor blood, as together they would closely resemble the systolic and diastolic pressure in a vein.

In 1866 Eulenburg and Landois devised a syringe designed primarily to prevent air from entering the recipient's veins, achieved by use of an air-trap glass tube *C*. The syringe barrel is stated to have been etched with measurements in multiples of one cubic centimetre to measure the amount of blood transfused.



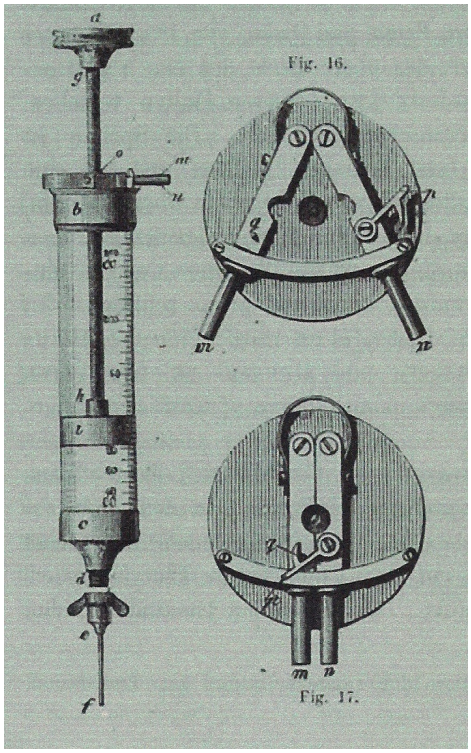
Apparatus attributed to Eulenburg and Landois – 1866 (Belina-Swiontkowski, 1869)
(Image credit: Wellcome Collection)

Belina-Swiontkowski states that an illustration of Richardson's apparatus was originally published in Neudorfer's Handbook of War Surgery in 1867. This piece of transfusion equipment consists of a fluted glass receptacle with ball valves that together with the use of an in-line air pressure ball-pump is designed to remove air from the donor blood whilst transfusing it under pressure to the recipient's vein.



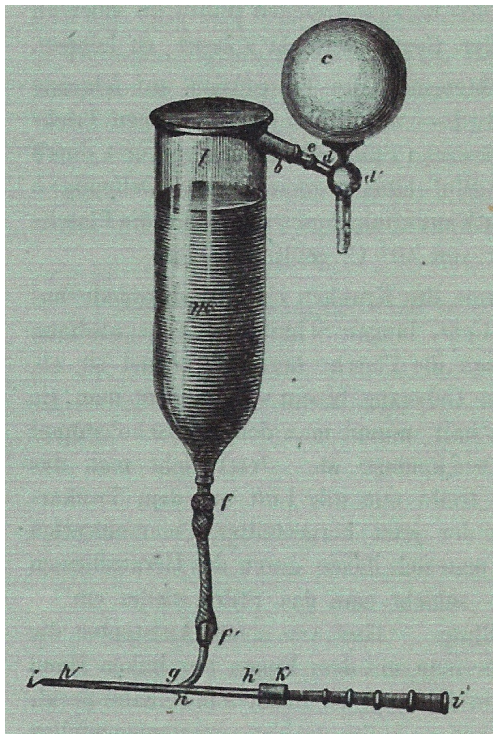
Apparatus attributed to Richardson – 1867 (Belina-Swiontkowski, 1869)
(Image credit: Wellcome Collection)

In 1867 Mosler designed a syringe for transfusing defibrinated blood that incorporates a plunger mechanism in a 30 c.c. glass-metal syringe. The syringe plunger is held in place by a removable locking mechanism, thereby allowing the syringe to be filled with the defibrinated donor blood, the plunger being replaced and clamped into position prior to use. The syringe barrel is graduated in cubic centimetres to enable the amount of blood transfused to be identified.

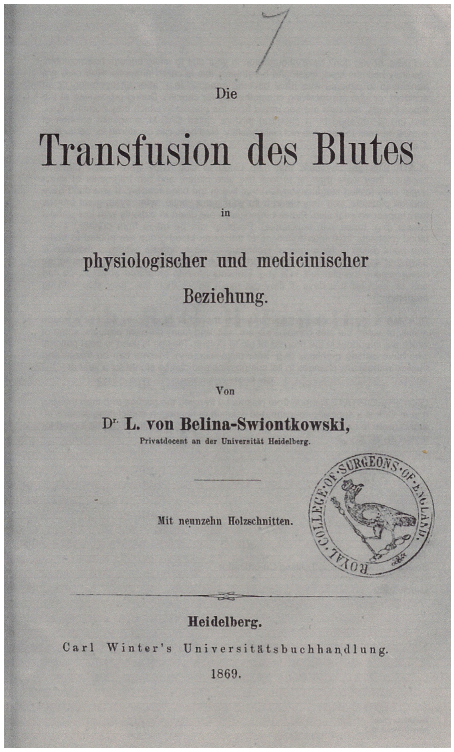


Apparatus attributed to Mosler – 1867 (Belina-Swiontkowski, 1869)
(Image credit: Wellcome Collection)

Finally Ladislao von Belina-Swiontkowski illustrates an example of his own 'portable' indirect transfusion apparatus consisting of a graduated 300 cubic centimetre glass tube that uses air compression from a rubber ball (*c*) and valve to push defibrinated blood from the glass vessel down a tube to a five centimetre long infusion pipe.



Apparatus devised to Belina-Swiontowski – 1869 (Belina-Swiontkowski, 1869)
(Image credit: Wellcome Collection)



Die

Transfusion des Blutes

in

physiologischer und medicinischer

Beziehung.

Von

Dr. L. von Belina-Swiontkowski,

Privatdocent an der Universität Heidelberg.

Mit neunzehn Holzschnitten.

Heidelberg.

Carl Winter's Universitätsbuchhandlung.

1869.

Title page of Die Transfusion des Blutes by L. von Belina-Swiontkowski (1869)
(Image credit: Wellcome Collection)

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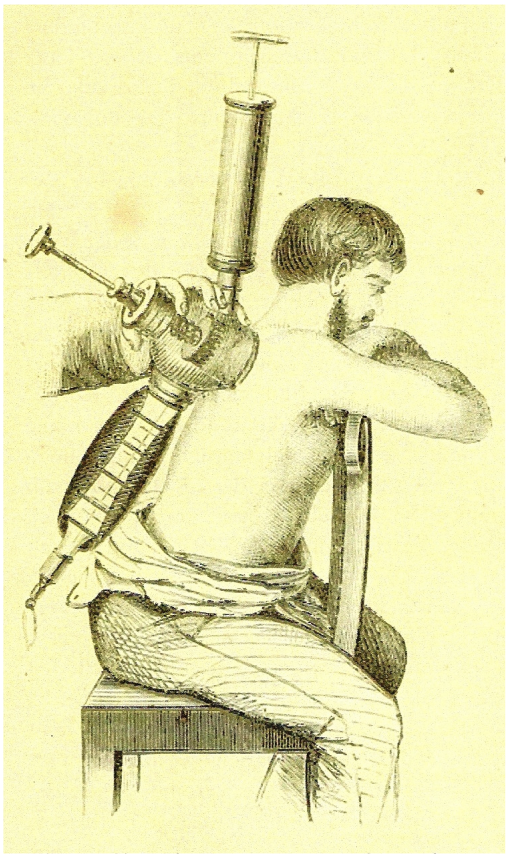
DIE TRANSFUSION DES BLUTES (1873) BY FRANZ GESELLIUS

In his book *Die Transfusion des Blutes, eine historische, kritisch und physiologische Studie* published in 1873, the Polish physician and surgeon Franz Gesellius described his apparatus for the collection and transfusion of blood. This instrument was in fact first described and illustrated five years earlier but only as a frontispiece in his 1868 book *Capillar-Blut undefibrinirtes zur Transfusion: ein neuer Apparat zur Transfusion, sowohl zur einfachen, als auch zur depletorischen*.

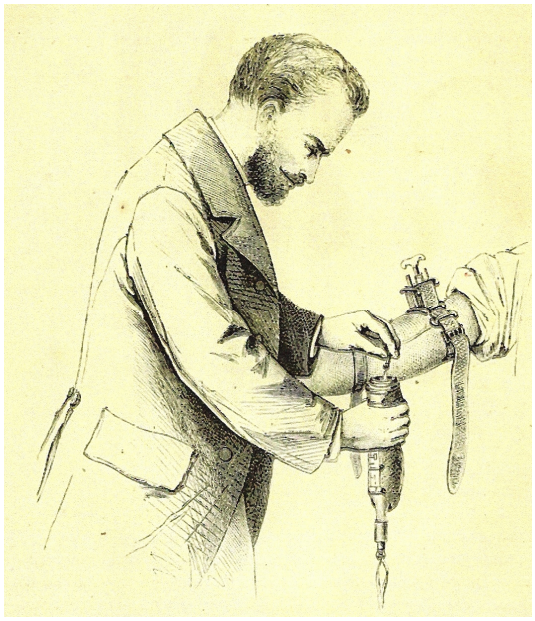
The 1873 book does not include an illustration of his actual transfusion technique but does illustrate the different pieces of equipment that he used. His initial methods used human donor capillary blood collected into a metal cup that was placed onto the donor's back. This metal cup incorporated a number of spring-loaded lancets which simultaneously punctured the skin at numerous sites. This capillary blood was then drawn into a jacketed metal-glass syringe attached to the cup. The image of this piece of equipment being used on a blood donor is included in his book, which also identifies that he performed 22 sheep to dog blood transfusions and 19 transfusions using either donor sheep or calf blood to human recipients.

Frontispiece – Gesellius 1868
(Image credit: Wellcome Collection)

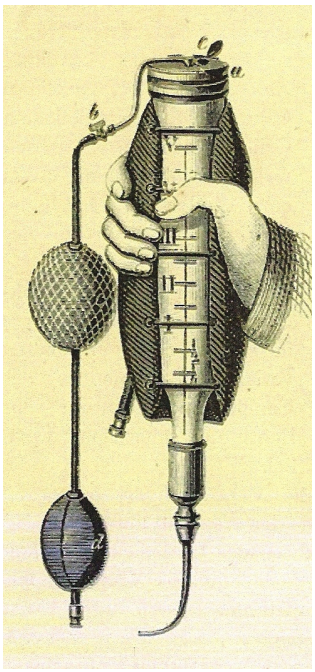


Capillary blood collection (Gesellius, 1873)
(Image credit: Wellcome Collection)

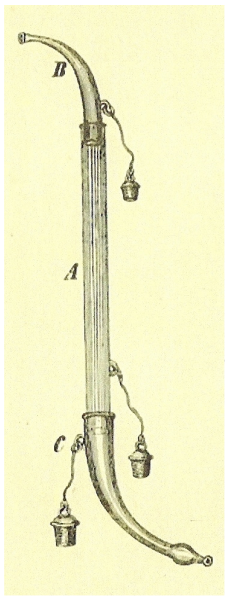
Somewhat understandably Gesellius changed the method of collecting donor blood from capillary to venous blood, collecting it directly into the jacketed syringe and his book also includes an illustration of him collecting blood directly from the vein of a human donor. The metal-glass jacketed syringe (to maintain the temperature of the donor blood) had a screw top which could be pressurised to increase the flow of blood into the recipient. The book describes both straight of curved needles that could be inserted into a recipient's vein.



Venous blood collection into the jacketed syringe (Gesellius, 1873)
(Image credit: Wellcome Collection)



Jacketed syringe (Gesellius, 1873)
(Image credit: Wellcome Collection)



Direct transfusion cannula (Gesellius, 1873)
A: Glass tube, **B**: Silver cannula – human vein,
C: Silver cannula – donor animal
(Image credit: Wellcome Collection)

However, from this somewhat promising start involving human blood donors, Gesellius passed onto supporting the use of animal donor blood and in a somewhat over elaborate investigation argued that greater dangers were associated with the use of human rather than animal donor blood. He persisted in using animal blood even though James Blundell's experiments in the early part of the 19th century had shown that the blood from one species of animal was potentially fatal to another. Shortly after the publication of Gesellius' book the issue of inter-species incompatibility was resolved by the experiments of Dr Ponfick who reported the dangers of transfusion between species in 1874 and by Dr Landois who published details of the effects of his cross-species experiments in 1875.

The book also contains an attack on transfusions using defibrinated blood, which Gesellius describes as being 'dead blood' and ends with a plea for the direct transfusion of blood from the artery of a lamb, stating that it is oxygen-rich, alive, and life-giving. His concluding prophecy of 'Die Lammblut Transfusion wird in der Medicin eine neue Aera die – blutspendende – inaugurieren', i.e. that 'lamb blood transfusion would inaugurate a new era within medicine' would soon prove to be very much misguided.

Gesellius was born in 1840 in Neubrandenburg and after studying medicine in Greifswald, Berlin and Breslau and then spending time in the army he obtained his doctorate in Rostock. Initially living in Helsinki he finally settled in St. Petersburg. His transfusion research post-dates that performed by James Blundell in England and took place 30 years before Karl Landsteiner discovered the human ABO blood group system. He was instrumental, together with Oscar Hasse, for reviving experimentation and research during the 1870's on the transfusion of animal blood into humans. However, when he reviewed his own and other animal-to-human transfusions for which he could find records, this showed that 56 percent of patients died shortly after the transfusion and that many other patients were not helped by the procedure.

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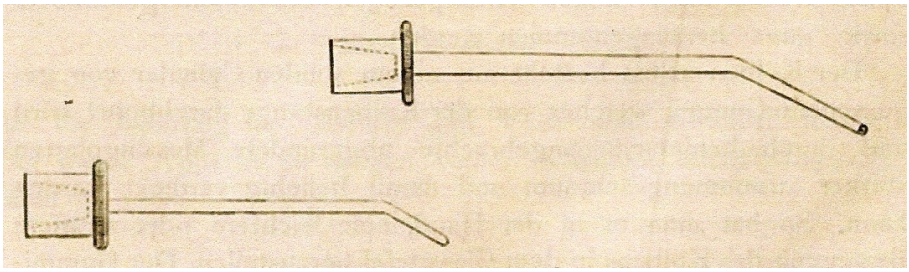
DIE LAMMBLUT-TRANSFUSION BEIM MENSCHEN (1874) BY OSCAR HASSE

The German physician Oscar Hasse (1837-1898) published his book *Die Lammblut-Transfusion beim Menschen* in Leipzig and St. Petersburg in 1874. Hasse, a respected physician from the German town of Nordhausen, performed a series of transfusions with sheep's blood and the frontispiece of the book depicts a woman receiving blood from a sheep. In this illustration, blood appears to pass from the carotid artery of the bound animal to the patient's antecubital vein via a short cannula in an operation depicted as tranquil and clean.

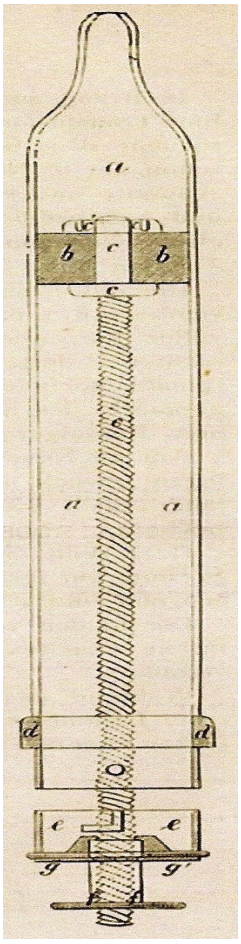
Illustration of a sheep-human direct transfusion (Hasse, 1874)
(Image credit: Wellcome Collection)

His first two blood transfusion cases were presented at the 1869 meeting of the Berlin Medical Society, after which he performed a number of similar transfusions. In 1873, having read Gesellius' recently published book on transfusion, Hasse contacted Gesellius who encouraged him to write an account of his first fifteen blood transfusions and helped him to publish them, which is why the book was published in St. Petersburg as well as Leipzig. His book includes illustrations of types of different sizes of cannulas that fit into the ends of rubber tubing via a spacer (shown in dotted lines).



Two cannulas of different sizes (Hasse, 1874)
(Image credit: Wellcome Collection)

The book also includes an image of a glass syringe device for the transfusion of defibrinated blood, but the text gives little information as to how it was used, i.e. how it was connected to a cannula, etc. The syringe (*a*) is described as having a close fitted rubber-ended (*b*) threaded plunger (*e*) that is stated to have four turns to one centimetre and is held in place by a nut (*g*) and turned by a turn key (*f*). In fact, a better description is provided in Joseph Eckhart's 1878 book 'Objective study about the transfusion of blood and their usability on the battlefield' (see page 75).



Glass syringe transfusion device (Hasse, 1874)
(Image credit: Wellcome Collection)

By mid 1874 Hasse had reportedly performed forty lamb-to-human transfusions. Although he described initial success, some recipients died whilst others had adverse effects of what would now be recognised as transfusion reactions (such as increased temperature, blood in their urine and jaundice). Even so, Hass fervently defended the use of animal blood donors for human transfusions, even when cross-species transfusion

Oscar Hasse (1837-1898) studied medicine in Greifswald and Berlin, where he obtained his doctorate degree in 1861, after which he worked at the Bethanien Hospital in Berlin. In 1864 he moved to Nordhausen and started a private practice. During the following few years having initially joined the medical corps of the German army, he left his medical practice to take part initially in the war with Denmark, then the Austro-Prussian war and in 1870 the Franco-Prussian war as a military surgeon. He did not perform any blood transfusions during this period and later complained about the lack of effective transfusion equipment as well as the lack of healthy potential donors in battle situations – something which may have later influenced him towards using animal donor blood.

Oscar Hasse (1837-1898)
(Image credit: nordhausen.de)


Die

Lammblut-Transfusion

beim Menschen.

Erste Reihe: 31 eigene Transfusionen umfassend.

Von

Dr. Oscar Hasse,

Mit 10 Holzschnitten.

St. Petersburg, Verlag von EDUARD HOPPE. 1874. Leipzig, In Commission bei FRANZ WAGNER.

Title page Die Lammblut-Transfusion beim Menschen
(Image credit: Wellcome Collection)

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Accessed: 4 September 2020

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THE TRANSFUSION OF BLOOD (1874) BY DR. BETIER

The illustration, titled 'The Transfusion of Blood – An operation at the "Hospital de la Pitié", at Paris' is part of an unsigned article titled 'The Transfusion of Blood' that appeared in the New York based American illustrated political magazine *Harper's Weekly, A Journal of Civilisation* on the 4th July 1874.

The Transfusion of Blood – *Harpers Weekly*, 4 July 1874
(Image credit: Harper's Weekly – babel hathitrust.org)

The illustration is a representation of a transfusion performed by the surgeon Dr. Betier, who is at the centre of the image and is described in the accompanying article as being 'one of the most popular surgeons of Paris'. His assistant Dr. Strauss is the seated blood donor. The illustration shows the blood freely gushing from the arm of the donor into a funnel that is connected by a tube to the patient's arm, though the article states that '…*blood is collected into the inferior part of the instrument, whence it is pumped by a small piston worked by a handle*'. Although not identified in the article this description may indicate that the transfusion equipment was devised by Dr. D. Moncoq in Paris. The article also states that 'to prevent the tendency to coagulation, the instrument must first be immersed in a basin of tepid water' and that 'previous to the insertion of the cannula the apparatus is put in working order and filled with blood – all air is thus effectively expelled'.

The rather 'staged' illustration includes a number of assistants who are wearing white aprons and spectators, including a nun, whose presence has been taken to possibly indicate the church's support for transfusion. The article explains that the patient is a twenty-two year old young woman, a servant 'who had fallen into a condition of extreme exhaustion incident to haemorrhage and overwork' and who 'in less than seven weeks she was able to resume her ordinary occupation', which would suggest that her recovery was as much to do with rest and appropriate nursing than to the transfusion itself.

The article also refers to a blood transfusion performed by Dr. Joseph W. Howe, visiting surgeon to the Charity Hospital, New York, the particulars of which were published in the New York *Medical Record*, April 1874.

The article that accompanies the illustration is reproduced as written in full as follows:

THE TRANSFUSION OF BLOOD

The notion of the transfusion of blood from one individual to another dates back to an early period, but no very reliable information that it was ever practically tested seems to present itself until the middle of the seventeenth century. At that time the possibility of the operation was suggested by Sir Christopher Wren in a communication which he made to the Royal Society of London. Drs. Lower and Denys became interested in the operation of transfusion, and commenced in all earnestness a series of experiments on animals. At Paris, in 1667, the first operation on the human subject was made by Denys and was a success. Subsequently Lower and King performed it a number of times in England and in every case transfusion was followed by recovery. The results of these operations gave rise to the idea that now a remedy was found to renovate the human species. But in the course of a year several mishaps occurred, which tended to discourage the friends of the operation. As in all these cases, successful or otherwise, the blood of animals was used, the opponents of the operation began to speak of the lowering of mankind, ascribing the honor of the invention to the devil. Transfusion was brought into bad repute and finally was interdicted by law, except when the Faculty of Paris granted permission for the operation to be performed.

Eventually this operation, on which people had built such high hopes, fell into disuse in all parts of the world; indeed it was hardly known any more by name even to physiologists. In 1685 it was revived. No attempt, however, was made to report to this operation for the purpose of restoring life in desperate cases until 1824 when James Blundell, of London, was the first to perform the operation with success upon the human subject with human blood. He then made in succession, three more successful transfusions. In several cases of post-partum haemorrhage transfusion was performed. Although there was marked improvement in the action of the heart and the respiration, the life of but one patient was saved. Transfusion in all these cases was indirect. Active investigation was made by various German physiologists in regard to the subject; but while the principle was recognised that blood could coagulate within the vessels, and was probably the cause of death, the true explanation was not understood.

Later it was scientifically shown that for transfusion on man only human blood, and that defibrillated, should be used; consequently, subsequent experimenters were in the practice of separating the fibrin from the blood by stirring it briskly, or whipping it with a thin rod.

At the present day the ordinary the ordinary transfusion syringe or aspirator has been superseded by new instruments with appropriate needles, cannulas, and tubing for direct transfusions. In this operation the blood undergoes no defibrillation, with its attendant loss of nutritive and stimulating properties; much valuable time is thus gained, in cases where the stimulus for healthy blood is needed at once to restore a patient to life.

In the case of the young woman represented in the illustration on page 570 the aspirator used for transfusion is constructed in such a manner that no amount of air can by any possibility enter the veins. This most happy result is obtained by a careful arrangement of its several valves through which the blood flows before being admitted into the new organisation which it is to restore.

The vital blood is sent into a cup from the veins of the donor who volunteers for the service. This blood is collected into the inferior part of the instrument, whence it is pumped by a small piston worked by a handle. It is then forced, in close imitation of nature, through a cannula which has been inserted into the veins of the patient. To prevent the tendency to coagulation, the instrument must first be immersed in a basin of tepid water. By constructing the tubes of gold, a precaution taken by Dr. Betier, a great degree of heat is given and sustained, thus rendering the operation a more certain success.

Previous to the insertion of the cannula the apparatus is put in working order and filled with blood. All air is thus effectively expelled. Owing to these preliminaries a quantity of blood is necessarily lost. Of the three ounces of blood taken from the veins of Dr. Strauss, only about one ounce is forced into the veins of the patient. But this quantity proved sufficient to insure recovery in a case which had been pronounced hopeless.

The young woman represented in the illustration is a servant, twenty-two years of age, who had fallen into a condition of extreme exhaustion incident to hemorrhage and overwork. Transfusion was proposed and performed a short time since at the Hôspital de la Pitié in Paris, by Dr. Betier, one of the most popular surgeons of Paris. Dr. Strauss offered his arm for the operation. The small transfusion introduced into her veins acted as a stimulus, and

restoration was established. In less than seven weeks she was able to resume her ordinary occupation.

In this case, Dr. Louville made microscopic analysis to test the efficacy of transfusion, and says that millions of globules formed with the greatest rapidity in the invigorated organism from the time of admission to the day of recovery.

Ordinarily transfusion could be used largely on the field where so many soldiers die from accidental hemorrhage. Although blood from amputation might be collected, it would undoubtedly be a very poor expedient. This discovery would not be really useful on a large scale, except in the Ashantee kingdom, where the veins of the hare may be drained to the last drop and introduced into the circulatory system of the grandees.

The subject of transfusion between animals of one species to animals of another species has recently been investigated by physiologists. A series of experiments in that direction has clearly proven that only small quantities of blood can be safely transfused from certain inferior animals into the circulation of the human system. It is doubtful, then, if the blood of horses, oxen, sheep, and pigs can ever be utilised for mankind, as some physiologists propose. In all cases where the blood of an animal having oval corpuscles was introduced into an animal whose blood contained round corpuscles death has followed, which fully established the fact that any considerable quantity of blood can not be transferred from one species to another with success.

The simplest operation of transfusion is performed by establishing communication between two animals of the same species in such a manner that the artery of the vigorous animal pumps blood into the system of the dying animal. This operation is a common one with physiologists, and attended almost always with success. It is, however, an experiment which is considered not practicable to be performed on the human subject as a means of restoration.

In the New York *Medical Record* for last April may be found a very interesting paper on this important subject, by Dr. Joseph W. Howe, visiting surgeon to Charity Hospital, in this city, containing an account of a simplified method of transfusion employed by him with the happiest results. In one instance, a woman forty years of age, who had been an invalid for several years, was treated by him. Her pulse at the time was very weak, rapid and irregular, and at times almost imperceptible. “I proceeded at once,” says Dr. Howe, “to perform transfusion, assisted by Drs. John H Ripley and Leroy M. Yale, visiting surgeons to the hospital. I abstracted by means of the aspirator four ounces of blood from the median basilica vein of a healthy man. Two days before I had taken eight ounces from the same individual. I made the second opening in the vein a quarter of an inch below the first. The latter had healed a few hours before the operation, and the second transfusion was scarcely perceptible. The blood thus obtained was injected into the cephalic vein of the patient. In a few moments she expressed herself as feeling better. There was an immediate and marked improvement in the volume and force of the pulse. This was so perceptible as to be noticed by all present, and prevented me from transferring any more blood… “The next morning I found her pulse still improving and her general condition excellent. She spoke in a clear voice, and stated that she could think clearly and remember all her sickness, which she could not do before the operation.”

Dr. Howe states that the patient regained her strength and recovered. He does not affirm that she would have died if the transfusion had not been made. There is, however, no doubt that the addition of four ounces of blood to her depleted system gave her the stimulus needed, produced an almost instantaneous change for the better in her general condition, and hastened her recovery.

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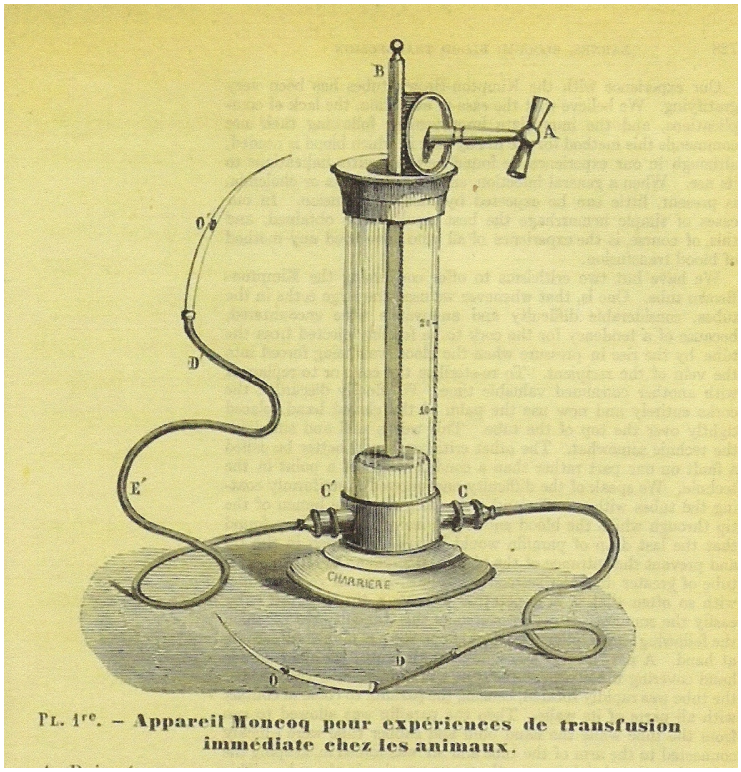
TRANSFUSION INSTANTANÈE DU SANG (1874) BY D. MONCOQ

The second edition of the book *Transfusion instantanée du sang: solution théorique et pratique de la transfusion médiate et de la transfusion immédiate chez les animaux et chez l'homme* by Dr. D Moncoq was published in Paris in 1874. It contains illustrations of five transfusion instruments that he designed together with images that illustrate two of these being used.

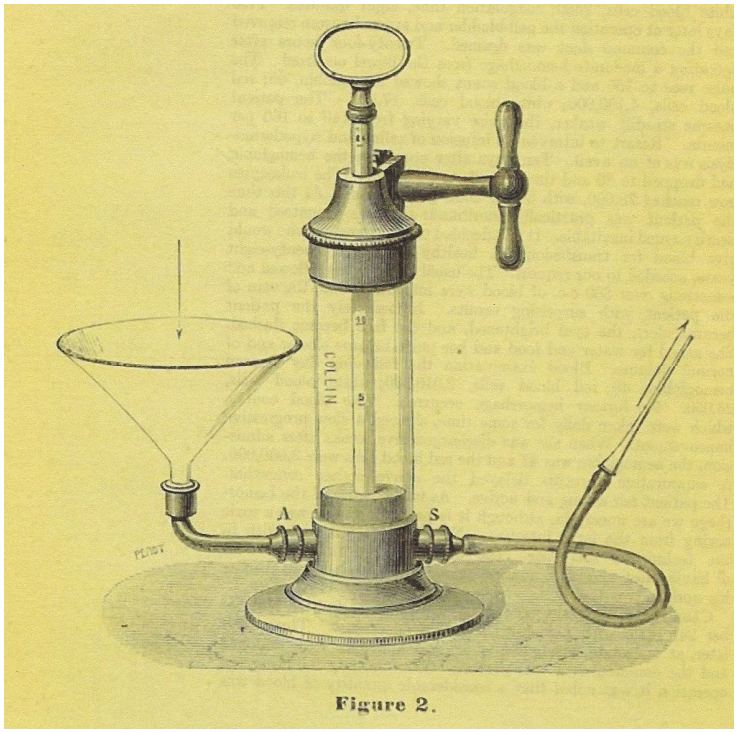


Moncoq's 1862 apparatus (Moncoq 1874 p.177)
(Image credit: Wellcome Collection)

Moncoq states that he devised this piece of apparatus in 1862 'for physiological experiments in animals', though it is identified in the books of Ladislao von Belina-Swiontkowski (1869) and Louis Jullien (1875) to have been used for direct transfusions to humans. It comprises a ratchet wheel operated plunger in a glass-metal syringe, the barrel of which holds 30 grams and is graduated to identify the volume of blood transfused. The base of the syringe has two valves (*C*′ and *C*) that connect to two thin rubber tubes and attached to the other ends of these tubes are small curved silver pipes that are inserted into the veins of the donor (*D*′) and recipient (*D*). By moving the piston up and down the valves alternatively open and close so that blood is drawn from the donor into the syringe and then pumped into the patient. Each of the rubber tubes is stated to be 10 cm. in length and very narrow. Moncoq believed that the narrow rubber pipes together with the movement of the syringe would prevent coagulation of the donor blood, as together they would closely resemble the systolic and diastolic pressure in a vein.

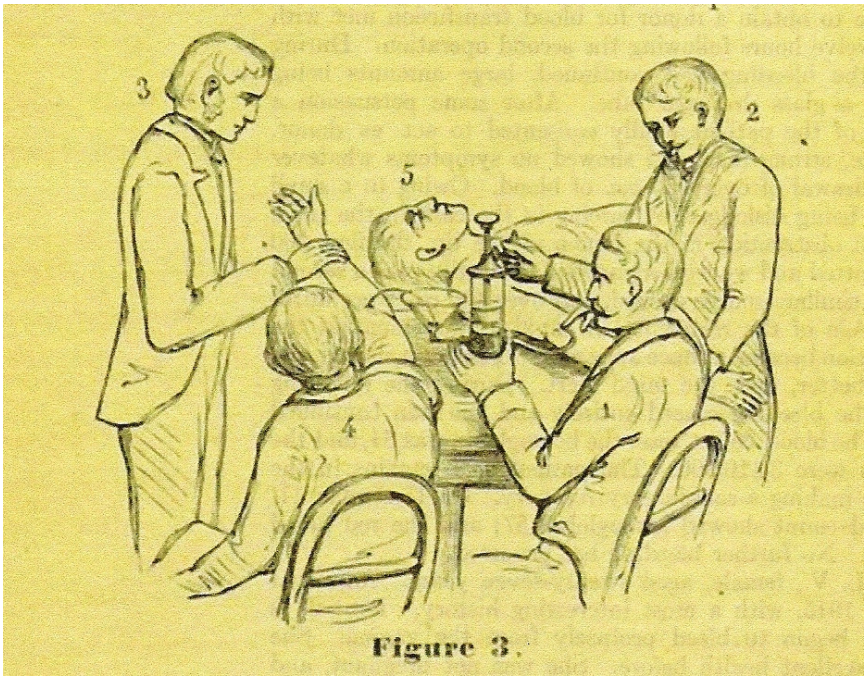
Moncoq provides an illustration of his '1863 apparatus for mediate transfusion' (Fig. 2) which he states somewhat confusingly to have been 'successfully used in humans since 1866'. Its design is similar to the 1862 apparatus but instead of a pipe that is inserted into the donor's vein there is a glass funnel-shaped vessel for collecting the donor's fresh (or defibrinated) blood. Blood is moved from this vessel through two valves by the action of the syringe plunger so that blood is sucked into the syringe

and then pushed out into the recipient via a small gauge rubber tube and a straight pipe that is inserted into the vein.



Moncoq's 1863 apparatus (Moncoq 1874 p.200)
(Image credit: Wellcome Collection)

An illustration (Figure 3) shows Moncoq's 1863 apparatus being used which shows blood from the donor spurting into the collection vessel whilst an assistant holds the cannula in place in the recipient's vein and the operator manipulates the syringe.

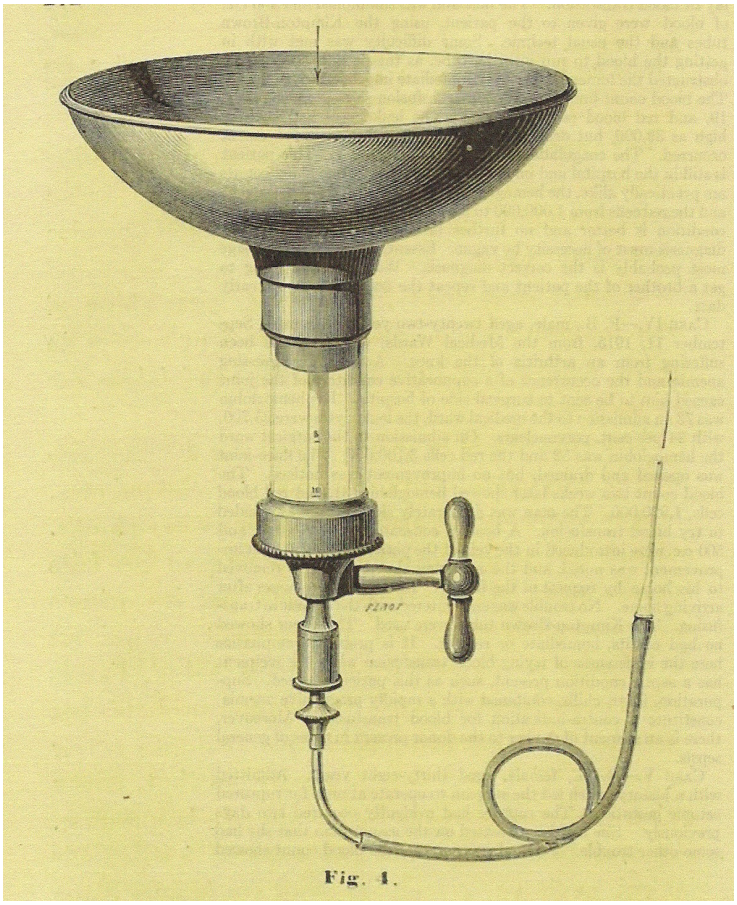


Moncoq's 1863 apparatus being used
(Image credit: Wellcome Collection)

Moncoq comments that the arms of the donor and the patient can be brought much closer that they are shown in the figure leaving as short a distance as possible when operating the equipment (i.e. presumably thereby providing as short a time as possible before the donor blood to starts to clot). The numbers in this image are identified as:

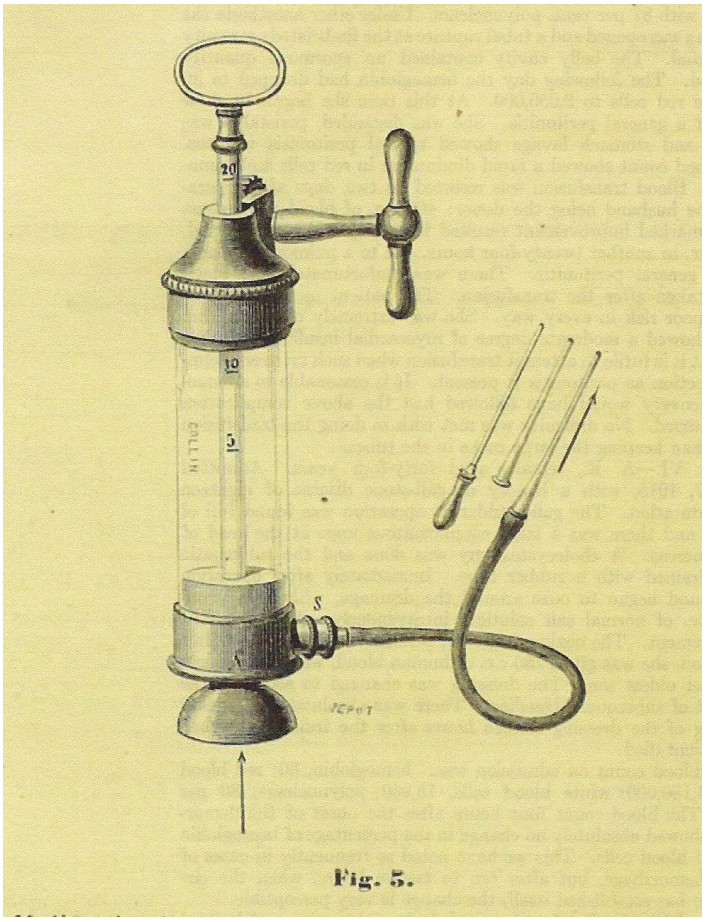
1. The operator
2. Helper who keeps the cannula in place in the recipient's vein
3. Helper who holds the donor's arm
4. Subject providing blood
5. The patient lies horizontally on their back near to the right edge of the bed

Figure 4 (page 212) is described as being 'a bad modification of the side funnel [1863] device' that he states was apparently a 'modification produced by the manufacturer' and 'should be rejected', due to the poor results he obtained from using it. Note: This apparatus was built by Collins (Paris).

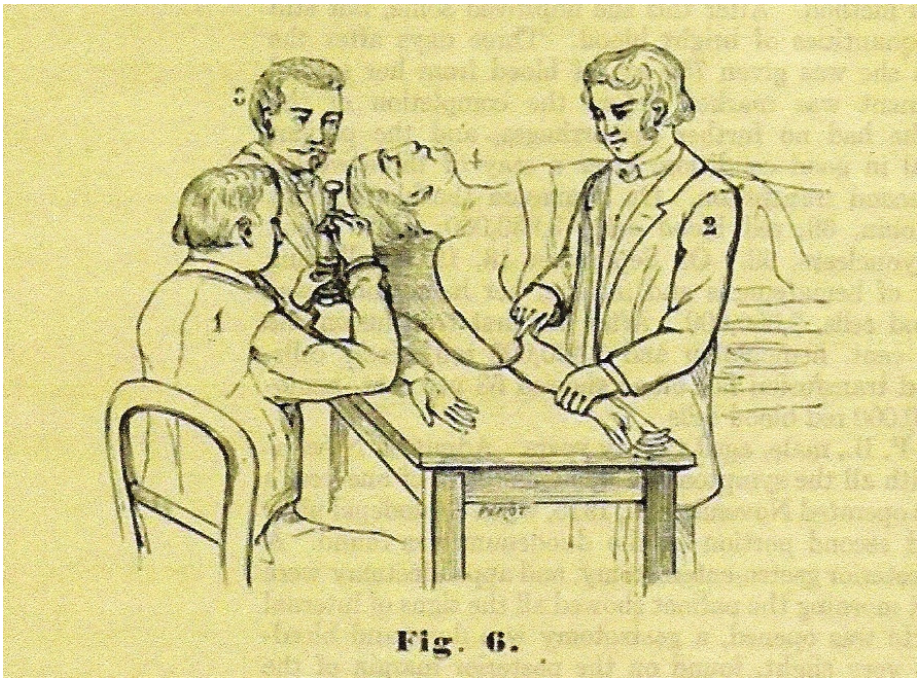


Moncoq's 'modified 1863 apparatus' (Moncoq 1874 p.212)
(Image credit: Wellcome Collection)

Moncoq describes his '1864 apparatus' (Fig.5) as being 'much simpler than the previous one' and that 'it is intended to replace it for the immediate transfusion of blood in humans'. Instead of the tube (from the donor's arm) there is an inverted glass cup that is pressed over the donor's open vein forming a vacuum-type arrangement. The single valve at the base of the syringe allows this blood to be alternatively sucked into the syringe and then pushed out again into the recipient's vein by means of the ratchet operated plunger.



Moncoq's 1864 apparatus 'for the immediate transfusion into humans' (Moncoq 1874 p.222)
(Image credit: Wellcome Collection)



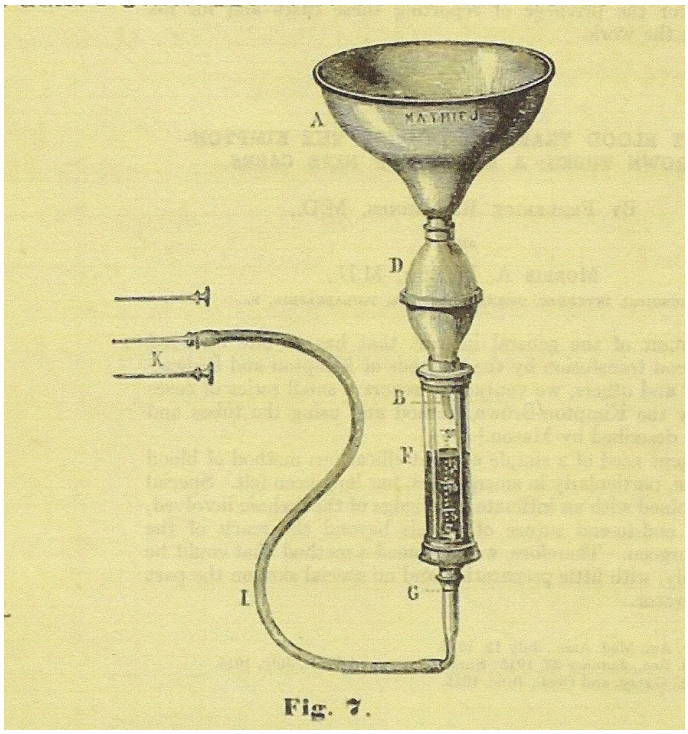
Moncoq's 1864 apparatus being used
(Image credit: Wellcome Collection)

The illustration of the '1864 apparatus being used' (Fig.6) shows someone holding the pipe in place in the recipient's exposed vein whilst the blood donor holds out his arm, i.e.

1. The operator holding the equipment on the donor's arm whilst operating the syringe
2. Helper who keeps the cannula in place in the recipient's vein
3. Subject providing blood from an arm vein
4. The patient lies horizontally on their back near to the right edge of the bed

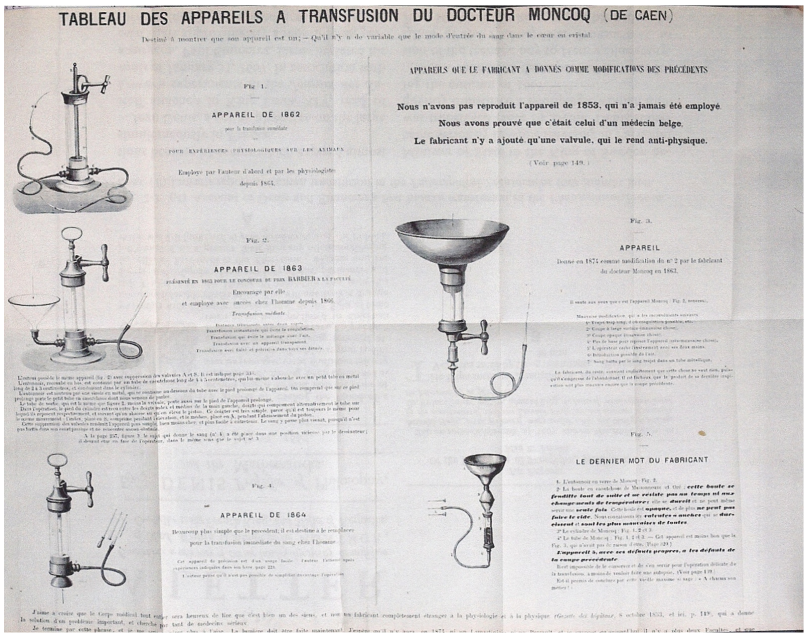
The book also provides an illustration of Moncoq's 1874 modification of his 1863 indirect apparatus, which instead of having the blood from the collection vessel being sucked into the syringe through a valve, this modification has a glass collection vessel attached to a rubber bulb that allows the donor blood to be quickly moved into a brass-glass graduated tube 'so it keeps its temperature'. The rubber bulb then acts to pump the blood from the glass cylinder via a narrow rubber tube into the patient's vein. This device is the same as one that is stated by Belina-Swiontkowski (1869), Louis Jullien (1875) and Joseph Roussel (1876) to have been devised by Mathieu in 1866. Moncoq's book includes a description of a priority dispute between him and Mathieu as to who devised/used this equipment first – they appear to have used the same Parisian surgical equipment manufacturer (F. Favre). In fact he notes that the parts of the apparatus are designated as:

A. Glass funnel - Moncoq
D. Rubber ball - Maisonneuve and Oré
BF: Crystal cylinder - Moncoq
IK: Rubber tube - Moncoq



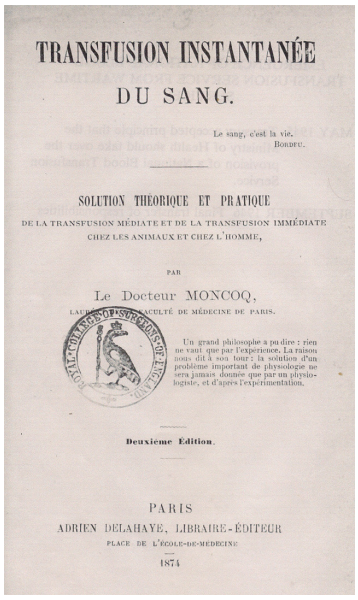
Moncoq's 1874 apparatus
(Image credit: Wellcome Collection)

At the end of the book there is an open-out sheet titled *Tableau des apparatus a transfusion du Docteur Moncoq (de Caen)*, that illustrates five types / modifications of transfusion apparatus devised by him.



Summary chart of Moncoq's different transfusion apparatus
(Image credit: Wellcome Collection)

Photograph of Dr D. Moncoq (1874 book – 1st Edition)
(Image credit: catawiki.pl)



Title page of Transfusion instantanée du sang (1874 book – 2nd Edition)
(Image credit: Wellcome Collection)

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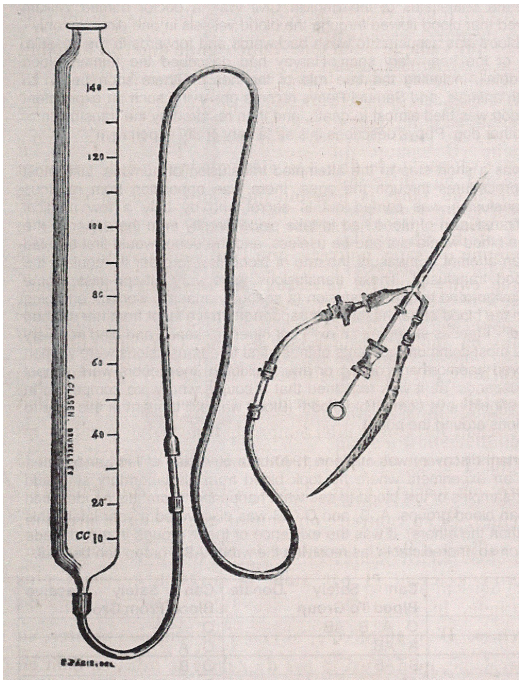
https://wellcomecollection.org/works/hfb6rhfg

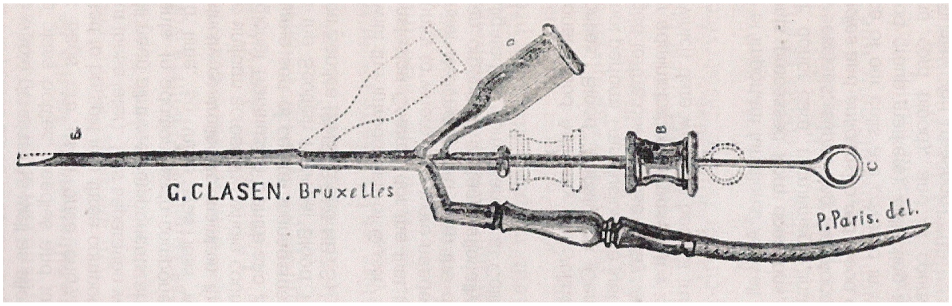
DE LA TRANSFUSION DU SANG (1874) BY JOSEPH CASSE

Joseph Casse's book *De la transfusion du sang* was published in Brussels in 1874. It contains an image of his apparatus used for indirect blood transfusion. This comprises a 30 centimetre long graduated glass vessel. The upper opening of this vessel is of a larger diameter than the lower one, allowing the introduction of a funnel through which is poured the defibrinated donor blood. The lower end is very narrow and connected to a 60 to 70 centimetre long rubber tube which incorporates glass sections for observing the blood flow. The other end of the rubber tube is connected to a cannula that is inserted into the recipient's vein. It is stated that when a volume of defibrinated blood equivalent to 10 – 20 centimetres is placed into the graduated tube it results in sufficient pressure to ensure that the blood enters the patient's vein – this pressure and therefore the blood flow, can be increased or decreased by raising or lowering the tube relative to the patient's arm. This allows a greater or lesser amount of blood to be introduced. This amount can be measured by the graduations on the side of the container.



Graduated glass blood transfusion vessel (Casse, 1874)
(Image credit: Wellcome Collection)

The apparatus incorporates a cannula designed by Casse, which is also illustrated in the book.



Cannula incorporated into the indirect blood transfusion apparatus (Casse, 1874)
(Image credit: Wellcome Collection)

It consists of a hollow needle which contains a second tube to which a nozzle has been attached at an acute angle, which slides into the inside of needle. The needle is first introduced into the exposed recipient's vein. To avoid the possibility of damaging the vascular walls by inserting the needle further (so it can be held there), the internal tube, which is hidden by the tip of the needle can be pushed forward, inserting it further into the vein (as illustrated by the dotted lines). The metal mandrel that fits inside this tube can then be removed allowing the donor blood to pass into the recipient's vein.

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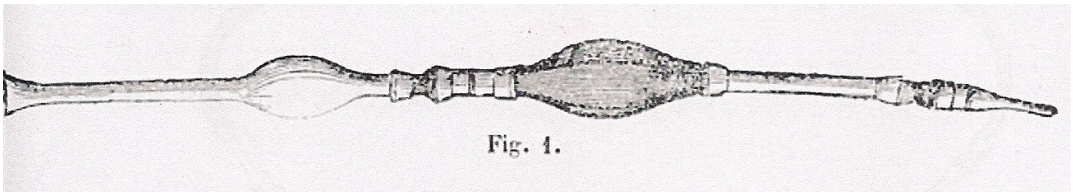
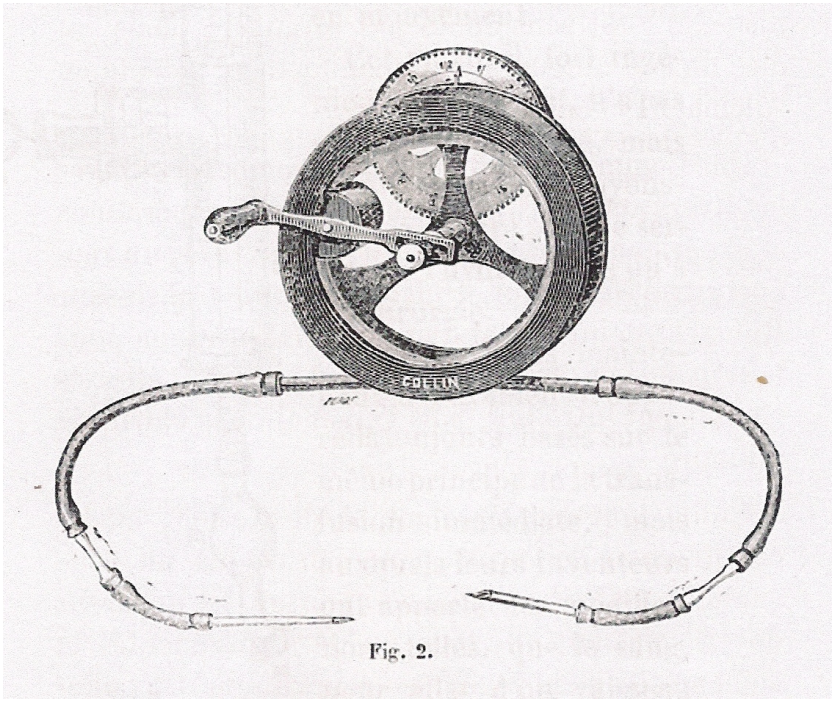
DE LA TRANSFUSION DU SANG (1875) BY LOUIS JULLIEN

Louis Jullien's book *De la transfusion du sang* published in 1875 is a comprehensive work of 329 pages that starts with an extensive section on the history of transfusion identifying and commenting on some of the key individuals involved, the types of transfusion techniques they employed and their experimental conclusions. He presents detailed results of the various animal transfusion experiments that he and others have performed, investigating the type of transfusion, the temperature of the blood used, the use of defibrinated blood, the volume of blood used, the differences between using arterial and venous donor blood, etc.

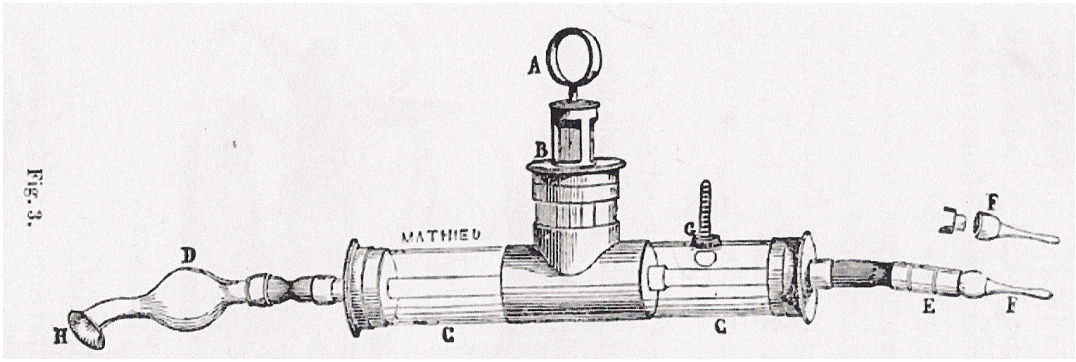
Following a section on the indications for using transfusion he then presents information on the different methods used for performing a blood transfusion. Finally in the section titled 'Des procédés et des Instruments' he comments on and provides images of the different instruments devised by various people, the same as two other authors of the same period, i.e. Ladislao Belina-Swiontkowski (1869) and Joseph Roussel (1876), which include examples of equipment for both direct and indirect transfusion methods.



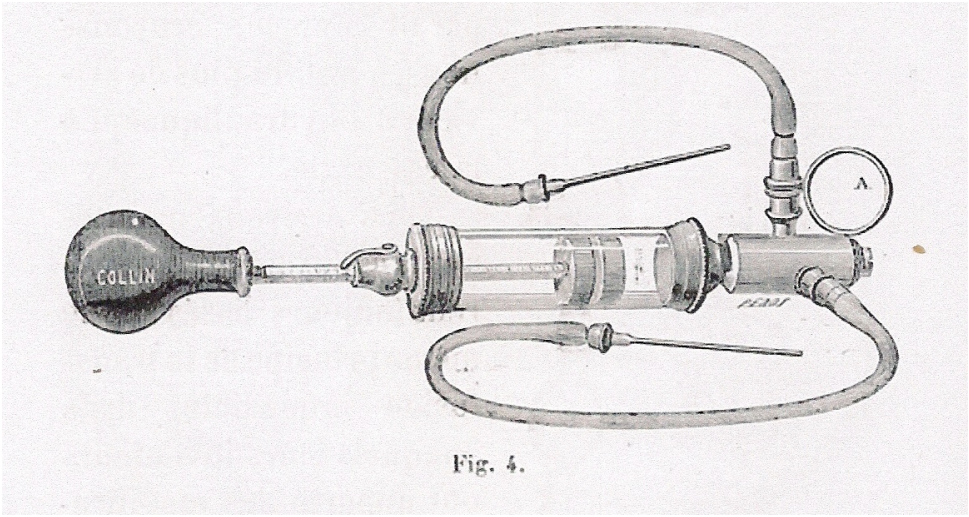
Transfusion apparatus devised by Mathieu – 1853 (Jullien, 1875)
(Image credit: Wellcome Collection)



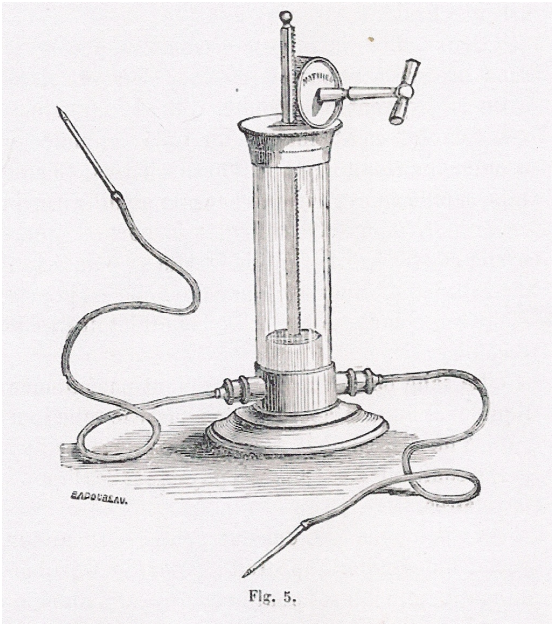
Direct (vein-to-vein) transfusion equipment built by Collin (equipment maker, Paris) - 1874
(Jullien, 1875)
(Image credit: Wellcome Collection)



Transfusion equipment devised by Mathieu – 1853 (Jullien, 1875)
(Image credit: Wellcome Collection)



Transfusion equipment built by Collin (Jullien, 1875)
(Image credit: Wellcome Collection)



Transfusion equipment devised by Moncoq – 1862 (Jullien, 1875)
(Image credit: Wellcome Collection)

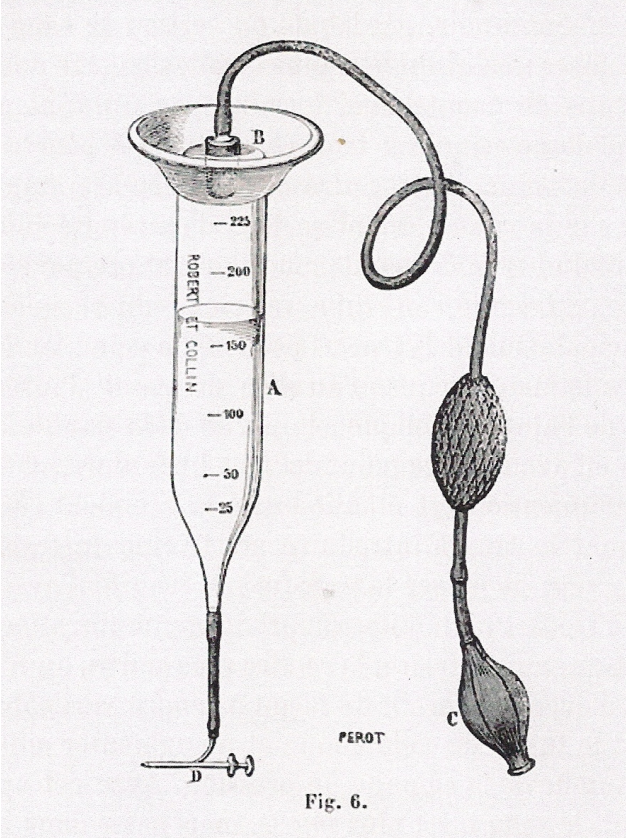


Fig. 6.

Indirect transfusion equipment devised by Belina-Swiontkowski (Jullien, 1875)
(Image credit: Wellcome Collection)

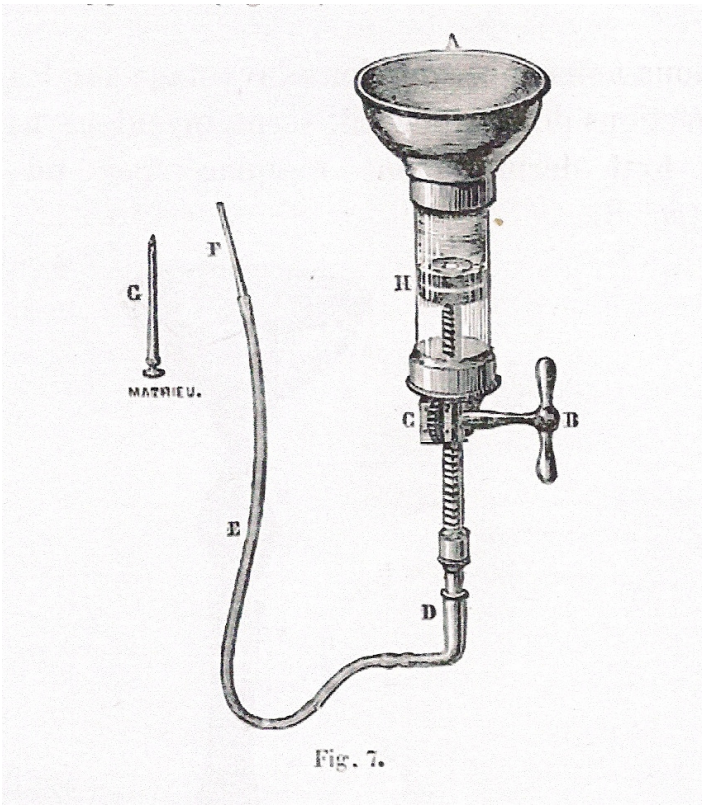
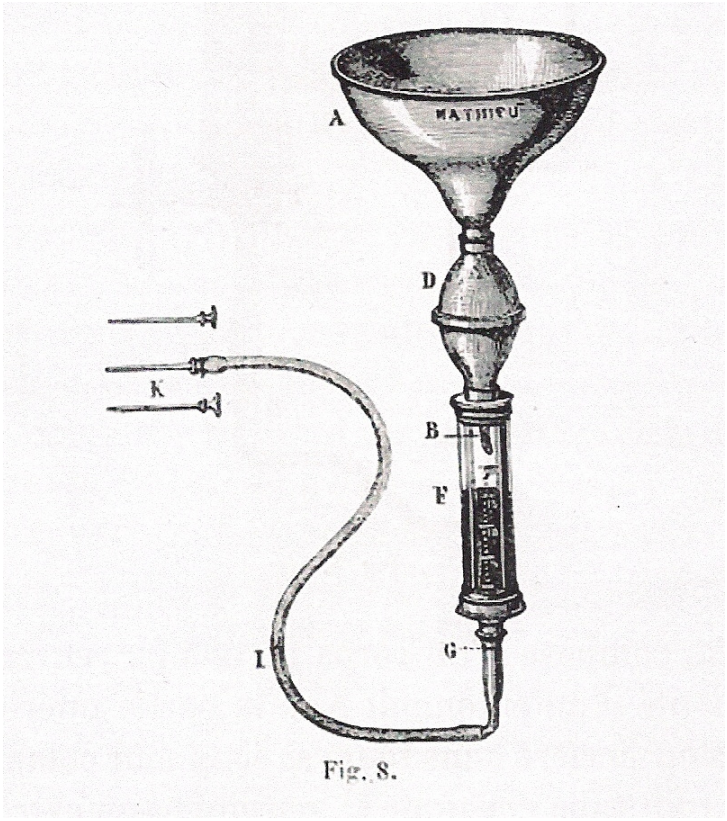


Fig. 7.

Transfusion equipment devised by Mathieu (Jullien, 1875)
(Image credit: Wellcome Collection)



Variation of the transfusion equipment devised by Mathieu (Jullien, 1875)
(Image credit: Wellcome Collection)

Note: Although Jullien states that these two pieces of equipment, Fig.7 and Fig.8, are by Mathieu, Moncoq claims that he devised them – see D. Moncoq 1874.

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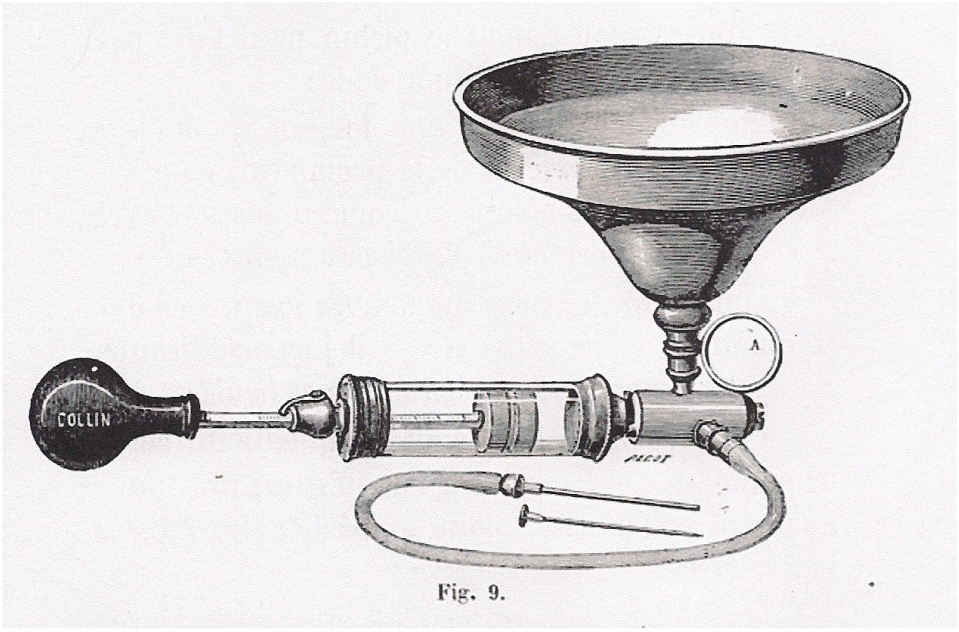
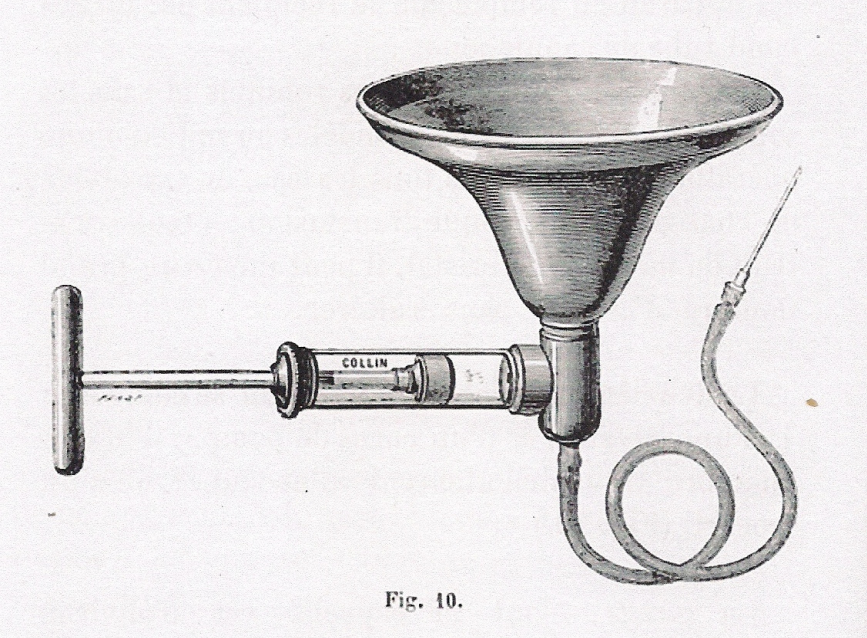
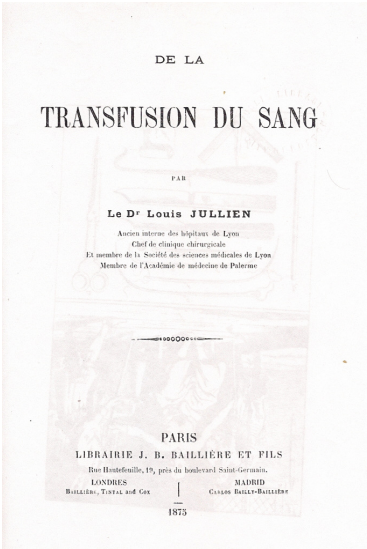


Transfusion equipment devised by Collin (Jullien, 1875)
(Image credit: Wellcome Collection)



Variation of the transfusion equipment devised by Collin (Jullien, 1875)
(Image credit: Wellcome Collection)

Louis Jullien was born in Lyon in 1850 and graduated Doctor of Medicine in 1873. He became an Associate Professor in Nancy in 1875, a venereal disease specialist. He died in Paris in 1913.


DE LA

TRANSFUSION DU SANG

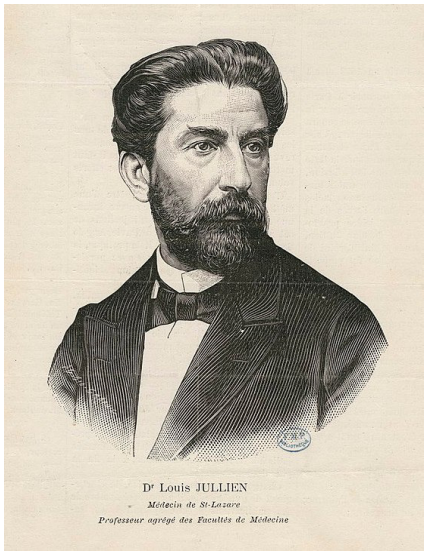
PAR

Le Dr Louis JULLIEN

Ancien interne des hôpitaux de Lyon
Chef de clinique chirurgicale
Et membre de la Société des sciences médicales de Lyon
Membre de l'Académie de médecine de Palerme

PARIS
LIBRAIRIE J. B. BAILLIÈRE ET FILS
Rue Hautefeuille, 19, près du boulevard Saint-Germain.
LONDRES
MADRID
1875

Title page of De la Transfusion du Sang (1875)
(Image credit: Wellcome Collection)



Dr Louis Jullien (1850-1913)
(Image credit: Wikimedia Commons)

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https://wellcomecollection.org/works/bvcssjmd

OBJECTIVE STUDIE UBER DIE TRANSFUSION DES BLUTES UND DEREN VERWERTHBARKEIT AUF DEM SCHLACHTFELDE (1876) BY JOSEF FRIEDRICH ECKERT

Franz Gesellius, whilst marketing his transfusion device, originated the idea of using lamb's blood for transfusing to injured soldiers on a battlefield. In his 1876 book *Objective Studie uber die transfusion des blutes und deren verwerthbarkeit auf dem schlachtfelde* Josef Friedrich Eckert further developed this idea, including proposing a harness arrangement for transporting the bound animal on the back of a medical assistant so it could be carried onto a battlefield. The illustrations at the end of Eckert's book include transfusion cannulas and a bound lamb being used for a direct blood transfusion.

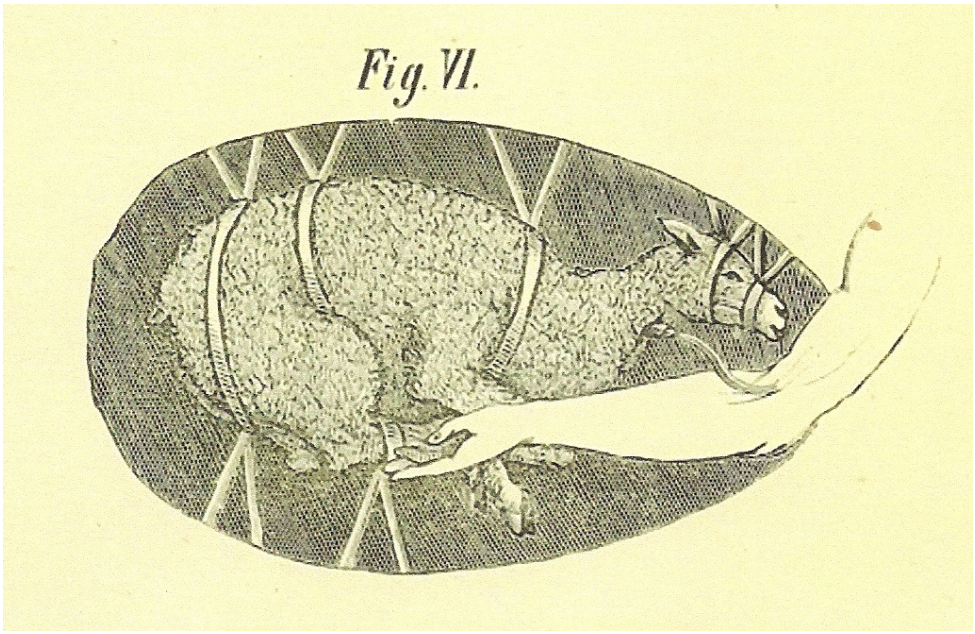
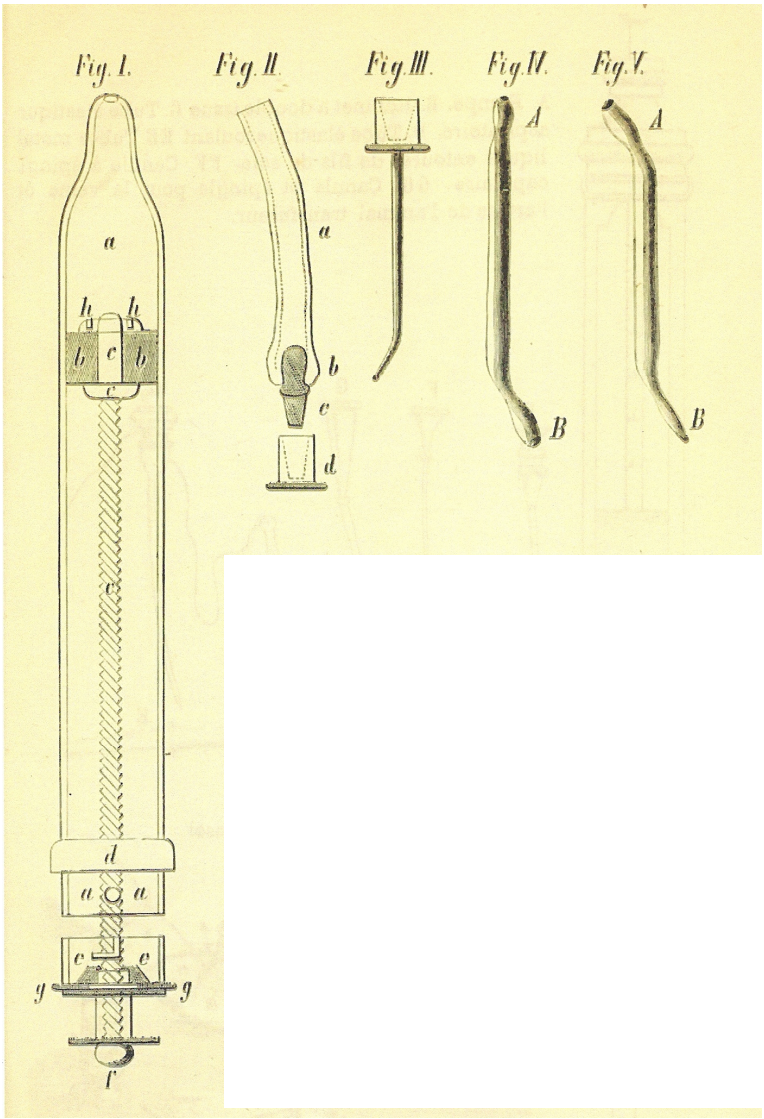


Fig. IV: Lamb-human blood transfusion (Eckert, 1876)
(Image credit: Wellcome Collection)

The Austrian military surgeon Ignaz Josef Neudörfer, who had performed transfusions with human blood in the Austro-Italian and Austro-Prussian wars of 1859 and 1866 also seized upon this idea. He is credited with (inhumanely) constructing a special cannula that could be inserted into the carotid of a lamb away from the battlefield (i.e. before a transfusion was actually needed). The lamb was then carried in the harness arrangement with the cannula in place thereby enabling a doctor to be able to swiftly transfuse blood from the animal to a wounded soldier in a dressing station near to the battlefield rather than have to wait for the wounded man to reach a field hospital.

Eckert's book also includes a diagram of Oscar Hasse's transfusion syringe device for the indirect transfusion of defibrinated blood together with an explanation of how it is used: "In the glass syringe *a*, Fig. I, it is the rubber piston *b*, which rests on the piston rod *c* that moves. This rubber piston can be pressed together by the screw nut *h* against the plate *c* of the piston so that it fits exactly into the glass tube. The entire length of the piston rod *c* shows a left-hand double thread on its surface, four turns per centimetre and is rotated by the nut *f*. The sleeve *d* is attached to the glass tube *a*. The capsule *e* fits exactly onto the base of this sleeve *d* and is held on to it by double bayonet fasteners. The nut *f* is attached to the capsule *e* by means of the

washer *g* in such a way that a screwed-in groove provides guidance and rotation. Fig. I is drawn in half size. A rubber hose *a*, Fig. II, is slipped over the rounded tip of the glass syringe, the free end of which receives the rounded part *b* of the intermediate piece *b c*. When the apparatus is filled with defibrinated blood, it is closed with the little silver cap *d*. This fits exactly onto the somewhat pointed part *c* of the intermediate piece *b c*. This also includes a silver cannula, Fig. III, the end of which is bent over at a length of 1 to 1½ centimetres at an obtuse angle. This bent part is inserted into the blood vessel, while the other part can be easily held."



Hasse's defibrinated blood transfusion syringe (Eckert, 1876)
(Image credit: Wellcome Collection)

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https://wellcomecollection.org/works/asxbmx32

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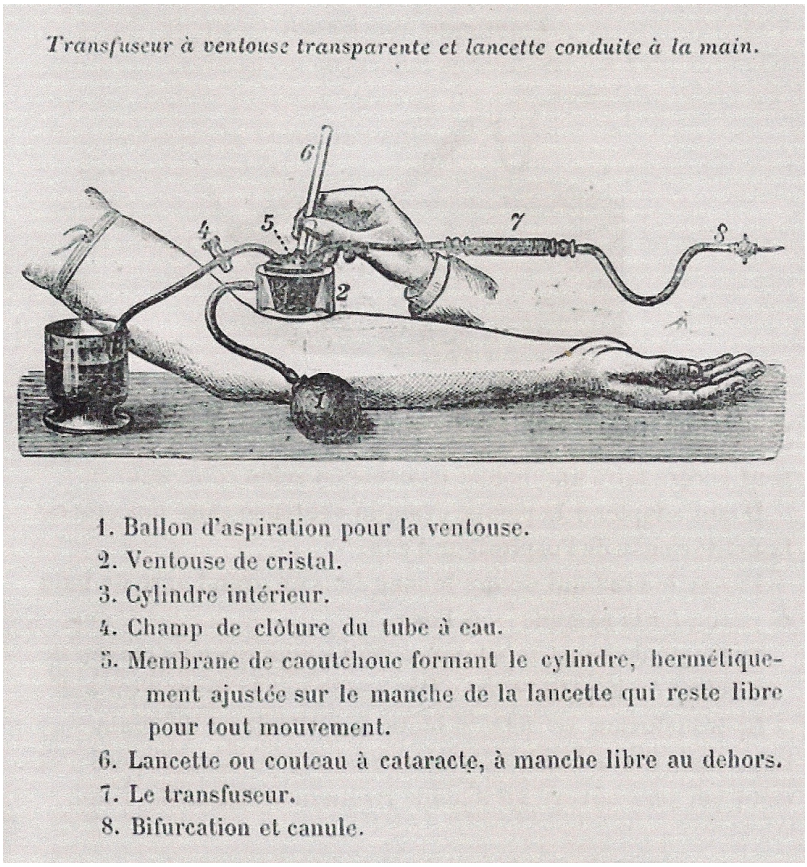
LA TRANSFUSION 1RE SÉRIE, 35 OPÉRATIONS (1876); TRANSFUSION OF HUMAN BLOOD BY THE METHOD OF J. ROUSSEL (1877); TRANSFUSION DIRECTE DU SANG VIVANT (1882) BY JOSEPH ROUSSEL

The instrument designed by Joseph Roussel and illustrated in his books published in 1876 and 1877 was complicated in that it was designed to avoid the donor blood coming into contact with air. 'Roussel's Transfuseur' included a 'cupping-cup' that sat over the donor's arm and by using negative pressure raised the donor's vein. A pump then admitted tepid-warm water into the cup and a built-in lancet cut open the donor's vein; opening a tap allowed the water mixed with some blood to be removed from the cup. By turning a stopcock and with the help of a bulb-pump, blood was then allowed to flow via a cannula to the recipient's vein. Roussel claimed that this arrangement prevented the blood from ever encountering air, thus avoiding the problem of the blood clotting.

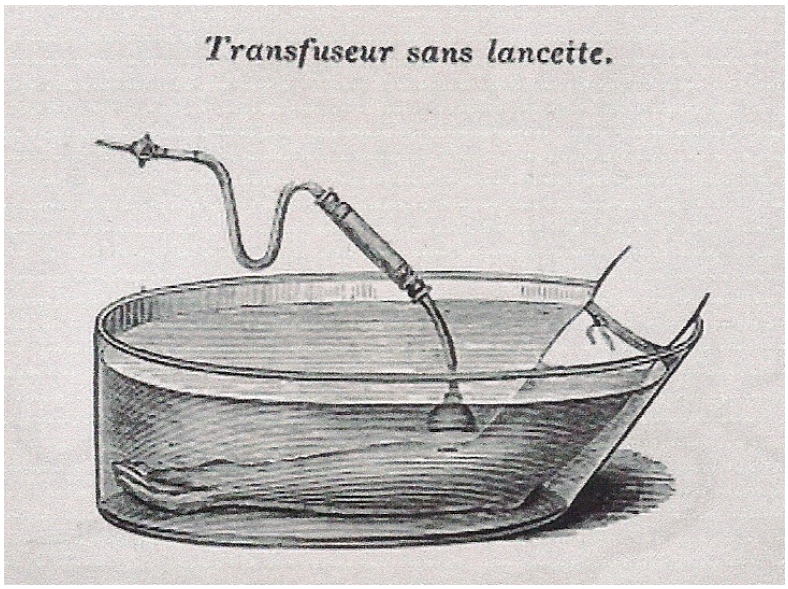
Roussel's Transfuseur (Roussel, 1876)
(Image credit: Wellcome Collection)

An additional illustration of his Transfuseur is also included in his 1876 book that shows it with a transparent suction cup and hand-operated lancet. In addition, this

book also includes an illustration of the Transfuseur being used without the built-in lancet, by placing the donor's arm under water.



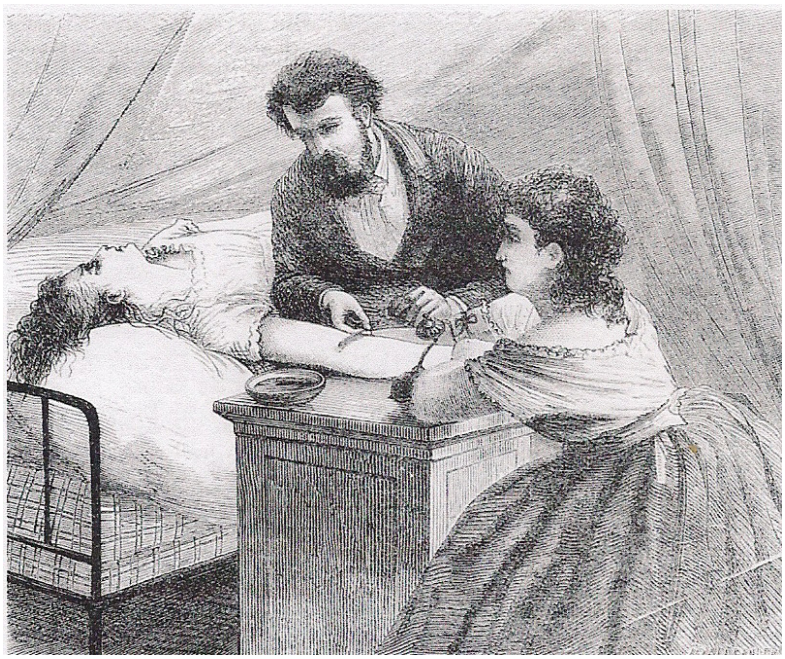
Roussel's Transfuseur (Roussel, 1876)
(Image credit: Wellcome Collection)



Roussel's transfusion method without a lancet (Roussel, 1876)
(Image credit: Wellcome Collection)

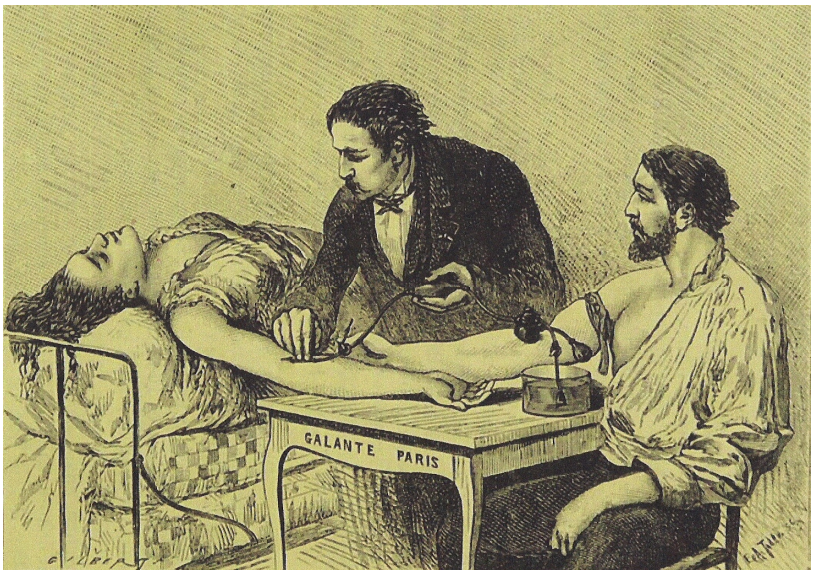
Joseph Roussel was an ardent advocate of blood transfusion in the second half of the 19th century. He was born in Geneva in 1837, studied medicine in Paris and then travelled extensively as a marine surgeon. He returned to Geneva where in

1864 he designed his blood transfusion apparatus, which he initially tested on animals. In December 1865 he attended a young woman who was unconscious and bleeding to death from a miscarriage. He later graphically described how, using the woman's sister as the only available blood donor, he successfully transfused the dying woman. He did not write about the operation until many years later, having subsequently discovered that the woman had not in fact miscarried but had undergone an illegal abortion. It is believed to be this event that is illustrated in Paul Niemeyer's 1874 book *Lebensrettung durch Blutüberleitung*.



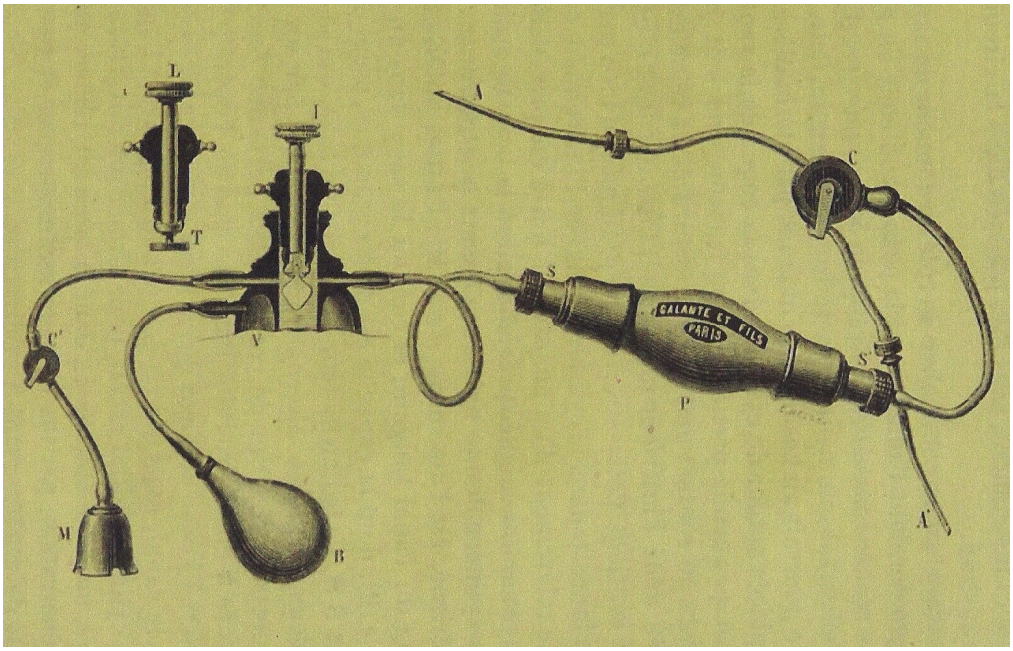
A blood transfusion with Roussel's instrument (Niemeyer, 1874)
(Image credit: Berner, 2020)

A different version of this image is included in Roussel's book *Transfusion directe du sang vivant* published in 1882, which substitutes a man as the blood donor.



A blood transfusion with Roussel's instrument (Roussel, 1882)
(Image credit: Wellcome Collection)

The title page of Roussel's 1882 book states that the content is an extract of the journal *Gazette des Hôpitaux* published on the 18th February 1882 and includes another illustration of his 'Transfuseur' which gives a clearer indication of the workings of the instrument.



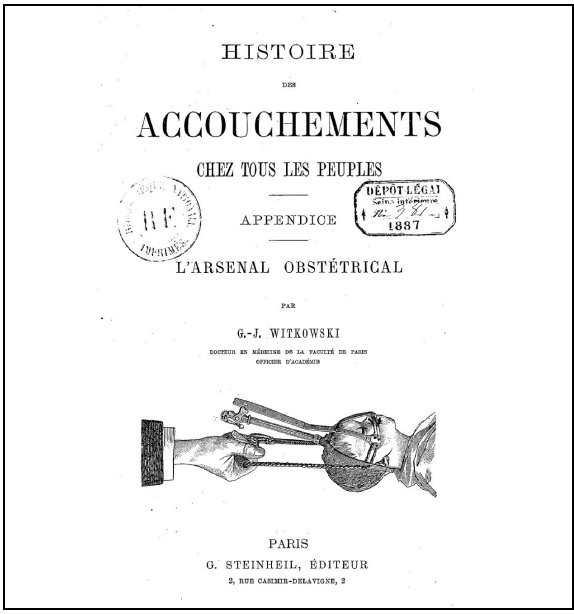
Roussel's Transfuseur (Roussel, 1882)
(Image credit: Wellcome Collection)

Roussel's transfusion equipment was also described and illustrated in 1867 in an article in the *Gazette des Hospital*, the main purpose of which appears to be that this method of transfusion could be used during a war.

Battlefield transfusion using Roussel's Transfuseur (1867)
(Image credit: Museum of Blood Transfusion and Blood Donation)

Roussel subsequently modified some aspects of his instrument and in 1870, just before the Franco-German war, he unsuccessfully demonstrated it to the French War Administration, after which he toured Europe performing both military and civil demonstrations of the instrument and his blood transfusion technique. In 1874 the Austrian military surgeon Josef Neudörfer recommended Roussel's apparatus for use by the Austrian military authorities. Roussel produced a stylised illustration to show that this method of transfusion could be used on the battlefield, though how effective the instrument would have been given its complexities (and requirement for warm water) is debatable. There are no official records of any transfusions being preformed with Roussel's apparatus during the Franco-Prussian War.

An image of 'Roussel's Transfuseur' is also included within the book *Histoire des Accouchements chez tous les peoples – L'Arsenal Obstétrical*, by Gustave J. Witkowski (1844-1922), published in Paris in 1887, which illustrates various types of obstetrical instruments available for use by physicians. Within the section 'Appareils contre les hémorragies' there are three images, one of which is titled 'Transfuseur de Roussel, de Genève'. Gustave J. Witkowski was a French physician and historian, the son of a Polish born doctor who worked at the Montpellier Medical School. He was the author of numerous works on anatomy, medicine and the history of medicine. His initial J has been interpreted variously as standing for Jules, Joseph or Jean.


HISTOIRE

DES

ACCOUCHEMENTS

CHEZ TOUS LES PEUPLES

APPENDICE

L'ARSENAL OBSTÉTRICAL

PAR

G.-J. WITKOWSKI

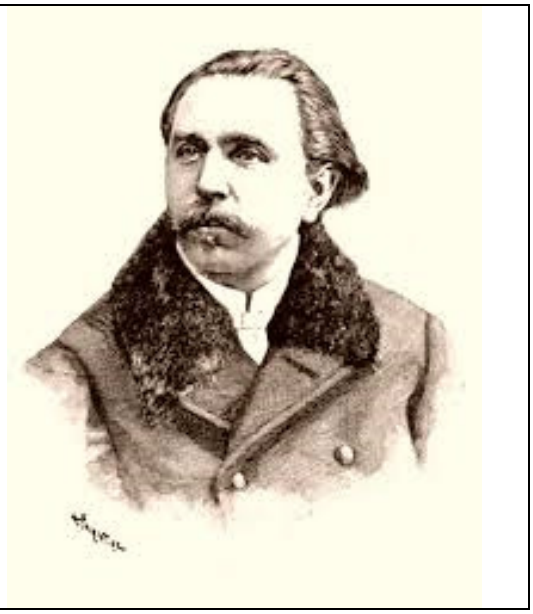
DOCTEUR EN MÉDECINE DE LA FACULTÉ DE PARIS
OFFICIER D'ACADÉMIE

PARIS

G. STEINHEIL, ÉDITEUR

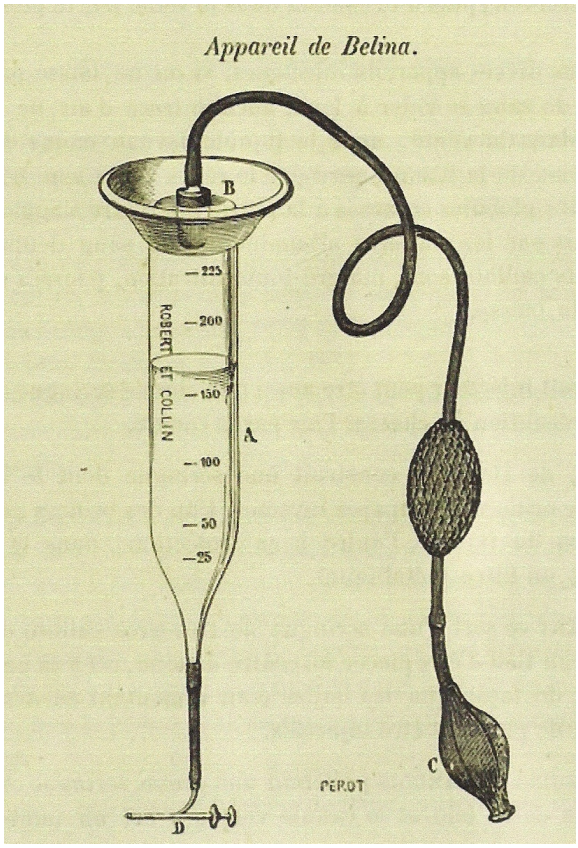
2, RUE CASIMIR-DELAVIGNE, 2

Frontispiece of Historie des Accouchements
(Image credit: Wellcome Collection)

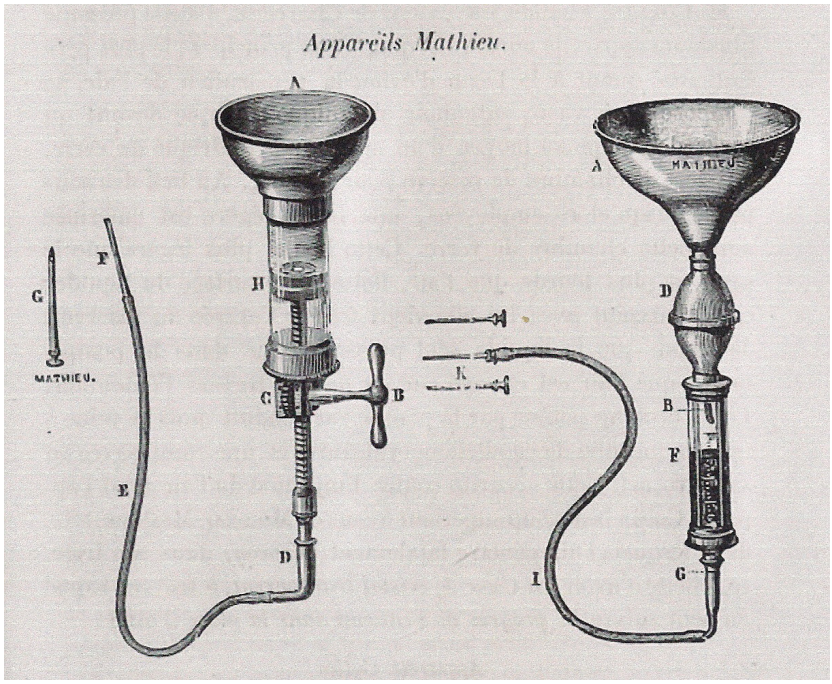


Gustave J. Witkowski
(Image credit: fr.wikipedia.org)

Like two other books of the same period, i.e. by Ladislao Belina-Swiontkowski (1869) and Louis Jullien (1875), Roussel's 1876 book *La Transfusion 1re série, 35 opérations* contains a number of images of different types of transfusion equipment designed by other people together with letters to them and comments by Roussel, which are not reproduced in his later books. There are six different images of these instruments, which Roussel attributes to Belina-Swiontowski (p.129), Mathieu (p.133), Collin (p.134 and 139), Noel (p.137) and Leblond (p.139).

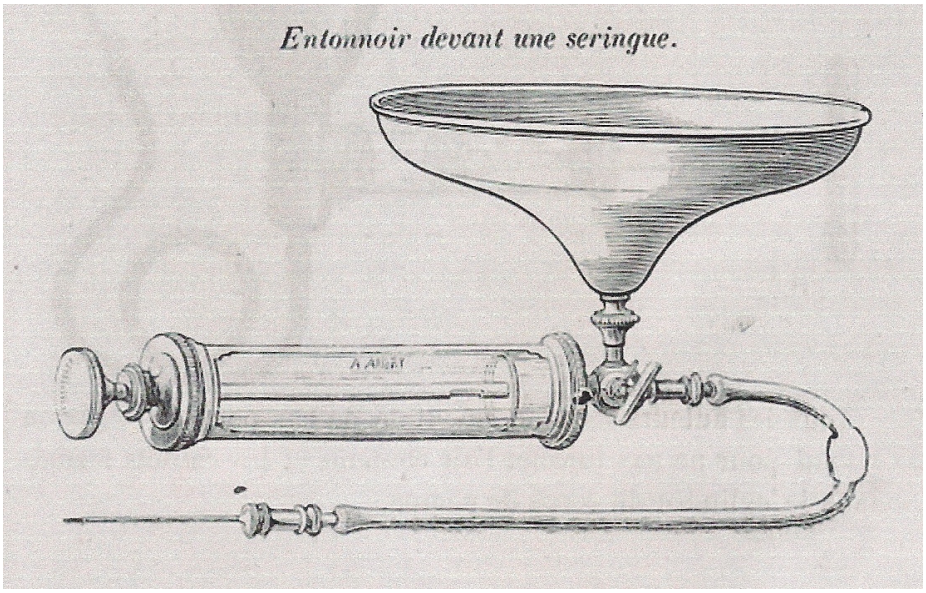


Apparatus devised to Belina-Swiontowski (Roussel, 1876)
(Image credit: Wellcome Collection)

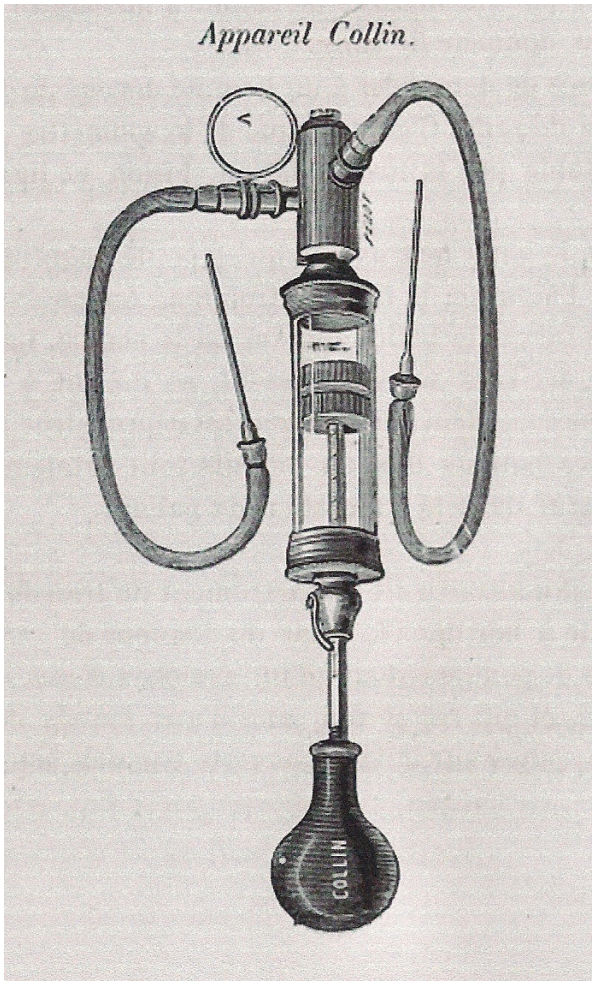


Apparatus devised by Mathieu (Roussel, 1876)
(Image credit: Wellcome Collection)

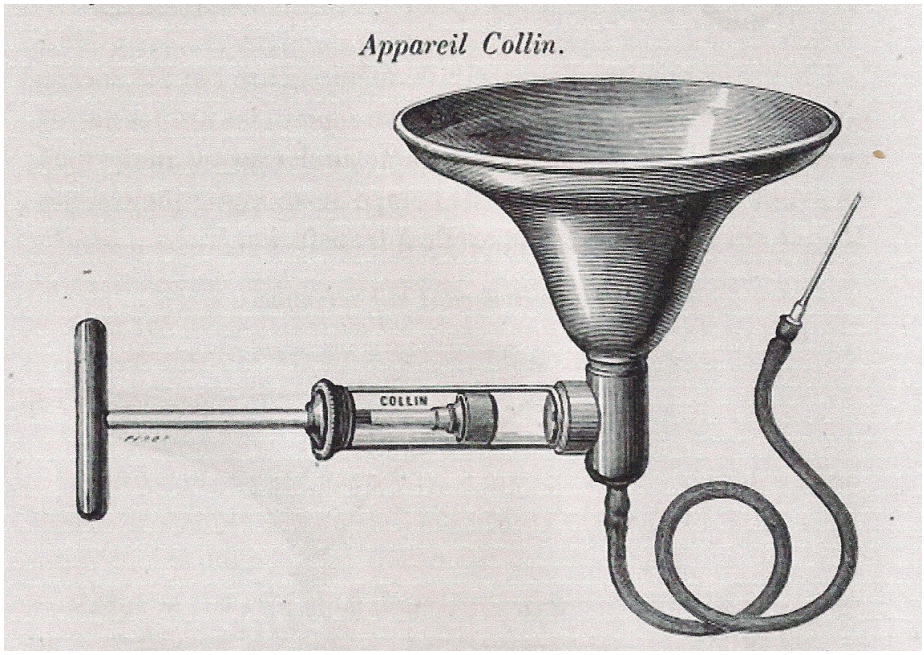
Note: Although Roussel states that these two pieces of equipment are by Mathieu, Moncoq claims that he devised them – see D. Moncoq 1874.



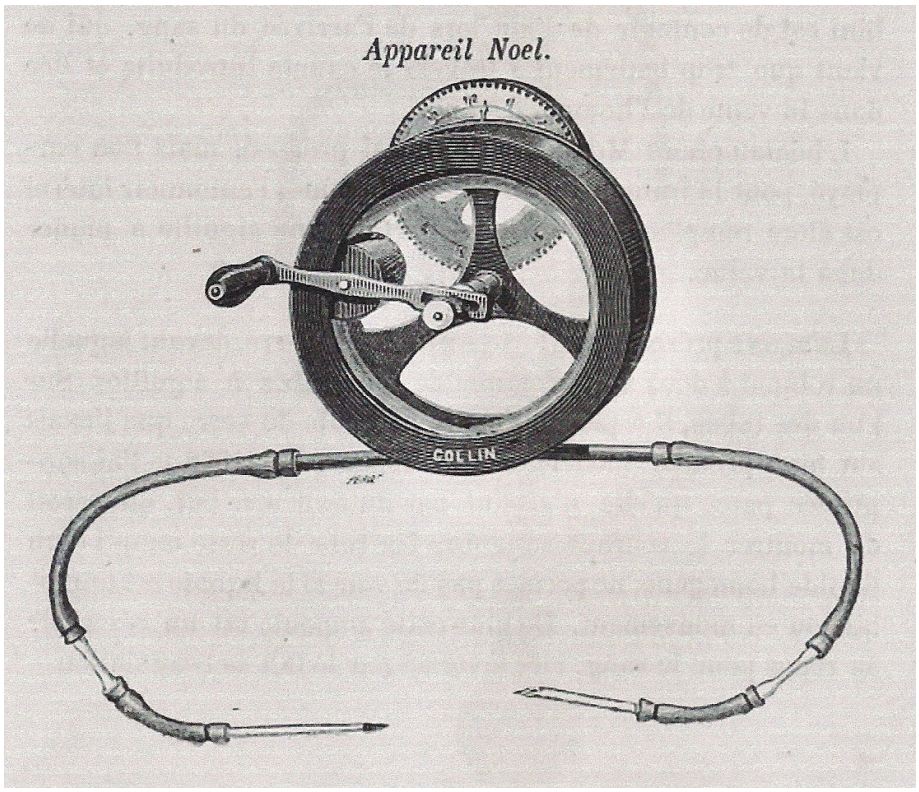
Variation of apparatus devised by Mathieu (Roussel, 1876)
(Image credit: Wellcome Collection)



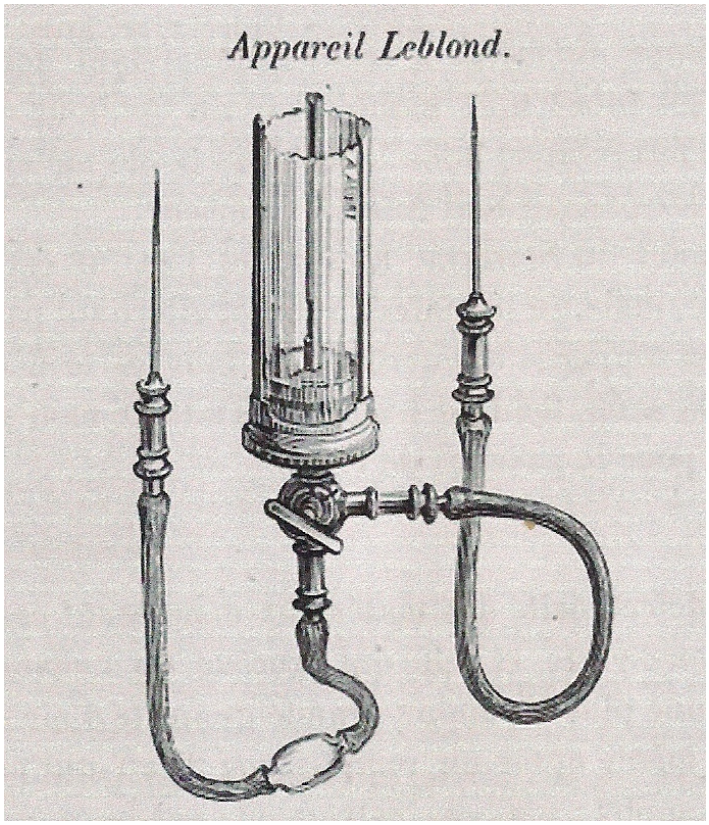
Apparatus devised by Collin (Roussel, 1876)
(Image credit: Wellcome Collection)



Apparatus devised by Collin (Roussel, 1876)
(Image credit: Wellcome Collection)



Apparatus devised by Noel [and built by Collin] (Roussel, 1876)
(Image credit: Wellcome Collection)



Apparatus devised by Leblond (Roussel, 1876)
(Image credit: Wellcome Collection)

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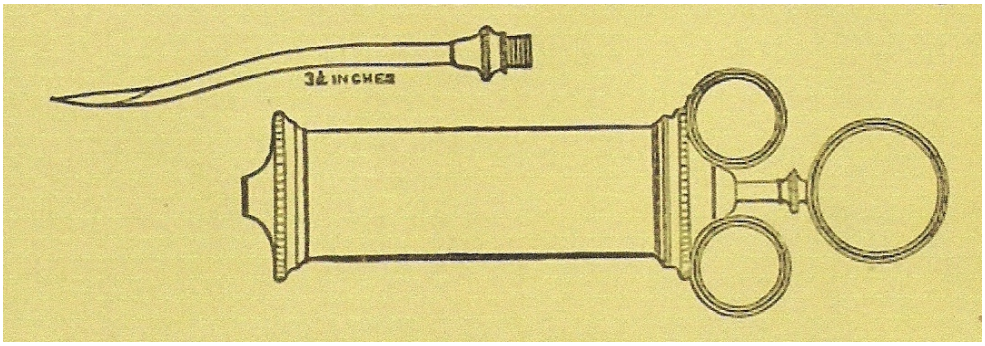
TRANSFUSION (1883, 1888) BY CHARLES EGERTON JENNINGS

Charles Egerton Jennings' book *Transfusion* was first published in 1883 having the sub-title of *Its History, Indications and Modes of Application*; however by the time that the second edition was published later that same year, the sub-title had been changed to *On Transfusion of Blood and Saline Fluids*, which probably more closely agrees with its content. The only other difference between the two volumes was that the second edition includes an appendix section that summarised four published cases of infusion to patients that had involved the use of Jennings' equipment, i.e. two published in the *Lancet* (30th Dec 1882) and two published in the *Medical Times and Gazette* (17th March 1883). The book's third edition, published in 1888, retained the sub-title of *On Transfusion of Blood and Saline Fluids*.

In the early part of the book Jennings presents figures (from combining information presented by other authors) regarding the success of blood transfusion, stating '… of a total of 243 cases in which transfusion was performed for acute or chronic anaemia prior to 1873 … 143 (46.9%) terminated in complete recovery; in 34 cases (14%) the operation was followed by temporary benefit, but failed to save life; in 95 cases (39.1%) no beneficial result whatever was achieved. Accordingly transfusion failed in little over a third of all these cases… '. Of the 243 cases, 113 were performed on account of haemorrhage during or immediately after delivery, of which 67 ended in complete recovery, 7 showed only a temporary recovery, while 39 terminated in fatally; i.e. a positive result was therefore achieved in 65.5%. He therefore concludes that '… as recoveries amount to more than half of the total number of cases, the obstetrician must consider transfusion obligatory whenever acute anaemia of sufficient severity to threaten life sets in …'.

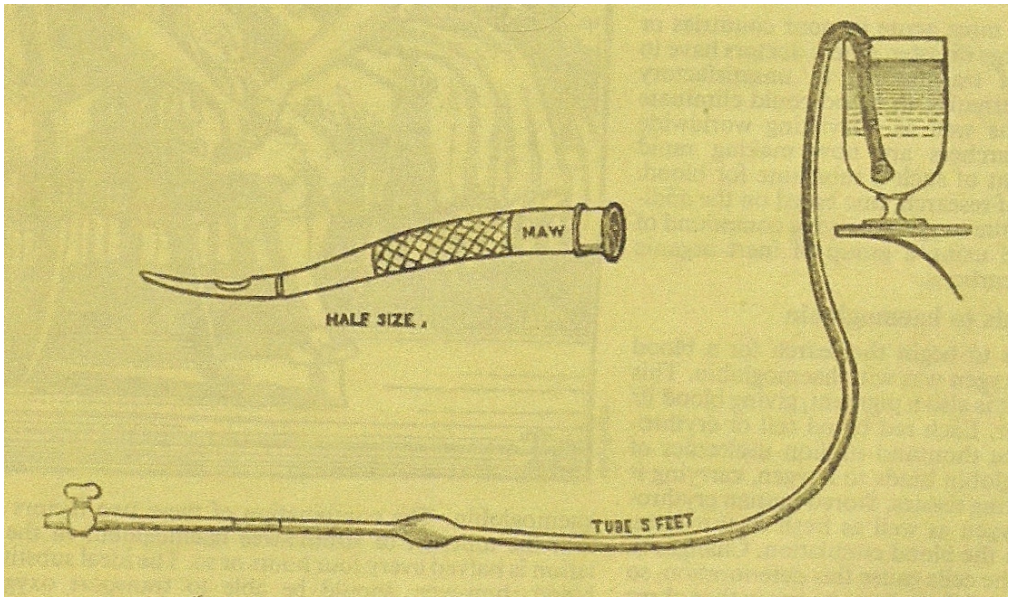
He comments that the transfusion syringe employed at the London Hospital (where he worked) is 'an instrument which, though efficient in the hands of an expert surgeon with able assistants, would prove unmanageable and dangerous under other circumstances'. He goes on to list the disadvantages of the brass syringe used for blood transfusion, that include heat loss, non-transparency, that the cannula is attached to the cylinder by mean of a screw instead of 'plugging-on' and due to its small capacity (less than three ounces) the component parts have to be unscrewed and readapted many times. In addition, given that the operator's hand is holding the cannula *in situ* the syringe has to be filled by an assistant and this increases the time that the (donor) blood is in the collection vessel.



Brass syringe employed by the London Hospital (Jennings, 1883)
(Image credit: Wellcome Collection)

Given that Jennings appears convinced of the usefulness of blood transfusion he then goes on to argue that blood transfusion has a number of inherent problems including air embolism, clotting (in both direct and indirect methods), the complexity

of some types of transfusion equipment, the difficulty of finding a suitable and willing blood donor quickly enough and of performing the operation without skilled assistance. He also summarises the work of Ponfick in stating that animal blood is unsuitable for human transfusion and in addition he notes the 1869 publication by Braxton-Hicks that postulates the use of 'water whose specific gravity is elevated to 2.5 by the addition of phosphate of soda' that can be added to the donor's blood to stop it from clotting. However, Jennings also states that 'evidence is lacking to show that it is sound practice to introduce abruptly into the vascular system phosphate of soda in proportion far exceeding that which normally exists in the blood …'. In other words he dismisses the idea of using anticoagulated donor blood as being untried.



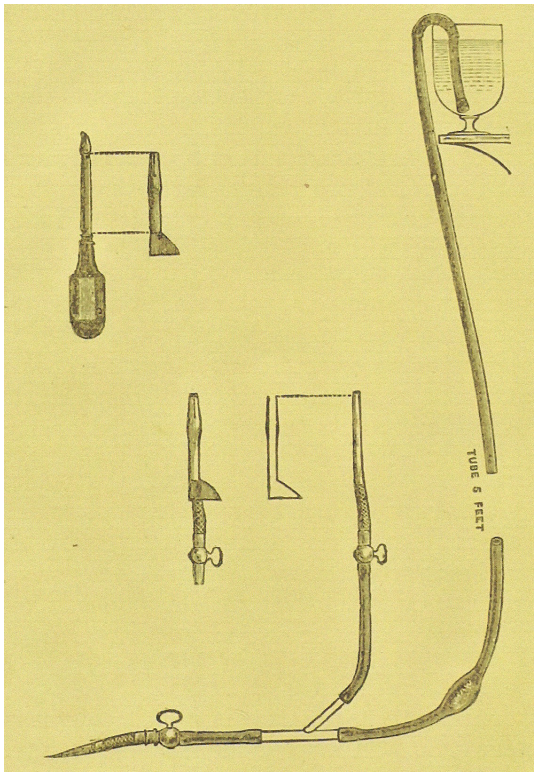
Saline infusion instrument showing the solution, rubber tubing, valve and recipient cannula (Jennings, 1883)
(Image credit: Wellcome Collection)

Given this information he then argues for the use of a saline-alcohol fluid instead of using blood, given intravenously by means of siphon, consisting of '… a piece of rubber tubing about five feet in length, provided with a small bulb and valve for exhausting the air contained in it prior to its use …'. The 'saline-alcohol' solution that he advocates for an infusion fluid consists of a powder made from:

Chloride of Sodium: 50 grains
Chloride of Potassium: 3 grains
Sulphate of Soda: 2.5 grains
Carbonate of Soda: 2.5 grains
Phosphate of Soda (NA_3PO_4): 2 grains

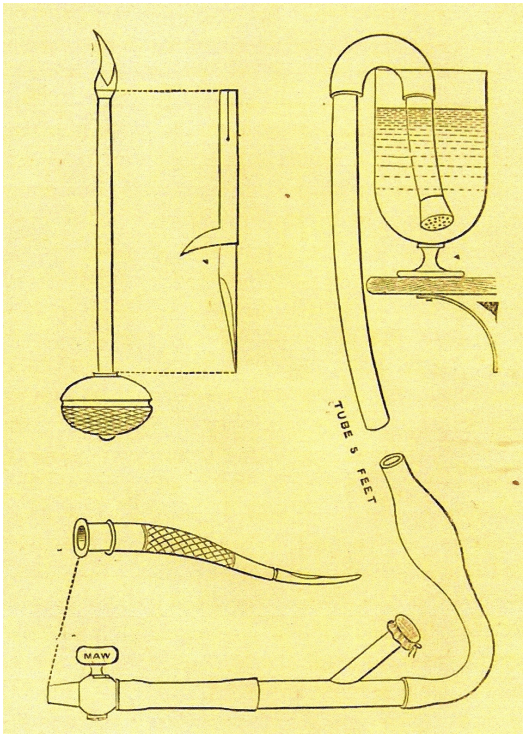
This power mixture is dissolved in 20 ounces of water at 100^{o}F, to which 2 drachms of absolute alcohol is then added.

Having advocated the use of this solution and his infusion set for transfusion use, Jennings then somewhat confusingly states that 'If however a few ounces of blood can be safely and readily obtained … it is obvious that the quality of the saline injection will be much enhanced by the admixture of blood with it'. He also includes a diagram of this modified infusion apparatus showing an additional aperture (which he notes 'should be less that half the calibre of the main trunk') to allow the addition of donor blood.

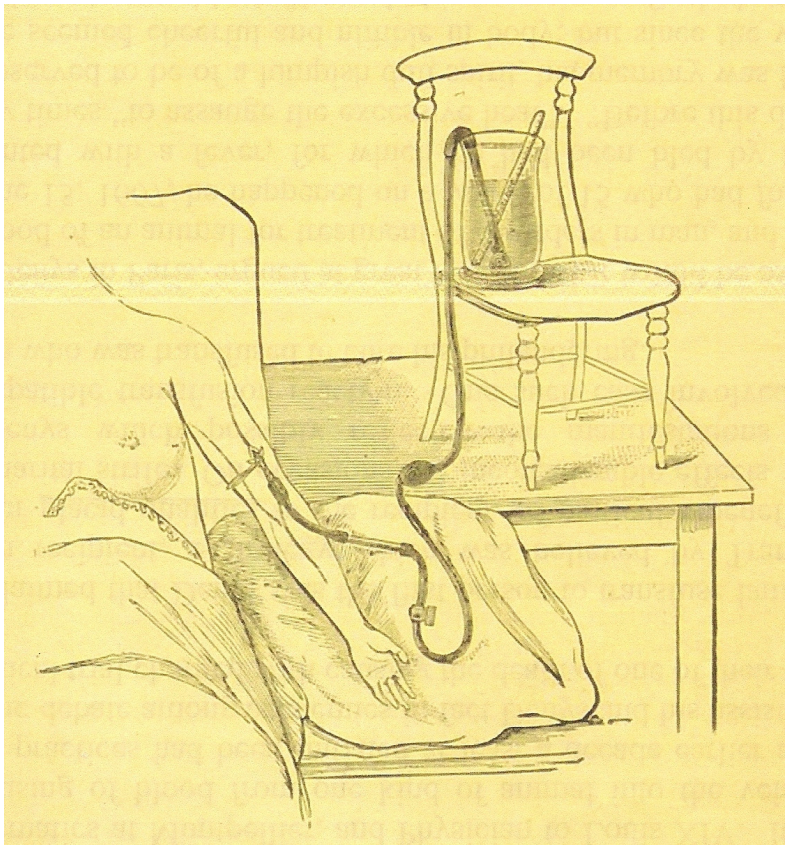


Saline-blood infusion set with additional aperture (Jennings, 1883)
(Image credit: Wellcome Collection)

The third edition of his book, published in 1888, includes a modified version of the diagram of his infusion equipment together with an image of it being used, making specific reference to ‘the mixing stick in the saline solution and the glass observation tube in the rubber tubing line’.

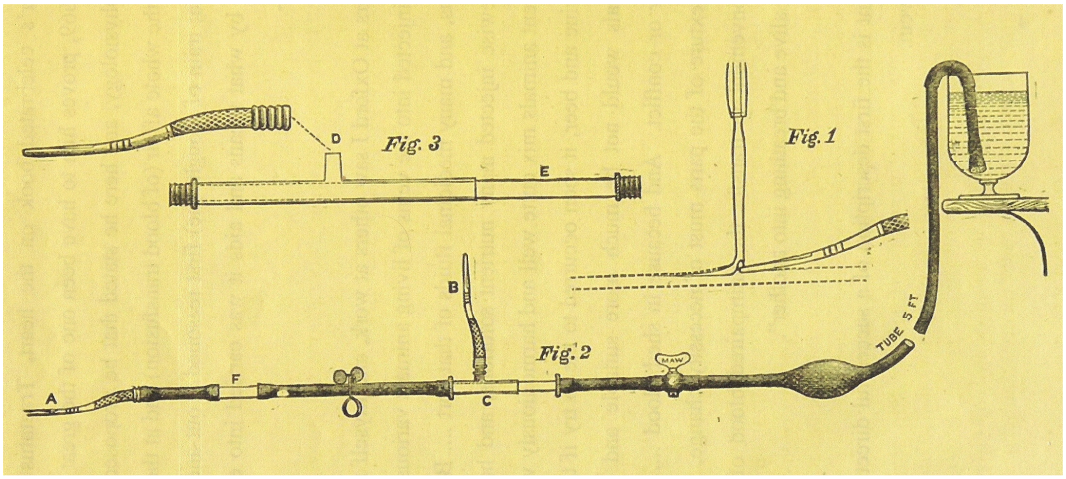


Saline-blood infusion set with additional aperture (Jennings, 1888)
(Image credit: Wellcome Collection)

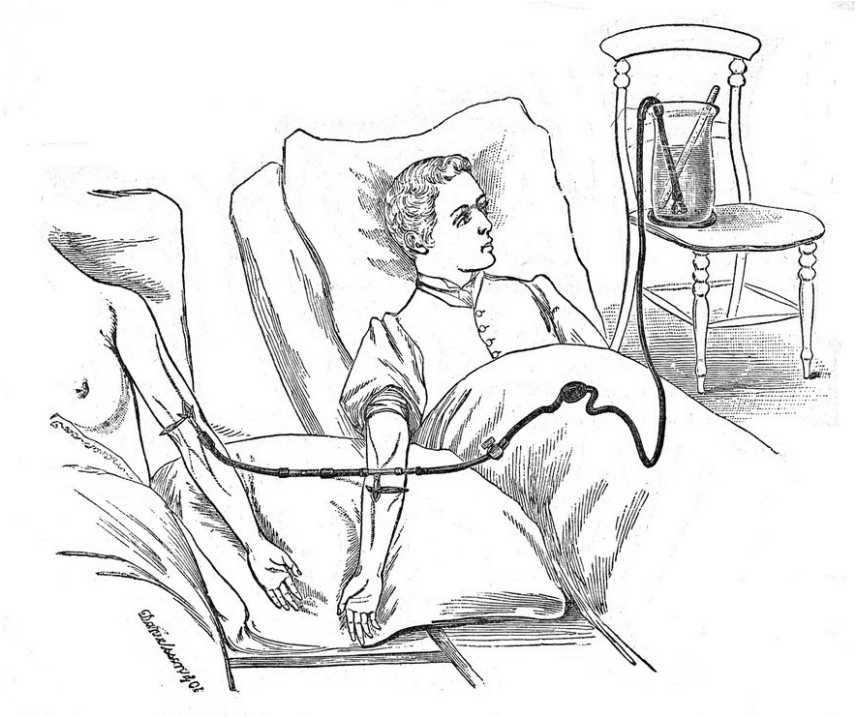


Jennings' saline infusion instrument in use (Jennings, 1888)
(Image credit: Wellcome Collection)

The third edition of his book also includes an image of a modified version of the equipment that allows the addition of blood from a donor together with an image of its use.

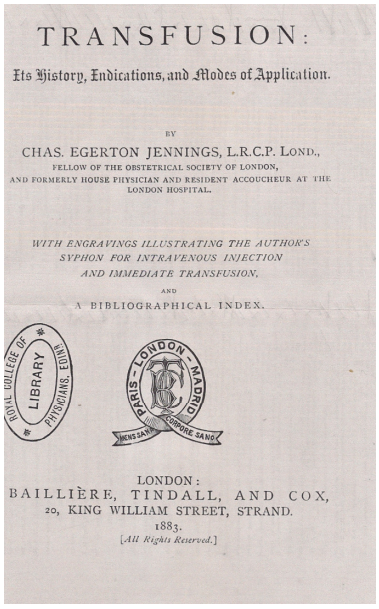


Modified Jennings' saline infusion instrument showing T-junction to allow addition of donor blood, together with the method for inserting the cannula in the donor vein (Jennings, 1888)
(Image credit: Wellcome Collection)



Jennings' modified saline-blood infusion instrument in use (Jennings, 1888)
(Image credit: Wellcome Collection)

Charles Egerton Jennings (1859 – 1930) was an assistant demonstrator of anatomy at the University of Durham where he obtained his MD in 1892. He became the resident accoucheur at the London Hospital and assistant surgeon at the North-West London Hospital and the London Cancer Hospital. As well as his book *Transfusion: Its history, indications and modes of application*, originally published in 1883, he also published the book *Cancer and its complications* published in 1889. Jennings retired in 1902 and died in Malmesbury in 1930.



TRANSFUSION:

Its History, Indications, and Modes of Application.

BY

CHAS. EGERTON JENNINGS, L.R.C.P. LOND.,
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WITH ENGRAVINGS ILLUSTRATING THE AUTHOR'S SYPHON FOR INTRAVENOUS INJECTION AND IMMEDIATE TRANSFUSION,

AND

A BIBLIOGRAPHICAL INDEX.

LONDON:
BAILLIÈRE, TINDALL, AND COX,
20, KING WILLIAM STREET, STRAND.
1883.

Title page of 'Transfusion: its history, indications and modes of application' (1883)
(Image credit: Wellcome Collection)

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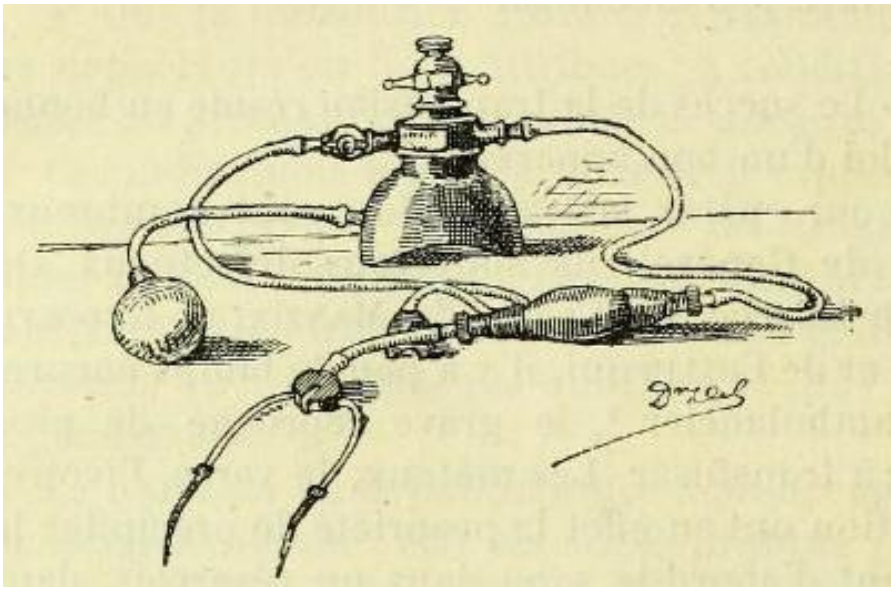
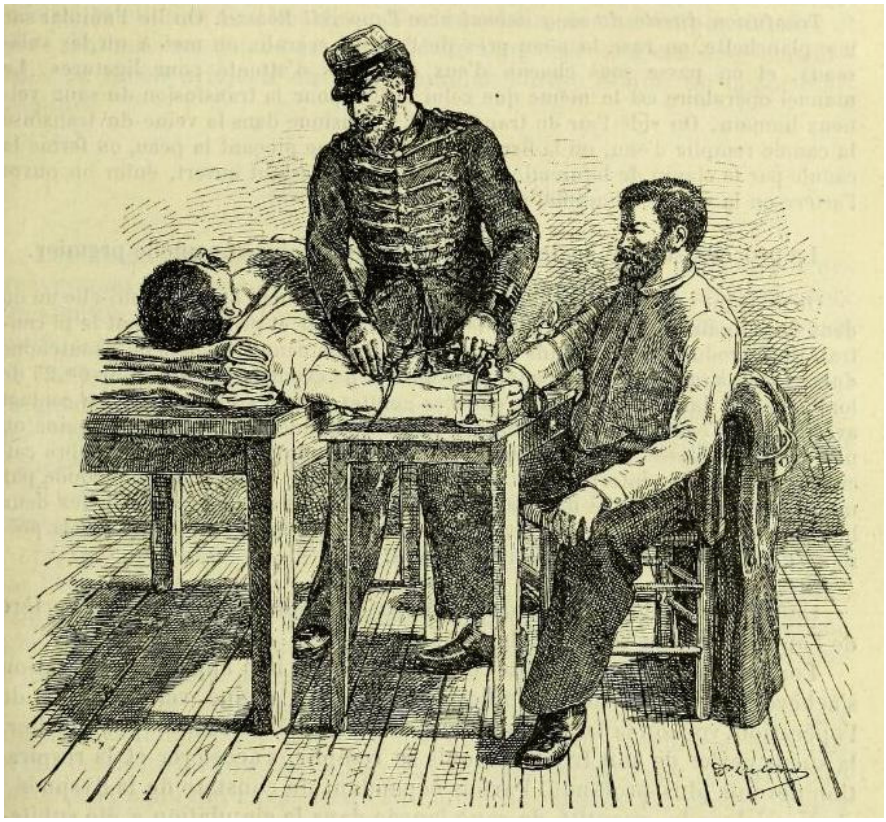
TRAITÉ DE CHIRURGIE DE GUERRE (1888) BY EDMOND DELORME

The book *Traité de chirurgie de guerre* by E. Delorme was published in Paris as two quite extensive volumes, the first in 1888 and the second in 1893. The first volume, of nearly 700 pages, includes a drawing of 'Roussel's Transfuseur' together with a drawing of the same instrument being used in a war setting.



Roussel's Transfuseur (Delorme, 1888)
(Image credit: Wellcome Collection)

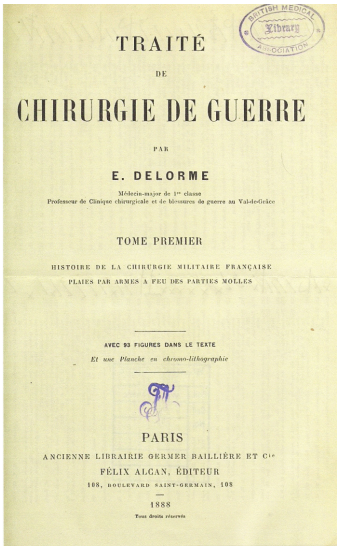


Blood transfusion using Roussel's Transfuseur – French Army (Delorme, 1888)
(Image credit: Wellcome Collection)

The first volume of *Traité de chirurgie de guerre* deals with the history of war surgery, dividing it into different time periods and foreign campaigns, especially those since 1850, and provides direct narratives and reports from surgeons who had taken an active part in these different wars. The report deals with the types of weapons used, such as blades, bullets and large projectiles, together with the methods used to treat the different types of wounds these weapons produced including the different types of dressings and treatments these wounds required. The section dealing with haemorrhage includes (pages 522-531) the use of blood transfusion as a form of treatment. It provides information regarding the use of 'man-to-man' transfusions, employing both direct and indirect techniques, with comments on defibrinated blood, as well as 'animal-to-man' direct transfusions, concluding that the use of human blood is better than animal blood. The 'dangers' of transfusion are also discussed as well as the advantages and disadvantages of the equipment used, especially Roussel's instrument – hence the inclusion of drawings of his 'Transfuseur'.

Edmond Delorme (1847-1929) enrolled in the medical military school at Strasbourg in 1866 and subsequently followed the French army throughout Europe and North Africa. In 1877 he became professor of operative medicine at Val de Grâce Hospital in Paris, professor of clinical surgery there in 1887 and head of all the health services of the French army in 1903.

Edmond Delorme
(Image credit: Picasa – fr.wikipedia.org)



Title page of Traité de chirurgie de guerre (188)
(Image credit: Wellcome Collection)

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TRANSFUSION DU SANG DU CHEVRE (1892) BY JULES ADLER

The realist painter Jules Adler's *Transfusion du sang du chèvre* (1892) depicts a direct animal-to-human blood transfusion. The patient, a young woman, depicted as being as 'white as a ghost', is being treated unconcernedly by the doctors around her by the use of a transfusion from a goat. The painting identifies the different people involved, a nurse in the background apparently preparing equipment, the man on the left with the apron is ensuring the goat remains motionless on the wooden table (his colleague with an apron apparently standing ready to help), the man kneeling by the patient is holding the cannula in her vein and the man on the right with the watch times the transfusion (to indicate the amount of blood transfused). The man standing in the middle without an apron holding the cannula in the animal's carotid is Dr. Samuel Bernheim (1855-1915). The painting was commissioned by Bernheim, a famous tuberculosis specialist, who believed that transfusing people with goat blood strengthened their immunity against the infectious respiratory disease. The painting was exhibited in Paris where it was viewed as depicting a breakthrough in medical science – it also launched Adler's career.

'Transfusion du sang du chevre' (Adler, 1892)
(Image credit: researchgate.net)

The use of goat transfusions by physicians in the 1890s was based on the experimental data which identified that goats were refractory to tuberculosis infection. In animal experiments, if rabbits were inoculated with tuberculosis they died within two months but if they were infused soon after inoculation with goat's blood the rabbits resisted the infection and if infused later the infection reduced and they appeared cured. As such, the transfusion of goat's blood to the rabbits appeared to produce a bactericidal condition. Physicians therefore thought that this effect may be transferable to humans, especially since animal blood had been used for transfusion in Europe for a number of years. This had been reportedly performed with some questionable degree of success by limiting the amount of goat blood that was transfused – this being presumably the reason for showing the man with the watch in the painting by Jules Adler.

There is also an engraving of Dr. Bernheim giving another tuberculosis patient a transfusion of goat's blood that is copyright managed – but can be viewed at:
https://www.gettyimages.co.uk/detail/news-photo/tuberculosis-patient-receiving-a-direct-blood-transfusion-news-photo/587495046
Accessed: 10 August 2020

The French painter Jules Adler was born in 1865 in Luxeuil-les-Bains, one of five children of an Alsatian Jewish family. His parents were cloth merchants with little interest in the visual arts but who ensured their son developed his early recognised talent, training in Paris at the Académie Julian and then entering the École des Beaux-Arts in 1884. A prolific painter of landscapes he was better known for his paintings of working people which revealed his socialist outlook and interest in social problems. He died in 1952 in Nogent-sur-Marne, Paris.

Jules Adler (1865 - 1952)
(Image credit: en.wikipedia.org)

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