The remarkable medical lineage of the Monro family: contributions of Alexander primus, secundus, and tertius

Historical vignette

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Among the families that have influenced the development of modern medicine into what it is today, the Monro lineage stands as one of the most notable. Alexander Monro primus (1697–1767) was the first of 3 generations with the same name, a dynasty that spanned 126 years occupying the Chair of Anatomy one after the other at the University of Edinburgh. After becoming Professor of Anatomy at the University of Edinburgh in 1719, Monro primus played a principal role in the establishment of the University of Edinburgh School of Medicine and the Edinburgh Royal Infirmary. In 1726, he published The Anatomy of the Humane Bones, of which 8 editions were printed during his lifetime. His son, Alexander Monro secundus (1733–1817), arguably the most notable of the 3 men, succeeded him as Professor of Anatomy. A highly regarded lecturer and anatomist, Monro secundus studied under many great physicians, including William Hunter and Johann Friedrich Meckel the Elder, and was also teacher to other well-known figures at the time, such as Joseph Black and Thomas Trotter. His most notable contributions include his work with the lymphatic system, the interventricular foramen (of Monro), and the Monro-Kellie doctrine. Alexander Monro tertius (1773–1859), the last of the dynasty, also succeeded his father as Professor of Anatomy. His work included insights into abdominal aortic aneurysms and the anatomy of the genitourinary system. The prominent association of the Monro family with the University of Edinburgh and the effects of a tenured professorship under the concept of “Ad vitam aut culpam” over successive generations are also described. To the best of the authors’ knowledge, this historical review of the Monro family is among the few published in neurosurgical literature. A vivid historical overview of the medical contributions of the most famous and influential dynasty of physicians in Edinburgh at that time is provided, with relevant excerpts from original publications.

(http://thejns.org/doi/abs/10.3171/2012.2.JNS11366)

KEY WORDS • Alexander Monro • interventricular foramen • foramen of Monro • University of Edinburgh • Monro-Kellie doctrine • neuroanatomy • functional neurosurgery

Alexander Monro primus (1697–1767)

Alexander Monro primus (Fig. 2) was born in London on September 8, 1697. His father was John Monro (1670–1740), an army surgeon who resigned from the service and moved to Edinburgh in 1700. There, he was admitted into the Town Council in 1702 and then into the Incorporation of Surgeons by examination the following year. Alexander's mother, Jean Forbes, was the daughter of Captain James Forbes. Alexander's father had high expectations and hopes for his only surviving son and made his education a top priority. He began tutoring Alexander at a young age, instructing him on a wide range of subjects, from the classic languages to philosophy and bookkeeping. In 1710, he attended the University of Edinburgh but did not obtain a degree and later apprenticed under his father as planned. In 1717, he traveled to London where he attended the natural philosophy lectures of...
Francis Hauksbee the Younger (1687–1763) and William Whiston (1667–1752), as well as the anatomy courses of William Cheselden (1688–1752), Alexander Monro sent home samples of his dissections, which his father proudly displayed to his colleagues in the College of Physicians and the Incorporation of Surgeons.22

In the spring of 1718, Monro traveled to Paris to attend classes at the Jardin du Roi and the Hotel-Dieu. In November, Monro enrolled at the University of Leiden as a medical student for 1 year. There he studied botany, chemistry, and clinical medicine under Herman Boerhaave (1668–1738), Professor of Medicine at Leiden most known in the modern era for first describing the syndrome of postemesis esophageal rupture, which bears his name. At the recommendation of Boerhaave, Monro sought out the anatomist Frederik Ruysch (1638–1731) in Amsterdam, who taught him the art of anatomical preparations.

In September of 1719, Monro returned to Edinburgh, passed his examinations, and was admitted to the Incorporation of Surgeons on November 18, 1719. Monro was appointed Professor of Anatomy after the joint professors, Adam Drummond and John McGill, resigned in favor of Monro. The Town Council gave him a modest salary of £15 sterling. This appointment is often viewed as the beginning of the University of Edinburgh School of Medicine, as well as its prominence across Great Britain and Europe.

At the age of 23 years, Monro offered his first anatomy course in the fall of 1720, which was advertised as “Alexander Monro, Professor of Anatomy in Edinburgh, gives a College of Anatomy in all its parts, the Operations of Surgery and Bandages, which begins the first Monday of November next.”22 His course was originally held in the anatomy theater in Surgeons’ Hall, but public rioting due to suspicions of grave robbing forced Monro to petition the Town Council to provide him a more secure site. At the time, the magistrates even offered £20 sterling for anyone who discovered the theft of bodies, although no one claimed the reward. In 1725, his class was moved to a room on the ground floor of the building to avoid protesters. His course became so popular that he had to expand it with a second offering taught by his son, Alexander Monro secundus.22 At the end of 1726, Monro published The Anatomy of the Humane Bones, which went through 8 editions during his lifetime and 3 editions posthumously.

Monro’s style of teaching was popular and engaging. Instead of Latin, he chose to conduct his lectures in English and never read from notes, a style that appealed to his many students. While he was not married to a particular school of thought, his teachings emphasized the principles of mechanistic physiology, which he adopted from Boerhaave.21,23 Taking cues from the natural philosophy lectures he attended in London and Paris, Monro made great use of animal models, waxes, and anatomical preparations. In 1722, after petitioning the Town Council, his professorship was made a lifetime appointment via the principle of “Ad vitam aut culpam.”2 Nominated by William Cheselden, Monro was elected as a fellow of the Royal Society of London on June 27, 1723. He was also nominated as a fellow of the Royal Academy of Surgery of Paris. In 1756, the University of Edinburgh conferred upon him a medical degree.

Another major accomplishment of Alexander Monro primus was his involvement in the creation of the Royal Infirmary of Edinburgh.22 He rented a house with 6 beds in 1729 at Robertson’s Close for providing clinical training to medical students. Originally named The Hospital for the Sick Poor, its creation was first inspired by his father, John Monro, and brought to fruition by Alexander with the support of then Provost Adam Drummond. Apart from functioning as a teaching hospital for medical students, the Royal Infirmary of Edinburgh also provided care for patients throughout Edinburgh. Its expansion in 1738 as the Royal Infirmary of Edinburgh included an operating theater that was designed by Alexander himself.

On January 3, 1725, Monro married Isabella MacDonald (1694–1774), the third daughter of Sir Donald MacDonald of Sleat on the Isle of Skye. Alexander and Isabella had 5 daughters, of whom only 1 survived to adulthood, and 3 sons. Apart from Alexander secundus, his other 2 sons were Donald Monro (1728–1802), who worked as a physician at St. George’s Hospital in London,
and John Monro (1725–1789), who became an advocate of Auchenbovie. Alexander primus took a major break from his academic career when he began to show signs of rectal cancer in 1762. Despite his illness, he remained active in other aspects of the University. Alexander Monro primus died on July 10, 1767, at his home in Covenant Close and was buried in Greyfriars churchyard in Edinburgh.

**Alexander Monro secundus (1733–1817)**

Alexander Monro secundus (Fig. 3), the third son of Alexander Monro primus and Isabella MacDonald, was born on May 20, 1733, in Edinburgh. Even at an early age, Alexander was designated to be his father’s successor as Professor of Anatomy at Edinburgh. His name first appears on the senior Monro’s anatomy class roster in 1744. At the age of 12 years, Monro secundus matriculated at Edinburgh University in 1745 and began attending medical lectures in 1750. He started teaching his father’s summer anatomy course by 1753 and was named conjoint Professor of Anatomy on June 10, 1754, at the petition of Monro primus. In 1755, he received his medical degree after presenting his thesis *De testibus et semine in variis animalibus*, the inaugural dissertation of which was dedicated to his father, who in June 1757 successfully petitioned the Town Council to change their titles to Professors of Medicine and Anatomy.

After graduation, Monro secundus traveled abroad, studying anatomy in London with William Hunter (1718–1783), a previous student of his father. He traveled to Paris but was forced to return to Edinburgh in 1757 to assist his ailing father with teaching anatomy and other duties around the University. After his father recovered, he spent several months in the home of Johann Friedrich Meckel the Elder (1724–1774) in Berlin, learning anatomy from the prominent figure. He enrolled at Leiden University in 1757 and befriended Bernhard Siegfried Albinus (1697–1770) and Petrus Camper (1722–1789), well-known anatomists of the time. Monro secundus returned home in 1758 to officially take over the lectures of his father. In 1759, he was elected as a fellow of the Royal College of Physicians of Edinburgh.

In his first publication, *De venis lymphaticis valvulosis* (1757), Monro secundus argued that the lymphatic system was absorbent and distinct from the circulatory system. His former professor, William Hunter, made the claim that he had been teaching this concept for years. He accused Monro of stealing the idea from him, while Monro countered that it was, in fact, Hunter who took the theory from his thesis. A heated and bitter exchange of writings ensued in which both sides laid claim to having priority of discovery. In the pamphlet *Observations, Anatomical and Physiological, Wherein Dr. Hunter’s Claim to some Discoveries is examined* (1758), Monro attacked Hunter, describing him as “a spiteful, but impetuous and unskilful Swordsman, by endeavouring to make too deep a thrust, run himself headlong upon his adversary’s weapon.” In actuality, Monro had published first, but Hunter had been teaching the theory years before the incident. However, neither realized that others, such as Francis Glisson and Friedrich Hoffman, had published...
their speculations approximately a century prior to Monro and Hunter. In 1767, William Hewson (1739–1774), a colleague of Hunter and former student of Monro, proposed the use of paracentesis of the thorax in traumatic pneumothorax and wrote on the existence of lacteals and lymphatic vessels in nonmammals. Monro defended his claim to priority to both in A State of Facts concerning the first proposal of performing the paracentesis of the thorax and the discovery of the lymphatic valvular absorbent system of oviparous animals. In answer to Mr Hewson, it appears that Monro preceded Hewson in performing paracentesis of the thorax, but Hewson was the first to publish on lymphatics in nonmammalian animals. However, Monro is most known for the interventricular foramen that bears his name, as well as the Monro-Kellie doctrine, both of which are described in detail later.

As a lecturer, Monro secundus was extremely successful. Alexander Monro tertius said of his father, “He was totally devoid of conceit, and unlike many professors who have lectured for nearly half a century, did not remain satisfied with the lectures he had written at the beginning of his career.” Benjamin Rush added this glowing review: “in anatomy he is superior perhaps to most men in Europe, and he speaks with great propriety, [and] As he commits all his Lectures to Memory, he embellishes them when speaking with all the Graces of Elocution.” His classes were so popular that a new lecture hall was built in 1764 to accommodate his growing number of students. Many copies of his lecture notes survive to this day.

Outside of teaching, Monro also had an extensive private medical practice. While he was not an operating surgeon, he was often consulted in difficult cases. As with his teaching, he was very methodical as a physician, keeping detailed patient records. Besides medicine, Monro secundus had a keen interest in gardening and theater. He bought a property of 271 acres on the eastern bank of the Water of Leith in Colinton parish, which he dedicated to gardening. Interestingly, he only had a small cottage with no bedroom because he refused to sleep away from his town house while he was in practice. In 1780, Monro secundus registered a coat of arms (Fig. 4).

On September 25, 1762, Monro married Katherine Inglis and had 3 sons and 2 daughters. In 1798, Monro retired from teaching, 54 years after his appointment, and passed the torch to his son, Alexander Monro tertius, who in 1718 had been appointed conjoint professor with him. Many of the medical faculty signed the recommendation appended to the petition, stating, “the appointment of the young Doctor Monro to be Colleague and successor to his father would be attended with much advantage to the Students and the University.” After returning to Edinburgh in 1800, Monro started lecturing alongside his father and, by 1808, the senior Monro had passed on all teaching duties to his son. However, it quickly became evident that Monro tertius did not measure up to his predecessors. Monro tertius was generally regarded as a poor teacher and scientist, whose “writings as a young man are as confused, prolix, and illogical as his senile productions.” Charles Darwin, who studied medicine at Edinburgh from 1825 to 1827, wrote that “Dr. Munro made his lectures on human anatomy as dull, as he was himself, and the subject disgusted me.” In a letter to his sister Caro-
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Figure 5. Illustration of Alexander Monro tertius (1773–1859).


line, Darwin added “I dislike him [and] his Lectures so much that I cannot speak with decency about them. He is so dirty in person [and] actions.” A popular but untrue story, first published in 1884, claimed “so lazy was he that he used to read his grandfather’s lectures, written about a century before; and he did not take the trouble even to alter the dates.”

Monro tertius was married twice, first in 1800 to Maria Agnes, with whom he had 6 sons and 6 daughters, and later to Jessie Hunter. In 1846, Monro resigned from his position. He spent his retirement at his home in Craiglockheart. He died on March 10, 1859, and was buried at Dean Cemetery in Edinburgh.

Medical Contributions of the Monro Dynasty

Few families have had as significant an impact on anatomy and surgery as the Monro family. They have made remarkable contributions to the advancement of the neurosciences. The first and most important work of Alexander Monro primus, The Anatomy of the Humane Bones, was originally published in 1726. In the second edition published in 1732, he appended an anatomical treatise on the nerves (Fig. 6). There he discussed 2 popular theories of the time; the first stated that nerves are solid and transmit vibrations, and the second stated that nerves are filled with fluid that traveled from the brain to the organs and muscles. Monro argued against the former, stating that the extremities are “quite soft and pappy, and therefore not susceptible of the vibrations supposed.” He added that “when a nerve is viewed with a microscope while the muscles it serves are in action, no contraction or motion is observed in it.” Monro concluded, “I rather incline to believe the Nerves to be Vessels containing a Fluid, which is sent into them from the Brain in an equal constant Stream, in the same Way as is done by other Glands to their Excretories, and can serve to solve all the Phaenomena that are commonly remarked in either muscular Motion or Sensations.”

The Anatomy of the Humane Bones remained in print for several decades, going through 11 editions in total and translated into most European languages. Monro primus wrote more than 50
papers, among which he reported the presence of foreign bodies in the vermis form appendix and that jaundice was rarely due to causes other than common bile duct obstruction. He used colored oil of turpentine to permeate cadavers, a technique that was unique from that used by others at the time. He also published on fetal nourishment via amniotic fluid and smallpox inoculation. When Monro *primus* tore his Achilles tendon, he even wrote a detailed account of the event.

Monro *secundus* is perhaps best known now for his description of the interventricular foramen, the communication in the brain connecting the lateral ventricles to the third ventricle (Fig. 7). In a paper presented before the Philosophical Society of Edinburgh in 1764, he first noted the foramen in a case of hydrocephalus, in which the foramen appeared enlarged on dissection. Monro made a detailed account of it in *Observations on the Structure and Functions of the Nervous System* (Fig. 8), published in 1783 and again in *Treatise on the Brain* published 14 years later. While many credit Monro with the discovery of the interventricular foramen, other anatomists were aware of its existence before him. In fact, he states, “These cavities have been described by Galen, and by many succeeding Authors of eminence, as at communicating with each other.” Among these authors were Andreas Vesalius (1514–1564), Adrian van der Spigelius (1578–1625), Thomas Willis (1621–1675), and Jacob B. Winslow (1669–1760). Additionally, while his description could be considered the most detailed of the time, it was not entirely accurate:

After laying open one of the lateral ventricles of the brain in the usual way, leaving the septum between the ventricles entire, let the gutter which is between the corpora striate and thalami nervorum opticorum, the bottom of which is occupied by the substance called Centrum semicircularum geminum, be traced inwards, and it will be found to lead to the fore part of an oval hole, large enough to admit a goose quill, under the fore part of the fornix. From this hole, a probe can readily be passed into the other lateral ventricle, shewing, in the first place that the two lateral ventricles communicate with each other. When the fornix is next divided transversely, we find that this passage has the anterior crura of the fornix in the fore part, and the joining or middle part of the choroid plexus of the lateral ventricles at its back part, and that its middle part is over a passage downwards, named the iter ad infundibulum, or vulva, which should rather be called iter ad tertium ventriculum.14

Monro thus proposed that the lateral ventricles are directly connected to each other via a transverse passage that opens inferiorly into the third ventricle via a vertical midline connection, which he referred to as “iter ad tertium ventriculum.” Of note, Monro denied the presence of any communications between the fourth ventricle and the spinal cord, which we now know as the 2 lateral foramina of Luschka and the midline foramen of Magendie.

In the same publication, Monro made several important observations about the cranial cavity, with the application of physical principles to the intracranial contents for the first time that eventually led to the Monro-Kellie doctrine. He first noted that the brain is enclosed in non-expandable bone and is nearly incompressible. He further noted that the volume of the blood in the cranial cavity is constant or nearly constant and that continuous venous blood outflow is required to make room for continuous incoming arterial blood. George Kellie (1758–1829), a former student of Monro, also studied the amount of blood in the brains of humans and animals and reached the same conclusions as his mentor. Kellie observed no changes in

**Fig. 7.** Left: Illustrations of the interventricular foramen. Right: Original description of “iter ad tertium ventriculum” by Monro *secundus.*
the amount of venous blood in the brains of humans and animals that died of drowning, hanging, or exsanguination. He also noted that the amount of blood in the cerebral vessels of dogs given lethal doses of prussic acid was not affected by gravity, whether the animal was hanged by the hind legs or ears. He and Monro dissected 2 pirates who were hanged at Leith and discovered during post-mortem examination that, while the extracranial vessels were congested, the intracranial vessels were not. Kel- lie’s findings were endorsed by John Abercrombie (1780–1844), a noted pathologist at the University of Edinburgh School of Medicine; hence, the hypothesis can sometimes be found cited as the Monro-Abercrombie doctrine. The presence of CSF was not known at the time and therefore was not yet factored into the Monro-Kellie doctrine. It wasn’t until the 19th century that CSF was recognized to exist and was introduced into the hypothesis by others such as George Burrows and Harvey Cushing.

Another of Monro secundus’ contributions to neuroscience came from his experiments of opium injections in animals. In his publication *Experiments on the Nervous system with Opium and Metalline Substances to determine the Nature and Effects of Animal Electricity* (1793), he stated the following:

I cut one hole in the fore and upper part of the cranium and dura mater of a frog and another in the back part of the lower-
most vertebrae, and then injected, from the one hole to the other, a small syringe full of water, in five ounces of which one ounce of opium had been infused for three days. The infusion, by this means brought into contact with the whole surface of the encephalon and spinal marrow, produced almost instantly universal convulsions; and, in less than two minutes thereafter, the animal was incapable of moving its body from the place where it was laid. A quarter of an hour thereafter, I found the heart beating twentyfive times only in the minute; and so feebly, that it could not entirely expel the blood. When half an hour thereafter, the sciatic nerves were pinched, a slight tremor only was excited in the muscles of the leg; and animal electricity produced but feeble twitchings of the muscles. The infusion of opium injected in the same manner in rabbits and in a pig, produced similar effects.5

He postulated that the toxic influence of opium was primarily caused by effects on the nervous system and not the vascular system as previously described by Felice Fontana (1730–1805), an Italian toxicologist. Monro summarized his experiments by saying:

I therefore then concluded, and now conclude, that opium and other poisons, even after they are mixed with the mass of blood, produced their fatal effects, chiefly and almost solely, by acting on the nerves of the heart and vascular system, and through these, affecting the whole of the nervous system.5

Monro secundus also had a remarkable knowledge of comparative anatomy, inspired by his father's research. In 1785, he published The Structure and Physiology of Fishes Explained and Compared with those of Man and other Animals.16 In his book A Description of all the Bursae Mucosae of the Human Body (1788),11 he extensively describes about 70 pairs of bursae in the human body (Fig. 9). During a time when the germ theory of disease was yet unheard of, he proposed that the chief cause of infection in joint surgery was due to exposure to air.

While Monro tertius published a large number of works, his best included Observations on Aneurism of the Abdominal Aorta (1827)19 and The Anatomy of the Urinary Bladder and Perinaeum of the Male (1842).17 His most notable neurosurgical contributions included The Morbid Anatomy of the Brain (1827)18 (Fig. 10). However, he was often criticized for being unoriginal and unclear in his work.

Ad Vitam aut Culpam (for life or until fault)

From 1720 to 1846, the Monro family occupied the position of Professor of Anatomy at the University of Edinburgh for 3 successive generations, accomplished in part by the careful planning of Alexander Monro primus and his popularity as a lecturer. In March 1722, he petitioned the Town Council to make his position a life appointment to which the Council gladly obliged, securing his position Ad vitam aut culpam. According to Monro primus, the benefits of this tenure were that “by taking away the least umbrage of uncertainty in the Office will likewise remove all pretences for neglect of duty in the exercise of it.”2

When faced with a potential threat to their professorships, the Monro family took the necessary steps to protect their tenure. In 1776, the Incorporation of Surgeons attempted to create a separate Chair of Surgery. However, Alexander Monro secundus secured his position by successfully petitioning the Town Council to change his title to Professor of Medicine, Anatomy, and Surgery, thus preventing the creation of a separate chair.22

After Alexander Monro secundus petitioned to have his son appointed conjoint professor, the Town Council
became concerned at the growing nepotism in the University. On March 7, 1798, in an attempt to combat this problem, the Council adopted a resolution against appointing a professor before the previous one had left. However, after careful consideration, the Council decided to allow an exception, and Monro tertius was made conjoint professor with his father.

In 1816, there was a proposal to create a separate Chair of Comparative Anatomy that would be filled by John Barclay. This proposal was met with great objection by Monro tertius and Robert Jameson, the Professor of Natural History, and never passed. However, the Royal College of Surgeons did not think that Monro’s lectures on surgery were sufficient for examination candidates. In 1827, the Town Council agreed stating that, “[first,] Anatomy and Surgery each afford ample employment for a separate Professor [and, second,] different qualifications are necessary for the successful teaching of these respective branches.”

Monro vehemently disagreed, stating that he “considered the two branches of study to be so intimately connect that it would be improper to disjoin them.” In 1830, the Crown created the Chairs of Surgery and Pathology to be occupied by John Thomson and J. W. Turner, respectively. Monro protested and continued to teach surgery, but a resolution that passed in 1838 by the Royal College of Surgeons prevented recognition of any lecturer to teach more than 1 subject in the same session.

On February 17, 1846, the Town Council received a letter of intent to resign from Alexander Monro tertius. On March 3, the Council accepted his resignation, and John Goodsir, F.R.S., his assistant, took over in the interim. Of the 9 original candidates for the newly vacated chair, Goodsir was ultimately inducted as Professor of Medicine and Anatomy on May 2, 1846, ending the 126-year tenure held by 3 generations of the Monro family.

**Conclusions**

Among the families that have influenced the development of medicine, the Monro lineage stands as one of the most notable. Few other families have made as profound a contribution to anatomy, pathology, and surgery. Theirs was a legacy that spanned 3 generations, 126 years, and helped shape the face of neuroscience.

**Disclosure**

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: all authors. Acquisition of data: all authors. Analysis and interpretation of data: all authors. Drafting the article: all authors. Critically revising the article: Cohen, Wu, Manjila. Reviewed submitted version of manuscript: Cohen, Wu, Manjila. Approved the final version of the manuscript on behalf of all authors: Cohen. Administrative/technical/material support: Wu, Manjila.
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