

EXTRACTS FROM ROBERT BOYLE'S LETTERS RELATING TO INFUSION AND BLOOD TRANSFUSION

ROBERT BOYLE'S CORRESPONDENCE

The fifth volume of 'The Works of the Honourable Robert Boyle', as well as other diverse material, contains a large collection of letters sent by him to other people as well as letters to him from various people (published from the originals). Predominant amongst these that relate to infusion and blood transfusion are letters sent from Henry Oldenburg and Richard Lower. The 'correspondence section' of volume 5 is contained between pages 229 and 655 inclusive. The first part of this section involved letters sent by Robert Boyle, some of which are to Henry Oldenburg (1619-1677), who was the first secretary of the Royal Society (along with John Wilkins). Robert Boyle became Oldenburg's lifelong patron.

The second and largest section involves a series of letters sent over a number of years from Henry Oldenburg to Robert Boyle. Oldenburg dealt with the Royal Society's foreign correspondence (he could communicate in German, English, Latin, Greek, Dutch and French) and was the founding editor/author/publisher of what was known as the Society's journal, the *Philosophical Transactions of the Royal Society*, during which time he began sending submitted manuscripts to relevant experts who could judge their quality and advise him regarding publication, essentially inventing the practice of peer review. One of the experts he frequently corresponded with was Robert Boyle. Oldenburg's letters contain a vast variety of different types of information not only relating to the Royal Society but also political and other events.

The third section contains a number of letters to Robert Boyle from Dr. Richard Lower (1631-1691), sent between 1661 and 1666, which contain details of his experiments with blood transfusions between dogs. The last of these, written on the 3 September 1666 includes a detailed description of the artery-to-vein technique he developed, which formed the basis of the paper describing this that was published in the 17 December 1666 edition of the *Philosophical Transactions of the Royal Society*.

The forth section contains only three letters from the large number sent to Robert Boyle from other people that include information relating to infusion or blood transfusion.

ROBERT BOYLE (1627 – 1691)

Robert Boyle was of Anglo-Irish decent, a theologian, natural philosopher, chemist, physicist, inventor and one of the pioneers of experimental technique, who is mainly remembered for his work with the pressure and volume of gases, i.e. 'Boyle's Laws'. His father, the 1st Earl of Cork had amassed great wealth and land by the time Robert was born; he was educated privately and at Eton College, England. Having travelled in Europe he returned to England with an interest in philosophy and scientific research and became a member of a group of like-minded people that became known as the 'Invisible College', who met frequently in London (usually at Gresham College) as well as Oxford. In 1663 Charles II granted the invisible college a royal charter and it became the 'Royal Society of London for improving Natural Knowledge'; Boyle was elected to its first council. From the end of the 1660's he gradually started to withdraw from public engagements due to increasing ill health and as a result became more dependant on his correspondence with friends, colleagues and fellow academics.

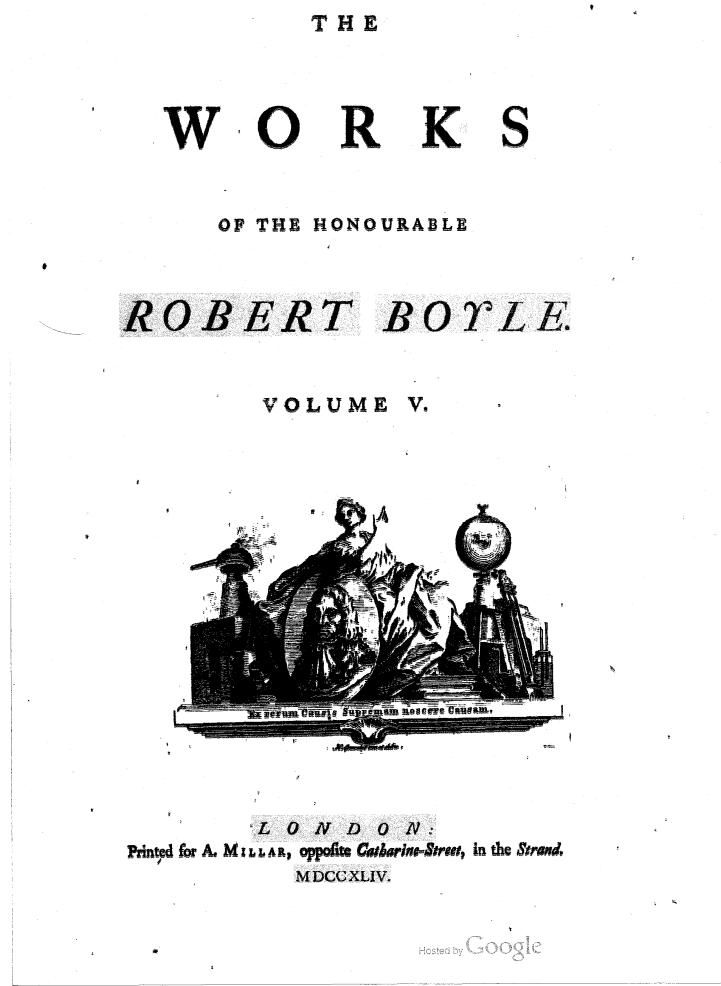
THE WORKS OF THE HONOURABLE ROBERT BOYLE

Many of the different publications produced by Robert Boyle were collected together by the historian Thomas Birch (1705-1766) into five volumes, which he co-wrote with Rev. Henry Miles in 1744. The five volumes can be read or downloaded from:

https://www.google.co.uk/books/edition/The_Works_of_the_Honourable_Robert_Boyle/6BJO5wQyoeMC?hl=en&gbpv=1&pg=PP8&printsec=frontcover#v=onepage&q&f=false

Volume 5 can also be viewed or downloaded from:

https://books.google.co.uk/books/about/The_Works_of_the_Honourable_Robert_Boyle.html?id=6BJO5wQyoeMC&redir_esc=y



Title page: The Works of the honourable Robert Boyle. Volume V (1744)
(Picture credit: books.google.co.uk)

Thomas Birch was the Secretary of the Royal Society from 1752 to 1765 and also produced a History of the Royal Society of London, published in 1756-1757.



Robert Boyle
(Picture credit: en.wikipedia.org)



Thomas Birch
(Picture credit: en.wikipedia.org)



Henry Oldenburg
(Picture credit: en.wikipedia.org)



Richard Lower
(Picture credit: en.wikipedia.org)

LETTER EXTRACTS RELATING TO INFUSION / BLOOD TRANSFUSION

All information relating to infusion or transfusion of blood has been extracted from the correspondence section of Vol. 5 of the Works of the Honourable Robert Boyle. This information is presented below in four sections, i.e.

1. Letter by Robert Boyle to other people.
2. Letters from Henry Oldenburg to Robert Boyle
3. Letters from Dr. Richard Lower to Robert Boyle
4. Letters from various other people to Robert Boyle

The relevant information, relating to infusion and/or transfusion has been extracted from the letters and is presented as such, or where necessary, the whole letter has been transcribed. The letters are identified by the page number of volume five where the letter extract appears, together with the letter's author and date that it was written.

The material has been transcribed as written with the exception of altering the spelling of some Old English words and replacing the letter f which was used to represent the letter s. I have added notes and personal comments regarding many of these entries, as well as appropriate internet references. These comments and references are in italics presented after the extract.

1. LETTERS BY ROBERT BOYLE TO OTHER PEOPLE

Note: There are only a relatively small number of letters written by Robert Boyle in this collection and only one of these contains anything about infusion or blood transfusion.

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Letter to Henry Oldenburg – 29 December 1667

... The experiment of transfusion, made upon a mad man, I shall look upon, if the cure hold, as a very considerable thing, and capable of improvements. ...

The date (and content) of this letter suggests that it is written in response to a letter from Henry Oldenburg that is dated 24 December 1667 (see page 377 below), in which he describes the contents of an anonymous letter from Paris that gives a brief description of the transfusion of 'a madman' (i.e. Antoine Mauroy, transfused on 19 December 1667). It is therefore very likely that it is this transfusion that Boyle is referring to and not the transfusions given to Arthur Coga (on the 23 November 1667 and 12 December 1667). Even though Arthur Coga is described by Henry Oldenburg as being 'looked upon as very freakish', an 'extravagant man' and an 'indignant person' and by Edmund King as 'his brain was sometimes a little too warm', indicating that Coga may have had some kind of mental problem or at least an unusual demeanour he is not described as 'mad' in any published accounts. Maluf (1954) however states that this was the reason why he was transfused, i.e. 'On 23 November 1667, Drs. Richard Lower and Edmund King attempted to change a man's character by transfusion' (Journal of the History of Medicine and Allied Sciences, 9, 1, page 65).

2. LETTERS FROM HENRY OLDENBURG

Note: Although there are a large number of letters from Henry Oldenburg included within this collection that pre-date and first one and post-date the last one presented below, none of these include information on infusion or transfusion.

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Letter from Henry Oldenburg – 21 November 1665

... And out of Germany a friend hath some particulars imparted to me of salt springs, and of an odd spring in Westphalia; of which my next Transactions will give an account; where I also make a narration of the rise and attempts of injections into veins, taking assistance from what you have recorded of that matter in your Usefulness of Experimental Philosophy; but wanting the precise time, when it was first started by Dr. Wren at Oxford, which if you do remember, or any of your friends, I pray let it be expressed, and corrected what I may have erred in, who have set down, that it is about six years ago, when the first mention of it was made in England, long before any others, as far as we know, thought on such a thing. If I had had my own book, I lent to Dr. Clerk, and that which you had lately from Hamburg, I should have been a little more particular in that business; but I hope, what I have said, will be sufficient. ...

This comment relates to Henry Oldenburg's defence of priority issues regarding the invention of the infusion / injection of different substances directly into the veins of animals. The editorial article referred to in the above letter extract is titled 'An account of the rise and attempts, of a way to convey liquors immediately into the mass of blood' published in the Philosophical Transactions of the Royal Society, 4 December 1665, Vol.1, No. 7, p. 128-130

<https://royalsocietypublishing.org/toc/rstl/1665/1/7>

The paper emphasises that it was Christopher Wren who invented and practiced the infusion of materials directly into the veins of animals (though no actual date is given as to when the first experiment by him was performed) and that Mr. Boyle continued this type of investigation, publishing it in his book 'Usefulness of Experimental Philosophy' (1663). The article also mentions the work of Dr. Timothy Clarke who was prominent in this research in England, who unfortunately did not publish his work before his death in 1672.

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Letter from Henry Oldenburg* – 17 March 1666

... At our meeting at Gresham last the president took some account of what several of the members then present had been employed in, during the late and sad long recess. Some related what had been done by them in the matter of ... others what in the perfecting of the experiments touching injection into veins, and particularly about the transfusing of blood out of one animal into another; concerning the last whereof, Dr. Clerk ** affirmed, that he had tried that experiment two years ago, but found it so difficult, that he gave it over: where upon Sir R. Moray mentioned, that Mr. Boyle had hopes of mastering the difficulties, that are met with in that experiment. Dr. Wallis being present, and desired to acquaint the company, what had been chiefly done at the meeting in Oxford last summer, related same of the musical experiments, that had been made; and being solicited to give them in writing, he made answer, that Mr. Boyle had recorded them. Whereupon the secretary was ordered to take notice of it in writing, that Mr. Boyle be desired to impart the said experiments, with all their circumstances. ...

* There is no name at the end of this letter but its content indicates that it must be from Henry Oldenburg.

** It is believed that this should be Dr. Timothy Clarke

The 'late and sad long recess' that is mentioned, relates of course to the plague; during which time many members of the Royal Society moved out of London into the country. Dr. [Timothy] Clarke's unsuccessful attempt at transfusing the blood from one animal to another is also recorded at the Society meeting held on the 14 March 1666 (Birch, *History of the Royal Society*, Vol. II, p. 67). Being unsuccessful, the details were not published so the reasons for the failure remain unknown apart from the statement that he 'found it difficult'. The comment by Sir R Moray can be inferred to identify that it is not Mr Boyle personally who has 'hopes of mastering the difficulties' but is, like Dr. Wallis, aware of the work performed by Dr. Lower, having been at 'the meeting in Oxford the previous summer. There is no evidence that Robert Boyle performed any experiments himself on blood transfusion.

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Letter from Henry Oldenburg – 15 November 1666

... We have now conquered the difficulty of bleeding one animal into another. Some persons; [*] appointed by the Society, performed the operation first by themselves upon a couple of sheep, with good success, as they reported: but then they did it yesterday, before the Society, very successfully also, upon a bull-mastiff, and a spaniel, the former being the emittent, the other the recipient. It took up so much time, that there was very little left to consider and discourse ...

* At the Society meeting of the 26 September 1666 (Birch, *The History of the Royal Society*, Vol. II, p. 115) identifies that the 'curators of the experiment', who are believed to be the same as 'some persons', are Mr. Daniel Coxe, Mr. Thomas Coxe, Mr. King, and Mr. Hooke. The transfusion was performed according to 'Lower's method'. Entries for the *History of the Royal Society* suggest that this 'private' experiment may have taken place on the 6 November 1666. Although this experiment was performed on two sheep, the 'public' demonstration in front of the Society was performed, as stated here, on the 14 November 1666 by Mr. King and Mr. Thomas Coxe and involved a transfusion between two dogs. It is not known how long the original animal transfusions took to perform but the comment in this letter of 'it took so much time...' gives an indication. Although an account of the experiment was read by Dr. King at the meeting of the Society on 21 November 1666 (Birch, *History of the Royal Society*, Vol. II, p. 125) it was not published in the *Philosophical Transactions of the Royal Society*.

NOTE: The gap in the dates between this and the next correspondence has been incorrectly identified to have been due to Oldenburg's brief period of imprisonment in the Tower of London in 1667. Some of his correspondence was suspected of being a means of supplying intelligence information during the second Anglo-Dutch war, resulting in him being accused of spying [Oldenburg was German by birth]. He was released without charge. Oldenburg corresponded on a regular basis with many people in Europe and as well as Royal Society business, many of his letters to Robert Boyle contain civil and European items of news.

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Letter from Henry Oldenburg – 12 September 1667

... The transfusing experiment I find grows famous; our friend at Yeovil offering some subjects to try it upon. They are, one a gentleman of the biggest account of that

country, and a sad example of draining away too much of his blood (to allay the distemper of his brain) now emasculated, and for these many years changed from the most haughty and courageous temper to the most pusillanimous: it is Sir John Stowell, elder brother to the high sheriff colonel Stowell. Perchance a supply of lamb's blood had done better, or might yet give some degree of recovery. But younger brothers perhaps would not be much obliged for the performance of such cures, no more than cardinals will for the confirmation of the health of popes this way. Another in the same country is one Mr. Thomas Hawker, who hath been outrageously distract above a year, upon whom two famed empirics have had their turns of trying all old ways in vain. Concerning this latter our friend faith, that he believes he could persuade his wife to send him to Oxford, she being well able and willing to gratify the physician. Sir, think of this, I prey and give me your advice, when you shall have communicated it with some of those that are versed in making the experiment, and have been informed, how successfully this trial hath been already made upon men, both sick and well at Paris.

There is no documented record of any blood transfusions being attempted on either Sir John Stowell or Mr. Thomas Hawker; see also the 'postscript' comment in Oldenburg's next letter – 17 September 1667.

The comments in this part of his letter identify that Henry Oldenburg is well aware of blood transfusions being attempted on 'both sick and well in Paris' – presumably referring to the transfusions given by Jean Denis to the young boy suffering from a persistent fever (who had been bled numerous times) who was transfused on 15 June 1667, and the healthy 45 year old man (who was paid to receive a transfusion). These two cases are described in Jean Denis's letter, dated 25 June 1667, titled 'A letter concerning a new way of curing sundry diseases by transfusion of blood, written to Monsieur de Montmor, Councillor to the French King, and Master of Requests', published in Philosophical Transactions of the Royal Society, 23 September 1667, Vol. 2, Issue 27, p. 489-504.

<https://royalsocietypublishing.org/toc/rstl/1667/2/27>

It is interesting however that Oldenburg appears to be comparing the 'draining away too much of his blood (to allay the distemper of his brain)' by Sir John Stowell's physicians with the young boy transfused in Paris, whose 'physicians had bled 20 times'. This comment is carried even further by stating that Mr. Thomas Hawker's physicians as being 'two famed empirics' who 'have had their turns of trying all old ways in vain'.

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Letter from Henry Oldenburg – 17 September 1667

... I know not, whether during my confinement, you had, or heard of the *Tetras anatomicarum epistolarum Malpighii (Siculi) et Fracassati (Pisani) de lingua et cerebro*; together with an exercitation *de omento*. It is in print, and written for by me, to be sent over. I pray, Sir, if you can conveniently, order the injecting into the veins of a dog some oil of sulphur, and see what will be the consequence of it, and observe particularly, whether the dog will feed with an extraordinary avidity upon it. I wish also, that an injection might be made with oil of tartar; and in case the dog die (as it is like he will) that he may be opened, and his blood well observed.

[Postscript:] ... I do not find by your last letter, that such an attempt of transfusion, for which I suggested in my examples in my former, will be undertaken by any body there.

It is not clear whether the book identified in the first sentence of this extract has any bearing upon why Oldenburg should suggest such an experiment or if he has been asked to make the request of Boyle from another source – it seems unlikely that he would suggest it himself in such detail. It does illustrate that the performance of such experiments, that were being widely performed in Germany were still suggested in England. There is not mention of such an experiment in the History of the Royal Society by Birch in entries prior to 17 September 1667. The ‘confinement’ refers to Oldenburg’s imprisonment in the Tower of London.

The postscript comment is believed to relate to Oldenburg’s statement in his previous letter (12 September 1667) regarding Mr. Thomas Hawker; ‘there’ being Oxford.

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Letter from Henry Oldenburg – 24 September 1667

... Mr. Martyn is now printing the Transactions of this month, which will comprise also the two next precedent; and contain in the beginning an animadversion on the Englished letter of Monsieur Denys concerning the transfusion: which transfusion I disown for mine, inscribing this tract with num. 27 which the stationer too boldly presumed to give to that translated letter.

I hope my censure on the there mentioned ten years conception before its birth here in England, will satisfy those ingenious gentlemen of England, that are concerned in that invention, of which I also discoursed lately with Dr. Lower who gave me a kind visit, and took occasion to speak of that particular; whom I assured, that I had no hand at all in the translation of that letter; which I was so far from, that though I had the French original before anybody had it in England, which was the same day as my confinement, yet I would not impart it to any person, because I fully intended not to publish it without such an animadversion, as I now have sent to the press. ...

This part of Henry Oldenburg’s letter relates to the translating and printing of Dr. Denis’s letter in the Philosophical Transactions of the Royal Society (number 27) published whilst Oldenburg was held in the Tower of London, accused of spying. His statements identify that he had no knowledge of or agreement with the publication of this translation. The letter by Dr. Denis, titled ‘A letter concerning a new way of curing sundry diseases by transfusion of blood, written to Monsieur de Montmor, Councillor to the French King, and Master of Requests, was published in the Philosophical Transactions of the Royal Society, Vol. 2, Issue 27, p. 489-504.

<https://royalsocietypublishing.org/toc/rstl/1667/2/27>

Oldenburg’s editorial criticism as promised in this letter, titled ‘An account of more tryals of transfusion, accompanied with some considerations thereon, chiefly in reference to its circumspect practice on man; together with a farther vindication of this invention from usurpers’, was published in the Philosophical Transactions of the Royal Society, Vol. 2, Issue 28, p. 517-525.

<https://royalsocietypublishing.org/toc/rstl/1667/2/28>

Oldenburg then wrote an additional editorial that examines the concept of priority, specifically if this could be just a thought, or if an experiment has been witnessed to have been performed and subsequently documented / published in a reputable journal. This editorial titled ‘A relation of some trials of the same operation, lately made in France’ was published in the Philosophical Transactions of the Royal Society, Vol. 2, Issue 30, p. 559-564.

<https://royalsocietypublishing.org/toc/rstl/1667/2/30>

Note: These comments regarding historical priority issues relating to the performance of the first blood transfusion in an animal and in a man that existed between England and France have been examined by a number of authors. Two examples of this discussion, including the issues caused by the publication of Dr. Denis's letter can be found in the following references:

Farr, A.D. (1980) *The first human blood transfusion*. *Medical History*, 24, 2, 143-162.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1082701/>

Hall, A.R., Hall, M.B. (1980) *The first human blood transfusion: priority disputes*. *Medical History*, 24; 4, 461-465.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1082682/>

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Letter from Henry Oldenburg – 1 October 1667

... [Talking about the content of the next edition of *Philosophical Transactions*] There are mixed, among the contents, some experiments and observations, sent out of Italy, and from Messina, about injections into veins, the tongue and brain, the optic nerve in fishes, &c. which perhaps will not displease you. ...

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Letter from Henry Oldenburg – 8 October 1667

... The experiment of transfusion was tried at Paris upon a baron of Sweden; but he dying, his intestines were found all gangrened, so that it was not possible to have recovered him by any known natural means. This invention is hugely disputed abroad pro and con; ...

This comment relates to Jean Denis's transfusion on the 24 July 1667 of Baron Bond, son of the Prime Minister of the King of Sweden, whom four doctors had been treating for three weeks for Fluxus hepaticus with lienterich bilious diarrhoea and a very violent fever. This transfusion is described in detail by Paul Scheel in his 1802 book 'Die transfusion des blutes und einspreitung der arzeneyen in die adern (see section §.44).

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Letter from Henry Oldenburg – 24 October 1667

[Postscript:] ... The notice you received from Mr. Williamson; concerning injections, I guess to be sent him from Hamburg; and then they are very likely to be the same with those I received a good many months since, which I did show you, and afterwards lent them to Dr. Clerk, who hath it still. One Dr. Major is the author thereof.

This postscript note presumably refers to Dr. Timothy Clarke and to Johann Daniel Major who performed infusion experiments in England and Germany respectively.

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Letter from Henry Oldenburg – 12 November 1667

... Dr. Lower has been making several trials amongst us, of giving a dropsy to a dog in a very short time, by tying up of the vena cava; which, it seems, has given him matter enough to write a tract, that may, together with some other experiments, conduce much to the clearing up of the doctrine of Pathology. He, in conjunction with several others, are like to do philosophy great service by anatomical discoveries.

Although not related directly to blood transfusion this is an interesting comment regarding Dr. Richard Lower's abilities.

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Letter from Henry Oldenburg – 25 November 1667

... On Thursday next, God willing, a report will be made of the good success of the first trial of transfusion practiced on a man, which was by order of the Society, and the approbation of a number of physicians, performed on Saturday last in Arundel house, in the presence of many spectators, among whom were Mr. Howard and both his sons, the bishop of Salisbury, four or five physicians, some parliament men, &c. by the management and operation of Dr. Lower and Dr. King, the latter of whom performed the chief part with great dexterity, and with so much ease to the patient, that he made not the least complaint, nor so much as any grimace during the whole time of the operation; in which the blood of a young sheep to the quantity of about eight or nine ounces by conjecture, was transmitted into the great vein of the right arm, after the man had let out some six or seven ounces of his own blood. All of which was done by the method of Dr. King's, which I published in num. 20 of the Transactions without any change at all of it, save only in the shape of one of the silver pipes, for more conveniency. Having let out before the transfusion, into a porringer, so much of the sheep's blood, as would run out in about a minute (which amounted to twelve ounces) to direct us as to the quantity to be transfused into the man, he, when he saw that florid arterial blood in the porringer, was so well pleased with it, that he took some of it upon a knife, and tasted it, and finding it of a good relish, he went the more courageously to its transmission into his veins, taking a cup or two of sack* before, and a glass of wormwood wine* and a pipe of tobacco after the operation, which no more disordered him, both by his own confession, and by appearance to all bystanders, than it did any of those that were in the room with him. The pipe being taken out of the man, the blood of the sheep ran a very free stream, to assure the spectators of an uninterrupted course of blood. The patient found himself very well upon it, his pulse better than before, and so his appetite. His sleep good, his body as soluble as usual, it being observed, that the same day of his operation he had three or four stools, as he used to have before. This morning our president (who by very pressing business could not be present in Arundel house) and I went to see him pretty early, and found him a bed, very well, as he assured us, and more composed, as his host affirmed, than he had been before, he being looked upon as a very freakish and extravagant man; who hath studied at Cambridge, and is said to be a bachelor of divinity, called Arthur Coga, an indigent person, and receiving a guinea for undergoing the experiment; which reward maketh him willing to have it repeated upon him, wherein he will easily be complied with, and that, I think, before the end of this very week, if circumstances shall persuade it. But I doubt, I do here *actum agere*, and trouble you with the repetition of what Dr. King hath related in this annexed letter, which he desired me to convey to you. ...

* 'Sack' is the name of a fortified wine imported from Spain or the Canary Islands that was much in vogue in England in the 16th and 17th centuries. 'Wormwood' is the name of a bitter / minty tasting herb that has supposed health benefits, which was used to spice wine, but is most famously used as one of the ingredients in absinthe.

Note: Much of the content of this extract is reproduced in the minutes of the Society meeting held on the 28 November 1667 (Birch, History of the Royal Society, Vol. II, p. 216)

The description of the first transfusion of a man in England by Edmund King was published in 9 December 1667 edition of the Philosophical Transactions of the Royal Society, Vol. 2, Issue 30, p. 557-559.

<https://royalsocietypublishing.org/toc/rstl/1667/2/30>

The account of this event by Henry Oldenburg in his letter has a number of interesting points to consider:

- *Given that the date of the letter is the 25 November 1667, which Samuel Pepys identifies to be a Monday, the 'Saturday last' identified as to when the experiment was performed must be the 23 November 1667. This date agrees with that given in Dr. King's written account published in the Philosophical Transactions of the Royal Society as well as that given at the Society meeting of the 28 November 1667 (Birch, History of the Royal Society, Vol. II, p. 216) where it states 'Mr. Coga, the first person in England on whom the experiment of transfusion was made on the 23d instant'.*
- *Oldenburg is at pains to identify some of the people who were witness to the event, which ensured its credibility, confirming to anyone reading the account that it definitely took place. In effect this could be interpreted as a form of validity endorsement or peer review.*
- *Dr. Edmund King is identified to have been the principle surgeon who performed the operation rather than Dr. Richard Lower. This description by Oldenburg identifies that sheep arterial blood was used, i.e. the 'florid arterial blood in the porringer'. This confirms the detail in King's written account, of using the 'carotid artery of a young sheep', which in fact goes against his own proposed vein-to-vein technique that was published in the Philosophical Transactions of the Royal Society, Vol. 2, Issue 25, p. 449-451.*

<https://royalsocietypublishing.org/toc/rstl/1667/2/25>

There is however some contradiction here, as Oldenburg writes that the operation 'was done by the method of Dr. King's, which I published in num. 20 of the Transactions without any change at all of it, save only in the shape of one of the silver pipes, for more conveniency.' This reference however relates to a paper by Dr. Lower, not Dr. King, i.e. Philosophical Transactions of the Royal Society, Vol. 1, Issue 20, p. 353-358.

<https://royalsocietypublishing.org/toc/rstl/1666/1/20>

This contradiction could however be explained by the fact that 'num. 20' in Oldenburg's letter should in fact be Issue 28 and not Issue 20 (i.e. a transcription or typographic error). This would then agree with what Dr. King states in his published account of Arthur Coga's transfusion, i.e. that the method used was '...after the method formally published numb. 28; which method we observed without any other alteration, but in the shape of one of our pipes; which we found more convenient for our purpose.' This 'numb. 28' relates to Oldenburg's editorial titled 'An account of more tryals of transfusion, accompanied with some considerations thereon, chiefly in reference to its circumspect practice on man; together with a farther vindication of this invention from usurpers', published in the Philosophical Transactions of the Royal Society, Vol. 2, Issue 28, p. 517-525.

<https://royalsocietypublishing.org/toc/rstl/1667/2/28>

This reference includes a letter by Dr. King describing a transfusion using 'the arterial blood of a lamb, kid, or what ever other animal may be thought proper into the vein of a man.' This letter appears to have been included to reinforce the idea that the transfusion to a man had already been considered and even planned for in England.

- *This account identifies that the amount of blood transfused was estimated by measuring the amount of arterial blood collected in one minute into a bowl (porringer) before connecting the pipe to the patient's arm – confirming the*

account given by Dr. King, who also goes on to suggest that the next time the animal donor could also be weighed before and after the transfusion. The process of removing the pipe from the patient's arm and allowing the sheep blood to flow freely was 'to assure the spectators of an uninterrupted course of blood', which they could not be able to see through the quills and pipes used – reaffirming that blood was actually transfused.

- Oldenburg makes some interesting comments about Mr. Arthur Coga, i.e. 'looked upon as very freakish', an 'extravagant man' and an 'indignant person'. Whilst when Oldenburg visited him the following morning, Coga's host affirmed that he was more composed than he had been before (i.e. indicating that he normally was not 'composed'). Although not stated here, part of the content of this letter is reproduced at the Society meeting of the 21 November 1667 (Birch, *History of the Royal Society*, Vol. II, p. 214) where Mr. Coga is described by Dr. King as 'about thirty-two years of age; that he spoke Latin well when he was in company, which he liked, but that his brain was sometimes a little too warm.' [See also the letter from Edmund King to Robert Boyle transcribed below – page 638.] These comments support the belief that Mr. Coga was thought to have some kind of mental problem.

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Letter from Henry Oldenburg – 3 December 1667

... among the papers that came from the Baltic, I find one written by a physician of Danzig, relating, that there they have cured the *lues venerea*, and convulsions, by injecting liquors into veins, which I intend, God willing, to read at our next meeting to occasion the Society to urge Dr. Clerke's [sic] publication of his experiments of that nature, though they come short of such effects. As far as I see, both those experiments that met with so much difficulty and contradiction at first (I mean that of infusion and transfusion) may at last prove very beneficial to men. The person, who hath the sheep's blood in his veins, is still very well, and like to continue so. If we durst believe himself, who is flatterously given, he is much better than he was before, as he tells us in a Latin account, he brought into the Society.

The infusion experiments are also included within Mr. Oldenburg's next letter to Mr. Robert Boyle dated 10 December 1667 – see below.

The reference to Mr. Arthur Coga, 'the person who hath the sheep's blood in his veins', who provided a personal report to the Society at the meeting on the 28 November 1667 reinforces his apparent 'flatterously' (flattering and fatuous?) attitude. The notes from that meeting do not identify the content of Arthur Coga's report or if this report was kept in the Society Register.

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Letter from Henry Oldenburg – 10 December 1667

... I think I mentioned in my former some of the heads of the particulars, lately sent me from the Baltic by Hevelius, &c. viz. of the surprising effects of injections into veins; ... That part, which concerns the injections was read at our last assembly, and containing an account of three persons, it had been tried upon, whereof two received great benefit, but the third died (though that was by the person's own neglect), a certain physician then present (else a learned and ingenious man) was to my great trouble, so precipitate, as to say, that he would engage, that that one, viz. with the ill success, was only true, but the other two both false. I could not but take him afterwards aside, and represent to him, how he would resent it, if time to time; if he should communicate upon his own knowledge an unusual experiment to the curious

at Danzig, and they in public brand it with the mark of falsehood: that such expressions in so public a place, and in so mixed an assembly, would certainly prove very destructive to all philosophical commerce, if the curious abroad should be once informed, how their symbolas were received at the Royal Society. On Thursday next the transfusion, which was omitted at our last meeting, for want of fit preparations, is ordered to be made, and doubtless have a crowd of spectators; it being discoursed of in most companies one resorts to.

This information regarding infusion experiments from Gdansk is actually identified at the Society meeting held on the 5 December 1667 (Birch, History of the Royal Society, Vol. II, p. 223), where Mr. Oldenburg makes a similar comment regarding the unsupported accusation made by an un-named member, i.e. 'a certain physician then present, a learned and ingenious man' and where he defends research based information.

The experiments performed by Dr. Fabricius were published in the 9 December 1667 edition of the Philosophical Transactions of the Royal Society, Vol. 2, Issue 30, p. 564-565.

<https://royalsocietypublishing.org/toc/rstl/1667/2/30>

Additional information regarding the infusion experiments performed in Danzig is presented as an extract of a letter, dated 18 August 1668, sent to Robert Boyle, published in the 21 September 1668 edition of the Philosophical Transactions of the Royal Society, Vol. 3, Issue 39, p. 766-767.

<https://royalsocietypublishing.org/toc/rstl/1668/3/39>

These infusion experiments are also mentioned at the Society meeting on 14 January 1669 (Birch, History of the Royal Society, Vol. II, p. 339), where it is stated that Dr. Fabricius had written a letter dated 20 October 1668 to Dr. Timothy Clarke; whilst at the meeting on the 21 January 1669 (Birch, History of the Royal Society, Vol. II, p. 341), it is stated that Dr. Clarke had received another letter, dated 2 November 1668, regarding infusion experiments from Mr. Michael Behm, consul at Danzig. Whilst the content of these letters is not identified or commented on further, this infusion information 'by a physician in Danzig' is presented and discussed by Paul Scheel in his 1802 book 'Die transfusion des blutes und einspreutzung der arzeneyen in die adern (section §.73).

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Letter from Henry Oldenburg – 17 December 1667

... and in the experiments of transfusion, which on Thursday last was repeated upon the same man, in the presence of a strange crowd, both of foreigners and domestics; the recipient enduring the operation with as little concern, as before; and finding himself at present, very well in health, though stocked with a far greater quantity this time, than before; which made him a day or two after the operation a little feverish; though that may be justly imputed to himself by intemperate drinking of wine.

The second transfusion of Arthur Coga is noted to have taken place at the Society meeting of 12 December 1667 (Birch, History of the Royal Society, Vol. II, p. 225), and an account of it recorded at the meeting on 9 January 1668 (Birch, History of the Royal Society, Vol. II, p. 236), whilst Arthur Coga gave a personal report of this transfusion to the Society at the meeting on 19 December 1667 (Birch, History of the Royal Society, Vol. II, p. 227).

This second transfusion of Mr. Arthur Coga was not recorded in the Philosophical Transactions of the Royal Society. Samuel Pepys identifies in his diary that the 17 December 1667 is a Tuesday, therefore ‘Thursday last’ as stated in this letter confirms that the transfusion took place on the 12 December 1667.

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Letter from Henry Oldenburg – 24 December 1667

... If those Parisians misrelate not, there hath been freshly made in that town an experiment of transfusion on a madman, with a surprising success; which I shall give you in my author's own words, viz.

Nous avons fait la transfusion ces jours passez sur un fol de la derniere extravagance, qui courroit les ruës tout nud, et qui faisoit compassion à tout le monde. Nous luy transfuse du sang de veau par 2 fois differentes, et apres la derniere, qui fut plus ample, et en presence de 8 medecins capables, il fit paroître quelques emotions, qui furent suivies d'un profond assoupissement pendant toute la nuit, au revueil duquel il donna tout tesmoignage d'un sens fort rassis, et comme il apprit, que nous estions au temps du jubilé, il demanda à se confesser, et son confesseur le trouva si raisonnable et si exact en toutes choses, qu'il jugea à propos de la laisser approcher de la communion. Nous ne scavons pas encore, quel en sera le succes. Je vous en apprendray le detail au plus-tost.

This is confirmed from another hand of the same place, with very little variation: which, together with an account of the present condition of the former patients of this operation, I shall be obliged to insert into the next Transactions; which, I think, will be all I shall have room for that month; ...

This anonymous account from a ‘Parisian colleague of Oldenburg’ of the transfusion of Antoine Mauroy can be translated as follows:

We made the transfusion these days passed on a madman of the last extravagance, who ran the rushes naked, and who was compassionate to everybody. We transfused him with calf's blood twice, and after the last one, which was more extensive, and in the presence of 8 capable doctors, he made a few emotions appear, which were followed by a deep slumber throughout the night, to the awakening of which he gave all the testimony of a very balanced meaning, and as he heard that we are in the time of the jubilee, he asked for confession, and his confessor found him so reasonable and so exact in all things, that he thought it advisable to let him approach communion. We do not yet know how successful it will be. I will tell you the details as soon as possible.

The details of this correspondence were not included within ‘the next Transactions’ not apparently because of lack of space as Oldenburg suggests but more likely due to the fact that the 10 February 1668 edition of Philosophical Transactions of the Royal Society (Vol. 2, Issue 32, p. 617-624) contains a letter from Jean Denis that includes information about the transfusion of Antoine Mouroy.

<https://royalsocietypublishing.org/toc/rstl/1668/2/32>

Note: A further letter, dated 30 November 1669, written during (and concentrating on) the trial that followed the death of Antoine Mauroy was published in the 13 December 1669 edition of the Philosophical Transactions of the Royal Society (Vol. 4, Issue 54, p. 1075-1077) in an article titled ‘A letter written by an intelligent and worthy English man from Paris, to a considerable member of the R. Society in London, concerning some transactions there, relating to the experiment of the transfusion of blood.’

<https://royalsocietypublishing.org/toc/rstl/1669/4/54>

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Letter from Henry Oldenburg – 31 December 1667

... I find by the Parisian letters, which I received since my last to you, that the madman has relapsed, and pisseth blood, supposed to proceed from too large a transfusion. ...

This comment appears, on the surface at least, to relate to the competitive nature of the English and French transfusion experiments but is actually an update for Boyle who had shown an interest in knowing the outcome of the transfusion, briefly described in his letter to Oldenburg dated 29 December 1667 (see page 253 above). This ‘update’ is continued in Oldenburg’s letters of 7 and 18 January 1668.

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Letter from Henry Oldenburg – 7 January 1668

... The madman, who found so notable change by transfusion, I think, I told you of, to have been lately experimented at Paris, is somewhat relapsed, and pisseth blood; perhaps from too plentiful transmission. It must be known, both how much blood is transfused, and how much is fit to be transfused, to go sure. ...

The last sentence of this extract appears to be a somewhat ingratiating comment by Oldenburg because he must know that Robert Boyle was the first person, at the Society meeting on 12 December 1666 (Birch, History of the Royal Society, Vol. II, p. 133), to suggest that the amount of blood transfused should be measured by means of weighing the donor animal before and after the transfusion; subsequently this was changed to measuring the amount of blood that flows into a bowl in a given time prior to the transfusion – though these methods are not included within Dr. King’s recommended transfusion method as published in the Philosophical Transactions of the Royal Society, Vol. 2, Issue 28, p. 517-525.

<https://royalsocietypublishing.org/toc/rstl/1667/2/28>

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Letter from Henry Oldenburg – 18 January 16678

... I hear, the frenetic man, that received the calves’ blood into him, is now very well, and that the experiment of it is printed by M. Denys, from whom I expect a copy of it every day. ...

This comment relates to the transfusion of Antoine Mauroy, who is here referred to as frenetic and not ‘the madman’. The article mentioned, by Jean Denis was published in the 10 February 1668 edition of the Philosophical Transactions of the Royal Society (Vol. 2, Issue 32, p. 617-624), with the title: ‘An extract of a letter, written by J. Denis, doctor of physick, and professor of philosophy and the mathematicks at Paris, touching a late cure of an inveterate phrensy by the transfusion of bloud.’

<https://royalsocietypublishing.org/toc/rstl/1668/2/32>

NOTE: There are fifteen letters from Henry Oldenburg included in the book sent after the one dated 18 January 1668 – none of them include any further information on blood transfusion. This fact may be a strong indicator of the effect that the ruling of the French court had on blood transfusion following the death of Antoine Mouroy.

3. LETTERS FROM RICHARD LOWER

Note: Volume 5 of 'The Works of the Honourable Robert Boyle' includes a total of eight letters written to him by Richard Lower covering a period from 18 January 1661 to the 3 September 1666. The ones presented below include information on infusion or transfusion, the last one being the most important, which has been transcribed in its entirety.

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Letter from Dr. Richard Lower – 18 January 1661

... Upon your relation of your experiment of Tunbridge water being syringed into a dog, a little while since I syringed into a dog's jugular vein about two quarts of warm water, and, in a little space, his bladder was very much distended with urine, though a little while before he had discharged himself that way very freely, as usually they do in such solemn frights. I had not the opportunity of doing it again, but intend to try it with several liquors; and I have a fancy to try, how long a dog may live without meat, by syringing into a vein a due quantity of good broth, made pretty sharp with nitre, as usually the chyle tastes taken out of your common receptaculum; ...

... When I am in the country, if I can have leisure to attend it, I shall try it in a dog, and I shall get a tin pipe made, about two inches long, and about the usual bigness of the jugular vein, and hollow, which I may put into the vein, by cutting the vein asunder, and drawing on the two ends of it upon the pipe, and tie it round with a thread there to remain, and, in the middle of the pipe, must come out a smaller pipe, fit for the small end of a syringe to go into, which may be stopped with a cork, to take out when need shall require: ...

The first extract identifies Lower's ideas of using infusion directly into the blood stream in order to feed an animal. At the meeting of the Royal Society held on the 18 April 1666 (Birch, History of the Royal Society, Vol. II, p. 83) Mr. Boyle states that he was 'once desirous to try whether a dog might be fed by injection [and] he injected some quantity of broth into the jugular vein; but that this dog soon after died, and being opened, the broth was found in the right ventricle of his heart.' Although Boyle made this statement over five years later, it appears very similar to Lower's.

The second extract from this letter indicates that Lower was already thinking of producing a metal pipe to use for infusion, even though he later used quills for blood transfusions, which he found difficult to anchor into an artery or vein with a ligature.

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Letter from Dr. Richard Lower – 8 June 1664

... Another experiment, which I intend to make as soon as I can get two dogs of equal bigness, is this; to let both bleed into one another at the same time, from the artery of one into the other's vein, & sic vice versa, for an hour's time, till they have wholly changed their blood: and then to make the experiment surer, whether one dog can live with another's blood, I intend to take away as much blood from one dog, until he be quite faint and cannot stand, and then let the other dog's blood run into him, to supply the loss, and see whether immediately he recovers his strength again, and will live after it. And if this succeed, it may be tried on creatures of several bloods, as on a sheep and a mastiff; but howsoever if the blood of two several creatures cannot agree together, yet perhaps that of a sheep may agree with a man's blood, and incorporate together, it being almost of the same taste and nature, and not so rank as that of unclean creatures, nor altogether so fibrous as that of oxen; and if so, it may be improved in several cases, viz. in great losses and evacuations of blood, to have it

supplied from a sheep, which may be dieted before, to make his blood more agreeable

A little while since, I syringed in about a quart of warm milk into a great dog (having first taken some blood from him to make room for the milk); and thought at first he seemed not much altered, but he looked upon it very unconcernedly, while it was doing, yet within a quarter of an hour he began to groan exceedingly, and draw his breath with great difficulty, and seemed to be very much depressed at heart and struggled very much; and, which was very remarkable, he drivelled at the mouth a white liquor, as if he had been lapping milk. When we perceived him in this agony, we removed him from the table; but he was not able to stand, nor raise his body, but lat drivelling and groaning, and almost presently died; and as soon as we opened him, we found all the vena cava, the ventricles of his heart, and the great artery, full of blood, mixed with milk, as if both had been curdled together, for it was very fastly mixed, so that it could not easily be separated.

NOTE: This statement by Richard Lower would make him one of the first people in England to suggest such an experiment. Although Dr. Timothy Clarke at the Royal Society meeting on the 14 March 1666 (Birch, History of the Royal Society, Vol. II, p. 67) stated that 'above two years before he had endeavoured to make that experiment [of transfusion], but found it so difficult, that he gave it over', this statement remains unconfirmed. Though the Royal Society meeting of 16 September 1663 (Birch, History of the Royal Society, Vol. I, p. 303) includes the statement: 'Some [members] proposed the experiment, to let the blood of a lusty young dog into the veins of an old one, by the contrivance of two silver pipes fastened to the veins of such two dogs with a leather pipe between both to move the blood forward; by which means the extravasating of the blood might be avoided', it is not identified if this suggested experiment was actually performed.

The first paragraph of this extract regarding the suggestion of a 'cross-transfusion' between two dogs is made at about the same time as infusion experiments were being performed by members of the Royal Society. As identified in a letter to Robert Boyle on the 15 November 1666, Henry Oldenburg reports the first successful blood transfusion between two dogs, performed according to 'Lower's method', believed to have first taken place in private on the 6 November 1666, and subsequently publically demonstrated between two sheep at a Society meeting on the 14 November 1666, by Mr. Edmund King and Mr. Thomas Coxe. This extract also identifies that Richard Lower had already performed an experiment of infusing milk into a dog and was already suggesting the cross-transfusion of blood between two dogs 'till they have wholly changed their blood' as well as suggesting that, if 'a sheep's blood agrees with a man's blood' the process could be used 'in great losses and evacuations of blood' in 1664.

It was not however until the 18 April 1666 meeting of the Royal Society (Birch, History of the Royal Society, Vol. II, p. 83) that Robert Boyle is recorded to have stated that he believed that the difficulties in the experiment of transfusing blood might be surmounted and that he thought that Dr. Lower would do so at Oxford. At the meeting of 20 June 1666 (Birch, History of the Royal Society, Vol. II, p. 98) it is recorded that: 'Dr. Wallis, upon the motion of Mr. Boyle, related the success of the experiment made at Oxford by Dr. Lower, of transfusing the blood of one animal into the body of another, ...'

The successful transfusion of blood from one animal to another in England by Richard Lower was first made by Henry Oldenburg in the notice 'The success of the experiment of transfusing the blood of one animal into another', published in the 19

November 1666 edition of the Philosophical Transactions of the Royal Society, Vol. 1, Issue 19, p. 352.
<https://royalsocietypublishing.org/toc/rstl/1666/1/19>

The second paragraph of this extract identifies that Lower had performed the experiment of infusing warm milk into a dog ‘some little while’ before 8 June 1664, the date of this letter. This experiment is described in detail by Paul Scheel in his 1802 book ‘Die transfusion des blutes und einspreitung der arzeneyen in die adern (section §.16), but he provides no reference as to the source of his information. He also describes Lower’s first dog-to-dog transfusion performed in the presence of Dr. Wallis and others ‘at the end of February 1666 at Oxford’ (section §.17). The idea of transfusing milk was ‘resurrected’ twice at meetings of the Royal Society, originally by Dr. Pope who proposed it on the 19 December 1666 (Birch, History of the Royal Society, Vol. II, p. 134) and by Dr. King who states that he has performed an infusion experiment using milk on a dog at the meeting on the 4 April 1667 (Birch, History of the Royal Society, Vol. II, p. 164) and subsequently reported at the meeting on 18 April 1667 (Birch, History of the Royal Society, Vol. II, p. 167).

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Letter from Dr. Richard Lower – 3 September 1666

Note: This letter is sent from Treemere, near Bodwin, Cornwall.

Due to its importance the whole letter has been transcribed as written (with corrections of Old English spelling), as follows:

Honoured Sir,

Yours of the 26th of June, after it had lain at Mr. Grosse’s about three months, was occasionally found and sent to me in the country by a friend, together with another from Mr. Mayer, with a little box of brass pipes; whereby I understand that the account of bleeding one dog into another, which I sent to you before I left Oxford, had miscarried, and that Dr. Wallis had not given you a full information how I performed it, for I tried it before him and several others with very good success, and that several times, but not by that way of conveying the blood from one dog’s jugular vein to the other by pipes, as we endeavoured to try, when you were there, and since then but found it altogether impossible, because the blood was apt to congeal in those pipes, and to stop its own passage: but the way I did effect it since, was by bleeding from one dog’s carotid artery into the other dog’s jugular vein, which by reason of the swift motion of the blood out of the artery will keep open its own passage. The exact way of doing it is this.

First take up the carotid artery, and separate it from the nerve of the eighth pair, and lay it bare above an inch: then take a strong ligature on the upper part of the artery not to be untied again; but an inch below, viz. toward the heart, make another ligature of a running knot, which may be loosened or fastened, as there shall be occasion; having made these two knots draw two threads under the artery, between the two ligatures, and then open the artery, and put in a quill, and tie the artery upon the quill very fast by those two threads, and stop the quill with a stick. After this make bare the jugular vein in the other dog, about an inch and half long, and at each end make a ligature with a running knot, and in the space betwixt the two running knots, draw under the vein two threads more: then make an incision in the vein, and put into it two quills; one into the descendent part of the vein to receive the blood from the other dog, and carry it to the heart; and the other quill put into the upper part of the jugular vein, which comes from the head, (out of which the dog’s own blood must run into dishes). These two quills being put in and tied fast, stop them with a stick, till there be occasion to open them.

All things being thus prepared, tie the dogs on their side toward one another so conveniently, that the quills may go into each other (for the dogs necks cannot be brought so near, but that you must put two or three several quills more into the first two to convey the blood from one to another). After that unstopp the quill going down into the dog's jugular vein, and the other quill coming out of the other dog's artery, and by the help of two or three other quills put into each other, according as there shall be occasion, put them into one another; then slip the running knots, and immediately the blood runs through the quills, as through an artery, very impetuously; and immediately as the blood runs into the dog, unstopp the other quill coming out of the upper part of his jugular vein (a ligature being first made about his neck, or else his other jugular vein being compressed by one's finger) and let his own blood run out at the same time into dishes, (yet not constantly, but according as you perceive him to bear it) till the other dog begin to cry and faint, and fall into convulsions, and at last die by his side.

Then take out both the quills out of the dog's jugular vein, and tie the running knots fast, and cut the vein asunder; which you may do without any harm to the dog, one jugular vein being sufficient to convey all the blood from the head and upper parts, by reason of a large anastomosis, whereby both jugular veins meet about the larynx: this done, sew up the skin, and dismiss him, and the dog will leap from the table, and shake himself, and run away, as if nothing ailed him. And this I have tried several times before several in the university, but never yet upon more than one dog at a time, for want of time and convenient supplies of several dogs at once: but when I return (which I hope may be this autumn) I doubt not but to give you a fuller account, not only by bleeding several dogs into one another, but several other creatures into one another, as you did propose to me before you left Oxford, which will be very easy to perform, and will afford many pleasant and perhaps not unuseful experiments.

But because there are many circumstances necessary to be observed on performing this experiment, and that you may better direct anyone to do it, without any danger of killing the dog, that is to receive the other's blood, I will mention two or three: first, that you fasten the dogs at such a convenient distance, that the vein nor artery be not stretched; for then being contracted, they will not admit or convey so much blood: 2. That you constantly observe the pulse beyond the quill in the dog's jugular vein (which it acquires from the impulse of the arterious blood) from if that fails, then it is a sign the quill is stopped by some congealed blood, so that you must draw out the arterial quill from the other, and with a probe open the passage again in both of them, so that the blood may have its free course again. For this must be expected, when the dog; that bleeds into the other, hath lost much blood, his heart will beat very faintly, and then the impulse of blood being weaker, it will be apt to congeal the sooner, so that at the latter end of the work, you must draw out the quill often, and clear the passage, if the dog be faint-hearted, as many are, though some stout fierce dogs will bleed freely and uninterruptedly till they are convulsed and die: but to prevent this trouble, and to make the experiment certain, you must bleed a great dog into a little, or a mastiff into a cur, as I once tried, and the little dog bled out at least double the quantity of his own blood, and left the mastiff dead upon the table; and after he was untied, he ran away, and shaked himself, as if he had been only thrown into the water: or else you may get three or four several dogs prepared in the same manner; and when one begins to fail, and leave off bleeding, administer another, and I am confident one dog will receive all their blood (and perhaps more) as long as it runs freely, till they are left almost dead by turns, provided that you set out the blood proportionably as you let it go into the dog, that is to live.

3. I suppose the dog, that is to bleed out in dishes, will endure it the better, if the dogs, that are to be administered to supply his blood, be of near equal age, and fed alike the day before, that both their bloods may be of a near strength and temper. There are many things, which I have observed upon bleeding dogs to death, which I

have seen since your departure from Oxford, of which I shall give you a relation in my next. In the mean time, since you were pleased to mention it to that honourable Society, with a promise to give them an account of this experiment, I could not but take the first opportunity to clear you from that obligation, and the more willingly, that I might express myself grateful for all those kind remembrances you have of me; and that I am, ...

R. Lower

This content of this letter is probably the one used as the basis for the article published in the 17 December 1666 edition of the Philosophical Transactions of the Royal Society (Vol. 1, Issue 20, p. 353-358), titled 'The method observed in transfusing the blood out of one animal into another: and how this experiment is like to be improved. Some considerations concerning the same', which starts by stating: 'It was first practiced by Dr Lower in Oxford, and by him communicated to the Honourable Robert Boyle, who imparted it to the Royal Society as follows; ...'

<https://royalsocietypublishing.org/toc/rstl/1666/1/20>

This letter must therefore also be the one identified in the minutes of the Royal Society meeting of the 16 September 1666 (Birch, History of the Royal Society, Vol. II, p. 115) where it is stated that: 'There was read a description of the method of transfusing the blood of one animal into another, as it had been practised with success at Oxford by Dr. Richard Lower; which description was communicated by him in a letter to Mr. Boyle. It was ordered to be registered^h,

^h Register, Vol. iii. p. 159. It is printed in Philosoph. Transact. Vol. i, N° 20, p. 353, for December 1666.

This letter is not however the same as the one printed in Lower's book, which he wrote to Robert Boyle on the 6 July 1666 when he was in Oxford, in reply to Boyle's letter of the 28 June 1666. According to an entry in Tractatus de Corde, Lower states that 'towards the latter end of February 1665, this method of transfusion was brought to perfection by me' (p. 188).

This letter explains that there was a three months delay due to Boyle's letter not reaching him because Lower was living in Cornwall and that Lower's letter to Boyle, written before he left Oxford, had also apparently been 'miscarried'. The letter identifies that Lower has performed the transfusion experiment 'several times' before Dr. Wallis and others at Oxford 'with very good success' and explains the need to use an artery-to-vein method and not a vein-to-vein one, due to the improved blood flow. This letter also includes the three suggestions or 'considerations' for ensuring success that were also included in the Philosophical Transactions of the Royal Society publication of December 1666. Lower also confirms that Boyle has suggested to him whilst in Oxford the experiment of bleeding several dogs into one another at the same time, though Lower had not done this due to the 'difficulties in obtaining sufficient number of subjects!'

4. LETTERS FROM OTHER PEOPLE

Note: Although Volume 5 of *The Works of the Honourable Robert Boyle* includes a letters from a large number of different people relating to an even larger number of different topics, only three have been identified to contain any information on the topics of infusion or transfusion.

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Letter from J. Beale – 24 January 1666

[Within a letter mainly about heat and heat transfer and the use of thermometers is the following] ... They may have some use in the transfusion of blood and other liquors, and it will oblige us, if we may be informed, what difference in the heat of blood of several animals; and of milk gushing out with the same celerity. It will direct you to fit the mixtures of milk, spirit of wine, &c. And the butchers at easy terms may give us the proportion of blood in several animals, fat and lean, wound and sick, by weighing them before and after the effusion, all apart un-separated. ...

This comment may be related to Boyle's idea regarding a method of estimating the quantity of blood transfused, which he proposed at the meeting of the Royal Society held on 12 December 1666 (Birch, History of the Royal Society, Vol. II, p. 133).

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Letter from Robert Hooke – 21 March 1666

... He [Mr. Shortgrave] shows me likewise some brass pipes, which if they be for injection, or transfusion of blood, they would be somewhat better to have small protuberances left at the end, that they may not slip out of the vessel, when they are tied on to it; but knowing not the designs of them, I could not direct him.

Lower and others had complained that tying quills or straight pipes into arteries and veins was difficult as they tended to slip out. The silver or brass pipes that were used instead of quills had bevelled ends that enabled them to be better tied into arteries and veins. This type of pipe is illustrated and described in Lower's book Tractatus de corde. It is not known if the suggestion in this letter indicates that it was Robert Hooke who first thought of this development.

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Letter from Edmund King – 25 November 1667

Note: This letter is sent from Boswell Court, London.

Due to its importance the whole letter has been transcribed as written (with corrections of Old English spelling), as follows:

Honoured Sir,

Perhaps at first sight you will wonder at my confidence in presuming to present you with a letter; but if you please to consider my great obligations to love and honour you, I hope I need make no apology for it, unless for want of language to express your worth, and my deep sense of it: for in earnest, Sir, I find by experience, that great thoughts are of difficult birth and I do blush at the defects of my expressive faculty; yet I will encourage myself with this, that the account of the following experiments will (for this time) purchase my pardon for giving you the trouble of it. Dr. Lower procured a man about thirty two years of age, willing to receive some sheep's blood (they call him Dr. Cogie, [sic] he speaks Latin well, when he is in that company he likes) his brain is sometimes a little too warm. On Saturday morning last at eleven at Arundel house we met, and having prepared the carotid of a sheep, I

opened a vein in the doctor's arm at once, as expressed in the last Transactions but one; and used just that method, without any alteration (only one pipe more convenient) after we had taken away about $\frac{3}{7}$ vii ["] of the doctor's blood, we infused (as near as we could guess) about x. or $\frac{3}{7}$ xi ["] of the sheep's blood, with very little trouble to him , three quills length beside the pipe: yet when we took it out, after near two minutes, it ran as fresh as at first, which was an infallible sign; it did not stop, but besides we felt a pulse in the arm; when we had done, we bound up the arm after blood-letting, and he well and merry, and drank a glass or two of Canary [**], and took a pipe of tobacco in the presence of forty or more persons; so went home, and continued well all day, having three or four stools as he did use to have; his pulse stronger and fuller than before; and he very sober and quite, more than before, as the people in the house tell us that think he was only let blood; in the night he slept well, but sweat two or three hours, and the next day was very well, and so remains, and is very willing to have it repeated (we gave him a guinea for his willingness) for his arm, he says, is well. This is a general account of it; I did intent to be more particular, but am forced to break off abruptly, for which I most humbly entreat your pardon, which will farther oblige ...

Edm. King

[Postscript:] One asked him, why he had not some other creature's blood, he told them, that *sanguis ovis symbolicam quamdam facultatem habet cum sanguine Christi; quia Christus est agnus Dei.* [***] You would have smiled, if you had heard him.

* These figures are given as Roman numerals with the old apothecaries' ounce sign (i.e. abbreviated $\frac{3}{7}$), indicating that the doctor was bled for 'about 7 ounces' and transfused with 'about 10 or 11 ounces' of blood.

** Canary was the word used to indicate a type of imported Spanish wine.

*** This broadly translates to: The blood of a sheep has symbolic power to the blood of Christ, because Christ is the Lamb of God.

The first transfusion of blood to a man in England is described by Edmund King in an article published in the *Philosophical Transactions of the Royal Society*, Vol. 2, Issue 30, pages 557-559, titled 'An account of the experiment of transfusion, practised upon a man in London'.

<https://royalsocietypublishing.org/toc/rstl/1667/2/30>

Dr. King gave his written account of the transfusion of sheep's blood into a vein of a man at the meeting of the Royal Society held on 5 December 1667 (Birch, *History of the Royal Society*, Vol. II, p. 222).

Note: Although he is called 'Cogie' by Dr. King in this letter, he is called Coga in the account published in the *Philosophical Transactions of the Royal Society* referred to above as well as in six separate Royal Society meetings, i.e. held on 21 and 28 November 1667, the 5, 12 and 19 December 1667 and the 9 January 1668 (Birch, *History of the Royal Society*, Vol. II, p. 214, 216, 222, 225, 227 and 236).

Note: Henry Oldenburg, in his letter to Robert Boyle dated 25 November 1667 (see page 372 listed above) ends his description of the transfusion of Arthur Coga with the following sentence: But I doubt, I do here actum agere, and trouble you with the repetition of what Dr. King hath related in this annexed letter, which he desired me to convey to you. This letter of Dr. King is also dated 25 November 1667 and may well therefore be the one referred to by Oldenburg.

Dr. King's comment in this letter that Arthur Coga's 'brain is sometimes a little too warm' is the same as that included in Oldenburg's report to the Royal Society on the 21 November 1667 (Birch, History of the Royal Society, Vol. II, p. 214). This comment can be compared with the comments made by Henry Oldenburg in his letter to Robert Boyle (see page 372 above) where he describes Arthur Coga as a 'very freakish and extravagant man' and 'an indignant person'. These comments taken together support the belief that Arthur Coga had some kind of mental problem. Although never actually stated as such, it is possible, given these various comments regarding Mr. Arthur Coga's demeanour that the transfusion was performed on him to see if it changed his character. Although not identified directly in published accounts of the transfusion, Maluf (1954) actually states that this was the reason why he was transfused (Journal of the History of Medicine and Allied Sciences, 9, 1, page 65).