Original Article

Leonardo Botallo (1530–1587) and his pioneering contributions to traumatology, cardiology and deontology

Journal of Medical Biography
0(0) 1–7

DOI: 10.1177/0967772020940976
journals.sagepub.com/home/jmb
SAGE

Pamela Tozzo[1], Alberto Zanatta[2], Gabriella D'Angiolella[3], Luciana Caenazzo[1] and Fabio Zampieri[3]

Abstract

Leonardo Botallo (1530–c. 1587) is widely known for the eponymous "foramen Botalli" and "ductus Botalli". The first, most commonly named "foramen ovale", allows blood in the fetal heart to enter the left atrium from the right atrium. The second, named "ductus arteriosus", consists of a blood vessel in the developing fetus connecting the trunk of the pulmonary artery to the proximal descending aorta. However, Botallo was a multifaceted figure who studied many aspects of human anatomy and physiology, also making important contributions to clinical and surgical practices. Moreover, as we will see in the last section of this paper, Botallo wrote a book on medical deontology having significant features in relationship to the history of medical ethics. Botallo's multidisciplinary approach is a typical characteristic of Renaissance physicians and scientists, who contributed to making this period a fundamental prelude to the scientific revolution of the 17th century.

Keywords

Leonardo Botallo, traumatology, foramen Botalli, ductus Botalli, bloodletting, medical deontology

Botallo's life

The life of Leonardo Botallo (1530 – c. 1587) can be reconstructed in its general outline, but documents about specific details of his personal history are unfortunately scarce. He was born in Asti, in the northwest of Italy, in 1530 to a noble family (some scholars state instead that he was born in 1515, others in 1519).[1] His family was called "*Botal*" in the local dialect, meaning "barrel", which might indicate that they were involved in wine production and trade.[2] Almost nothing is known about his early life. He attended the University of Pavia, Italy, where he graduated with a degree in medicine, probably in 1543.[1] At the same time, he attended the lessons that Gabriele Falloppio (1523–1562) held at the anatomical theatre of Padua.[3] Falloppio, at that time, was probably the most important anatomist at the international level and the medical school of the University of Padua boasted the best reputation in anatomical studies. After graduation, he spent a period in Asti practicing medicine and surgery under the guidance of his brother Secondo, professor of surgery at Pavia University. Then, Botallo became a doctor of the French troops. His presence is attested at "The Battle of Ceresole" on 11 April 1544.[4] During his service, he had the opportunity to improve his clinical skills, especially in traumatology, to which, as we will see, he made an important contribution. He definitely moved to France, where, for his merits as a military doctor and surgeon, the Queen Caterina de' Medici (1519–1589) ("Queen Consort of France" from 1547 to 1559) gave him the role of archiater and counselor of the King Henry II of France (1519–1559) around 1550.[2] Thanks to this new position, Botallo travelled throughout Europe (France, Austria, England and Belgium) at the service of different courts connected to Caterina. For instance, he was the personal

[1]Department of Molecular Medicine, University of Padua, Padua, Italy
[2]University Museums Centre CAM, University of Padua, Padua, Italy
[3]Department of Cardiac, Thoracic, Vascular Sciences and Public Health, University of Padua, Padua, Italy

Corresponding author:
Alberto Zanatta, University Museums Centre CAM, University of Padua, Via A. Gabelli, 61 – 35121 Padua, Italy.
Email: alberto.zanatta.1@unipd.it

physician of Elisabeth of Austria, Queen of France (1554–1592) and Louise of Lorraine (1553–1601).[3] Around 1565, he was called to Lyon by Jacques of Savoy, Duke of Nemours (1531–1585), probably to render assistance during an epidemic.[2] In 1575, he was called to the battlefield of Chateau-Thierry to treat Henry I, Duke of Guise (1550–1588), for a gunshot wound to his face, after which he was called *Le Balafré* (Scarface). Botallo received a reward of *156 livres* for his assistance.[4]

At the French court, his success and, particularly, his defense of the practice of bloodletting exposed him to the envy of courtiers and colleagues, such as Bonaventure Grangier (a French physician working in Paris, who died in 1589), Jacques Poms (a French doctor practicing in Lyon), and others.[5,6] In particular, Grangier wrote a pamphlet in 1578 exclusively focused on sharply attacking Botallo's method of bloodletting.[7] However, his fame remained unaltered and he even earned the honorary role of "adviser" conferred upon him by Henry III of France (1551–1589), and the title of "*abbé commendataire*" (commendatory abbot: a "secular" role having the imprimatur of an ecclesiastic institution) at the abbeys of Digne and Notre-Dame de Chambre.

In August 1586, Botallo fell seriously ill, due to the exacerbation of the malarial fevers he had suffered for years. Extremely weak from the bloodletting he was subjected to and in conditions of painful indigence, he only had the comfort of the friendship of his protector, Caterina de' Medici, who repeatedly came to his aid. The place and the exact year of his death are uncertain. He probably died around 1587 because this date coincides with the cessation of his service at the French Royal Court.[2,4,8]

Botallo's traumatology

In 1560, Botallo published his first work, which reflected his experience as a military doctor in France. Entitled *De curandis vulneribus sclopettorum* (On the cure of wounds by harquebus),[9] it consists of a detailed analysis of gunshot wounds and is one of the first works on that issue ever published. It was a common opinion of his time that the bullet of a harquebus produced traumatic and pathological consequences in the body through the heat generated by the burst of the gunshot, which acted as a sort of poison. According to this theory, gunshot wounds were specific kind of burns. Botallo rejected this theory, positing that gunshot affected the parts of the body as a strong trauma. He recommended promptly extracting the bullet and possible bone splinters and to be as conservative as possible in the treatment of the wound. For instance, he suggested amputating a limb only in case of gangrene. Finally, he supported the idea that the cure of gunshot wounds must not be limited to the lesion but had to be extended to the whole body. As already mentioned, he demonstrated his ability in treating gunshot by saving the life of Henry I, Duke of Guise.

Botallo's cardiology: "Foramen botalli", "ductus botalli" and bloodletting

Botallo learned anatomy under Gabriele Falloppio at the University of Padua. This training probably influenced his deep interest in anatomy, which he had throughout his life. Other than using anatomical knowledge to improve his surgical and clinical practice, the dissection of human and animal cadavers led him to describe (rather than discover) a structure, which still bears his name-namely, the foramen ovale, also called "foramen Botalli". However, Botallo misunderstood its function. The discovery of another structure is wrongly attributed to him, namely the ductus arteriosus, also named "ductus Botalli".

Where and how Botallo described the foramen ovale is a complex and in some way obscure question.

In some 19th and 20th century historical accounts, three works published by Botallo referring to the description of foramen ovale are mentioned, namely *De foramine ovali dissertatio* (1561), *De via sanguinis a dextero ad sinistrum cordis ventriculum* (1564), and *Sententia de via sanguinis* (1564).[3,5,10]

However, we have not been able to find these exact references, including titles and years of publication, either in Italian or in other European libraries and archives. So, we are obliged to conclude that these works, if they ever existed, are now lost. In particular, there is no trace of the *De foramine ovali dissertatio*, while there are similar titles to the other two, but published much later.

What can be documented is a brief note entitled *Vena arteriarum nutrix, a nullo antea notata*, which Botallo published in 1564 at the end of his *De catarrho*, preceded by two other notes, one referring to a "monstrous kidney" and the other to a "bone inside a brain ventricle".[11] The first note on the *Vena arteriarum* was republished two times, in 1640 and in 1641, edited by Cecilius Folius (1615–1650), a Venetian physician who, some years before, found a pervious foramen ovale in an adult cadaver. He immediately jumped to the conclusion that it was a normal structure and that the blood passed in all cases by the route he had observed.[12,13] This was exactly the same opinion that Botallo advanced in 1564. The first one appeared in Venice, without mention of the publisher, under the title *De Via sanguinis a dextro in sinistrum cordis*

ventriculum Leonardi Bottalli, sententia promulgata Parisiis anno salutis 1564. The second one appeared, with the same title, in Frankfurt by the publisher J. Beyerus.

Finally, the Leiden anatomist Johann Van Horne (1621–1670) edited Botallo's *Opera omnia* in 1660. Here, under a section entitled "*Anatomical observations*", Van Horne reported the three notes published by Botallo at the end of *De catharro*, including the *Vena arteriarum nutrix, a nullo antea notate*.[14]

Therefore, the only work where Botallo discussed the forame ovale is the note originally published in *De catarrho* and republished in 1640, 1641 and 1660. A further confirmation of that can be found in the first volume of the monumental *Histoire de l'anatomie et de la chirurgie* published by the French anatomist Antoine Portal (1742–1832) in 1770, where, under the name "Botal", he also reports his publications. Portal lists *De catharro* of 1564; the *Opera Omnia* edited by Van Horne, specifying that inside there was also a paper entitled "*Observatio de vena arteriarum nutrice*", which however does not correspond exactly to the title given in the original Van Horne edition. Finally, he mentions the "*Sententia de via sanguinis in corde*" published in Venice in 1640.[15] There is no mention of any work published by Botallo in 1561 with the title *De foramine ovali dissertatio*.

To better understand the description made by Botallo, it might be worth mentioning that, at his time, pulmonary circulation in man was still under dispute. As well known, according to Galen of Pergamon (c. 129–210 AD), the passage of blood from the right to the left part of the heart was postulated through "invisible pores" in the interventricular septum. These pores remained a sort of dogma for centuries. Moreover, in his *De usu partium* (*On the usefulness of parts*), Galen already described the foramen ovale and, even if the passage is of difficult interpretation, it seems clear he understood that this structure was peculiar to the foetal heart and that it closes after birth.[16] Matteo Realdo Colombo (1516–1559), professor of anatomy in Padua, Pisa and Rome, in 1559, first demonstrated that the passage of blood from the right to the left ventricle of the heart was carried out through the lung, rejecting Galenic dogma and establishing the new pathway of the so-called "little circulation".[17,18] However, Colombo's discovery was not immediately accepted by the medical community. Some insisted in believing in Galen's dogma, while others advanced alternative views. We have already mentioned that Cecilius Folius observed a patent forame ovale in an adult cadaver and believed he had found the real pathway of blood passage from the right to the left part of the heart. Botallo proposed exactly the same theory, basing his assumption both on animal and human dissections. In his note, Botallo wrote of being led to his "discovery" through the discrepancy between the accounts given by Galen and Colombo about the blood-pathway from the right to the left side of the heart. After previously attempting without success to check these accounts, he had returned to the task and, while dissecting a calf heart, had found a fairly large "ductus" or "channel" leading directly into the left auricle from just above the coronary vein: "I began to dissect the heart of a calf, in which I discovered [...] a channel [...] near the right auricle [...] that leads directly [...] to the left auricle. [...] This pathway which I discovered is quite large and clearly visible in calves, pigs and dogs. In man instead it is a bit smaller [...]".[11] He considered this ductus, therefore, to be the nutrient vessel of the arteries and the "vital spirits". It was believed, in fact, that the arteriosus blood contained also this kind of "air" (called *pneuma*) responsible for several physiological or psychic functions, according to different theories that had been developed since the time of classic Greek medicine. According to Galen, it was formed in the left ventricle by the mixture of venous blood coming from the right ventricle though the invisible pores and air coming from the lungs though the pulmonary veins. According to Colombo, instead, it was formed in the lungs by the mixture of venous blood coming from the pulmonary arteries and air coming from the trachea. Then, it arrived in the left auricle and ventricle through the pulmonary veins.

Given that Botallo claimed to have found the foramen ovale in the cadaver of adult human beings and animals, he observed, of course, the persistence of that duct which might occur in adult mammals, but it represents a disorder which might have severe consequences. This condition is now called Patent Foramen Ovale (PFO) and it is present in 20–25% of the population,[19] although the underlying mechanism which accounts for it is not entirely clear.[20]

Therefore, in anatomical nomenclature the term "foramen Botalli" should be used for designating the Patent Foramen Ovale (even if Botallo did not understand that it was a disorder), while the foetal foramen ovale should be styled "foramen Galeni", given that Galen described it for the first time.[21]

With regard to the ductus arteriosus, the eponymous "ductus Botalli" is completely wrong because Botallo never described this structure either in foetal hearts or in adult hearts. In Botallo's *De catarrho* there is no mention of the ductus arteriosus, nor is there in the 1640, 1641 and 1660 reeditions of Botallo's *De via sanguinis*. The wrong attribution most probably originated from a misunderstanding of the Van Horne edition of Botallo's *Opera Omnia*. Van Horne inserted a plate where, in figs. ii and iii, there were depicted both the "foramen ovale" and the "ductus arteriosus"

(called "*canalis à pulmonali arteria tendens in aortam*") (Figure 1). In the footnote, van Horne referred, probably ironically, to Botallo's claim: "*Immediately he exclaimed with Archimedes eureka, but celebrated the triumph before the victory*".[14,21,22] Later authors, probably without grasping the irony of this footnote, falsely attributed the figure in the Van Horne edition to Botallo himself, who thus became famous and inadvertently made his way into the *nomina anatomica* at the Basel conference in 1895 and the ICD-10.[23] So, this anatomical eponym should also be corrected. Even the ductus arteriosus, in fact, was first described by Galen and his description was subsequently confirmed and improved during Botallo's time. In particular, Gabriele Falloppio mentioned this structure in his *Observationes anatomicae* of 1561, even if he added almost nothing more compared to Galen's original description.[24] A few years later, another Italian anatomist, Giulio Cesare Aranzio (1530–1589), described in greater detail both the forame ovale and the ductus arteriosus in his *De humano foetus libellus* of 1564. Here, there is also an account of the ductus venous, completing the picture of what we now call the three foetal cardiac shunts (namely the foramen ovale, the ductus arteriosus and venous).[21] The ductus venous, in fact, is also called "ductus Arantii". However, this structure was already described in 1561, even if only published in 1564, by Aranzio's master, the famous anatomist Andreas Vesalius (1514–1564).[25] Therefore, also this eponym is incorrect, and should be styled as "ductus venosus Vesalii".[21] Finally, in 1574 the Italian physician Giovanni Battista Carcano Leone

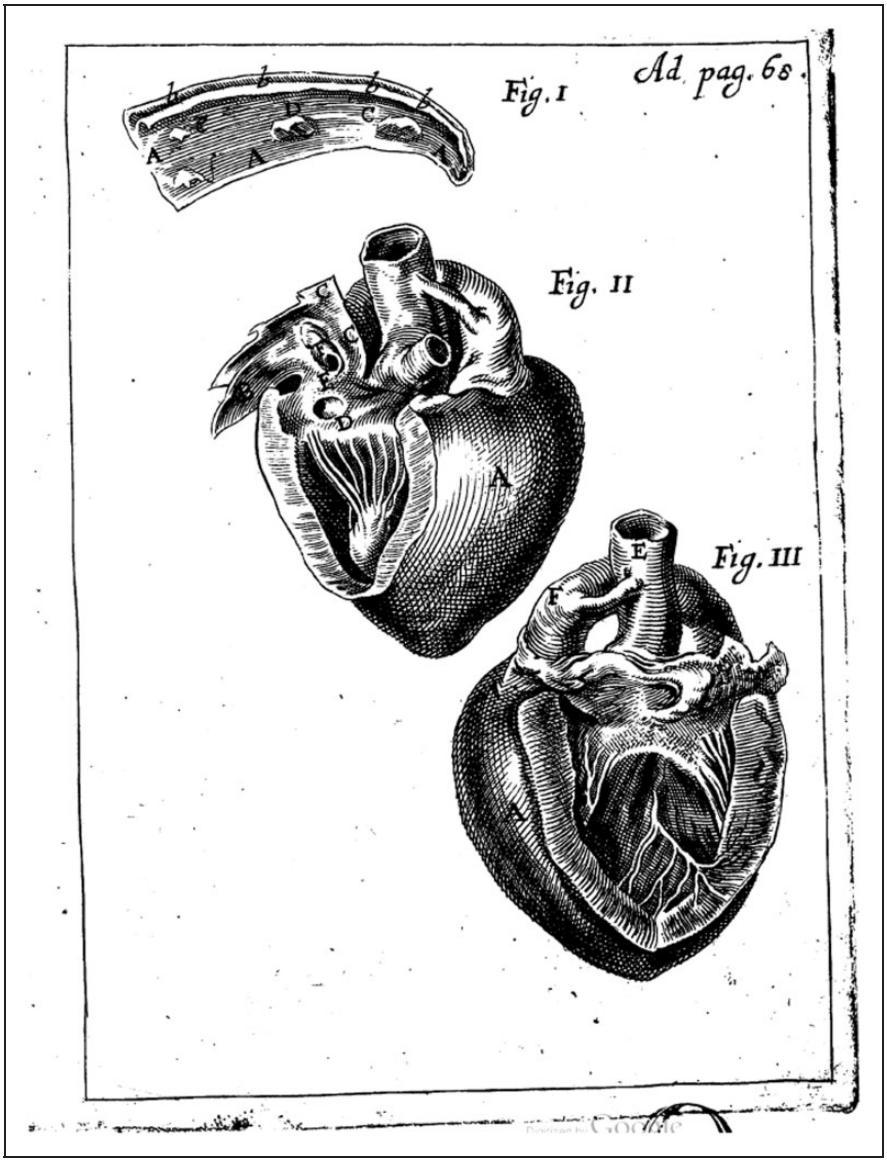

Figure 1. Illustration of the heart added by Van Horne in Botallo's *Opera Omnia*, where the foramen ovale (fig. ii, letter F) and the ductus arteriosus (fig. iii., letter F) are depicted.

(1536–1606) published the *Anatomici libri duo*, in the first part of which he described the foramen ovale and the ductus arteriosus.[26] His descriptions were more accurate than those of Vesalius and Aranzio and brought this latter to correct some of his affirmations in the *De humanu foetu*.[27,28]

To conclude this section, it is worth mentioning another important aspect of Botallo's career, partly related to cardiology, namely his works on bloodletting. In his "*De incidendae venae, cutis scarificandae et hirudinum applicandarum modo*" (On the manner of bloodletting, cutaneous scarification and leech application) and in "*De curatione per sanguinis missionem*" (On the treatment of diseases through bloodletting),[29] Botallo expressed the conviction, drawn from his daily experience, of the therapeutic value of bloodletting – scarcely considered in France where he worked at that time. Botallo, in fact, was a strong believer in bloodletting and specified in his works its usefulness, other than in plethoric states, also in conditions of toxaemia.[3] Furthermore, he sustained a sort of patient-centred approach, affirming that bloodletting should be applied not after considering astral influences or the season, which at that time were particularly important features in medical theory. Instead, he supported the idea that physicians should consider the real conditions of the patient and the morbid form by which he was affected, evaluating, on the basis of the organism's reactivity, the opportunity to repeat it or not. He actually stressed the importance of a qualitative and quantitative accuracy in bloodletting, underlining that sometimes this procedure could not be healing, but only if it is used in an improper manner, too late or too sparingly.[30]

Botallo's medical deontology

In addition to his works on traumatology and cardiology, another Botallo work deserves a special place in the history of medicine because it represents one of the first works in modern times on medical ethics. It was written during a crucial period for the development of this discipline that, however, is still partially underestimated by historians. As well known, the first work in which the term "medical ethics" appeared was written by Thomas Percival (1740–1804), English physician and health reformer, who published his *Medical Ethics*[31] in 1803. Before Percival's work, the primary ethical code of Western medicine was represented by the famous *Hippocratic Oath*, dating back to the 5th century BC. Between the *Oath* and the work of Percival, however, many texts on medical ethics were written, in particular during the late Middle Ages and the Renaissance, which makes this period particularly important in understanding the origin of this discipline. During this period, in fact, the "medical class" became a specific social entity. The "guild" of doctors was composed of university graduates who, by virtue of their curriculum, were clearly distinguished from competing groups in the healthcare market, generically labelled "charlatans". Becoming part of a specific social fabric, the doctor took on roles involving new duties, such as caring for the sick in the event of an epidemic, treating the destitute and performing other medico-legal tasks.[32] Consequently, the risk of being accused of not taking responsibility, or of being responsible for shortcomings in relation to their social and institutional duties increased. This context favoured the appearance of "codes of conduct" aimed at safeguarding the guild of doctors against these risks. The fundamental instrument of preservation was commonly the adoption of a moral code that could became a sort of guarantee, before the social community, of physicians' behaviour. Among these new "codes", the most famous were *De cautelis medicorum* attributed to Arnaldo di Villanova (1240–1313)[33]; the *Collectiones medicinae* by Alessandro Benedetti (1450–1512)[34]; *De cautelis medicorum* by Gabriele de Zerbi (1445–1505)[35]; and, finally, Botallo's *Commentarioli duo, alter de medici, alter de aegroti munere*.[36] These texts mark a fundamental difference with the *Hippocratic Oath*. The latter, in fact, was the expression of a choice made by the doctor, who declared his decision to follow a given moral code. In other terms, the *Oath* was the expression of self-determination.[37] The work of Botallo speaks instead of given "*duties*" which are, in some sense, imposed on physicians by the social circumstances of their practice. Moreover, in Botallo the duties of physicians' assistants, as well as those of patients, are also mentioned. The title itself, which can be translated as "*Treatise on the duties of the doctor and the patient*", clearly reveals this new approach to medical ethics. The book was dedicated to Jacques of Savoy, indicating that it was probably written during the period when Botallo practiced in Lyon.

There is a strong awareness, in Botallo's work, that physicians belong to a guild where every member is required to demonstrate the "honour" of the group. For instance, a physician must avoid useless and speculative discussions, but, at the same time, must be learned in rhetoric and dialectic, so as to be able to speak to his patients and colleagues with clarity. He needs to be acquainted with mathematics and geometry, but, at the same time, he must be aware that medicine is a conjectural science. This point is particularly important because patients and their families must not claim that a doctor's cure, even if correctly performed, always provides a certain result. To avoid that risk, physicians must to be very cautious with prognoses:

"*If the doctor does not know everything of the disease, he must give only a hypothetical prognosis*".[36]

Botallo advances the need for a strict alliance among the members of the guild. Internal medicine and surgery need to collaborate, rather than being in competition. Physicians must cooperate to treat complex cases. When a patient is in critical condition, his doctor should allow him to ask for another opinion. The doctor should regularly keep clinical reports on his patients to be discussed with his colleagues. On the other hand, physicians and surgeons need to be allied against external competitors: "*Medicine in the hands of the incompetent is like a sword in the hands of a child*".[36] The term "charlatan" recurs several times throughout the treatise. For instance, physicians must avoid any kind of "popular medicine". They need to be learned in astronomy, so as to be able to debunk the mistaken beliefs of astrologers who also give medical advice.

With regard to physicians' collaborators, Botallo states that they must never do anything for patients that doctors disapprove of. To the best of our knowledge, he is the first to mention the conflict of interest, which could occur between physicians and pharmacists: "*It is not honest for a physician to share interests with a pharmacy*".[36] With regard to patients, their first duty is never to take drugs without the advice of the practitioner. They must be careful in explaining their symptoms and personal history, without omitting any detail. They must have faith in the doctor, as well as having faith that the doctor must deserve that confidence. For that purpose, physicians must also take special care with their appearance: "*The patient is conditioned by doctor's dressing, haircut, perfume, and posture*".[36] In the end, Botallo proclaims the need for a mutual alliance among physicians, surgeons, assistants, patients, and families: "*Although the doctor is the one who commands, the assistants and patients are those who obey and bear, their purpose must be the same*".[36]

It may be of interest to quote one of the final sentences of the book: "*It is necessary that the physician combines generosity and solidarity, avoids any attachment to his own interest. Otherwise, not only his work, but also his own name would be devalued and corrupted*".[36] Preserving the "good name" of a doctor was strictly correlated to the honour of the whole social class of physicians. This was the ultimate way of preserving the guild in a public setting that imposed specific duties as well as new risks with legal implications.

Conclusions

It is a paradox that Botallo's is universally known for two eponyms, which are, as has been explained, wrongly attributed to him. This misunderstanding, moreover, might overshadow the richness and polyvalence of Botallo's work, which ranged from anatomy to pathology, clinics and surgery. For instance, other than the works we have analyzed in this paper, Botallo wrote a significant book on syphilis.[38] He embodied the figure of a typical Renaissance physician, who combined a strong knowledge of ancient and modern literature with experience, practice and experimentation. In this way, he contributed to the further development of medicine which would become, in the following centuries, even more effective in understanding and treating human diseases.

Declaration of Conflicting Interests

The author(s) declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) have received no financial support for the research, authorship, and/or publication of this article.

ORCID iDs

Alberto Zanatta https://orcid.org/0000-0002-9326-611X
Gabriella D'Angiolella https://orcid.org/0000-0003-4324-0808

References

1. Fransson SG. The Botallo mystery. *Clin Cardiol* 1999; 22: 434–436.
2. Firpo L. Medici piemontesi nel cinquecento. In: Carerj L and Bogetti Fassone A (eds) *Leonardo Botallo. I doveri del medico e del malato*. Torino: UTET, 1981, pp.9–51.
3. Taccari E. Botallo, Leonardo. In: *Dizionario Biografico degli Italiani* (vol. 13). Roma: Treccani, 1971, pp.412–415.
4. Le Paulmier CS. *Ambroise Paré. D'aprés des nouveaux documents dècouverts aux Archives Nationales et des papiers de famille*. Paris: Charavay Frères Éditeurs, 1884, p.77.
5. Sprengel C. *Storia prammatica della medicina* (vol. 2). 9 vols. Firenze: Tipografia della Speranza, 1840–1849, p.75.
6. O'Malley CD. Botallo, Leonardo. In: *Dictionary of scientific biography* (vol. 2). New York: Charles Scribner's Sons, 1970, p.336.
7. Grangier B. *De cautionibus in sanguinis missione adhibendis admonition ad*. Botallum. L. Paris: Apud P.J. Huillier, 1578.
8. French RK. The thorax in history, 5. Discovery of the pulmonary transit. *Thorax* 1978; 33: 555–564.
9. Botallo L. *De curandis vulneribus sclopettorum*. Leiden: Apud Gulielmum Rovillium, 1560.
10. Bonino G. *Biografia medica piemontese*. Torino: Della Tipografia Bianca, 1834.
11. Botallo L. *De catarrho*. Paris: Apud Bernardum Turrisanum via Iacobaea, 1564.

12. Folius C. *Sanguinis a dextro in sinistrum cordis ventriculum defluentis facilis reperta via cui non vulgaris in lacteas nuper patefactas venas animadversio praeponitur*. Venice: Apud Bertanos, 1639.
13. Kasten Tallmadge G. Caecilius Folius on the circulation. *Bull Hist Med* 1954; 28: 15–31.
14. Botallo L. *Opera omnia medica et chirurgica. Haec postrema editione a mendis repurgata, methodice disposita, paragraphis distincta, notis marginalibus, et authorum testimoniis aucta, hinc inde annotationibus illustrata, prodeunt e musaeo Joannis van Horne*. Lugduni Batavorum: Ex officina Danielis et Abrahami a Gaasbeeck, 1660.
15. Portal A. *Histoire de l'anatomie et de la chirurgie*. 5 vols. Paris: Chez P. Fr. Didot le Jeune, 1770, 1, p.565.
16. May T (ed.). *Galen on the usefulness of the parts of the body*. (2 vols). Ithaca: Cornell University Press, 1968, 1, p.59.
17. Colombo R. *De re anatomica*. Venetiis: ex typographia Nicolai Beuilacquae, 1559.
18. Elmaghawry M, Zanatta A and Zampieri F. The discovery of pulmonary circulation from Imhotep to William Harvey. *Glob Cardiol Sci Pract* 2014; 2014: 31–116.
19. Hara H, Virmani R, Ladich E, et al. Patent foramen ovale: current pathology, pathophysiology, and clinical status. *J Am Coll Cardiol* 2005; 46: 1768–1776.
20. Schneider DJ. The patent ductus arteriosus in term infants, children, and adults. *Semin Perinatol* 2012; 36: 146–153.
21. Franklin KJ. Ductus venosus (Arantii) and ductus arteriosus (Botalli). *Bull Hist Med* 1941; 9: 580–584.
22. Obladen M. History of the ductus arteriosus: 1. Anatomy and spontaneous closure. *Neonatology* 2011; 99: 83–89.
23. Kopsch F and Knese K-H. *Nomina anatomica. Vergleichende Übersicht der Basler, Jenaer und Pariser Nomenklatur*. 5th ed. Stuttgart: Thieme, 1957, p.28.
24. Falloppio G. *Observationes anatomicae*. Venezia (Grazioso Percacino) per Marcantonio Olmo, 1561.
25. Vesalius A. *Anatomicarum Gabrielis Falloppii observationum examen*. Venetiis: Apud F. de Franciscis senensem, 1564.
26. Carcano L. *Anatomici libri duo*. Pavia: Apud Hieronimum Bartholum, 1574.
27. Scarpa A. *Elogio storico di Giovanni Battista Carcano*. Milano: De Renzi, 1813.
28. Mazzarello P and Cani V. *Insegnare la Medicina*. In: Mantovani D (ed.) *Almum studium Papiense. Storia dell'università di Pavia*. Milan: Cisalpino-Monduzzi, 2013, pp.1111–1138.
29. Botallo L. *De curatione per sanguinis missionem: de incidendae venae, cutis scarificandae, et hirudinum applicandarum modo*. Lyons: J. Huguetan, 1577.
30. Paine M and Ruggles W. *Columbian College in the District of Columbia, Materia medica and therapeutics*. Wood: New York, 1848.
31. Percival T. *Medical Ethics; or, a Code of Institutes and Precepts, Adapted to the Professional Conduct of Physicians and Surgeons*. London: John Churchill, 1803.
32. Linden DE. Gabriele Zerbi's De cautelis medicorum and the Tradition of Medical Prudence. *Bull Hist Med* 1999; 73: 19–37.
33. Sigerist H. Bedside manners in the middle ages; the treatise de cautelis medicorum attributed to Arnald of Villanova. *Q Bull Northwestern Univ Med School* 1946; 20: 136–143.
34. Benedetti A. *Collectiones medicinae*. Venice: J. & G. de Gregoriis, 1493.
35. De Zerbi G. *De cautelis medicorum*. Padua: Christophorus de Pensis, 1495.
36. Botallo L. *Commentarioli duo, alter de medici, alter de aegroti munere*. Leiden: apud Antonium Gryphium, 1565.
37. Rodriguez D. Bentham o Botallo? *Rivista Italiana di Medicina Legale* 1; 30:3–12.
38. Botallo L. *Luis venereae curandae ratio*. Paris: apud Joannem Foucherium, 1563.

Author biographies

Pamela Tozzo is Researcher in Legal Medicine at the Department of Molecular Medicine of the University of Padova, Italy. Her interests of research comprise forensic genetics, medical deontology, ethical aspects of public health. She teaches legal medicine and bioethics to rehabilitation health professions' students.

Alberto Zanatta is curator of the Morgagni Museum of Pathological Anatomy of the University of Padua, Italy. His fields of interest are anthropology, paleopathology and history of medicine, in particular medical museology. He teaches scientific research methodology to the Sciences of the Health Professions Diagnostic Techniques' students.

Gabriella D'Angiolella is resident in Legal Medicine at the University of Padova, Italy. Her first research experiences concern forensic medicine and the ethical aspects of healthcare professions.

Luciana Caenazzo is Associate Professor in Legal Medicine at the Department of Molecular Medicine of the University of Padova, Italy. Her interests of research also comprise, ethical questions of genetics, forensic genetics and justice, other main research interest is in the ethical aspects of the clinical use of genetics (ethical issues arising

in their day-to-day practice and to share good practice) and big data management. She teaches legal medicine and bioethics to both law and healthcare professionals students.

Fabio Zampieri is Associate Professor of History of Medicine at the Department of Cardiac, Thoracic, Vascular Sciences and Public Health of the University of Padua, Italy. He is recognized as one of the leading experts in the history of Darwinian medicine, in the figure of Giovanni Battista Morgagni and the history of the anatomo-clinical method. He teaches History of Medicine to medicine's students.