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Boundary Stones: Morbid Concretions and the Chemistry of Early Nineteenth Century Medicine

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Boundary Stones: Morbid Concretions and the Chemistry of Early Nineteenth Century
Medicine

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DEDICATION

This dissertation is dedicated to my daughter, Mildred Penelope Driggers, who I joyfully awaited while writing this dissertation. I want this dissertation to be first and foremost a testament to my wife's unwavering and dedicated support. She believed in me every moment of every day, through every surgery, every struggle, and every move. With time, dedication, and spirit she was with me every page. It is also meant to honor my father's memory, my mother's support, and the many named and unnamed individuals whose suffering was witnessed in the case histories that were discussed in this dissertation. Finally, this dissertation is meant to honor the optimism, courage, and guidance that my advisor has shown me throughout my years as her student.

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Many librarians were instrumental in the completion of this dissertation, including my wife Rachel who helped with transcription and editing, all the while asking difficult questions and arguing opposite points to my poorly constructed ideas. Archivists, librarians, and historians at the Royal Society of Medicine, the Royal College of Surgeons, the Waring Museum of Medical History at the Medical University of South Carolina, South Carolinian Library, and Duke University Rubenstein Rare Books Room are reason behind anything of quality in this dissertation.

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Dr. Michelle DiMeo, Nadia Berenstein, Daniel Liu, and Britt Dahlberg. Dr. Robert Hicks of the Mutter Museum at the College of Physicians of Philadelphia offered supportive words during my time at CHF. My fellow graduate students in the history department at the University of South Carolina provided support and feedback. Special thanks to Tim Minella who read chapter drafts, graciously offered housing for two of my research fellowships, and shared in numerous discussions over bourbon. I'd also like to thank Dr. David Dangerfield for the good barbeque and conversation. I received several helpful comments at the Women's Health Conference at the Pennsylvania Hospital in the spring of 2015. Feedback was also generously offered at History of Science Society Meeting in Boston during the winter of 2013, and in Charleston at the Southern Association for the History of Medicine and Science Annual Meeting in 2013. Finally, immense gratitude is due to my advisor, Dr. Ann Johnson, who read endless drafts, offered her always excellent advice, her time, and her honesty and encouragement throughout this project, and throughout my graduate studies. Without Dr. Johnson, this dissertation would not exist. I believe it is important to note here that all mistakes are my own, and are in no way the fault of anyone aforementioned.

ABSTRACT

My dissertation is the story of communities of physicians seeking to understand the morbid concretion of the body using the new chemistry from the late eighteenth century. Morbid concretions, or calculi, were occurred in the urinary passages, lungs, joints, pancreas, uterus, and other areas of the body. At the turn of the nineteenth century, some physicians saw analytical chemistry, emerging out of the so-called chemical revolution, as applicable in understanding and treating stone-based diseases. However, some physicians and surgeons saw the treatment of stones with chemistry as evidence of the need to return to older practices of medicine, like humoral pathology, or the theory of health based on the balance of the fluids of the body. My dissertation examines the work of several medico-chemists and surgeons across the Atlantic cities of Charleston, London, and Philadelphia. They were united in their desire to understand the morbid concretions, offer better interventions to their patients, and in the optimism that chemistry held analytical value to medicine. The medical treatment of the stone intersects with questions regarding race and gender, as well as a transitory moment in medicine trying to explain diseases related to fluid blockages, like gout, diabetes, urinary calculi, and skin color.

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CHAPTER 1

INTRODUCTION:

THE MORBID CONCRETIONS OF THE HUMAN BODY

1.1 Chemical Constitution and Uterine Calculi

On May 27, 1834 at a meeting of the Medico-Chirurgical Society, an intellectual society that involved physicians, apothecaries, surgeons, and chemists in greater London, John Bostock read a paper entitled “On the Chemical Constitution of Calcareous Tumours of the Uterus.”¹ Bostock was a physician with an interest in chemistry, who had worked with chemists interested in analyzing the fluids of the body, including Jöns Jacob Berzelius, and Thomas Thomson. Bostock opened his paper by stating, “It is well known that various parts of the body are liable to have deposits formed in them of an earthy or bony matter. These bodies have, in a few instances, been made the subject of experiment, and have been found generally to be composed of the phosphate of lime, combined with a small portion of the carbonate cemented together by a quantity of animal matter.”²

Bostock wanted to break concretions like these “tumours” down chemically to understand how the body’s fluids created blockages, or deposits in the body, and how the

¹John Bostock, “On the Chemical Constitution of Calcareous Tumours of the Uterus, and Other Parts,” *Medico-Chirurgical Transactions* 19 (1835): 81-93.

²Bostock, “On the Chemical Constitution,” 81.

subsequent blockage of the body's fluids contributed to disease.³ Physicians interested in chemistry, or medico-chemists, were inspired to understand concretions in the body, such as urinary calculi, or in this case stones in the uterus, in order to treat them more effectively.

Concretions were analyzed through chemical reactions by medico-chemists and physicians, which led them to draw comparisons between stones of different parts of the body. Bostock pointed to the chemical similarity of the "tumour" found in the uterus and a concretion found in the salivary gland. The chemical similarities suggested that the fluids of the body contributed to stone development, and these stones could cause diseases in the body. He compared ovarian and salivary stones, and also pulmonary stones, writing: "I had the opportunity, many years ago, of examining a salivary calculus, which I found to be composed of phosphate of lime, with a little animal matter, and more lately I found nearly the same constituents in a pulmonary calculus, and in two concretions from the ovaries."⁴ Through the Medico-Chirurgical Society, Bostock met Dr. Richard Lee, a physician and expert in midwifery.⁵

Lee provided Bostock with seven calculi that were either discharged or removed from the uterus from several patients. He described the calculi: varying in size from a pin head to three times larger and yellowish/white, resembling ivory. They were dried after

³Bostock, "On the Chemical Constitution," 81.

⁴Bostock, "On the Chemical Constitution," 82.

⁵Best known for his work: *Clinical Midwifery: Comprising the Histories of Five Hundred and Forty-Five Cases of Difficult, Preternatural, and Complicated Labour* (Philadelphia: Lea and Clanchard, 1849). I examined the first American edition that was published from the second edition that appeared in London.

being exposed to heat and weighed 6.2 grams. The stones' reaction to various acids had been tested. Physicians tested concretions to determine their chemical composition, with the hope that by understanding the composition of a calculus, from any part of the body, it could be treated with chemical substances that could weaken the stone in the body, and lead to its easy removal by a surgeon. Some physicians also hoped that they could prevent or arrest the formation of the stone entirely.

At the same time that chemistry was becoming more quantitatively and analytically precise in discerning the chemical composition of stones, medico-chemists like Bostock were still using terminology and ideas from humoral pathology. Bostock received case notes from other physicians about calculi that he examined: "On examination, we found the uterus the seat of disease; its substance occupied by a number of tumours, beneath the peritoneal covering; several the size of an orange, and one very large one, pendulous, and attached to the back part of the fundus uteri, by a short strong peduncle."⁶ Hippocratic physicians believed that there were "seats" where diseases originated. The seat could be a fluid (often a humor) or an organ, and the idea of a seat as being involved with the origin of disease continued into the early nineteenth century.⁷ In looking for causes of unfamiliar diseases, physicians like Bostock used familiar theories of medicine.

⁶Bostock, "On the Chemical Constitution," 89.

⁷Roy Porter, *The Greatest Benefit of Mankind: A Medical History of Humanity* (New York: W. W. Norton & Company, 1999) and see the *Lancet*, Volume 1, which appeared in 1830; see page 68.

Humoral practitioners were also attempting to understand the body's fluids and secretions and in addition to his work on calculi Bostock also analyzed blood, hoping for further insight into the role of fluids in diseases and the formation of stones. While Bostock's work had increasing chemical specificity, it also pushed him to retain a belief in the utility of humoral pathology, and he called for its partial reintegration into medicine. In his entry on the history of medicine in *The Cyclopaedia of Practical Medicine* he wrote:

And as we must take the fluids, and the changes proper to the fluids into account in all attempts at explanation of physiological phenomena, so we must be prepared to admit Humoral Pathology as essential to the explanation of all the more important phenomena of disease; but this must be a pathology founded on observed changes, not simply of the chemical or chemical condition, but of the strictly vital properties of the fluids, and especially of the blood.⁸

Perhaps ironically, increasingly sophisticated chemistry seemed to propose a reconsideration and revision of humoral pathology through the study of the body's fluids and the production of concretions in the body.

By 1840, physicians like Bostock still saw humoral pathology, at least in part, as valuable, and recognized its historical value. In the *Medical Times*, foreign reports of physicians' speeches pointed out that humoral pathology was being improved and perfected. Gabriel Andral (1797-1876), a famous professor of medicine at the University

⁸Bostock, "History of Medicine," pg. 84 in *The Cyclopaedia of Practical Medicine, Comprising the Treatise on the Nature and Treatment of Diseases, Materia Medical and Therapeutics, Medical Jurisprudence, ETC, ETC.* eds. John Forbes et al (London: Sherwood, Gilbert, and Piper, and Baldwin, and Cradock, Paternoster-Row; Whittaker, Teacher, and Co., Ave-Maria-Lane, 1832) Volume I.

of Paris, inspired one of the writers for the *Medical Times* to proclaim: “...that humoral pathology, purged of its errors, will once more take a prominent place among medical theories.”⁹ Chemistry, humoral pathology, and medicine were entangled with each other in the first half of the nineteenth century.

Humoral pathology was a topic of wide discussion among some British and American physicians, chemists, and surgeons. These individuals lived in cities that included Philadelphia, London, and Charleston. A Google Ngram (figure 1.1) shows high levels of literature preserved in Google Books digital archive concerning the term humoral pathology, especially between 1820-1840. The advent of enlightenment chemistry to medicine drove this renaissance of interest in humoral pathology during early nineteenth century medical practice in Britain and America.

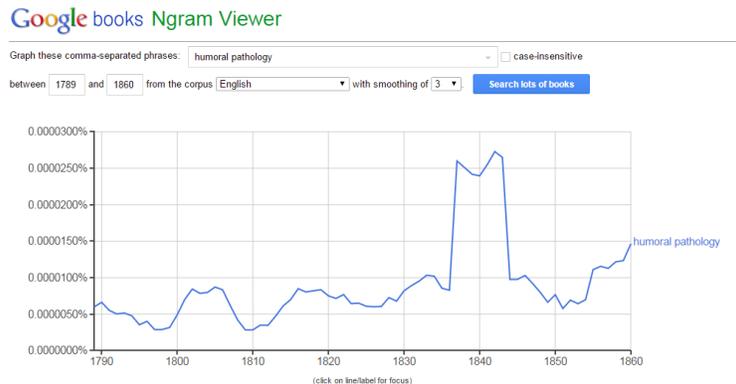


Figure 1.1 Ngram Results for Humoral Pathology

⁹Foreign Journals: *The Gazette des Medicus Practicus*, in a Report of the Lectures on Pathology and Therapeutics of Professor ANDRAL,” *The Medical Times: A Journal of English and Foreign Medicine, and Miscellany of Medical Affairs* 2 (1840): 164.

1.2 Humoral Pathology and Chemistry

This dissertation will explain the importance of the chemical analysis of the morbid concretions (stones) of the body and their effect on medical practice from the late eighteenth through the middle of the nineteenth century. Some physicians were interested in analyzing stones to advance the chemical knowledge of their communities, while other physicians saw stones as evidence that medical attitudes toward humoral pathology at the turn of the nineteenth century needed to be reconsidered, and argued for a return to some of the useful aspects of the theory and practice.

Physicians on both sides of the Atlantic believed that stones were one of medicine's most pressing questions. Alexander Marcet, another medico-chemist, estimated that fifteen percent of all patients admitted into the hospital were admitted for urinary stones, and surgeons and physicians highlighted the difficulty of treating cases of the stones.¹⁰ This dissertation examines the work of physicians in the cities of Charleston, Philadelphia, and London as representative of the medico-chemical investigations occurring around the Atlantic. These specific cities were chosen to highlight the appearance of intellectual societies that either directly discussed, or supported members who were interested in the chemical analysis of stones. Many of the actors discussed here were in communication with each other, either through correspondence or citations in journals, speeches, and books. These physicians were therefore networked together through publication, friendship, educational institutions, and memberships in similar societies.

¹⁰Alexander Marcet, *An Essay on the Chemical History and Medical Treatment of Calculous Disorders* (London: Longman, Hurst, Rees, Orme, and Brown, 1817)

1.3 The Changing Paradigm of Chemistry

The Chemical Revolution of the late eighteenth century was central to re-establishing a revised humoral pathology, and therefore some credit for this development must go to the central figure of that revolution, the French chemist Antoine Lavoisier (1743-1794). However, chemists before Lavoisier were working on the chemical analysis of stones. It was while looking for treatments for stones, that another chemist discovered a new type of gas, fixed air or what is now known as carbon dioxide.

Joseph Black (1728-1799), a physician who later became a chemist, wrote his doctoral thesis at the University of Edinburgh on urinary stones. Black began his chemical researches by searching for a proper solvent for stones. Physicians knew that acids would dissolve stones, but these experiments occurred only once stones had been removed from the body, since physicians could not find a non-lethal acid that could be ingested.¹¹ Black tried an experiment in 1755 on magnesia-alba heating it and forcing it through limewater; It made the limewater turn a thick white color, and the reaction released a gas. This gas was not the same as atmospheric air. He found that he could reconstitute the gas by applying acid to the limestone. He thought he had liberated this “fixed air” from the magnesia. He was able to show that a gas was coming off of the magnesia-alba later as the “fixed air” was released because the magnesia-alba was lighter.¹² Physicians like Black were involved in important experiments prior to Chemical

¹¹Levere, *Transforming Matter: A History of Chemistry from Alchemy to the Buckyball* (Baltimore: Johns Hopkins Press, 2001), 42, 54-56, 75-76, and 123.

¹²Henry Marshall Leicester and Herbert S. Klickstein, *A Source Book in Chemistry, 1400-1900* (Cambridge, Mass: Harvard University Press, 1963), 80-92, and Levere, *Transforming Matter*, 54-56.

Revolution. The search to understand solvents, calculi, and urine would continue through the work of Lavoisier and his peers.

In Lavoisier's *Elements of Chemistry*, Lavoisier analyzed the composition of urine, among other substances. However, in Kerr's 1802 edition, the translator included a discussion of bladder stones and biliary stones. Kerr was inspired by the decomposition of substances into elements and applied that form of analysis to the fluids and products of the animal body (like blood, milk, cheese, and bile).¹³ Kerr noted the success of chemical analysis in regards to biliary concretions: "By chemical analysis, they [biliary concretions] afford resin of bile, benzoic acid, and small quantities of lime, soda, and neutral salts, having a basis of ammonia."¹⁴ Lavoisier's chemistry resonated with physicians like Kerr because it showed them that they were on the cusp of a breakthrough, of understanding a mysterious disease.¹⁵ Stones as a phenomena were now something that could be at least measured.

After Lavoisier was executed in 1794 during the French Revolution, many chemists in Britain and France continued his work. Antoine Francois, Comte de Fourcroy and Louis Nicolas Vauquelin performed chemical analysis on human urine in order to determine the cause of stones.¹⁶ In Britain George Pearson translated Lavoisier's work into English, and also worked on the chemical analysis of urine. He published an analysis

¹³Antoine Laurent Lavoisier, *Elements of Chemistry*, trans. by Robert Kerr (Edinburgh: W. Creech, 1802), 214-216

¹⁴Lavoisier, *Elements of Chemistry*, 214.

¹⁵Lavoisier, *Elements of Chemistry*, 214.

¹⁶ Leicester and Klickstein, *A Source Book in Chemistry, 1400-1900*.

of urinary concretions in the *Philosophical Transactions*.¹⁷ He found that concretions could cause both urinary and arthritic problems. He was a physician-chemist that inspired the careful analysis of concretions with chemical reagents. William Hyde Wollaston, a Copley Medal winner and vice president of the Royal Society, inspired a generation of analyses of concretions found in the body. Wollaston laid out chemical categories of concretions and extended his analysis to gout. Many of the characters highlighted in this dissertation praised Wollaston's work and claimed that Wollaston's work served as an inspiration for their work.¹⁸

1.4 Humoral Pathology

Humoral pathology was based on a doctrine of medical theory and practice that originated in the works of Hippocrates and Galen.¹⁹ The ideas of the four humors, which included black bile, yellow bile, phlegm, and blood, were later paired with temperaments by Persian physicians, like Ibn Sina. These temperaments included: melancholic,

¹⁷George Pearson, "Experiments and Observations, Tending to Show the Composition and Properties of Urinary Concretions," *Philosophical Transactions of the Royal Society* 88 (1798): 15-46. Characters in this dissertation also often cited his work on pus: "Observations and Experiments on Pus" *Philosophical Transactions of the Royal Society* 100 (1810): 294-317. See also N.G. Coley, "George Pearson MD, FRS (1751-1828): 'The Greatest Chemist in England?'" *Notes and Records of the Royal Society* 57 (2003): 161-175.

¹⁸See the Marcet's *Essay*

¹⁹Hippocrates, *Hippocratic Writings*, trans. J. Chadwick and W. N. Mann (New York: Penguin Books, 1978) and also Siraisi, Nancy G. *Communities of Learned Experience Epistolary Medicine in the Renaissance*. (Baltimore: Johns Hopkins University Press, 2013 [electronic edition]) and *History, Medicine, and the Traditions of Renaissance Learning* (Ann Arbor: University of Michigan Press, 2007), and Roy Porter, *The Greatest Benefit to Mankind: A Medical History of Humanity* (New York: W.W. Norton, 1997).

choleric, phlegmatic, and sanguine. These humors were also linked to qualities and seasons. There was also a system of chemistry linked to humoral pathology, which included the four elements. The four elements included: earth, fire, water, and air. The four elements from Greece were linked to a corresponding humor. Blood was linked to air, yellow bile was linked to fire, black bile was linked to earth, and phlegm was linked to water.²⁰ However, one of the reasons why humoral theory was overturned by more anatomically-based theories of disease was that the chemical ideas underlying humoral pathology were abandoned for newer chemical ideas in the sixteenth century. One point of departure was the work of iatrochemists, like Paracelsus, advocating for a system of chemistry that broke substances into different salts and earths. Paracelsus was also aggressively dismissive against any ancient authorities of medicine.²¹

Physicians conceived that diseases were linked to an imbalance of or an excess of one humor or another; therapies consisted of rebalancing the humors, for example by bleeding and emetics. The ideas of balances and temperaments from the original medical theory remained, even though the chemical system that originally supported it did not survive.²² Physicians intervened for fever by drawing blood off to cool the body down. They inspected the urine of patients, as well as feces, to determine what was going on inside the body. Discolored feces or odd-smelling urine could signal internal disease and

²⁰Nancy G. Siraisi, *Medieval and Early Renaissance Medicine: An Introduction to Knowledge and Practice* (Chicago: University of Chicago Press, 1990)

²¹Siraisi, *Medieval and Early Renaissance Medicine*

²²Walter Pagel, *From Paracelsus to Van Helmont* (London: Variorum Reprints, 1986), *Paracelsus: An Introduction to Philosophical Medicine in the Era of the Renaissance*, 2nd Edition (Basel, Switzerland: Karger, 1982), and Bruce T. Moran.

distress.²³ Doctors, even at the turn of the eighteenth century, were “breathing veins” (or bleeding patients with a lancet) to treat all kinds of health issues.²⁴ At the turn of the nineteenth century physicians were still using humorally-based interventions into the body and saw the new chemistry as actually further justifying their practice. Theories of medicine based solely on anatomical ideas were thought to be impractical or therapeutically useless. Even physicians who were skeptical of humoral pathology had to have an accounting of how the body’s fluids operated. Neo-humoral pathologists thought principally that humoral pathology was *useful* and offered explanations of diseases and means of intervention into disease that no other medical theory did.

1.5 Histories of Science, Objects, and Medical Practice

In this dissertation, I argue that morbid concretions, or stones, function as boundary objects between communities in Philadelphia, Charleston, and London at the turn of the nineteenth century. The concept of boundary objects was first introduced by Susan Leigh Star and James R. Griesemer in their 1989 article “Institutional Ecology, ‘Transitions’ and Boundary Objects: Amateurs and Professionals in Berkeley’s Museum

²³Lester S. King, *The Road to Medical Enlightenment: 1650-1695* (London: Macdonald, 1970), Susan C. Lawrence, *Charitable Knowledge: Hospital Pupils and Practitioners in Eighteenth-Century London* (Cambridge, UK: Cambridge University Press, 1996), Cunningham, Andrew and R. K. French, *The Medical Enlightenment of the Eighteenth Century* (Cambridge, UK: Cambridge University Press, 1990), Lester S. King, *The Medical World of the Eighteenth Century* (Chicago: University of Chicago Press, 1958), and Lester S. King, *Transformations in American Medicine: From Benjamin Rush to William Osler* (Baltimore: Johns Hopkins University Press, 1991).

²⁴There is a museum exhibit that represents this practice in the Chemical Heritage Foundation’s museum in Philadelphia, PA.

of Vertebrate Zoology, 1907-39.”²⁵ The authors point to a natural tension between disciplines and the need for generalization to facilitate conversation between different groups. Boundary objects serve as communication prompts between different groups.

Boundary objects are very specific. They are defined as, “objects which are both plastic enough to adapt to local needs and the constraints of several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual site use. These objects may be abstract or concrete.”²⁶ The authors generally describe the museum as being viewed by different actors as a place for ecology, an object for preservation, or product of amateur collection, or a site of economic value for a university.

Work with boundary objects often involves collaboration, translation, negotiation, debate, triangulation, and simplification between actors who need to reconcile different meanings of objects. The reconciliation of knowledge about boundary objects often leads to authority or status as gate keepers of knowledge. Many of the actors in this dissertation have to work creatively with other fields and translate their knowledge to diverse audiences. Stones mean different things to different groups, but they also spur their interactions.²⁷

²⁵Susan Leigh Star and James R. Griesemer, “Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39,” *Social Studies of Science* 19 (1989): 387-420. Star wrote a follow up to the growing body of literature: “This is Not a Boundary Object: Reflections on the Origin of a Concept,” *Science, Technology, and Human Values* 35 (2010): 601-617.

²⁶Star and Griesemer, “Institutional Ecology, ‘Translations’ and Boundary Objects: Amateurs and Professionals in Berkeley’s Museum of Vertebrate Zoology, 1907-1939” *Social Studies of Science* 19 (1989): 393.

²⁷Star and Griesemer, “Institutional Ecology,” 388-389

For nineteenth century scientists and physicians morbid concretions fit Starr and Griesemer's definition of boundary objects. They meant different things to different characters in the dissertation. For physicians they were bodily products, causing the blockage of the body's fluids which, in turn, caused disease. Stones represented a problem that some physicians considered explainable and treatable using theories and practices in humoral pathology. Chemists saw stones as objects that Lavoisier's analytical chemistry could be used on. Surgeons viewed stones as objects that needed to be removed and that spurred collaboration with other medical practitioners. Museum curators collected them in order to compare and categorize them to build knowledge about them. Of course, members of these groups also overlapped.

John Pickstone offers a different interpretation of material objects in his *Ways of Knowing*. Pickstone asserts that there are three ways of knowing: through natural history, analysis, and experimentation.²⁸ The natural historical way of knowing is about classifying information or items, while analyzing is about breaking things down into their elements, and experimenting is attempting to control and create phenomena. Pickstone argues that science, technology, and medicine can be understood using these three ways of knowing, and that "making and "work" is linked to ways of knowing. In the case of medicine, ways of knowing contribute to "mending."²⁹ In the case of calculi, many of the actors in this dissertation use the three ways of knowing that Pickstone describes. Calculi fit into a similar narrative. Physicians have to classify the stone using natural historical typologies in order to organize and understand them. Medico-Chemists analyze and

²⁸Pickstone, *Ways of Knowing*, 1-4

²⁹Pickstone, *Ways of Knowing*, 3.

experiment with stones order to classify and understand why they occur. All three ways of knowing focus on the mending aspect, or the therapeutic goals of the physicians and surgeons, interested in studying stones of the body.

In *The Therapeutic Perspective* John Harley Warner pointed out that physicians often embraced science before they understood its therapeutic benefits. In the case of American medicine, Warner argued, this was especially true. What counted as science versus what counted as science to physicians was a shifting target. Warner railed against both Whig historians and those who cast science out of narratives in order to exclusively pursue social and professional themes.³⁰ Though he admitted it was impossible to construct a master narrative of history, Warner calls for complex narratives in medicine. Historians of medicine must be ready to deal with issues that come up in their work, and not be myopic in terms of addressing one historical issue or perspective. He cautioned that, “The task is to supplant an either-or approach with a readiness to acknowledge that we are looking *either* at one aspect *or* another of a more complex issue.”³¹ Warner

³⁰John Harley Warner, “Grand Narrative and Its Discontents: Medical History and the Social Transformation of American Medicine,” *Journal of Health Politics, Policy and Law* 29 (2004): 757-780. Also see *The Therapeutic Perspective: Medical Practice, Knowledge, and Identity in America, 1820-1885* (Cambridge, Mass: Harvard University Press, 1986), *Against the Spirit of System: The French Impulse in Nineteenth-Century American Medicine*. (Princeton, N.J.: Princeton University Press, 1998), “Ideals of Science and Their Discontents in Late Nineteenth-Century American Medicine,” *Isis* 82 (1991): 454-478, “Science in Medicine,” *Osiris* 1 (1985): 37-58, “The History of Science and the Sciences of Medicine,” *Osiris* 10 (1995): 164-193, and “Power, Conflict, and Identity in Mid-Nineteenth-Century American Medicine: Therapeutic Change at the Commercial Hospital in Cincinnati” *The Journal of American History* 73 (1987): 934-956. Also see: Adrian Wilson and T. G. Ashplant, “Whig History and Present-Centered History” *The Historical Journal* 31 (1988), 1-16, and Herbert Butterfield, *The Whig Interpretation of History* (New York, Penguin, 1973 reprint of 1931 edition), and Michael Worboys, “Practice and Science of Medicine in the Nineteenth Century,” *Isis* 102 (2011): 109-115.

concludes that, “Once we are free from looking for the *one* meaning of science in medicine, then the work of the past two decades appears not merely as a fragmentation of perspectives in need of integration, but as a springboard to posing more refined questions.”³²

The revival of humoral pathology in this dissertation by medico-chemists and surgeons ignoring the latest scientific theories but embracing them as good evidence. Humoral pathology returned to practice medico-chemists making very sophisticated arguments. Warner argued against presentism in the history of medicine. He was extremely critical of historians of medicine who were very present minded and privileging scientific as the improvement of medicine: “‘Science’ in American medicine was never monolithic. It meant different things at various times and to assorted social groups, including the varieties of medical practitioners...a self-conscious awareness of the multiplicity of the meanings of science in medicine is one of the most promising guides to research that can illuminate the place and function of science in medicine and of medical science in American culture.”³³ Arguably humoral pathology could be thought of as science in the nineteenth century. Many medico-chemists in this dissertation thought of humoral pathology as a science. Changes in practice could have more to do with squabbles over authority than best practice, as in Lawrence Principe’s book *The Secrets of Alchemy*.³⁴

³¹Warner, “The History of Science and the Sciences of Medicine,” 177.

³²Warner, “The History of Science and the Sciences of Medicine 178.

³³Warner, “Science in Medicine,” 50.

This dissertation takes place nearly half century before the development and acceptance of germ theory.³⁵ But the themes and practices here are related to that later advance. Germs were discovered through the close analysis of fluids. Chemists who were interested in urology, like Golding Bird, transitioned from the careful analysis of urinary stones to describing their crystalline makeup.³⁶ Golding exemplifies a shift in medicine thinking from a holistic interpretation of the body to a reductionist one, reducing disease to its microscopic, cellular, and chemical elements in the late nineteenth century. This study is situated in one of the last periods where the patient and the physician, as Charles Rosenberg argues, see therapy as successful because they can literally see it work.³⁷ This study reveals the coupling of an ancient theory of disease with analytical tools that the actors in the study viewed as modern. Rosenberg astutely points out that changes in science do not happen overnight, and in this study older medical theories were made newly viable through new scientific ideas.³⁸

³⁴Lawrence Principe, *The Secrets of Alchemy* (Chicago: University of Chicago Press, 2013).

³⁵Michael Worboys, *Spreading Germs: Diseases, Theories, and Medical Practice in Britain, 1865-1900* (Cambridge, UK: Cambridge University Press, 2000).

³⁶Golding Bird, *Urinary Deposits: Their Diagnosis, Pathology, and Therapeutically Indications* (Philadelphia: Blanchard & Lea, 1859). This was a new edition for America and the fifth edition from London.

³⁷Charles Rosenberg, "The Therapeutic Revolution: Medicine, Meaning, and Social Change in Nineteenth-Century America," in *The Therapeutic Revolution: Essays in the Social History of American Medicine*, eds. Morris J. Vogel and Charles E. Rosenberg (Philadelphia: University of Pennsylvania Press, 1979), 3-27.

³⁸See note above.

A useful comment on the history of medicine comes from the historian of science, Andrew J. Lewis, who explores the transition of natural history practitioners from amateurs to reasoned professionals. He points out that Americans openly questioned the purpose of natural history, explaining:

Ordinary Americans and naturalists themselves were asking similar questions: Just what was natural history for? What exactly did it do? Who should be considered a naturalist and why? Early republic Americans agreed that natural history could catalog and describe nature, but, as practiced by an orthodox elite in the United States, it imposed limitations on theorizing about nature's cases and emphasized the assemble of individual facts.³⁹

Lewis described these transitions in natural history as a change from a Democracy of Facts to an Empire of Reason. Medicine, in Charleston, Philadelphia, and London, was very much a Democracy of Facts. Membership in medical societies and other intellectual bodies was not limited to experts, or even medical practitioners. Communication in the Democracy of Facts functioned through the printed word, such as in journals, pamphlets, books, and published speeches, thus links members across long distances.

The professionalization of medicine in the nineteenth century is parallel to Lewis's Empire of Reason. The professionalization of medicine has been a well-explored and debated question in the history of medicine.⁴⁰ John Harley Warner argued

³⁹Andrew J. Lewis, *A Democracy of Facts: Natural History in the Early Republic* (Philadelphia: University of Pennsylvania Press, 2011), 1.

⁴⁰Paul Starr, *The Social Transformation of American Medicine* (New York: Basic Books, 1982), Thomas Neville Bonner, *Becoming a Physician: Medical Education in Britain, France, Germany, and the United States, 1750-1945* (New York: Oxford University Press, 1995), GH Brieger, "The Historiography of Medicine in America,"

that professionalization in American medicine occurred not through power grabs and nefarious means, but through a desire to transform and establish a medical culture that imitated the clinics of Paris.⁴¹ Antebellum American physicians did not simply import French ideas about physiology and bedside interventions, but made “...highly selective constructions that made the Paris School stand for a celebration of empiricism and animus against rationalistic systems.”⁴² Medico-chemists in this dissertation used a selective construction of humoral pathology from what they knew from the history of humoral medicine, and then used the new analytical chemistry to support it.

Philip Rieder and Micheline Louis-Courvoisier argue that aspiring physicians sought to capture some of the medical marketplace by advertising their practice as informed by Enlightenment science. They wanted to construct an identity for themselves that was rooted in not only philosophical knowledge, but also gentlemanly culture.⁴³ This

Medicina Nei Secoli 10 (1998): 189-207, S. E. D. Shortt, “Physicians, Science, and Status: Issues in the Professionalization of Anglo-American Medicine in the Nineteenth Century,” *Medical History* 27 (1983): 51-68, Michael Brown, *Performing Medicine: Medical Culture and Identity in Provincial England, ca. 176-1850* (Manchester: Manchester University Press, 2011), and Eliot Freidson, *Profession of Medicine: A Study of the Sociology of Applied Knowledge* (Chicago: University of Chicago Press, 1988). Also see the work of John Harley Warner, especially his two monographs mentioned in this introduction. The debate regarding the professionalization of medicine is far from settled.

⁴¹Warner, *Against the Spirit of System*, Michel Foucault, *The Birth of the Clinic: An Archaeology of Medical Perception*, trans. Alan Sheridan (New York: Vintage Books, 1994). Erwin Heinz Ackerknecht, *Medicine at the Paris Hospital, 1794-1848* (Baltimore: Johns Hopkins Press, 1967).

⁴²Warner, *Against the Spirit*, 4.

⁴³Philip Rieder and Micheline Louis-Courvoisier, “Enlightened Physicians: Setting Out on an Elite Academic Career in the Second Half of the Eighteenth Century,” *Bulletin of the History of Medicine* 84 (2010): 578-606.

dissertation focuses a period in which professionalization was not yet on every practitioners' radar, but building a culture of chemical knowledge, was a goal for some physicians and some surgeons. This dissertation takes place when science was part of gentlemanly culture.⁴⁴ Many physicians had enough social capital, wealth, institutional support, royal favor, or status to minimize their interest in consolidating professional power.

1.6 Historiographical Contributions to the History of Chemistry

The history of chemistry is generally periodized into alchemy, iatrochemistry, the Chemical Revolution, and examinations of recent chemical practice. The term “Chemical Revolution” is troublesome because it does not take into account the preceding chemical work prior to Lavoisier's chemical practice. Periodization obscures the continuity of ideas.

Principe's *Secrets of Alchemy* critiques the periodization of alchemy.⁴⁵ There are three eras (or the “Standard periodization”) commonly associated with alchemy. These periods are: Greco-Egyptian, Arabic, and Latin European. He argued for a fourth era that occurred in the eighteenth century to present, as there were several “revivals” of alchemy. Periodization is problematic because “...revealing the surprising (and surprisingly late)

⁴⁴Steven Shapin, *The Scientific Life: A Moral History of a Late Modern Vocation* (Chicago: University of Chicago Press, 2008) and *Never Pure: Historical Studies of Science As It Was Produced by People With Bodies* (Baltimore: Johns Hopkins University Press, 2010).

⁴⁵Lawrence M. Principe, ed. *New Narratives in Eighteenth-Century Chemistry: Contributions from the First Francis Bacon Workshop, 21-23 April 2005, California Institute of Technology, Pasadena, California (Archimedes)* (New York: Springer, 2007).

origins of many ideas about alchemy widely held today is sufficiently important to warrant violating chronological order.”⁴⁶ It is extremely difficult to compartmentalize historical phenomena into standard chronological periods.

John G. McEvoy, in his 2010 study, *The Historiography of the Chemical Revolution*, sketches the historiographical complexities of interpreting the Chemical Revolution and the actors involved.⁴⁷ Historians often undermine the idea that modern chemistry represents a complete break from the past. The tensions McEvoy highlights are related to these two questions:

Did this act of parturition, which brought forth modern chemistry, hinge upon an experimental discovery, a theoretical insight, a methodological reform, an epistemological reorientation, or an ontological purification? Or did it involve the coming of reason to an arcane corner of experimental knowledge, or merely the machination of local sociological forces?⁴⁸

McEvoy surveys the historiography of the Chemical Revolution and new perspectives from the fields of history, philosophy, and sociology of science.

This study argues that the new chemistry of the Chemical Revolution was used to advance and revisit older ideas of medical practice, specifically as a substitute for the

⁴⁶Principe, *Secrets of Alchemy*, 4-5.

⁴⁷John G. McEvoy, *The Historiography of the Chemical Revolution: Patterns of Interpretation in the History of Science* (London and Brookfield, Vt.: Pickering & Chatto, 2010). Also, see Seymour H. Mauskopf, “Thomas S. Kuhn and the Chemical Revolution,” *Historical Studies in the Natural Sciences* 42 (2012): 551-556, Frederic L. Holmes, “The Boundaries of Lavoisier’s Chemical Revolution,” *Revue D’Histoire des Sciences* 48 (1995): 9-48, and John G. McEvoy, “The Chemical Revolution in Context,” *Eighteenth Century* 33 (1992): 198-216.

⁴⁸McEvoy, *The Historiography of the Chemical Revolution*, 1.

four element chemistry that had supported ancient humoral medicine. McEvoy's metaphor for the appropriation of the chemistry of the late eighteenth century that was used to explain questions related to blockages is that it is like putting "old wine into new bottles." The Chemical Revolution was multi-faceted and applied to different questions, like the chemical processes of life.

Frederic L. Holmes argues that there was a Chemical Revolution: "If revolutions really occur in science, then the chemical revolution identified with Antoine Lavoisier is a classic example."⁴⁹ Thomas Kuhn also used the Chemical Revolution as a key example of a paradigm shift in his *The Structures of Scientific Revolutions*.⁵⁰ The Chemical Revolution, in a general sense, was a signal event in the history of science and medicine. Using the term Chemical Revolution captures the excitement and optimism of medico-chemists who were conducting research. Characters in this dissertation felt that they were doing analytical work that was revolutionary.

Holmes also explores the dependence of the chemical revolution on the study of life processes, like respiration and digestion, in *Lavoisier and the Chemistry of Life*. Holmes argues that Lavoisier's work was intimately tied with the chemical investigation into the life processes of plants and animals.⁵¹ Lavoisier investigated pneumatic chemistry in order to get an insight into the "animal economy." I argue in this dissertation, that chemists applied Lavoisier's investigative methods of decomposition to

⁴⁹ Holmes, "The Boundaries of Lavoisier's Chemical Revolution," 9.

⁵⁰ Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962).

⁵¹ Holmes, *Lavoisier and the Chemistry of Life*.

the body's fluids and that they were perpetuators of the Chemical Revolution and users of Lavoisier's methodology. In short, a medical aspect needs to be written into the history of the Chemical Revolution.

Lavoisier's new chemistry provided new methods of examination that could be readily applied to the concretions of the body and the body's fluids. In this study, as medico-chemists became more adept at applying quantitative methods of measurement, they found that the body was like a hydraulic system. The body could be thought of as system of pipes, which had pressures and worked well when flowing uninterrupted. Medico-chemists thought that chemical knowledge about the makeup of concretions and the ideal composition of the body's fluids would provide them with insights into how to rid the body of disease. The Chemical Revolution facilitated moves by actors in this dissertation to revive humoral pathology.

Chemistry, especially the medico-chemistry discussed in this dissertation, was further shaped by the value placed on quantifying during the Enlightenment. *The Quantifying Spirit in the Eighteenth Century*, edited by Tore Frangsmyr, J. L. Heilbron, and Robin E. Rider, situates the Enlightenment as a time when quantitative information from instrumentation grew significantly in both quantity and quality.⁵² Fields like meteorology exploded with quantitative information, or "rampaging numbers."⁵³ The Royal Society desired to measure everything it could in regards to the weather, and often

⁵²Tore Frangsmyr, J. L. Heilbron, and Robin E. Rider, eds. *The Quantifying Spirit in the Eighteenth Century* (Berkeley: University of California Press, 1990).

⁵³J. L. Heilbron, "Introductory Essay," 9.

used networks to accomplish this task across the globe. Tables of numbers appeared through correspondence and close measurements with instruments.⁵⁴

Governments also valued quantification.⁵⁵ For instance, the population of a kingdom was not clearly known until late in the eighteenth century. The number was thought to be important in assessing the strength and health of a nation state. Heilbron gives us the following analogy between quantification and population: The population was instrumental, and its reading an indicator of health or decline. Lavoisier and the intendant des Poemmelles likened measuring population to a thermometer, “the thermometer of public prosperity,” a pleasant image since, in French usage of the time, “temperature” was to the air what “temperament” was to the bodily humors, that is, an indicator of condition or temper, and climate was a recognized factor in public health.⁵⁶

The spirit of quantification affected the way philosophes saw the world and their craft. To improve knowledge about population, intellectuals could perform more intricate measurements and calculations, for example a detailed census, and they thought they could improve their knowledge through more careful numbers. Analytical chemistry applied to stones was no different; it was a deliberate move towards quantification of the objects and their constituent parts in order to rate one’s health and solve problems.

⁵⁴J. L. Heilbron, “Introductory Essay,” 10-12.

⁵⁵J. L. Heilbron, “Introductory Essay,” 10.

⁵⁶J. L. Heilbron, “Introductory Essay,” 11.

Finally, America, as well as Europe, was part of the *Longue Durée* of the Enlightenment.⁵⁷ The editors of the *Sciences in Enlightened Europe* criticized scholarship for its dominant view that the Enlightenment was construed with too limited a geographicality, “Too often, the Enlightenment has been seen as a purely mental construct, granted a geography and a temporality only insofar as it began in a certain place and diffused elsewhere.”⁵⁸ The Enlightenment impulse to quantify and collect was both practiced and communicated back to Europe. Chemical knowledge itself was communicated to many different types of people in many different places. In *Science as Public Culture*, Jan Golinski writes that “The image of chemical knowledge as a component of general enlightenment also inspired its communication at lower levels of society.”⁵⁹ It is unsurprising then that middle and upper class physicians saw chemistry and quantification as tools of the Enlightenment and were well versed in its ideas. According to Golinski, Humphrey Davy, a famous chemist and president of the Royal Society, was able to promote chemistry, “Middleclass audiences clearly appreciated his

⁵⁷Alexandra Oleson and Sanborn C. Brown, eds. *The Pursuit of Knowledge in the Early Republic: American Scientific and Learned Societies from Colonial Times to the Civil War* (Baltimore: The Johns Hopkins University Press, 1976), Joyce E. Chaplin, *An Anxious Pursuit: Agricultural Innovation and Modernity in the Lower South, 1730-1815* (Chapel Hill: University of North Carolina Press, 1993), Joyce E. Chaplin, *Subject Matter: Technology, the Body, and Science on the Anglo-American Frontier, 1500-1676* (Cambridge, Mass: Harvard University Press, 2001). For the “Longue Durée” see Fernand Braudel, *The Mediterranean and the Mediterranean World in the Age of Philip II* (New York: Harper & Row, 1972). For the New World’s influence of Europe, see Alix Cooper, *Inventing the Indigenous: Local Knowledge and Natural History in Early Modern Europe* (Cambridge: Cambridge University Press, 2007).

⁵⁸William Clark, Jan Golinski, and Simon Schaffer, ed. *The Sciences in Enlightened Europe* (Chicago: University of Chicago Press, 1999), 31.

⁵⁹Jan Golinski, *Science as Public Culture: Chemistry and Enlightenment in Britain, 1760-1820* (Cambridge, UK: Cambridge University Press, 1992) 242.

assurances that the progress promised by chemistry posed no threat to the social order.”⁶⁰ Chemistry was exciting and in line with Enlightenment excitement of possessing “true” knowledge and rational progress.⁶¹

Andrew Cunningham wrote that in the Enlightenment there was “...a renunciation of authorities: Galen, venerated as the prime medical authority since antiquity, now ceased to be held in esteem. Instead, every man became his own authority, and there was a proliferation of people offering new medical ‘systems.’” This dissertation questions some of the radical changes in the Enlightenment. Though theories might be destroyed by competing ideas in a general sense, shards of their influence continue and persist into new theories. Though ancient authorities like Galen, Hippocrates, and other classical physicians were relegated to the past by the Enlightenment, their influence continued in medicine. New scientific methods of investigations are also re-applied to fit interpretations of older theories. Cunningham described the Enlightenment as characterized as that of “Progress” and “Reason.”⁶² Humoral pathology’s chemical revival in the late Enlightenment complicates our notions of reason and progress in medicine.

⁶⁰Golinski, *Science as Public Culture*, 242.

⁶¹David Cahan, ed. *From Natural Philosophy to the Sciences* (Chicago: The University of Chicago Press, 2003).

⁶²Andrew Cunningham, “Introduction,” in *The Medical Enlightenment of the Eighteenth Century* edited by Andrew Cunningham and Roger French (Cambridge, UK: Cambridge University Press, 1990), 1-3.

1.7 Chapter Overview

This opening chapter serves as an introduction to the themes of the dissertation. The second chapter explores the chemical origins of American medicine through the life of Benjamin Rush. Rush was educated under Joseph Black and other prominent British and Scottish chemists while abroad. He returned to America to become professor of chemistry at the University of Pennsylvania. Rush applied chemical analysis to problems related to the fluids of the body. Chemistry augmented his belief in a humoral pathology. Bloodletting and diseases related to the fluids of the body were perfected through a more intensive chemical knowledge. An ardent abolitionist, Rush used chemistry and humoral pathology to argue that Africans were not from an inferior race but were, in fact, sick Caucasians. He explored the chemical and fluid-based nature of other diseases including cholera and invasive agents like worms during the American Revolution. Rush used chemistry to carefully measure a key fluid of the body, blood, and carefully establish proper amounts patients needed to be bled in order to re-establish health. This chapter seeks to explain the merging of chemistry and humoral pathology in the early Republic by studying one of its most well-known figures.

The third chapter explores in greater detail the argument for the integration of chemistry into medical practice. The life of Thomas Cooper and his *Discourse on the Connexion Between Medicine and Chemistry* are examined to understand early nineteenth century physicians' justifications of the integration of chemistry into medicine. It is also examined to understand how such an integration re-established humoral pathology as a viable part of medical practice. Cooper was a British chemist, physician, and political ideologue who fled Britain because of persecution due to his support for the French

Revolution.⁶³ Cooper saw the fluids of the body as the vehicle that conveyed diseases, including yellow fever. He also saw nature and its related miasmas as an active agent in causing fluid blockages that led to disease. Cooper's career as a chemist and a physician collapsed under his controversial religious and political agenda. The third chapter explores the inter-relatedness of chemistry, medicine, and humoral pathology and the influence of British practitioners on American medicine.

The fourth chapter explores many of the themes of the first two chapters, but in a clinical setting in the American backcountry. Edward Darrell Smith was a physician who decided to become a chemist after treating patients suffering from painful cases of urinary calculi. Smith and other urologists at the turn of the nineteenth century faced a changing world in medicine. Underlying theories, professional attitudes, and structures were in flux. Urologists carefully measured the body's fluids in the hopes that they could understand the chemistry of urine and understand what caused urinary stones. Physicians like Smith hoped that by measuring the acidity of urine and the chemical composition of stones they could treat or even prevent stones. Smith's chemical research and case studies encouraged him to call for revisions in humoral pathology, highlighting its usefulness in medical practice. The chapter discussing Edward Darrell Smith's medical practices charts the persistence of humoral theory and his treatments due to chemistry.

The fifth chapter builds on the British practice of medico-chemistry in examining two subjects more closely. First, it explores the work of Alexander Marcet and his desire to improve lithotomies through the improvement of chemical knowledge about the stone.

⁶³ Dumas Malone, *The Public Life of Thomas Cooper, 1783-1839* (New Haven: Yale University Press, 1926).

Marcet published the culmination of his experiences as a physician at Guy's Hospital and work as a chemist in *An Essay on the Chemical History and Medical Treatment of Calculous Disorders*. The *Essay* not only chemically categorized and organized urinary and other calculi in the body by their chemical composition but it also explained to physicians how to test, identify, and chemically treat stones in the body. The second part of this chapter focuses on the interest and contributions of surgeons to the chemical analysis of calculi in the body. The chapter focuses on the close friendship between Alexander Marcet and Astley Cooper, a relationship made possible by the role of bodily stones as boundary objects. Cooper was a famous surgeon and leader of the Royal College of Surgeons. Surgeons were interested in the chemical analysis of stones in order to improve lithotomies, or surgical procedures to remove calculi from the body, since physicians like Marcet pointed out how risky the procedure was. Even Hippocrates includes a caution and prohibition to physicians concerning cutting for the stone: "I will not use the knife, not even on suffers from the stone, but will withdraw in favor of such men as are engaged in this work."⁶⁴ Cooper provided the specimens that Marcet analyzed and was involved in the discovery of new chemical typologies of stones. Surgeons, as well as physicians like Marcet, included references to humoral pathology and its related ideas in their published works. This chapter highlights the importance of surgery and collaboration in the chemical study of urinary stones.

The sixth and final chapter explores the societies in which questions about the fluids of the body and morbid concretions were exchanged. This chapter aims to give the

⁶⁴Patrick Guinan, *Hippocrates Is Not Dead: An Anthology of Hippocratic Readings* (Bloomington, In: AuthorHouse, 2011), 20.

reader the context to the long-ranging geographies of the morbid concretions and bodily fluids. The societies examined are grouped by their geographical locations: Philadelphia, Charleston, and London. In Philadelphia, the Chemical Society of Philadelphia [or Chymical Society of Philadelphia] is explored through the works of its early leadership by Felix Pascalis, a French immigrant to Philadelphia who, like Rush, believed that the changing of the body's fluids could produce skin changes and who saw disease as fluid-based. The Columbian Society is also examined, since one its leaders, George F. Lehman produced work on biliary stones. In Charleston, the Literary and Philosophical Society was interested in chemistry as a way to bring modernity into a society thought to be lacking in intellectual life. Several physicians were members and even non-physicians were interested in chemistry and published literature about pulmonary stones.

In London, some of the actors already mentioned, including Alexander Marcet, Astley Cooper, and John Bostock, were involved in establishing the Medico-Chirurgical Society, the forerunner to the Royal Society of Medicine. *The Medico-Chirurgical Transactions* contained published papers read before the society. Many of the topics of these papers included concretions, humoral pathology, and measurements of the fluids of the body. Through its publication the Society was able to be an active contributor in medical debates, as many of its publications are mentioned in previous chapters. The society was interested in recording chemical information about extracted calculi as a means to determining a link between populations with high rates of lithotomies. John Yelloly, another founder of the Society, published a collection of analytical chemical works about stones and attempted to correlate statistical information with chemical information.

The first curator at the Royal College of Surgeons, William Clift, consolidated and organized the larger collection of stones from famous surgeons like William Blizard and John Hunter. Clift attempted to publish detailed catalogues of the college's holdings. He, along with Thomas Taylor, and others published *A Descriptive and Illustrated Catalogue of the Calculi and other Animal Concretions Contained in the Museum of the Royal College of Surgeons in London* (1838-1842). The catalogue consisted of three volumes, with a typology of each stone, along with its constituent chemical-natural history. The chemical analysis of each stone was outsourced through Clift's network of chemist-collaborators. The systematization of chemical knowledge about the stones of the body comes through collaboration between surgery, chemistry, and medicine.

This dissertation argues that bodily calculi are boundary objects. They were discussed by different occupations, such as medicine, chemistry, and surgery, in order to understand why bodies produce calculi and what treatments would work well. Chemistry was used to measure the fluids of the body in order to determine their relationship to health and their role in producing calculi. Characters in this dissertation organized stones by their chemical makeup. The more chemical information that was collected about the body's fluids and the stones it produced, the more medico-chemists and surgeons looked to humoral theory to explain their findings. Treatments that were characteristic of humoral pathology were validated by analytical chemistry. This dissertation will study boundary object negotiations and collaborations regarding stones across three cities: London, Charleston, and Philadelphia.

CHAPTER 2
THE REPUBLIC OF MEDICINE:
BENJAMIN RUSH'S MEDICO-CHEMISTRY

2.1 Introduction

In 1812, the last year of his life, Benjamin Rush responded in writing to his nomination to the Royal Academy of Madrid, Spain. He retrospectively identified his public life and medical contributions with Sancho Panza, the main protagonist in Cervantes' seventeenth century novel *Don Quixote*. He begins: “Where said Sancho when he retired from Government (and was asked how he liked it) ‘Where are my shoes and stockin(gs?).[‘]’⁶⁵ Rush thought that a similar sentiment fit his public life in medicine, “Should a similar question be asked of a physician when he retires from public life, his answer should accord in indignation and contempt with that of Sancho’s. It should be ‘Where is my pestle, and mortar – where is my library – where is my pen and ink?’” Rush reflected on the virtue of the business of practice over the praise of the public, and the sentiment that a public figure never retires. He closes by exalting that the library, pestle, and pen and ink are, “...the only Sources of enjoyment and usefulness to a man who had once tasted of the pleasures of Service & Benevolence.”

⁶⁵1812 Benjamin Rush to Madrid Royal Society, Benjamin Rush Papers, David M. Rubenstein Rare Book & Manuscript Library, Duke University

Rush's interest in the analysis involved in medical practice never faded, and was a crucial part of his practice before retirement. He signed the letter with "Health, respect, and friendship, from your brother in the republic of Medicine."⁶⁶ The republic of medicine that Rush spoke of was built on shared theories regarding the chemical analysis of the fluids of the body.

In fourth volume of his *Medical Observations and Inquiries*, Rush argued that fevers and fluid irritations were linked, sometimes resulting from stones and the solids of the body. He wrote that, "The NEPHRITIC state of fever is often induced by calculi, but it frequently occurs in the gout, small-pox, and malignant states of fever."⁶⁷ Rush played a well-known role in the study and treatment of yellow fever. He explained the cause of fever through the putrefaction of vegetable matter and its effects on the fluids of the body. He cites chemists like Joseph Priestley and Joseph Black as agreeing with his chemical explanations of yellow fever. Rush's medical work serves as a bridge between older chemically-based understandings of diseases in the body and the turn of the nineteenth century's chemical analysis of the stones of the body. Humoral pathology is evident in his chemical work as well.

Rush's theory of humoral pathology built on chemical ideas from the seventeenth century, which investigated fluid blockages in the body through humoral pathology. In *Inventing Chemistry: Herman Boerhaave and the Reform of the Chemical Arts* John Powers discusses the importance of chemistry in medicine, and its cosmological

⁶⁶Benjamin Rush to Madrid Royal Society.

⁶⁷Benjamin Rush, *Medical Observations and Inquiries* (Philadelphia: Thomas Dobson, 1796), 171.

relationship to humoral pathology. The blockage of blood or other fluids of the body disrupted the health of the body. According to Powers, Boerhaave, an early eighteenth century physician and chemist, believed that, “The proper flow of the bodily fluids denoted the health and life of the organism. Retarded fluid flow in some part of the body caused illness, and a complete halt in all fluid flow indicated death.”⁶⁸ Boerhaave believed that illness came from irritability, or the spasm. Rush traveled to Europe to study chemistry under William Cullen, who placed similar importance on chemistry in medicine as Boerhaave, and on chemistry’s relationship to the humors. But Cullen departed from Boerhaave’s hydraulic, mechanistic, humoral pathology. Rush’s work was a combination of the two men’s, with his own additions.⁶⁹ Still, it is worth noting that Cullen, Boerhaave, and Rush were all committed practitioners of humoral pathology.⁷⁰

In this chapter I argue that Rush’s theories about irritability and the fluids of the body were based on chemistry and humoral pathology. Actual chemical practices were used to regulate the body’s fluids, by measuring the amount of blood removed from sick patients. Rush advocated the removal of filth from the city to avoid irritating the body’s fluids or create blockages. He hoped that epidemics like yellow fever could be prevented through the application of his chemically based ideas. Rush’s racial and political politics influenced his chemical understandings of the body, too. He thought that African slaves were not inferior per se, but were in actuality really sick white people, whose fluid

⁶⁸John Powers, *Inventing Chemistry: Herman Boerhaave and the Reform of the Chemical Arts* (Chicago: The University of Chicago Press, 2012), 109.

⁶⁹Powers, *Inventing Chemistry*.

⁷⁰Powers, *Inventing Chemistry*

imbalances caused their skin to darken. In order to heal Africans, the use of chemistry and fluid regulation promised an effective remedy. When reading Rush's work through a medico-chemical framework, even race can be seen as a disease related to the fluids of the body, and could be cured by using understandings from humoral pathology.

2.2 Climate, Race, and the Fluids of the Body

During the 1790s, the president of The College of New Jersey (later Princeton University) was interested in advocating for the equality of blacks and whites. Samuel Stanhope Smith wrote "An Essay on the Causes of the Variety of the Complexion and Figure in the Human Species," based on an oration to the American Philosophical Society in 1787.⁷¹ Smith later enlarged the edition in a second volume to address detractors and critics in 1810. The work, in the theme of humoral pathology, argued that climate drastically affected the fluids of the air and of the body, generating people of different skin colors.⁷²

Rush was extremely interested in Smith's work—he was both a chemist and an abolitionist. He summarized Smith's ideas about what causes people to appear to be

⁷¹Katy L. Chiles, *Transformable Race: Surprising Metamorphoses in the Literature of Early America* (New York: Oxford University Press, 2014), 17-18 and Bruce Dain, *A Hideous Monster of the Mind: American Race Theory in the Early Republic* (Cambridge: Harvard University Press, 2002), 41-42.

⁷²Samuel Stanhope Smith, *An Essay on the Causes of the Variety of Complexion and Figure in Human Species* (New Brunswick: J. Simpson and Co., Williams and Whiting, and L. Deare, 1810)

different colors: "...climate, diet, state of society, and diseases."⁷³ Rush mostly agreed with Smith's findings, but added to Smith's theory:

I admit the Doctor's facts, and reasoning as far as he has extended them, in the fullest manner. I shall only add to them a few observations which are intended to prove that the color and figure of that part of our fellow creatures who are known by the epithet of negroes, are derived from a modification of the disease, which is known by the name of Leprosy.⁷⁴

Rush believed that black skin was indicative of disease. He cited a historical link between leprosy and diet. Heat was the cause of Africans' "bilious fevers" and their "savage manners."⁷⁵ Rush implied that heat and diet were the main causes of leprosy in Africa. Natural elements influenced constitutions and caused dark skin. Physicians had observed leprosy to cause the darkening of the skin. Rush cited an account that originated from Arabians, called "black albaras," where, "The Skin becomes black, thick and greasy.— There are neither pustules, nor turbercles, nor scales, or any thing out of the way of the skin."⁷⁶ The darkening skin was the internalizing of the external symptoms.⁷⁷

⁷³Benjamin Rush, "Observations to Favour a Supposition that the Black Color (As It is Called) of the Negroes is Derived from the Leprosy," *Transactions of the American Philosophical Association* 4 (1799): 289-297. This quote came from page 289.

⁷⁴Rush, "Observations to Favour a Supposition," 289.

⁷⁵Rush, "Observations to Favour a Supposition," 289.

⁷⁶ Rush, "Observations to Favour a Supposition," 290.

⁷⁷Edward Darrell Smith and later physicians in the early nineteenth century referred to similar situations as a "sympathy." See Lester King *Transformations*.

Rush consulted the Bible, specifically the Old Testament. He cited leprosy in the Old Testament causing a “preternatural whiteness” to victims of the disease.⁷⁸ He analogized this story to the present label of “*albanos*.”⁷⁹ Europeans exploring in the New World had regarded albinos as diseased and dangerous. Rush wondered if “*albanos*” suffered from leprosy and speculated on the skin conditions caused by leprosy. He wondered, “The leprosy sometimes appears with white and black spots blended together in every part of the body. A picture of a negro man in Virginia in whom this mixture of white and black had taken place, has been happily preserved by Mr. Peale [Charles Wilson Peale] in his museum.”⁸⁰

Rush considered the leprosy a constitutional problem. He wrote that the disease caused nerve problems, specifically a “morbid insensibility.”⁸¹ Leprosy robbed its victims of the ability to feel, and, according to Rush, witnesses had reported this symptom in “negros.”⁸² Doctor Moseley, whom Rush quoted, highlighted this difference:

[“]...They [Negroes] sleep sound in every disease, nor does any mental disturbance ever keep them awake. They bear surgical operations much better than white people, and what would be a cause of insupportable pain to a white

⁷⁸Rush, “Observations Intended to Favour a Supposition,” 290.

⁷⁹Rush, “Observations to Favour a Supposition,” 290.

⁸⁰Rush, “Observations to Favour a Supposition,” 292.

⁸¹Rush, “Observations to Favour a Supposition,” 292.

⁸²Rush, “Observations to Favour a Supposition,” 292.

man, a negro would almost disregard. I have amputated the legs of many negroes, who have held the upper part of the limb themselves.”⁸³

The constitution of Africans caused them to suffer from strong venereal “desires,” according to Rush.⁸⁴ Rush pointed to “big lip and flat nose” as symptoms of leprosy.⁸⁵ But he could not explain their “woolly heads” through climate or the other reasons mentioned in the beginning of the article and speculated it, too, was a symptom of leprosy. Rush compared the “wooly hair” in other hair-related afflictions like trichoma and plica polonica, which had been documented as occurring in the “Poles.”⁸⁶

However, how did the leprosy that affected Africans continue to persist if the disease ought to have lost its strength in subsequent generations? Attempting to answer the continuation question, Rush discussed the example that in Iceland the disease disappeared in the second and subsequent generations.⁸⁷ Rush wrote that, “Madness, and consumption in like manner are hereditary in many families, both of which occupy parts of the body, much more liable to change in successive generations, than the skin.”⁸⁸

⁸³Rush, “Observations to Favour a Supposition,” 292.

⁸⁴Rush, “Observations to Favour a Supposition,” 292.

⁸⁵ Rush, “Observations to Favour a Supposition,” 293.

⁸⁶ Rush, “Observations to Favour a Supposition,” 293.

⁸⁷He responds to his question by again, reaching back to a historical example. Like the current inhabitants of Scotland who suffer facial changes from their ancestors high cheek bones and red hair, and the Cretins who live in the Alps have tumors that occur in their throats because of previous ancestor’s help, so do Africans have dark skin because of their ancestors suffering from leprosy. See page 294.

⁸⁸Rush, “Observations to Favour a Supposition,” 294.

He anticipated criticism to this theory. One criticism was that leprosy is not an “infectious disorder.”⁸⁹ The criticism continued to wonder why people do not catch leprosy through contact and why dark skin was not spread to others. An example was a woman living in North Carolina whose features changed when she was living with and married to a “black husband.”⁹⁰

Rush claimed blacks were simply white people who had their skin darkened because of disease, though their skin was a different color, it did not indicate any other sort of poor health. Contouring ideas of different health, “...negroes are as healthy, and long lived as the white people. Local skin disease seldom affects the general health of the body, or the duration of human life.”⁹¹ Famous physicians had stated that leprosy did not diminish total lifespans.⁹²

There are extremely important social and economic ramifications and values that Rush was interested in promoting, He wrote,

...That all the claims of superiority of the whites over the blacks, on account of their color, are founded alike in ignorance and inhumanity. If the color of the negroes be the effect of a disease, instead of inviting us to tyrannise over them, it should entitle them to a double portion of our humanity, for disease all over the world has always been the signal for immediate and universal compassion.”⁹³

⁸⁹Rush, “Observations to Favour a Supposition,”294.

⁹⁰Another case in Pennsylvania further supports Rush’s theory. See page 294.

⁹¹Rush, “Observations to Favour a Supposition,” 294.

⁹²Rush, “Observations to Favour a Supposition,” 294.

⁹³Rush, “Observations to Favour a Supposition,” 295.

The system of white superiority was inhumane and lacking compassion. Rush asked rhetorically, "...Is the color of the negroes a disease?" And he responded to his question that, "...let science and humanity combine their efforts, and endeavour to discover a remedy for it. Nature has lately unfurled a banner upon this subject."⁹⁴ Rush then recounted instances where black people were cured of their dark skin.

The case of Henry Moss, a man who traveled the country, played into Rush's humoral explanation of the question at hand. Moss's skin had been gradually turning from black to a "fleshy white," for five years.⁹⁵ The wool of his head had "changed into hair."⁹⁶ Rush explained the color change in Moss in terms of fluids. He wrote that, "...In Henry Moss the color was first discharged from the skin in those places, on which there was most pressure from cloathing [sic], and most attrition from labor, as on the trunk of the body, and on his fingers."⁹⁷ Rush continued to describe the change in Moss by speaking of the "absorption" of the "colouring matter" in the area of the "rete mucosum."⁹⁸ He pointed out that,

...perhaps of the rete mucosum itself, for pressure and friction, it is well known, aid the absorbing action of the lymphatics in every part of the body. It is from the latter cause, that the palms of the hands of negro women who spend their lives at

⁹⁴Rush, "Observations to Favour a Supposition," 295.

⁹⁵Rush, "Observations to Favour a Supposition," 295.

⁹⁶Rush, "Observations to Favour a Supposition," 295-296.

⁹⁷Rush, "Observations to Favour a Supposition," 296.

⁹⁸Rush, "Observations to Favour a Supposition," 296. According to the *OED* it was a mucous layer below the skin.

a washing tub, are generally as fair as the palms of the hands in laboring white people.⁹⁹

Rush asserted that skin color was a fluid that washed off the body or was absorbed by it. Bleeding, then, was a sensible treatment for Africans' pathological dark skin. Rush justified the method, saying

Depletion, whether by bleeding, purging, or abstinence has been observed to lessen the black color in negroes. The effects of the above remedies in curing the common leprosy, satisfy me that they might be used with advantage in the state of leprosy which I conceive to exist in the skin of the negroes.¹⁰⁰

He believed that the same techniques that were useful in treating leprosy would treat this skin "problem."

Rush articulated a chemical conception of the skin problems of blacks. He gave the account of Thomas Beddoes, a famous physician and chemist. Dr. Beddoes had used "oxygenated muriatic acid" on the "black wool" of an African "...and lessened it by the same means in the hand of a negro man."¹⁰¹ Rush pointed out that climate still affected the skin of people living in Africa; their skin was now changing to a "dusky grey."¹⁰²

Physicians proposed that the African air was carbonic because of its purported ability to put out fires. The air caused Africans' itching symptoms and "prickling sensation" as

⁹⁹Rush, "Observations to Favour a Supposition," 296.

¹⁰⁰Rush, "Observations to Favour a Supposition," 296.

¹⁰¹Rush, "Observations to Favour a Supposition," 296.

¹⁰²Rush, "Observations to Favour a Supposition," 296.

well.¹⁰³ African skin was also thought to respond to other fluids, Rush claimed. He used the account of a Philadelphian who claimed to have seen the hand of an African boy changed to white after exposure to unripe peach juice, which the boy regularly consumed.¹⁰⁴ He concludes the article by writing about how much happier blacks would be in having white skin; Rush assumed that they preferred that color. Healing the condition that caused black skin, he believed, would end arguments for the inferiority of the enslaved. Finally, he wrote that the whole human race would be shown to be from one single pair of humans, further supporting “Christian revelation,” and would “inculcate” benevolence.¹⁰⁵ Through Rush’s chemical conceptions of the body, blacks would gain equality and improvement to their overall health.

2.3 Rush’s Chemical Education

Chemistry was a major point in Rush’s training as a physician and a tool with which he built his reputation. Benjamin Rush was born in 1746 near Philadelphia.¹⁰⁶ His early education occurred at Nottingham Academy in Maryland. After finishing at the

¹⁰³Rush, “Observations to Favour a Supposition,” 296.

¹⁰⁴Rush, “Observations to Favour a Supposition,” 296.

¹⁰⁵Rush, “Observations to Favour a Supposition,” 296.

¹⁰⁶The biographical sources regarding Benjamin Rush’s life came from a variety of sources including: Wyndham Miles, “Benjamin Rush, Chemist,” *Chymia* 4 (1953): 37-77, Harry G. Good, *Benjamin Rush and His services to American Education* (Berne, Indiana: Witness Press, 1918), and Carl Binger, *Revolutionary Doctor: Benjamin Rush 1746-1819* (New York: W. W. Norton & Company, 1966.) The Good book is a published copy of his doctoral thesis. The Miles piece was helpful in constructing a biography of Rush’s chemical work.

academy, he studied for his bachelor's degree at the College of New Jersey. After completing his collegiate education, Rush decided, after a brief attempt to study law, to apprentice himself to medicine. He became the apprentice of John Redman, a well-established physician practicing in Philadelphia. Rush befriended one of the early leaders of medical education in Pennsylvania, John Morgan. Morgan was one of the first chemical educators in North America. Participating in Morgan's circle instilled in Rush the importance of chemistry as well as medical knowledge. Rush decided to travel to the University of Edinburgh, an intellectual center for medical education, in order to study for his Doctorate in Medicine.

Morgan learned of Rush's decision and encouraged him to attend the lectures of the famous chemist Joseph Black. Black, also a physician, was a leader in chemistry, known for his experiments with magnesia alba and his work on the treatment of urinary stones.¹⁰⁷ Morgan encouraged Rush to attend Black's lectures in order to have the knowledge to teach chemistry upon his return to Philadelphia. It is unclear whether Morgan promised Rush a teaching position at the College of Pennsylvania upon his return. Nevertheless, Rush attended lectures and received his M.D. during June of 1768. After graduation, Rush toured London and furthered his medical education. Rush also met with Benjamin Franklin in Paris.¹⁰⁸

Rush was elected to the chair of chemistry in August of 1769 at the University of Pennsylvania. Rush's chemical lectures were published as an abbreviated syllabus in

¹⁰⁷See biographical note above.

¹⁰⁸See biographical note above.

1770, possibly becoming the first chemical textbook written in North America. Benjamin Rush was active in both the first and second meeting of the Continental Congresses between 1774 and 1778, signing the Declaration of Independence. With Benjamin Franklin, Rush provided a method for producing saltpeter (potassium nitrate) to counter a continual shortage of this crucial component of gunpowder for the Continental Army during the American Revolution.

Rush taught chemistry to more than just University of Pennsylvania's male students; he also taught an abbreviated version of his chemical lectures for women.¹⁰⁹ The lectures targeted chemistry useful in domestic and culinary matters that were more in line with ideals concerning the role of women in society. Rush did not view women as equals and advocated for the ideal of "Republican Motherhood."¹¹⁰ Republican Motherhood was a political and social ideology that women should be present only in domestic matters and should concentrate on instilling the values of the Revolution in the next generation of citizens of the newly established United States.

When John Morgan passed away on October 15, 1789; Rush was elected to replace him in the professorship of medical theory and practice just one week later.¹¹¹ When he became a professor of medicine, Rush transferred his beliefs about the importance of chemistry to medicine. The idea appears several times in Rush's career

¹⁰⁹See Marion B. Sacin and Harold J. Abrahams, "Benjamin Rush's Course in Chemistry at the Young Ladies' Academy," *Journal of the Franklin Institute* 262 (1956): 425-435.

¹¹⁰Linda K. Kerber, *Women of the Republic: Intellect and Ideology in Revolutionary America* (Chapel Hill: University of North Carolina Press, 1980).

¹¹¹Miles, "Benjamin Rush, Chemist."

retrospective work, *Sixteen Introductory Lectures to Courses Upon the Institutes and Practice of Medicine, with a Syllabus of the Latter*.¹¹²

Rush celebrated chemistry, writing that “The study of chemistry affords a perpetual source of pleasure, by unfolding the effects of heat and mixture.”¹¹³ Rush thought Drs. Black and Priestley always appeared very happy because of their chemical experiments. Rush lamented the death of Antoine Lavoisier and “...wished his execution to be suspended only till he could fill up the measure of his happiness by completing a course of experiments to ascertain a principle in chemistry.”¹¹⁴ Chemistry was needed for rigorous investigation, and “All the sciences bear testimony to the truth of this remark. Earth, air, water, fire, animals, vegetables, and fossils refuse to yield the component parts to any of the means that have been mentioned. They must be tortured by chemical and mechanical agents for this purpose.”¹¹⁵ Rush’s conception of chemistry involved investigations into all types of substances. The chemical investigations of remedies and of the body’s processes provided medical knowledge that Rush wanted to share with the medical community.

¹¹²Benjamin Rush, *Sixteen Introductory Lectures of Courses Upon the Institutes and Practice of Medicine, with a Syllabus of the Latter*. (Philadelphia: Bradford and Inskeep, 1811)

¹¹³Rush goes on to cite the interesting chemical inquiries related to water, the “bowels of the earth,” air, animals, and vegetables. See page 223.

¹¹⁴Rush, *Sixteen Introductory Lectures*, 348.

¹¹⁵Rush, *Sixteen Introductory Lectures*, 348.

2.4. Chemistry and Treatment: The Case of Worms

Rush recounted a medical case from the past in order to discuss a chemical history of Thornapple.¹¹⁶ He wrote that he had visited a little girl who was suffering from fevers, “delirium, tremors in her limbs, and a general eruption on her skin, accompanied with a considerable swelling, itching and inflammation.”¹¹⁷ The girl’s suffering surprised Rush because it was August, when inflammatory diseases were supposed to cease. He also did not know of any cases in the city that matched the girl’s case. Rush admitted that he really had no idea what was causing the girl’s symptoms.¹¹⁸ Her pulse was examined by Rush and he proceeded to bleed her by a small amount and administer laxatives. A warm bath and “stimulating cataplasms” which he applied to her feet, followed.¹¹⁹ The medications removed “ascaride worms” from the girl, but Rush did not think the worms were the root of her problem.¹²⁰

¹¹⁶Benjamin Rush, “An Account of the Effects of the Strammonium, or Thorn-Apple,” *Transactions of the American Philosophical Society* 1 (1769): 318-322.

¹¹⁷Rush, “An Account of the Effects of the Strammonium,” 318-319.

¹¹⁸Rush writes that, “...I acknowledge I was much surprised at it, and knew not what cause to call in, to account for a fever attended with such acute symptoms, at a time of the year, when most of people, especially children, were subject to complaints of a very different nature.” See page 319.

¹¹⁹This means “A poultice: formerly also a plaster.” *Oxford English Dictionary*.

¹²⁰These worms might be the round worms that Rush discusses in his other works upon worms, which are mentioned later in this section.

Rush remarked that the most powerful vermifuge medicines were “Anthelmin,” or “Worm-Grass” from Jamaica and the “Pink-Root” from Carolina.¹²¹ These remedies were narcotics, and if the remedies were taken in large doses, they produced symptoms similar to those of Strammonium, or “Thornapple.”¹²² Rush questioned if all worm-ridding remedies relied on their narcotic properties. He wondered if all narcotic substances had worm-killing properties, especially if given with purging medications. But it is unclear if Rush could answer these questions, and he acknowledged his digression.

Rush recorded the action of the sick girl’s mother. Most of his remedies had been ineffective. The mother informed Rush that there was Strammonium growing in her garden.¹²³ The child had been playing there, and she had suffered “disorder” from eating the seeds of Strammonium.¹²⁴ Rush induced vomiting in the girl, but she only produced phlegm from her stomach.¹²⁵ He tried to give her large quantities of sweet oil, mixed with “oleum Ricini,” which expelled the Strammonium seeds. He repeated this purge for a week since it made the girl feel better the first time.¹²⁶ Unfortunately, girl did not make a quick recovery. She still suffered from tremors in her hands, and, though her delirium

¹²¹Vermifuge is a type of medicine “Causing or promoting the evacuation or expulsion of worms or other animal parasites from the intestines; anthelmintic.” See the *Oxford English Dictionary*

¹²²Strammonium is a flower.

¹²³Rush, “An Account of the Effects of the Strammonium,” 319.

¹²⁴Rush, “An Account of the Effects of the Strammonium,” 319.

¹²⁵Rush, “An Account of the Effects of the Strammonium,” 319-320.

¹²⁶Rush, “An Account of the Effects of the Strammonium,” 320.

ceased, she was “...stupid and blind.”¹²⁷ Rush went on to describe the suffering of the girl:

The pupils of her eyes were much dilated and she caught at the bed--cloathes and at every thing around her, in the same manner as a person in the last stage of a fever. I was persuaded the oil she had taken, had evacuated all such of the seeds as were in the gutts, I began to suspect, that her complains were still kept up by a few seeds which still remained in her stomach. I therefore gave her four grains of tart. Emetic, in the manner I formerly mentioned, and had the pleasure to find, that it brought up above 80 of the seeds, and second time it puked her. Finding the stupor and blindness still continue, I repeated the puke, which brought up, above 20 more. Upon this all her complaints vanished, and in a few days she appeared perfectly well.¹²⁸

Physicians had described worse symptoms when the patient ingested fewer seeds than the child in the case. Rush determined that the seeds must have been dried. Dried seeds do not produce all of the “virtues” of their plants. Rush explained that many dried opium seeds can be ingested, even in large quantities, with very little effect.¹²⁹

Rush had two reasons for discussing this case. His two observations were useful to cases beyond this one. The surface of the skin connects to the “alimentary canal” somehow. Skin eruptions were a fluid problem and were a result of problems in the

¹²⁷Rush, “An Account of the Effects of the Strammonium,” 320.

¹²⁸Rush, “An Account of the Effects of the Strammonium,” 320. The quotation is correct, as quoted directly from the source.

¹²⁹Rush, “An Account of the Effects of the Strammonium,” 320.

patient's blood. However, this case showed the link between the stomach and bowel's irritation and irritation of the skin. Vegetable and animal matter caused irritation in the stomach and bowels that would then irritate the skin in a similar manner as this case. Rush argued that substances irritated the stomach and bowels much sooner than the blood. He wrote that, "It is impossible to tell, what species of the eruptive disease [...] are occasioned by the preference of morbid matter in the primae viae; but in all those cases, where it is doubtful, it would not be amiss to suspect it, and order our medicines accordingly."¹³⁰ Dr. Korr of St Croix told Rush

...that he had once an obstinate humour upon his arm, which alternated with a complaint in his stomach, arising from the too great predominance of an acid, and that he was never able to re[m]ove it with all the applications he could use, till he cured the disorder in his stomach by bitter and astringent medicines.¹³¹

The humors of the body signaled internal problems using external parts of the body.

The second point that Rush wanted to make about this case was that "pukes," used to purge the contents of the stomach, might not be a good remedy for worms. Rush recounted the frustration of not being able to dislodge worms from the stomach by inducing vomiting. Physicians had to increase the strength of the purging medications or use potentially deadly medications to expel worms from the stomach. Rush admitted that he had used acids or other narcotics, acids being an extremely powerful antidote.¹³² But

¹³⁰Rush, "An Account of the Effects of the Strammonium," 320.

¹³¹Rush, "An Account of the Effects of the Strammonium," 321.

¹³²Rush, "An Account of the Effects of the Strammonium," 321.

he wrote that, "...if we may be allowed to reason from analogy, I think we may presume, that there is scarcely a poisonous substance in nature but what has an antidote provided for it."¹³³ Experiments, not "reasoning a-priori," revealed these proper medications. Physicians had to deal with poisoning frequently, and thus poisons were "...worthy of the attention of the Faculty of Physic."¹³⁴

As a chemist, Rush wanted to find chemical and "mechanical substances" that would cure a patient of worms. Throughout his career Rush was interested in better understanding worms. He wrote a letter to Thomas Jefferson in 1791 advocating the virtues of sugar.¹³⁵ One of those virtues was its use in preventing worms. Rush wrote that, "The plentiful use of sugar in diet is one of the best preventives that has ever been discovered of the diseases which are produced by worms."¹³⁶

Rush investigated the role of worms in "Observations upon Worms in the Alimentary Canal."¹³⁷ He described worms appearing in lots of different types of animals and existing in animal bodies without necessarily causing diseases. He inquired as to

¹³³Rush, "An Account of the Effects of the Strammonium," 322.

¹³⁴Rush, "An Account of the Effects of the Strammonium," 322.

¹³⁵Benjamin Rush, "To Thomas Jefferson: An Account of the Sugar Maple Tree," sent from Philadelphia on July 10, 1791 in *Letters of Benjamin Rush*, ed. L. H. Butterfield, Princeton: Princeton University Press, 1951, Vol. 1 pg. 587-599.

¹³⁶Rush, "To Thomas Jefferson," 594.

¹³⁷Benjamin Rush, "Observations upon Worms in the Alimentary Canal," in *Medical Inquiries and Observations* Volume 1 (Philadelphia: Johnson and Warner, Mathew Carey, et al, 1809), 215-34. Many of the pieces that appear in the four volume set were pre-published and augmented in this volume. Additionally, see the letter to Walter Stone on pages 576-577 in the *Letters of Benjamin Rush*.

whether worms might be important to the “animal economy.”¹³⁸ Rush hypothesized that worms ate some excessive bodily substance, questioning, “Do they consume the superfluous aliment which all young animals are disposed to take, before they have been taught, by experience or reason, the bad consequences which arise from it?”¹³⁹

Worms did not exist everywhere, and it was unclear if they caused disease. Rush theorized that if worms did cause disease, it might be a problem of achieving a balance of worms in the body. He asked, “Do worms produce disease from an *excess* in their *number*, and an error in their place, in the same manner that blood, bile, and air produce disease from an *error* in their place, or from *excess* in their *quantities*?”¹⁴⁰ Rush suspected that worms and disease were somewhat linked and provided observational evidence to explore such a link.

In diseases like small pox or measles, children who did not show any symptoms discharged worms.¹⁴¹ He observed worms in children with “gross habits” and “...vigorous constitutions.”¹⁴² Rush cited work indicating that worms appeared in livers of healthy rats. However, children became ill even when they did not have any worms in

¹³⁸Animal economy’s definition from the *Oxford English Dictionary*: “Biol. The interactions between organisms, their individual biology, form, and functions; (in later use often) spec. physiology. Esp. in animal economy, vegetable economy, etc...”

¹³⁹Rush, “Observations upon Worms,” 217.

¹⁴⁰Rush, “Observations upon Worms,” 218.

¹⁴¹Rush, “Observations upon Worms,” 219.

¹⁴²Rush, “Observations upon Worms,” 219.

their bodies. Rush thought that worms helped children who overindulged in their diets because, “It is in this way that nature, in many instances cures evil by evil.”¹⁴³

Other physicians speculated that worms and fevers related to each other. Indians believed, and Rush agreed, that even though the body expelled worms when experiencing a fever, worms did not cause the fever.¹⁴⁴ Rush linked nervous fevers and disorders together as well:

I grant that worms appear more frequently in some epidemic diseases than in others, and oftener in some years than in others. But may not the same heat, moisture, and diet which produced the diseases, have produced the worms? And may not their discharge from the bowels have been occasioned in those epidemics, as in the small-pox and measles, by the increased heat of the body, but the want of nourishment, or by an anthelmintic quality being accidentally combined with some of the medicines that are usually given in fevers?¹⁴⁵

Worms therefore were “complications of symptoms,” not the causes of diseases. They increased the danger of fevers but did not cause them.¹⁴⁶

Implied in Rush’s writings about worms was the idea that a balance can be achieved in the body by controlling the amount of bodily worms with anthelmintic (or

¹⁴³Rush, “Observations upon Worms,” 219.

¹⁴⁴Rush writes that, “The Indians in this country say there is not, and ascribe the discharge of worms to a fever, and not a fever to the worms.” He also writes that, “By adopting this opinion, I am aware that I contradict the observations of many eminent and respectable physicians.” These quotes appear on page 220.

¹⁴⁵Rush, “Observations upon Worms,” 221.

¹⁴⁶Rush, “Observations upon Worms,” 222

worm destroying) substances. Rush agreed that “chronic” and “nervous diseases” found in children, which were often deadly, came with worms. As a chemist, Rush tested many anthelmintic substances and recorded them in several tables in his article (an example, from page 221, is in figure 2.1 below).

I. BITTER and ASTRINGENT SUBSTANCES.	Hours.	Minutes.
Watery Infusion of Aloes,	2	48
———— of Rhubarb,	1	30
———— of Peruvian bark,	1	30
II. PURGES.		
Watery Infusion of Jalap,	1	—
———— of Bears-foot,	1	17
———— of Gamboge,	1	—
III. SALTS.		
1. <i>Acids.</i>		
Vinegar, - - -	—	1½ convulsed.
Lime Juice,	—	1
Diluted nitrous Acid,	—	1½
2. <i>Alkali.</i>		
A watery Solution of Salt of Tartar, - - -	—	2 convulsed, throwing up a mucus on the surface of the water.
3. <i>Neutral Salts.</i>		
In a watery Solution of common Salt, - - -	—	1 convulsed.
———— of Nitre, - - -	—	ditto.
———— of Sal Diuretic, - - -	—	ditto.
———— of Sal Ammoniac, - - -	—	1½
———— of common Salt and Sugar, - - -	—	4
P 2		4. <i>Earily</i>

Figure 2.1 Anthelmintic Substances

In 1771, Rush performed several experiments with earthworms and anthelmintic substances. The experiments involved earthworms because naturalists believed they were most similar to the “round” worms found in the body.¹⁴⁷ But Rush cautioned that the stomach and the bowels mixed and distributed substances through the body, and the power of a remedy could differ in each individual. Rush implied that a remedy’s efficacy depended on how the body processed it internally.

¹⁴⁷Rush, “Observations upon Worms,” 224.

Rush contextualized his chemical work. He broke down the remedies into three groups. The first group was “mechanical” because of their “indirect” action upon the body.¹⁴⁸ Mechanical remedies included purges, bark, and “wormseed.”¹⁴⁹ The next group was the chemical group. Chemical anthelmintic remedies include different types of salts. It was not difficult to get children to ingest chemical anthelmintic remedies because “nature” had imbued children with, “...an early appetite for common salt, ripe fruits, and saccharine substances; all of which appear to be among the most speedy and effectual poisons for worms.”¹⁵⁰ Rush reflected that,

Let it not be said, that nature here counteracts her own purposes. Her conduct in this business is comfortable to many of her operations in the human body, as well as throughout all of her works. The bile is a necessary part of the animal fluids, and yet an appetite for ripe fluids seems to be implanted chiefly to obviate the consequences of its excess, or acrimony, in the summer and autumnal months.¹⁵¹ Nature, the fluids of the body, and weather were linked and balanced by each other. Rush tested remedies like onion juice and even gunpowder. He shared that he had “...often prescribed a tea-spoonful of gunpowder in the morning upon an empty stomach with obvious advantage.”¹⁵² But there were also medicines that shared characteristics of both

¹⁴⁸Rush, “Observations upon Worms,” 228.

¹⁴⁹Rush, “Observations upon Worms,” 228.

¹⁵⁰Rush, “Observations upon Worms,” 229.

¹⁵¹Rush, “Observations upon Worms,” 229.

¹⁵²Rush, “Observations upon Worms,” 231.

mechanical and chemical anthelmintic remedies, like both purgative methods of calomel or steel powder.

Rush's conclusion drew on insights into a chemical-humoral system of the body. Remedies, especially those of an anthelmintic nature, depend on the "action" of the stomach. Sometimes the stomach changed anthelmintic medicines so that they failed to provide a remedy for the worms. The "digestive powers" of the body affected remedies, though when they were unchanged by the stomach, they worked in a very "concentrated" manner on worms.¹⁵³

2.5 Humoral Pathology and the Revolution

In the late eighteenth century, Rush was caught up in the political revolution in America. The war shaped Rush's theories about medicine by providing him with many different experiences treating disease. The war was not easy for Rush, he had to deal with a high number of soldiers needing treatment and a difficult hierarchy of command. Rush sometimes sabotaged his own status in the Revolutionary government because of personality issues. Many of Rush's wartime experiences were later written up in case studies and appeared in his portfolio of medical writings. Like the writings mentioned above, Rush brought humoral theory and chemistry to investigate his experiences. Importantly, the war pushed Rush to think about nature to a greater degree. Nature seemed to influence the fluids of the body, causing disease.

¹⁵³Rush, "Observations upon Worms," 233.

The war was far from an easy matter for the United States. In addition to failures on the battlefield, there were logistical and medical problems.¹⁵⁴ Congress removed John Morgan as Director of the Medical Department on January 9, 1777, for leadership problems, underlined by material shortage and rampant personnel problems. Rush was a member of the leadership as a member of the Medical Committee.¹⁵⁵ On April 11, 1777, Rush was appointed Surgeon General of the Hospital of the Middle Department. William Shippen took over as Director General of the Hospital Department and divided medical services for the army into three districts or departments: A Middle, Eastern, and Northern Department. Rush had unofficially served soldiers after the Battle of Trenton and before Washington's quick retreat to Princeton, New Jersey. He tended the wounded between his services in the Continental Congress as well. Rush often faced overcrowding and continual breakouts of fever and disease while serving the Middle Department.

Throughout his service there, Rush voiced his outrage at lack of supplies and medicines and poor camp conditions, and he waged a personal campaign, along with John Morgan (whose name was later cleared of mismanagement by Congress), against the head of the Medical Department, William Shippen. Rush and Morgan successfully manipulated Congress to remove Shippen. Throughout the course of the war Rush

¹⁵⁴Mary C. Gillet, *The Army Medical Department: 1775-1818* (Washington: Center of Military History United States Army, 1990) and Oscar Reiss, *Medicine and the American Revolution: How Diseases and Their Treatments Affected the Colonial Army* (Jefferson, North Carolina: McFarland & Company, 1998). Both these works contributed to the biographical section about Rush concerning his medical work during the American Revolution. The Gillet piece had a clear narrative concerning Rush.

¹⁵⁵Gillet, *The Army Medical Department*.

practiced medicine and served soldiers until he resigned his commission over public revelation that he had criticized George Washington's leadership.¹⁵⁶

During the war, Rush was proactive in suggesting measures to protect the American army. Often Rush's admiration for British medicine crept into his writing. Rush viewed nature as the main worry in his attempts to stabilize the health of soldiers. His writings represented a neo-Hippocratic perspective of nature and proposed humoral interventions in treating or preventing diseases.

On April 22 of 1777, Rush published directions aimed at protecting the health of patriot soldiers. Rush summarized his worries in a single statement, "Fatal experience has taught the people of America the truth of a proposition long since established in Europe, that a greater proportion of men perish with sickness in all armies than fall by the sword."¹⁵⁷ There had been several breakouts of diseases including small pox and camp illness.¹⁵⁸ Rush wanted to improve the overall health of the Continental Army. The health of the soldiers had been declining throughout the war because of camp sickness (like dysentery and fever) and other supply problems. General Washington on several occasions complained to Congress, the Surgeon General (John Morgan at the time), and the leadership of the states to improve the lot of soldiers encamped in places like Valley

¹⁵⁶Gillet, *The Army Medical Department*.

¹⁵⁷Benjamin Rush, "To the Officers in the Army of the United American States: Directions for Preserving the Health of Soldiers," in Butterfield, ed. *Letters of Benjamin Rush*, Vol. 1, pgs. 140-147. This quote came from page 140.

¹⁵⁸Gillet, *The Army Medical Department*.

Forge.¹⁵⁹ Congress never properly solved Washington's problems.¹⁶⁰ Rush wrote to Washington and complained about the problems in the hospitals and described the lack of supplies, the poor leadership of the surgeons, and overcrowding.¹⁶¹

Rush's directions on improving the conditions of soldiers focused on four areas: dress, diet, cleanliness, and the encampments.¹⁶² Generally, Rush's comments about the soldiers' dress were based in an attempt to avoid miasmas. The manner in which a soldier dressed could greatly affect his health. At that time, the soldiers wore linen because it was the proper economic choice. Rush cautioned that, "It is a well-known fact that the perspiration of the body, by attaching itself to linen and afterwards by mixing with rain, is disposed to miasmata, which produce fevers."¹⁶³ He wanted to "banish" the rifle shirt from the army all together because of its harmful effect on soldiers' health. Beyond its accumulation of miasmas, it concealed filth and prevented cleaning.¹⁶⁴ Rush wanted the soldiers to change to woolen flannel shirts because of flannel's historical precedence in

¹⁵⁹Gillet, *The Army Medical Department*.

¹⁶⁰Gillet, *The Army Medical Department*.

¹⁶¹Benjamin Rush, "Benjamin Rush to George Washington, December 26, 1777," in Butterfield, ed. *The Letters of Benjamin Rush*, pg. 180-182. His experience was rocky at best, as Rush's personality and the public disclosure of his private criticisms of General Washington made him many enemies in Congress and in the army.

¹⁶²Rush, "To the Officers in the Army," 140-145.

¹⁶³Rush, "To the Officers in the Army," 141.

¹⁶⁴*Oxford English Dictionary* for miasma: "Noxious vapour rising from putrescent organic matter, marshland, etc., which pollutes the atmosphere; a cloud of such vapour. Also in extended use."

preventing intermittent fevers. Rush also criticized long hair, as it became “putrid.”¹⁶⁵ The soldiers needed to dress their hair daily and keep it short in order to preserve their health.

Rush commented on the soldiers’ diet as well.¹⁶⁶ Vegetables needed to make up the majority of the soldiers’ diet. Both their jobs and their constitutions required vegetables. The vegetables needed to be “well cooked” because of worries about rot. Physicians in the eighteenth century believed that stomach ailments resulted from food “rotting” in the body.¹⁶⁷ Fevers and other diseases originated through food rot in the guts. Initially, physicians thought foodstuffs in the new world were intolerable to European constitutions, but the theory later evolved to focus on some sort of rot that occurred in raw vegetables in the body.¹⁶⁸ The rot was not limited to vegetables: meats caused disease by rotting in the body as well. He worried about soldiers eating too much meat and acquiring fevers, especially remitting fever. Soldiers needed to consume Jesuit’s bark (cinchona) in vast quantities, but he hoped that, “If every tree on the continent of America produced Jesuit’s bark, it would not be sufficient to preserve or to restore the health of

¹⁶⁵Rush, “To the Officers in the Army,” 141.

¹⁶⁶Joyce Chaplin, *An Anxious Pursuit: Agricultural Innovation and Modernity in the Lower South, 1730-1815* (Chapel Hill: University of North Carolina Press, 1993) and Joyce E. Chaplin, *Subject Matter: Technology, the Body, and Science on the Anglo-American Frontier, 1500-1676* (Cambridge: Harvard University Press, 2001).

¹⁶⁷Rush, “To the Officers in the Army,” 141-145.

¹⁶⁸Rush, “To the Officers in the Army;” Rush worried about the soldiers serving rotting flour.

soldiers who eat two or three pounds of flesh in a day.”¹⁶⁹ The soldiers’ diets were as important as any other protection against disease.

He made a special point of criticizing alcohol. He argued that the “need” for rum to protecting soldiers from the cold was incorrect. The warmth rum produced in a soldier’s body in winter and the “elevation of spirits in summer” only made the body more “languid” and susceptible to weather later on.¹⁷⁰ Appealing to history, Rush called for soldiers to carry vinegar in their canteens, as those in Caesar’s army had. Vinegar protected their health because it, “...effectually resists that tendency to putrefaction to which heat and labor dispose the fluids.”¹⁷¹ Vinegar could stimulate the body, and “It moreover calms the inordinate action of the solids which is created by hard duty.”¹⁷² However, Rush believed that there was a handful of cases where rum, which must be mixed with three to four parts water, could be used. These cases include sentry duty or cases of extreme fatigue.

Overall, Rush advocated the principles of “CLEANLINESS.”¹⁷³ Soldiers ought to wash their entire body at least two or three times in a week, and especially in the summer. They must take cold baths in order to protect their overall health. Soldiers needed to follow the principles of food preparation that Rush had laid out. He called for soldiers to

¹⁶⁹Rush, “To the Officers in the Army,” 142.

¹⁷⁰Rush, “To the Officers in the Army,” 142.

¹⁷¹Rush, “To the Officers in the Army,” 143.

¹⁷²Rush, “To the Officers in the Army,” 143.

¹⁷³Rush, “To the Officers in the Army,” 143.

wash the food well and to avoid crowded areas, as “jail fever” could break out in crowds because it was the, “...offspring of the perspiration and respiration of human bodies brought into a compass too narrow to be diluted and rendered inert by a mixture with the atmosphere.”¹⁷⁴

Soldiers, Rush said, should put their bedding (mostly hay or straw) in the sun each day in order to “...prevent the perspiration from becoming morbid and dangerous by accumulating upon it.”¹⁷⁵ Rush insisted that other filth, like animal waste, be either buried or taken away from the camp. The “environs” of each soldier's tent and the camp in general should be guarded against “filth.”¹⁷⁶ *Miasmata* (miasma) was the real worry for Rush in his concern with cleanliness.

Winds transported miasmata, and the winds brought camp disease. Hippocrates had put great emphasis on the direction in which the winds blew upon a town, and correlated it with the diseases that men and women experienced.¹⁷⁷ Rush echoed Hippocrates by writing about the importance of the winds and seasons on the encampments of soldiers. He reminded commanders that,

Sometimes it may be necessary to encamp an army upon the side of the river.

Previous to this step, it is the duty of the quartermaster to inquire from what

¹⁷⁴Rush, “To the Officers in the Army,” 144.

¹⁷⁵Rush, “To the Officers in the Army,” 144.

¹⁷⁶Rush, “To the Officers in the Army,” 144.

¹⁷⁷Hippocrates, *Hippocratic Writings*, trans. J. Chadwick and W. N. Mann (New York: Penguin Books, 1978). The section “Airs, Waters, Places,” can be found on pages 148-170; please examine pages 149-151 for these ideas.

quarter the winds come at the season of his encampment. If they pass across the river before they reach his army, they will probably bring with them the seeds of bilious and intermitting fevers, and this will more especially be the case in the fall of the year.¹⁷⁸

Rush actually advocates imitating the British. He said that the British, when they were encamped in Pensacola, changed their camp every year to avoid the ill effects of the winds and “...have preserved their health in a manner scarcely to be paralleled in so warm a climate.”¹⁷⁹

Commanders were instructed to keep the air in their camp safe by following Rush’s advice: “The fire and smoke of wood, as also the burning of sulphur and the explosion of gunpowder, have a singular efficacy in preserving and restoring the purity of the air.”¹⁸⁰ It was the duty of commanding officers to not take any unnecessary risks with the health of his soldiers. Rush wrote that it was utterly reckless for a commander to lose twice as many men while encamped through “negligence” as on the battlefield.¹⁸¹ He finished with a reminder to “Consider in the first place that the principal study of an officer in the time of war should be to save the blood of his men.”¹⁸²

¹⁷⁸Rush, “To the Officers in the Army,” 144.

¹⁷⁹Rush, “To the Officers in the Army,” 144.

¹⁸⁰Rush, “To the Officers in the Army,” 145.

¹⁸¹Rush, “To the Officers in the Army,” 145.

¹⁸²Rush, “To the Officers in the Army,” 145.

General Nathanael Greene approved of Rush's recommendation. In a letter to Rush on May 3, 1777, Greene wrote that Rush's plan, "...very deservedly merit my approbation."¹⁸³ He wanted Rush to spread the information to soldiers through pamphlets. Greene became Rush's apparent ally during the war, as can be seen through their correspondence, though in his private journal Rush criticized Greene for a lack of discipline.¹⁸⁴ In a letter to Greene, Rush complained of the lack of discipline in the hospital using slave-master metaphors: "A Soldier should never be suffered to exist a single hour without a sense of his having a master being imposed upon his mind, nor the fear of military punishment."¹⁸⁵ Rush voiced frustration regarding military hierarchy, discipline, and leadership during his time in the Medical Department.

During the War, Rush encountered many diseases, including tetanus. He shared his casework with the medical community in order to further the knowledge of disease treatment. Often these speculations included humoral treatment methods. When Rush had encountered cases of tetanus during private practice, he often prescribed opium, which failed to cure patients. Working through cases of tetanus during the Revolution allowed him to gain insights.

¹⁸³The citation came from the notes in the Rush's directive to the Army offices. Nathanael Greene, "To Benjamin Rush, 3rd of May 1777," in Richard K. Showman, ed. *The Papers of Nathanael Greene* (Chapel Hill: The University of North Carolina Press, 1980), 68

¹⁸⁴Benjamin Rush letter to Nathanael Greene on December 2, 1777 on page 229-230 in *The Papers of Nathanael Greene*. Also see note one on page 230 about Rush's backbiting criticism.

¹⁸⁵Rush to Greene, 229-230.

Rush found tetanus “to be a disorder of warm climates, and warm season. This led me to ascribe it to relation.”¹⁸⁶ Rush, in the humoral mode of medicine, attempted to apply remedies that were the disease’s opposite. When Rush met Col. John Stone, who was wounded at the battle of Germantown, Pennsylvania in 1777, the colonel was in excruciating pain.¹⁸⁷ Rush stopped the surgeon from continuing opium treatment and applied wine and bark. After his prescribed remedies had their desired effects, Rush continued humoral treatment to relieve the irritability acting upon the patient’s system. For Rush, disease occurred in the system when it was irritated, and physicians removed the irritation on the body through bloodletting or other balancing methods, like blistering, purging, or chemical interventions. In the next part of the treatment Rush, “...applied a blister between his shoulders, and rubbed in two or three ounces of mercurial ointment upon the outside of his throat.”¹⁸⁸ Stone made a recovery, though he continued to have “spasms” in his foot.

At the end of the write up of the cases concerning tetanus, Rush theorized that the disease was caused by a lack of relaxation in an overly heated environment. Tetanus was often found in troops arriving from the West Indies, but Rush knew of no soldier who suffered from tetanus in, for example, Rhode Island, a decidedly cooler climate. The heat of excessive labor, like marching, caused the lack of relaxation in patients. Battlefield wounds also caused tetanus. The medications used to treat tetanus brought about

¹⁸⁶Benjamin Rush, “Observations on the Cause and Cure of the Tetanus,” *Transactions of the American Philosophical Society* 2 (1786): 225-231.

¹⁸⁷Rush, “Observations on the Cause,” 225-226.

¹⁸⁸Rush, “Observations on the Cause,” 226.

relaxation in the system. Rush cited a case where the patient was cured by “deep and expensive incisions” on the foot that had previous been wounded with a nail.¹⁸⁹ Mercury was useful since it produced “salivation.”¹⁹⁰ It was important to produce salivation in the patient’s mouth because, “The irritation and inflammation produced in the mouth and throat, seldom fail to produce the inflammatory diathesis, as blood drawn in a salvation has repeatedly shewn.”¹⁹¹ Cold baths and tonics produced relaxation in the system as well.

Though Rush did not forbid opium in the treatment of tetanus, he reminded physicians of its careful use. He cited a case of a “Negro” man whose physician administered a large dose of laudanum to treat his tetanus. The man died, and, after “opening him,” the physician found that his stomach was both “inflamed” and “mortified.”¹⁹² Rush said that opium was appropriate for treating spasms and providing relief, but it must be prescribed carefully. He cautioned of opium that “...its qualities are complicated, and its efficacy doubtful, I think it ought to yield to more simple and more powerful remedies.”¹⁹³

Speculation was useful to Rush and other physicians. Case write-ups, including physicians' own speculations, seemed useful to turn of the nineteenth century physicians

¹⁸⁹Rush, “Observations on the Cause,” 229.

¹⁹⁰Rush, “Observations on the Cause,” 228.

¹⁹¹Rush, “Observations on the Cause,” 229-230.

¹⁹²Rush, “Observations on the Cause,” 229-230.

¹⁹³Rush, “Observations on the Cause,” 230.

like Rush. It moved medicine forward because physicians found it a venue to disseminate useful information. Rush concluded the article by writing that, “In a disease so deplorable and hitherto so unsuccessfully treated, even a conjecture may lead to useful experiment and enquiries.”¹⁹⁴ The case study was an experiment, similar to those experiments being performed in Rush’s chemistry. Lester King has said that Rush was an empiricist who wanted to rationalize his own experiences with logical analysis.¹⁹⁵ The Revolution could be viewed as another part of Rush’s humoral laboratory.

After the war came the Yellow Fever of 1793. Though the war had primed Rush for such a deadly epidemic, he still experienced guilt from the great loss of life during the 1793 outbreak, and it was in response to the epidemic that Rush’s humoral medical theory was articulated in its boldest and broadest form.

2.6 Fevers and Humoral Pathology

One tenth of Philadelphia's population perished in the 1793 epidemic.¹⁹⁶ Previously, the city had experienced yellow fever in 1699, 1741, 1747, and 1762.¹⁹⁷

¹⁹⁴Rush, “Observations on the Cause,” 231.

¹⁹⁵King, *Transformations*.

¹⁹⁶See W. S. Middleton, “The Yellow Fever Epidemic of 1793 Philadelphia,” *Annals of Medical History* 10 (1928): 434-450. This source was listed on page 96 note 25 of the Rush autobiography. Another summary piece, though a bit old and theoretically problematic, is “The Enigma of Yellow Fever,” pg. 193-235 (Chapter 11) in Charles-Edward Amory Winslow, *The Conquest of Epidemic Disease: A Chapter in the History of Ideas* (Hafner Pub. Co, 1943). Please also see J.H. Powell, *Bring Out Your Dead: The Great Plague of Yellow Fever in Philadelphia in 1793* (Philadelphia: University of Pennsylvania Press, 1949) and Paul E. Kopperman, “‘Venerate the Lancet’: Benjamin Rush’s Yellow Fever Therapy in Context,” *Bulletin of the History of Medicine* (2004): 539-574.

¹⁹⁷See note 132.

The disease was a form of bilious fever that left the skin yellow in appearance. Other parts of the body could turn yellow or take on a yellow color. Rush recounted in his autobiography approximately seven years later the sadness he continued to feel about the 1793 epidemic: “The lapse of years has not much lessened the painful recollection of the events of that melancholy year.”¹⁹⁸ Yellow fever was defined by a humoral imbalance: an excess of yellow bile.

The epidemic was a watershed moment in Rush’s medical career. Rush published a descriptive account of the outbreak in 1799: *Observations Upon the Origin of the Malignant Bilious, Or Yellow Fever in Philadelphia*.¹⁹⁹ Rush argued that yellow fever was caused by natural forces originating in America, a claim that was extremely controversial to the College of Physicians in Philadelphia. Rush’s claim would ultimately cause him to leave the college entirely and break with the group over his ideas.²⁰⁰

Rush argued for the “remote cause” of yellow fever.²⁰¹ He based his theory on miasmas originating in nature and in the man-made world. Rush argued that disease came as a result of nature irritating the body. Rush proposed “This disease is the offspring of putrid vegetable and animal exhalations in all countries.—It prevails only in hot climates

¹⁹⁸Benjamin Rush, *The Autobiography of Benjamin Rush*, ed. George W. Corner (Princeton: Princeton University Press, 1948), 95-96.

¹⁹⁹Benjamin Rush, *Observations Upon the Origin of the Malignant Bilious, Or Yellow Fever in Philadelphia*. (Philadelphia: Thomas Dobson, 1799).

²⁰⁰Rush, *Autobiography*, 95-99.

²⁰¹Rush, *Observations Upon the Origin*, 4.

and seasons.”²⁰² He then justified his theory by citing several chief circumstances in Philadelphia as causing the miasmas: the docks, the air, the gutters, dirty areas, privies, the city itself, and the impure “pump water.”²⁰³ The docks in Philadelphia concentrated filthy matter, and the filth spread by the coming and going of ships and people. Rush never defines filth, but gives it a negative connotation. Matter from the docks in New York traveled to Philadelphia and made people sick. Ships contained foul air as well.²⁰⁴

Rush complained of the “common sewers” in Philadelphia, too. Rush presented the case of Calcutta, India, which had a common sewer that harmed the health of the people. Rush argued that removing the filth of the city through other means improved the health of the people.

Yards and “dirty cellars” were additional probable causes in Rush’s analysis; these areas produced “...fever in all seasons of the year.”²⁰⁵ Rush argued that air in a cellar was “shut up” and trapped; sufferers of the fevers entered into the cellars and breathed the bad air no matter what the season. “Privies” or toilets were causative of fevers because of the foul air that could be found around them. Water and “masses of matter” in the city were also mentioned as probably sources.²⁰⁶ Though physicians agreed that “common bilious and dysentery” originated from “these sources,” some physicians

²⁰²Rush, *Observations Upon the Origin*, 4.

²⁰³Rush, *Observations Upon the Origin*, 5.

²⁰⁴Rush could be alluding to the foul air produced below deck or air being caught in the sails of the ship. Like filth, Rush is vague in his description.

²⁰⁵Rush, *Observations Upon the Origin*, 5.

²⁰⁶Rush, *Observations Upon the Origin*, 5.

did not agree with Rush's ideas about treatment or his theory that Yellow Fever had domestic origins.²⁰⁷ Rush's peers fretted about his copious use of bloodletting and his enthusiastic use of purgatives. A physician should never combine purgatives and vivisection because the patient would become too weak from the bloodletting and might kill the patient.²⁰⁸

Rush's *Observations* aimed to justify his theory of yellow fever and ultimately to defend his therapeutic position. In order for yellow fever to emerge and attack a city, Rush argued that three events needed to happen. First, there needed to be "putrid exhalations."²⁰⁹ These were foul vapors. Secondly, "...An inflammatory constitution of the atmosphere."²¹⁰ Rush referred to a warm temperature outside. And three, "...An exciting cause, such as great heat, cold, fatigue from riding, walking, swimming, gunning, or unusual labour, intemperance in eating or drinking, ice creams, indigestible aliment, or violent emotion of the mind."²¹¹ All of these causes related to one's constitution. Diseases resulted from changes in temperature or activity. These changes removed the body from its normal mode and caused a person to acquire yellow fever, or

²⁰⁷Rush, *Observations Upon the Origin*, 5.

²⁰⁸Paul E. Kopperman sums up this probation on page 549 writing that, "Almost all writers warned against the use of emetics in treating yellow fever, their objection being that vomiting weakened patients who were already debilitated, and that since nausea regularly attended yellow fever, emetics might well provoke vomiting that was uncontrollable and ultimately fatal."

²⁰⁹Oxford English Dictionary helped me piece together these meanings that Rush lays out. This includes all three items that needed to happen.

²¹⁰Rush, *Observations Upon the Origin*, 6.

²¹¹Rush, *Observations Upon the Origin*, 6.

some other disease. Rush thought that air quickly spread the disease. Other diseases spread by the air included rheumatism, gout, and hives.²¹² The ease and spread of disease by the air explains why the disease was not limited to seaports and other areas near the ocean. The atmospheric changes, though they remained unknown, caused disease. Rush pointed to Hippocrates and Sydenham in citing these connections.²¹³

Observations represented Rush's neo-Hippocratic beliefs. Changes in the atmosphere affected every living thing on earth, from animals to people. In a rhetorical question-and-answer, Rush tried to combat questions and potential logical issues in his own argument for a domestic, nature-based cause for yellow fever. Some questions included why fever was not present prior to 1791, or why the fever was not in every city that was filthy in its condition. First, the disease *had* been present prior to 1791, particularly in 1761. Rush provided an extremely interesting answer to the second question. He pointed out that the fever did not appear when a city was in one of two physical states, "a dry" or a "liquid" state.²¹⁴ Times when an area was dry from excessive heat or when heavy rains occurred did not produce the fever. However, when the two met, when heat acted upon moisture, trouble occurred. Rush believed that when the sun shone on filth in a "moist state," it led to circumstances that produced fevers.²¹⁵ Rush used an interesting metaphor to describe the beginnings of fever.

²¹²Rush, *Observations Upon the Origin*, 6.

²¹³Rush published an edited volume of Sydenham's work.

²¹⁴Rush, *Observations Upon the Origin*, 9

²¹⁵Rush and Thomas Cooper shared ideas about miasmata.

The foul air of our city may be compared to gunpowder with which the bodies of our citizens are charged from the beginning of summer. The atmosphere may be compared to sparks of fire. Heat, cold, fatigue, intemperance and the other exciting causes which have been mentioned, may be compared to a *hand*, which combines these sparks, with the gunpowder accumulated in our bodies. The concurrence of all these causes is necessary to produce a yellow fever. Putrid exhalations act but feebly upon the body, unless they are aided by the inflammatory activity of the atmosphere.²¹⁶

Rush's metaphor was clearly rooted in a humoral understanding of the body and fever. Some type of substance in the fluids of the bodies that by external force of temperature or change in constitution ignite. The result was the production of fever or disease.²¹⁷

The other logical issue entwined in explaining the causes of yellow fever was why some people got fever, while others did not. The answer, according to Rush, was that some people's constitutions were stronger, possibly protecting them from the rotting substances which produced fever. Others did not get the disease because they fled when they smelled miasmas. Though Rush continually criticized the use of alcohol consumption, in the case of yellow fever the "stimulation" of "spirituous liquours" was a possible preventative. Rush noted that it must have been what kept "*habitual drunkards*

²¹⁶Rush, *Observations Upon the Origin*, 10.

²¹⁷The definition of inflammation is "The action of inflaming; setting on fire or catching fire; the condition of being in flames, conflagration." But medically, the word means, "A morbid process affecting some organ or part of the body, characterized by excessive heat, swelling, pain, and redness; also, a particular instance or occurrence of this." Roy Porter and other historians have historicized the medical definition and linked its origin with the first definition.

from the yellow fever.”²¹⁸ Yellow fever was not likely a “contagious disease,” or spread to others through contagion. There are three or four situations where the contagion spread. However, he knew of no instance where it spread in the hospital. Rush’s tone implied that he was skeptical of the likelihood of the contagious spread of the disease.

Nonetheless, Rush explained how people or nature could spread the disease. Thinking that yellow fever was a communicable disease was completely in line with humoral thinking. In the eighteenth century humoral theory explained communicable diseases well, but not completely. Poor air or people encountering expelled “peccant” humors spread communicable diseases.²¹⁹ A sufferer of the yellow fever could spread it to others by close contact. Persons acquiring the sickness might intake a sufferer’s breath or get sick by way of the air that was trapped in a small room. The body was more vulnerable to picking up the disease in certain weakened states, such as during extreme grief.

Rush estimated that over one thousand people transferred the fever to other cities. Though he was skeptical of the contagion theory, he does spill a lot of ink explaining how it works. Writing out the mechanics of spreadable disease, “Clothes impregnated with the effluvia of a person who had died of the Yellow fever might produce a similar disease, but it would be only in consequence of those effluvia partaking of the nature of putrid

²¹⁸Rush, *Observations Upon the Origin*, 11.

²¹⁹Roy Porter, *To the Greatest Benefit of Mankind: A Medical History of Humanity* (New York: W. W. Norton, 1988), 259-262.

matters derived from any other animal source.”²²⁰ The same condition of rotting materials impregnating clothes could occur after contact with a dead body “putrefying.”²²¹

Though Rush fully articulated how contagion worked, or potentially worked in regards to yellow fever, he believed that cases attributed to contagion in the West Indies were caused by natural “noxious exhalations.” These exhalations spread over long distances and have a particular smell to them that can lead to “disagreeable sensations” to those persons attending to the sufferer.²²² But Rush tried to downplay his observation by explaining that “...similar effects are produced from a hundred other smells which do not occasion a fever.”²²³

The rains washed away the epidemic in Philadelphia, and Rush attributed this to the fact that the disease was not contagious. Philadelphia imported other fevers from countries like Holland, but these fevers had a different nature. Those fevers, coming from ships, jails, or hospitals, came from living bodies, often in crowded areas. Yellow fever came exclusively from the atmosphere. Rush’s solution for preventing yellow fever was to clean up the city. Channeling Paracelsus, he wrote that, “To every natural evil, Heaven has provided an antidote, and it is not more certain, that houses are preserved from the

²²⁰Rush, *Observations Upon the Origin*, 13 and *Oxford English Dictionary* of Effluvia: “An ‘exhalation’ affecting the sense of smell, or producing effects by being received into the lungs. In mod. popular use chiefly: a noxious or disgusting exhalation or odour.”

²²¹Rush, *Observations Upon the Origin*, 13.

²²² Rush, *Observations Upon the Origin*, 13, note at the bottom of the page.

²²³ Rush, *Observations Upon the Origin*, 13.

destructive effects of lighting by metal conductors, than our cities might be preserved, under the usual operation of the laws of nature, from the Yellow Fever by *cleanliness*.”²²⁴

Yellow fever brought Rush into conflict with the medical community and caused him personal anguish.²²⁵ In his autobiography, Rush included another retrospective of his experiences in the epidemic. Rush was clearly resentful of his peers and the College of Physicians in Philadelphia regarding their conduct in 1793. He speculated that his colleagues secretly dissuaded students from attending his lectures and that there was “secret hostility” towards him and his medical theories.²²⁶ Overall, Rush viewed his work on yellow fever as extremely successful:

The success which attended the remedies which it pleased God to make men the instrument of introducing into general practice in the treatment of the fever of 1793 produced a sudden combination of all who had been either publicly or privately my enemies, and the most violent and undisguised exertion to oppose and discredit those remedies.²²⁷

²²⁴Ibid., 26.

²²⁵Paul E. Kopperman writes of Rush personal difficulties, “He was high strung and combative, easily offended and slow to forgive. During the course of the epidemic he published several letters attacking physicians who followed methods other than depletion and he showed little collegiality toward them, providing at most a patina of respect. He had some allies, but he felt betrayed by friends who adhered to other practices and he also feared that rival methods would win over the people, thousands of whom would die in consequence.” From pg. 567.

²²⁶Rush, *Autobiography*, 96.

²²⁷Rush, *Autobiography*, 97.

Rush wrote that he shouldered all of this criticism in a heroic and self-sacrificing manner for the people of Philadelphia. He said that,

Never did I feel less unkindness to a fellow creature than at this time. I considered myself as destined to the Hearse, and ambition of course held forth no prospects of future advantages from a victory in a contest with my brethren. No, citizens of Philadelphia, it was for your sakes only I opposed their errors and prejudices, and to this opposition many thousands people owed their lives. Had I consulted my own interest or reputation I would have concealed my remedies, instead of communicating an account of them to the apothecaries who derived large sums of money from the sale of them.²²⁸

Rush was wholeheartedly interested in defending his actions of the epidemic and in explaining the good that he brought the people of Philadelphia. According to Rush, his biggest offense was not consulting with his peers. The College of Physicians could not stomach Rush's idea that the fever originated in America. Most of the physicians in the College thought that the disease originated from the West Indies or Barbados.²²⁹

However, Rush thought he had people's support. Rush chose to tender his resignation to the College after the yellow fever had subsided. However, in a final act of passive-aggressive self-justification, he included with his resignation letter a copy of Sydenham's

²²⁸Rush, *Autobiography*, 97.

²²⁹Rush, *Autobiography*, pg. 98, note 38 and see Rush's fully body of work on Yellow Fever.

edited works.²³⁰ Sydenham's work supported Rush's humoral beliefs about nature and fevers, such as the theory that miasmata caused the fever.²³¹

Yellow fever returned to Philadelphia in 1797, and it gave Rush an opportunity to mend personal relationships by attending to patients with physicians who formerly did not agree with him. But Rush concluded his autobiographical entry about yellow fever complaining that old and new enemies personally attacked him.

Rush's view of the causes of yellow fever was rooted in neo-Hippocratic and humoral pathological theories of medicine, and his cure for yellow fever was centrally rooted in controlling the fluids of the body, specifically the blood. Rush defended his treatment of fevers in *A Defense of Blood-Letting As a Remedy for Certain Diseases*, republished in *Medical Inquiries and Observations* in 1796 in Volume IV.²³² He wrote *A Defense*, in part, as a way to protect his reputation against attackers who did not agree with his theories about bloodletting as a useful remedy.

2.7 Humoral Interventions and Chemistry: Using the Lancet

In *A Defense of Blood Letting*, Rush first had to introduce all of the common remedies for fevers in order to dismiss the usefulness of each compared to bloodletting. Generally, physicians treated fevers by removing the external stimulus acting on the body

²³⁰Rush included his own edited volume of Sydenham's work. See Rush, *Autobiography*

²³¹Benjamin Rush, *Autobiography*, pg. 98, note 39.

²³²Benjamin Rush, "A Defense of Blood-letting as a Remedy for Certain Diseases," in *Medical Inquiries and Observations*, Volume IV (1796): 183-254.

that was causing the fever. The maxim was equalization, or achieving the golden mean (which was a Greek maxim for balance and evenness in the body.)²³³ Rush explained that the “exciting action” could afflict many parts of the body including the stomach, bowels, skin, nerves, and even the muscles.²³⁴ The reduction of the stimulation of the body reduced the action on the blood vessels. The primary methods of treating a fever included bleeding, purging, sweating, vomiting, salivation (usually brought about by mercury), and blistering.²³⁵ Rush’s remedies for arresting the fluids of the body are included in the table below.²³⁶

Table 2.1 Blood Letting Table

External Stimulant (usually to an excessive degree)	Solution
Heat	Cold air, cold water, ice
Food	Abstinence
Light	Silence and darkness
“invigorating passion”	Moderate fear
Motion	Rest
Acrimony	Diluted drinks and cleanliness

²³³Moderation in all things was the montra of the Greek physicians. See Porter, page 64.

²³⁴Rush, “A Defense,” 183

²³⁵Rush, “A Defense,” 183-184.

²³⁶Table was abstracted from the second section found on page 184 of Rush, “A Defense.”

Inflammation was a disease that wreaked havoc on the body and often distorted the vital processes. Physicians treated the condition of fever with the methods listed in the table above. However, medicines that sedated the patient were also applied, which included nitre, neutral salts, antimony, sugar of lead, foxglove, and sweet oil.²³⁷ The physician had many stimulants at the ready to correct the internal system, too. These stimulants included liquor, volatile alkali, empyreumatic and aromatic oils, opium, aether, bark, bitters, mercury, and pure air.²³⁸ The physician had medications that worked as “external stimulants,” including baths of different temperatures, blistering, cataplasm (which included those made of onions, garlic and mustard applied to the feet), caustics, and boiling water.

Rush argued that bloodletting needed to be defended. Some physicians during the outbreak of yellow fever questioned Rush’s copious and seemingly indiscriminate use of bloodletting.²³⁹ Bloodletting treated the inflammatory state of fever. Fever was by its very nature either the “suppression” or “diminution” of the discharges of the body.²⁴⁰ These discharges included those from the pores, bowels, or the kidneys.²⁴¹ Fevers, like most diseases in Rush’s conception of medicine, resulted from some external force acting upon

²³⁷Rush, “A Defense,” 99.

²³⁸Rush, “A Defense,” 185

²³⁹See Rush, *Autobiography*, and his fully body of work about bloodletting and Yellow Fever.

²⁴⁰Rush, “A Defense,” 186.

²⁴¹Rush, *A Defense*, 186.

the blood vessels. The reaction of the vessels was disease.²⁴² The sufferer of a fever underwent many symptoms or “states,” potentially including diminished pulse, sleepiness, delirium, rapid pulse, and pain.

Rush justified bleeding as a natural remedy. He admonished critics of bloodletting, saying, “Let no one call bleeding a cruel or unnatural remedy.”²⁴³ Rush discussed natural bleeding in the body as ineffective and harmful. He wrote of the female nature and her natural bloodletting: “She frequently pours the stimulating and oppressing mass of blood into the lungs and the brain; and when she finds an outlet for it through the nose, it is discharged either in such a deficient or excessive quantity, as to be useless or hurtful.”²⁴⁴ Rush, as both a man and a physician, could transcend the natural bleeding which “...in the use of it she seldom affords much relief.”²⁴⁵ “Artificial bloodletting,” allowed the physician to “regulate its quantity by the degrees of action in the blood-vessels.”²⁴⁶ The physician carefully regulating the bleeding of a patient was far safer than a patient bleeding from some other cause because the physician did not take large amounts of blood and did not take the blood from the stomach and the bowels, which was quite dangerous. Nature was a bit reckless in Rush’s eyes. Ironically, Rush advocated the physician to take a lot of blood as well, but in his mind the physician was still careful.

²⁴²Rush, “A Defense,” 187.

²⁴³Rush, “A Defense,” 187.

²⁴⁴ Rush, “A Defense,” 188.

²⁴⁵Rush, “A Defense,” 187.

²⁴⁶Rush, “A Defense,” 188.

The physician practiced the same type of analytical scrutiny and precision advocated in Lavoisier's chemistry.

Bloodletting acted directly in "...reducing the force of the sanguiferous system[,]" and did not diminish the system but provided it strength by removing "debility."²⁴⁷ The remedy regulated the pulse and bowels, "checks nausea and vomiting," and allowed mercury to work quicker.²⁴⁸ The pulse could be reduced from 176 "strokes" to 140 strokes by removing ten ounces of blood.²⁴⁹ Bleeding encouraged the body to sweat, removed the symptoms of dryness and blackness from the tongue, treated pain, and removed heat from the skin, the last of which was a key, as Rush lamented, "...heat of the skin, and the burning heat in the stomach, so common and so distressing in the yellow fever."²⁵⁰ Bloodletting cured diarrhea and "tenesmus" as well.²⁵¹ It could treat many other diseases, including cough, consumption, jaundice, abscesses of the liver, and dropsy of various types.²⁵² Bloodletting was especially effective against yellow fever, as Rush cited a woman who had her fever cured by seven treatments.

²⁴⁷Rush, "A Defense," 188.

²⁴⁸Rush, "A Defense," 189.

²⁴⁹Rush, "A Defense," 189.

²⁵⁰Rush, "A Defense," 190.

²⁵¹ Rush, "A Defense." *The Oxford English Dictionary* described tenesmus as "A continual inclination to void the contents of the bowels or bladder, accompanied by straining, but with little or no discharge."

²⁵² Rush, "A Defense," 191.

Fevers often “terminate[d]” into gangrene or “chronic states.” “Copious bleeding” prevented fever from turning into these.²⁵³ Bleeding allowed medicines to work quicker, especially medicines like Jesuit’s bark and tonic water, by removing the “morbid action” of the blood vessels and allowing the medicine to dominate the system and return the body to health.²⁵⁴ Bleeding prevented patients from relapsing into fever. Rush’s account implied that bleeding removed blockages that were preventing medicines from being effective or cleared obstacles that prevented the system from returning to its natural state.

Rush then proceeded to dismiss the objections to bloodletting, some of which involved circumstances of treatment. The first circumstance was bleeding people in warm weather. Rush dismissed this worry out of hand. He cited historical precedence going back to Galen. Empirically, he knew of no reasons for such a prohibition. The same prohibition against bleeding people born in warm climates was similarly not applicable. Rush responded that people born in warm climates needed bleeding the most. Prohibitions against bleeding the weak were not valid. Citing Hippocrates, Rush wrote that, “This sameness of symptoms from opposite states of the system is taken notice...”²⁵⁵ Depletion was the proper method of treatment, and bleeding was the best method of depletion. Rush offered up a metaphor to bloodletting’s usefulness in cases of weakness: “Thus it is more necessary to throw overboard, a large part of the cargo of an

²⁵³Rush, “A Defense,” 193.

²⁵⁴Rush, “A Defense,” 194.

²⁵⁵Rush, “A Defense,” 197.

old and leaky vessel in a storm, than of a new and strong one.”²⁵⁶ Bleeding was the best way to solve a weak constitution.

Children and infants should be bled as well, despite objections. Dr. Sydenham bled children, and Rush imitated his hero. Children suffered from inflammatory diseases, and bleeding was the best way to return the body to a healthy state. Rush discussed bleeding his oldest daughter when she was six weeks old. He bled his youngest son two times before the boy was two months old. Rush believed that he saved both his children from danger through these actions. The elderly needed to be bled as well, and neglecting to do so had cost some elderly people their lives.²⁵⁷

Rush believed that women should be bled during menstruation. He advocated bleeding because, “The system during this period is plethoric and excitable, and of course disposed to a violent degree of inflammatory fever, from all the causes which excite it.”²⁵⁸ Rush implied that women’s bodies could not regulate themselves and needed a physician’s precise bleeding; “Formerly the natural discharge from the uterus was trusted to, to remove a fever contracted during the time of menstruation. But what relief can the discharge of four or five ounces of blood from the uterus afford, in a fever which requires the loss of 50, or perhaps of an 100 ounces to cure it?”²⁵⁹ Women needed bleeding during

²⁵⁶Rush, “A Defense,” 197.

²⁵⁷Rush, “A Defense,” 198-199.

²⁵⁸Rush, “A Defense,” 199.

²⁵⁹Rush, “A Defense,” 199.

pregnancy as well. Pregnancy, by the “distention” of the uterus, called for bleeding in order to relieve inflammation.

Rush expanded his discussion of pregnancy, and many other topics, in the summary of his career, *Medical Inquiries and Observations*. In his expanded section on the justification of bleeding, he framed pregnancy as a disease caused by a blockage. He discusses “parturition,” which he framed as the disease of pregnancy. Rush defined parturition as “...a higher grade of disease than that which takes place in pregnancy. It consists of convulsive or chronic spasms in the uterus, supervening its inflammation, and is accompanied with chills, heat thirst, a quick, full, tense, or a frequent and depressed pulse, and great pain.”²⁶⁰ Rush explained that some divines theorized that the “disease” came about because of woman’s original sin and displeasing of God. However, Rush wrote that some women did not experience the “curse” of pain in pregnancy in areas like Brazil, Calabria, areas in Africa, and some parts of Turkey.²⁶¹ These women reduced their pain by purging their systems often with oils during pregnancy. Rush himself was not convinced that women needed to experience pain during pregnancy, and wrote, “I was induced to believe pain does not accompany child-bearing by an immutable decree of Heaven.”²⁶² Bloodletting “relieves this pain” and other “spasms” and relaxed the muscles. The practice was so successful that even midwives “of both sexes” embraced the practice in Philadelphia.²⁶³ He further implied that that pregnancy, almost like a stone,

²⁶⁰Rush, *Medical Inquiries and Observations*, Vol. 3, pg. 353.

²⁶¹Rush, *Medical Inquiries and Observations*, Vol. 3, pg. 353.

²⁶²Rush, *Medical Inquires and Observations*, Vol. 3, pg. 353.

²⁶³Rush, *Medical Inquires and Observations*, Vol. 3, 353-354.

was a problem of blocked fluids of the body, and in this case specifically the blood. Rush speculated that,

The severity of the pains in these cases created a disease, which prevented internal congestion in the womb. Bleeding, by depleting the uterus, obviates at once both disease and congestion. Its efficacy is much aided by means of gylsters, which, by emptying the lower bowels, lessen the pressure upon the uterus.²⁶⁴

Bleeding returned any system to normalcy by removing pain. Rush implied that pregnancy, like yellow fever, was a disease of the body experiencing irritation.

Rush favored bleeding because it was precise and certain compared to other interventions like purging, vomiting, and blistering. Blistering removed inflammation from parts of the body that were “seats” of inflammation, it did not balance the system like bloodletting did.²⁶⁵ Physicians simply could not rely on blisters for relief and balance of the system. Rush wrote that “To depend upon them in cases of great inflammatory action, is as unwise, as it would be to attempt to bale the water from a leaky and sinking ship by the hollow of the hand, instead of discharging it by two or three pumps.”²⁶⁶ Bloodletting also set itself apart from other interventions because anyone, rich or poor, could perform the remedy upon themselves, making it valuable during dangerous epidemics when physicians were in short supply.²⁶⁷

²⁶⁴ Rush, *Medical Inquires and Observations*, Vol. 3, 355.

²⁶⁵Rush, *A Defense*, 219. I have retuned back to the original, published version.

²⁶⁶Rush, *A Defense*, 219.

²⁶⁷Rush, *A Defense*, 221.

As a humoral physician, Rush prescribed how much blood a patient should lose, especially those suffering from “inflammatory fever.”²⁶⁸ Rush estimated that a normal person contained between twenty-five and twenty-eight pounds of blood. Since analytical chemistry at the time places an emphasis on weighing substances in order to define and understand them. Rush, being a chemist, was likely influenced by that form of analysis.

More blood could be removed when the person was sick than when they were well. When people were well, they needed all of their blood, but when they were sick, they needed much less than the “natural amount.” Rush estimated that they only needed about four or five pounds in order “...to keep up an equal and vigorous circulation.”²⁶⁹ Rush analogized that,

Thus very small portions of light, and sound, are sufficient to excite vision and hearing in an inflamed, and highly excitable state of the eyes and ears. Thus too, a single glass of wine will often produce delirium in a fever in a man, who, when in health, is in the habit of drinking a bottle every day without having his pulse quickened by it.²⁷⁰

Small amounts of vital fluids were extremely powerful and life giving; and Rush knew that bloodletting could change the constitution drastically.

Drawing blood depended on precision. Clumsy and ignorant persons did not know enough about blood to draw it carefully, which led to bloodletting’s poor reputation.

²⁶⁸Rush, *A Defense*, 234.

²⁶⁹ Rush, *A Defense*, 234

²⁷⁰Rush, *A Defense*, 234-235.

(However, Rush also proclaimed the ability of everyman to practice bloodletting as a virtue of the remedy). One physician took three hundred and twenty ounces of a patient's blood in a hospital over the course of twenty days, and another woman was bled one thousand and twenty times over the course of nineteen years to cure hysteria, but Rush was never attributed with any cases where the patient expired because of excessive bloodletting. In fact, many of the extreme examples of bloodletting to which Rush referred did not end with the death of a patient. Rush never worried about how much blood was taken because he believed, through experiential and historical knowledge, that blood regenerated quickly. The physician should never feel trepidations toward bleeding the patient. Bleeding a patient "moderately" was a half-hearted effort to cure the patient, he believed, and was often dangerous: "There are, it has been said, no half truths in government. It is equally true, that there are no half truths in medicine. This half-way practice of moderate bleeding, has kept up the mortality of pestilential fevers in all ages, and in all countries."²⁷¹

Physicians needed to complete the job. Rush likened bleeding to the cleansing of the bowels in the distressing condition of colic. The physician would not stop purging before the bowels were fully opened, so why would he quite the bloodletting prematurely?²⁷² Rush was so comfortable bleeding patients that he was not bothered when the patient became pale or "fainty."²⁷³ Bleeding could be used as a palliative

²⁷¹Rush, *A Defense*, 237.

²⁷²Rush, *A Defense*, 238.

²⁷³Rush, *A Defense*, 238.

measure as well, “It belongs to this remedy, in such cases, to ease pain, to prevent convulsions, and compose the mind, to protract the use of reason, to induce, sleep, and thus to smooth the passage out of life.”²⁷⁴

2.8 Rush’s Death

Ironically, Rush himself passed away from a fever on April 19, 1813. Rush complained of experiencing a chill with his tea on April 14 after visiting his patients. True to his theory of medicine, Rush insisted on being bled to relieve his symptoms. Ten ounces of blood were withdrawn from Rush’s body. Dr. Dorsey was then called for to treat Rush. The two physicians disagreed about the disease Rush was suffering: Dorsey believed that Rush had typhus, while Rush believed that he had pulmonary tuberculosis. Dr. Phillip Physic was called in next and drew three ounces of blood from Rush through cupping.²⁷⁵ Though Rush had brief periods of relief, he passed away at five o’clock on April 19. Rush’s death was lamented by physicians around the United States as well as political leaders.²⁷⁶

In summarizing Rush’s life and medical theories, he both lived and died by the state of his fluids and the lancet. Understanding the fluid of the body was key to Rush’s medical philosophy: a better understanding of those fluids of the body, especially blood,

²⁷⁴Rush, *A Defense*, 241.

²⁷⁵Binger, *Revolutionary Doctor*, 294-296.

²⁷⁶These mourners included Thomas Jefferson, Thomas Cooper, John Adams, and many others. Binger lists a letter from Jefferson to Thomas Cooper hinting at Jefferson’s affection and lament for Rush; but the letter was critical to Rush’s humoral medical theories.

could provide relief from anything external or internal that might be irritating the body. Relieving irritation restored the body back to its natural balance. Chemistry was part of Rush's analytical project and a new tool in understanding an old, but not static, theory of medicine based on the humors. In his practice, whether it was practicing medicine during the Revolutionary War, or treating sufferers of yellow fever, Rush brought forth elements of chemical analysis and humoral pathology to explain and intervene on vexing medical problems at the turn of the nineteenth century.

2.9 Conclusion

Benjamin Rush was a first and foremost a chemically minded physician. The robust chemical education he received in Europe directed his medical investigations and treatments of diseases. His interest in chemistry was incorporated into his desire for the abolition of slavery, as he used chemical explanations to explain differences in humans. He explained African's dark skin color as not a mark of biological difference, but as that of sickness that needed to be cured. Dark skin color was produced by a fluid problem in the body, like other diseases that Rush encountered.

Rush treated cholera sufferers during his time in the Medical Department of the Continental Army. Useful interventions were those that balanced the fluids of the body, such as excess blood in sufferers. However, removing blood from the body was not half hazard, or done without precision. Remove of the blood from the body was performed by physicians carefully, with similar care as analytical chemist measuring substances. Rush laid out specific amounts to remove depending on the cause of the patient's suffering.

Chemical remedies were applied to the body's fluids in order to remove parasites. Worms were destroyed by chemistry, as Rush could apply specific medicines to destroy worms in the body. The more experience that Rush gathered by successfully treating illness with chemistry, the more his medical thinking hinged on controlling and measuring the fluids of the body. Humoral theory, or a theory that based on explanation of health in the balance of the body's fluids, was seen as a viable theory again because of its newly found chemical support. Rush's interest in chemistry and its potential application to medical treatments would be championed by Thomas Cooper. Cooper, a British medico-chemist immigrated to South Carolina by way of Pennsylvania. He shared many of the same views of Rush, especially in the potential to revive humoral pathology by using the new chemistry.

CHAPTER 3

“[T]HE INFANCY OF HERCULES”:

THOMAS COOPER’S MEDICO-CHEMICAL WORLDVIEW

3.1 Introduction

On November 5, 1818, Thomas Cooper delivered a speech to the University of Pennsylvania, where he briefly taught chemistry. He later published his discourse in honor of the trustees at the University of New York, who had awarded Cooper an honorary doctorate of medicine. In keeping with his personality, Cooper’s speech was aggressive and provocative. Without fear of offending his audience, he makes clear in his speech the changes he believes necessary in medicine. He asserted that:

Professors and practitioners of medicine, in every part of Europe, are now alive to the claims of chemistry, too imperious in its present improved state to be neglected. The time has arrived, when, however reluctantly, we must retrace our steps : nor is it difficult to shew that even the humoural pathology, stands upon much higher ground than those who smile at the application of chemistry to medicine, are willing to allow, or able to deny.²⁷⁷

²⁷⁷Thomas Cooper, *A Discourse on the Connexion Between Chemistry and Medicine* (Philadelphia: Abraham Small, 1818), 18.

Cooper attempted to integrate and build upon previous theories of humoral pathology of chemistry from William Cullen and other thinkers, including fellow Philadelphian Benjamin Rush. He remarked:

Such also was the case with the medical school of Philadelphia, the leading feature of Dr. Rush's theory being, that pathology is reducible to the morbid action of the living solids. The humoural pathology, with its cacochymia, lentors, fermentations, and spiculae, could no longer be supported by the imperfect chemistry of the day.²⁷⁸

Rush was a physician who framed his theories regarding solid elements in the body with humoral pathology.²⁷⁹ But Cooper had grand designs in arguing the prominence of humoral pathology; he saw it as comprehensive theory of diseases.

Cooper's scientific writings, like his political writings, reflected his reputation for being bombastic and pugnacious. Historians have previously written about Cooper as a Southern rights fetish figure, an Englishman who immigrated to America and took up the Southern cause during the 1830s.²⁸⁰ Cooper had fled his native England because of his Jacobin leanings during the French Revolution.²⁸¹ Public criticism of President John

²⁷⁸Cooper, *A Discourse*, 18.

²⁷⁹See the chapter on Rush in this dissertation.

²⁸⁰Freehling, *The Road to Disunion I: Secessionists at Bay*, 256. The American Civil War historian William Freehling writes that Cooper was the "Professor of Revolution" and that "He had come to crusty old Carolina, apparently the wrong place for a reckless hothead, at the right time, when the tariff and colonization crises were simultaneously occurring." Prior to the American Civil War, Cooper was foremost a "nullifier." Nullifiers were a group of Southern radicals who believed that they could "nullify" Federal law when it conflicted with State law or rights.

Adams landed Cooper in jail under the Alien and Sedition Acts. Cooper was a magnet for other controversial personalities; he had friendships with radical thinkers like Joseph Priestley and corresponded with Thomas Jefferson. He had been publically criticized by Edmund Burke in Parliament.²⁸²

Cooper's personality aside, he was writing in a very difficult period of suffering and disease, where patients perished in high numbers even under a physician's care.²⁸³ Yellow fever was a deadly and mysterious scourge at the turn of the eighteenth century. Charles Rosenberg writes of Jacksonian America as a period where physicians were trying to improve public health despite poorly understanding epidemics. Some physicians, even more radical than Cooper, advocated that the only way to heal a patient was to abandon "traditional therapies," and rested their hopes on the natural powers of the body to heal itself. Some physicians thought that "clean streets, airy apartments, [and] a pure supply of water, were certain safeguards against epidemic disease." While Cooper agreed that external factors were important, the balance of the internal body was more

²⁸¹Historians like Dumas Malone have carefully chronicled the extremes of Cooper's character, religion, and politics. Dumas Malone, *The Public Life of Thomas Cooper (1783-1839)* (New Haven: Yale University Press, 1926). See also endnote 27 on page 29 in Daniel L. Dreisbach ed., *Religion and Politics in the Early Republic: And the Church-State Debate* (Lexington: University Press of Kentucky, 1996). Cooper is also known as an enemy of religious institutions, as he took many controversial stances on books of the Bible and gave public lectures at South Carolina College. His lectures often criticized the clergy or challenged canonical beliefs about Biblical timelines. He ultimately lost his position at South Carolina College because of his controversial religious stances and missed a professorship at the University of Virginia because the clergy were so deeply opposed his religious beliefs. Throughout his life, Cooper had a habit of irritating authorities.

²⁸²See note above.

²⁸³But what time period is this not the case. Historians of medicine can easily point to the heterogeneity of scientific responds to epidemics in the twentieth century.

critical. In his public lecture of 1818, Cooper argued that chemistry was the key to unlocking the secrets of the body by revealing the fluid processes of the body. A link existed between the solid parts of the body and the fluids of the body. The makeup of the fluids of the body stimulated the solid parts of the body. The compositions of the fluids were important in stimulating the solids to action. But the body could produce disease (including inflammation) by the blockage of bodily fluids, from calculi produced in the body, or blockages from nature. Cooper framed his argument in humoral pathology, since the theory, though much different than ancient ascendants, argued for the roots of disease based on the blockage of the body's fluids, or humors. Though Cooper criticized the idea of a panacea of diseases, he argued for his own de facto comprehensive theory.

Cooper's rhetoric in his speech is important to examine because it shows an aggressive and confident medico-chemist arguing for the return of humoral pathology, the value of ancient language, and a place in medical history for himself. Ancient authorities, or Cooper's interpretation of those authorities, were channeled to support his arguments.²⁸⁴

Rhetoric in American medicine has not received the same attention as early modern European medicine.²⁸⁵ Cooper's ideas about the safeguarding of the public from

²⁸⁴The first lines in his preface were directed at Benjamin Rush, who was critical of classical learning. Rush was a target because Cooper felt that Rush's stance hurt a silo of support for humoral pathology. Cooper swipes at "DR. RUSH, whose talents, industry, and acquirements, gave him deservedly a very high standing among his fellow citizens, set his face against the utility of classical learning in what he deemed the present improved state of education."

²⁸⁵Stephen Pender and Nancy S. Struever eds., *Rhetoric and Medicine in Early Modern Europe* (Burlington, VT: Ashgate Publishing Limited, 2012).

diseases run along the same vein as his chemistry. From his lecture, Cooper promotes his own ideas for American medicine that are on par with the chemically based medicine of Europe, and similarly rooted in humoral pathology.

3.2 Thomas Cooper's Medical and Chemical Training

Early in Cooper's life he showed an interest in chemistry. Cooper's father was a brick maker, and Cooper possibly picked up some chemical knowledge from him, but Cooper was primarily a self-taught chemist who simply read widely.²⁸⁶ Dumas Malone noted that while Cooper was living in Manchester, he published a work on bleaching, and Malone thought that, "It was probably his [Cooper's] interest in chemistry which led him to become a member of the firm of Baker, Teasdale, Bridges, and Cooper, calico-printers at Raikers, near Bolton and about ten miles from Manchester."²⁸⁷ There is also some evidence that Cooper received some chemical education while he was at Oxford University, but it is unclear if he took a degree there.

Cooper's professional life included time as a barrister, judge, physician, chemist, and college president. Cooper also engaged the larger intellectual world by participating in the Manchester Literary society during the late eighteenth century. Cooper chose to leave England during the early nineteenth century and traveled to America to live with

²⁸⁶Pender and Struever, *Rhetoric*, 6.

²⁸⁷Pender and Struever, *Rhetoric*.6.

chemist and theologian Joseph Priestley. The men shared an intimate friendship, and Cooper later edited Priestley's memoirs.²⁸⁸

Cooper's work as a chemist picked up when he lost his judgeship after his arrest under the Alien and Sedition Acts. By 1811 Cooper had received an appointment to the chair of chemistry at Carlisle (now Dickinson) College. Cooper had many friends who were impressed by his chemical knowledge, including Benjamin Rush, who enthusiastically voted for his appointment. Unfortunately, Cooper's personality was problematic, even to his friends. He left the institution in 1815, apparently to the benefit of all parties involved.

By December 6, 1815 Cooper had taken up the position of chair of chemistry and mineralogy at the University of Pennsylvania. In 1818 he sought appointment in the medical department as professor of chemistry, but he lost the appointment to another chemist, Robert Hare. Cooper then left Pennsylvania to seek out opportunities in the South. Cooper's friend and non-conformist religious ally, Thomas Jefferson, wanted to get Cooper appointed as a professor at his newly established University of Virginia. Cooper was elected as a professor of chemistry there in 1817, but, although Jefferson, Cooper, and the botanist Joseph Correa de Serra were all excited about Cooper taking the position, the clergy of Virginia banded together to prevent the appointment.

He found a one-year appointment as professor of chemistry at South Carolina College in 1819 and had a full-time permanent position by 1820. In May of that year, after the death of Jonathan Maxcy, president of South Carolina College, Cooper became

²⁸⁸Joseph Priestley, *The Memoirs of Joseph Priestley*, ed. Thomas Cooper (London: E. Hemsted, 1807). Priestley's son and William Christie also contributed to the memoirs.

pro-tempore president of the institution, and he accepted the position of president in December of 1821. Throughout these years, Cooper was also busy editing and contributing to the chemical literature of the early nineteenth century. With all of his chemical work, Cooper became convinced that chemistry was indispensable to medical education. Thomas Cooper wanted to improve the quality of medicine and sought to do so by suggesting changes to medical education. According to Cooper, a good physician was a good chemist.

3.3 Chemistry, Medicine, and a Humoral Pathology

Cooper was a physician as well as a chemist. He had practiced without charging fees in England prior to immigrating to Pennsylvania. While he lived in Pennsylvania, he again practiced medicine for free and without a formal degree. Cooper received an honorary degree from the University of New York in 1817. While at the University of Pennsylvania he gave an introductory speech, as was the custom for starting a professorship, which he later published as: *A Discourse on the Connexion Between Chemistry and Medicine*.²⁸⁹ He began by historicizing the destruction of humoral pathology. Humoral theory fell apart because of changing ideas in medical theory and the failure of the chemistry that supported it. Cooper said that, “The humoral pathology, with its cacochymia, lentors, fermentations, and spiculae, could no longer be supported by the imperfect chemistry of the day.”²⁹⁰ He wanted to change the previous perception of

²⁸⁹Thomas Cooper, *A Discourse on the Connexion Between Chemistry and Medicine* (Philadelphia: Abraham Small, 1818).

²⁹⁰Cooper, *A Discourse*, 18. The *Oxford English Dictionary* defines “cacochymia” and “lentors.” Cacochymia comes from the adjective form of “cacoethic” meaning

chemistry's role in medicine as well. Historically, the motto that used to define chemico-medical ideas in Edinburgh, London, and Philadelphia had been "Chemiae in medicina, fere' nullus est usus," which translates, "Chemistry in medicine is almost of no use."²⁹¹ It could also be translated as "almost none is used."

A generation of doctors had had this idea ingrained in their minds. But chemistry had changed and, according to Cooper, had become "indispensable" to physicians.²⁹² Physicians needed to revive and rethink older theories in order to move medicine forward. As he said, "The time has arrived, when, however reluctantly, we must retrace our steps: nor is it difficult to shew that even the humoral pathology, stands upon much higher ground than those who smile at the application of chemistry to medicine, are willing to allow, or able to deny."²⁹³

Medical theory at the time focused on the "living solids" and not on the "fluids of the body." Cooper planned to dismiss this claim logically through his speech in order to set up the conclusion that medicine must return to humoral pathology. First, Cooper acknowledged that there were some difficult issues with this stance. He noted that "animal fibre," which included the nerves, muscles, etc., did not fit any chemical or mechanical theory of medicine.²⁹⁴ But there were fluids produced by morbid actions from

"Obstinate or malignant." And "lentors" means blood or "Of the blood, etc.: Clamminess, tenacity, viscosity."

²⁹¹Cooper, *A Discourse on the Connexion*, 19.

²⁹²Cooper, *A Discourse*, 19.

²⁹³Cooper, *A Discourse*, 19.

²⁹⁴*Oxford English Dictionary*

the “fibre.”²⁹⁵ He acknowledged the idea, too, of sympathy between the solid parts of the body, examples of which include headaches causing indigestion or pain in the thigh caused by kidney or ureter issues. Cooper could not deny “hundreds” of other morbid sympathies. Cooper’s counter claim was that humoral theory does not have to explain every “morbid phenomena” to be valid.²⁹⁶ The real reason for humoral pathology’s rejection, according to Cooper, was that theorists did not understand it completely.²⁹⁷ He claimed that the current “doctrine of morbid action” would also sink under the requirement of explaining all medical phenomena. He admitted that, “...there is too much truth both in the one doctrine and the other, to reject either altogether.”²⁹⁸ The argument was that there is a place both for humoral pathology and for the doctrine of morbid action.

He explored gout to argue the point that it was foolish to focus on just one explanation for a given ailment. Physicians thought that morbid acrimony of the body’s fluids explained gout. Cooper noted that, back then, bleeding (venesection), cathartics, and diaphoretics (drugs to make patients perspire) failed to treat gout.²⁹⁹ Morbid acrimony seemed logical as the cause of gout because of the observation of the lithat of soda (or chalk stones). Another possible cause was morbid secretions producing acid,

²⁹⁵Cooper, *A Discourse*, 19.

²⁹⁶Cooper, *A Discourse*, 20.

²⁹⁷Cooper, *A Discourse*, 20.

²⁹⁸Cooper, *A Discourse*, 20.

²⁹⁹*Oxford English Dictionary*

leading to inflammation. A third idea was that lithic or uric acids built up in the body because of people drinking acidic drinks. Cooper highlighted the reasonableness of the uric acid causing gout because there was a lot of urea secreted in “gouty diathesis” (predisposition of the patient’s constitution towards gout). Overloading the stomach and bowels was yet another proposed cause of gout. Cooper thought this explanation also useful because he felt that temperance in diet prevented fits of gout.

Cooper’s direct and confrontational personality seemed to affect his position in medical science as aggressively as it did his political and religious positions. In this speech, Cooper went on to argue that there must be multiple reasons for disease and no single reason was the exclusive cause. He said that,

Intolerance is the bane of improvement. Intolerance in politics, intolerance in religion, intolerance in medicine. Those who deem themselves entitled to the patent right of the system, will admit to no competitor and no sharer. Everything must be done and explained by the *sole* instrumentality of their exclusive method.³⁰⁰

Cooper’s speech attacks medical theory because it was so rigid. His assertive personality gave the audience a clear picture of his critique.

The problem with system makers, Cooper underscored was “exclusiveness.” He was especially skeptical of new theories because they tended to overpromise. He wrote that, “New theories explain everything: new remedies are panaceas: hence the propensity in all of us, to reject what is useful from its occasional alliance with unfounded

³⁰⁰Cooper, *A Discourse*, 21.

pretension.”³⁰¹ Cooper had no trouble accepting information that did not fit the theoretical stance in the search for something that was useful. Utility seemed to be the key to Cooper’s medicine. And Cooper did not seem aware of the irony that he was also a system maker, simply advocating for the merging of an older system with a new one. Cooper asserted that the humoral pathology was special, above other theories. He argued that, “the humoral pathology, which admits that the causes of disease may exist in the fluids as well as in the solids of the body, stands, as I suppose, upon ground too firm to be shaken.”³⁰² Humoral pathology was more logical and explicative, in Cooper’s mind, than other theories.

3.4 The Rhetoric of Humoral Pathology

He proceeded to lay out several chemical propositions to prove the logic of humoral theory through chemistry. Cooper appealed to chemical theorists and surgeons, like Sir Everard Home and John Hunter. The value in exploring Cooper’s speech is in the logical propositions nineteenth-century chemists followed to conclude that they must return to humoral pathology. Cooper formed his argument by making twelve claims (technically thirteen, as he adds another claims after the twelfth).³⁰³

Cooper asserted that there was a link between the solid parts of the body and the fluids of the body. The makeup of the fluids of the body stimulated the solid parts of the body. The compositions of the fluids were important in stimulating the solids to actions.

³⁰¹Cooper, *A Discourse*, 21.

³⁰²Cooper, *A Discourse*, 21.

³⁰³Cooper, *A Discourse*, 22-24.

The fluids of the body caused the stimulation of the solid parts of the body. This process could occur through involuntary motion, but the fluids of the body were continually transforming materials. For instance, blood was produce from chyle, and chyle was produced from the chime as a result of food being transformed by the pancreas and liver.³⁰⁴ (Recall from humoral theory, the liver was where the food vitalizes the blood).³⁰⁵ The fluids of the body had to control the solids because the process could be reproduced through artificially stimulation by chemicals. For instance, all saline chemical substances, acids, and earth metals worked to stimulate the body. Cooper also added gasses, “common” electricity, and galvanism to the list because they act like fluids as well.³⁰⁶

The body continually decomposed, and chemical changes of body took place in acid, alkaline, and neutral substances. The nature of the food taken into the body characterized the saline “stimulates” in the body’s fluids. The urine and perspiration indicated the character of the body’s fluids, especially the acidity or alkaline nature of these fluids. These fluids or stimuli combined with the blood throughout the body.³⁰⁷ Blood not only stimulated the solid parts of the body; it also could be stimulated by and stimulate the fibers (vascular) of the body.³⁰⁸ Citing the work of Everard Home, John

³⁰⁴Cooper validates his claim by citing the examples of “sea scurvy” and gout—apparently, these conditions were the result of the body’s fluids.

³⁰⁵Roy Porter, *The Greatest Benefit to Mankind: A Medical History of Humanity* (New York: W. W. Norton, 1997). 73-82.

³⁰⁶For more information about electricity and galvanism see James Delbourgo, *A Most Amazing Scene of Wonders: Electricity and Enlightenment in Early America* (Cambridge, Mass: Harvard University Press, 2006).

³⁰⁷Cooper, *A Discourse*, 22-25.

³⁰⁸Cooper, *A Discourse*, 22-25.

Hunter, and Edward Darrell Smith, Cooper pointed out that medicines were absorbed into the body unchanged and acted on the fluids.³⁰⁹

Poisons traveled into the body through the fluids and acted on the solids, as in the case of small pox (variolous), syphilis, scrophilia, and cancer. Medicines stimulated or sedated, and often appeared in fluid form. He finished his propositions by citing the chemical axiom *corpora non agunt nisi soluta*, or “Compounds do not react unless dissolved.” There can be no reaction without water.”³¹⁰ Cooper’s highlighting of the importance of water appealed to an older tradition in chemistry. Chemists like Scheele believed that there was one universal element, like water, which resulted in all life. The importance of water persisted through the history of chemistry into the work of Lavoisier and other chemists, who was able to decompose it into oxygen and hydrogen. Cooper repeating that axiom appealed to history to highlight the importance of the liquids of the body, and prop up the validity of humoral theory.

Cooper engaged with the claim that the body’s fluids and liquid medicine caused or “excited” the cause of diseases. He believed that he could provide “...an outline, however, that sufficiently proves the fluids of the body may be diseases themselves, and may produce morbid action in the solids.”³¹¹

³⁰⁹Cooper, *A Discourse*, 23, 31, and 39.

³¹⁰This is a rough translation of the French.

³¹¹Cooper, *A Discourse*, 24.

Cooper mentioned vitality, which turn-of-the-nineteenth-century physicians would have thought of as life force.³¹² The fluids of the body were not dead; physicians thought they conveyed and could modify life forces throughout the body. Cooper provided an illustration of this idea. He seemed to paraphrase Newton's third law of motion when he said, "It is an universal law that action and reaction are equal and contrary."³¹³ General laws seemed to govern the body's fluid processes.

Cooper emphasized affinity as important in the validity of the claim that fluids cause the disease of the body.³¹⁴ The body's fluids were constantly in flux. The particles in the body were constantly assimilated and secreted, preventing these particles from attracting each other. Cooper speculated that "galvanic" (electrical) and vital forces were working together to prevent affinity as well. But diseases occurred when the fluids escaped "healthy action" and allowed affinity to occur, at which time the fluids produced "morbi" (possibly disease particles) and disease. Cooper snidely remarked that to those who study "...the laws of chemical affinity in connexion with the laws of animal economy..." it will be obvious, and that those who do not study chemistry will not

³¹²"Vital force, power, or principle as possessed or manifested by living things (cf. vital adj. 1); the principle of life; animation." From *Oxford English Dictionary*. Also see Peter Dear, *The Intelligibility of Nature: How Science Makes Sense of the World* (Chicago: University of Chicago Press, 2006) and Mi Gyung Kim, *Affinity, That Elusive Dream A Genealogy of the Chemical Revolution* (Cambridge, Mass: MIT Press, 2003).

³¹³Cooper, *A Discourse*, 24.

³¹⁴See Trevor H. Levere, *Transforming Matter: A History of Chemistry from Alchemy to the Buckyball* (Baltimore: The Johns Hopkins University Press, 2001), 45-48, for a good explanation of Affinity.

understand it.³¹⁵ Cooper attempted to convince the reader of the connection between chemistry and medicine with obvious logic and plenty of examples.³¹⁶

Understanding nineteenth-century chemistry rhetoric is also important in the analysis of Thomas Cooper's arguments. Cooper and Joseph Priestley had immigrated to America to escape religious persecution and negative political fallout from their support of the Jacobins in the French Revolution.³¹⁷ Before that, Priestley had engaged in an important debate with Lavoisier about the nature of oxygen and why substances burn. And though Priestley was credited with the discovery of oxygen, he still maintained staunch support for the theory of phlogiston. Like Cooper, Priestley was a man of many intellectual talents and interests, writing books about religion and rhetoric, as well as chemistry.

In Nan Johnson's historical survey of nineteenth-century rhetoric, she cited Priestley's work on rhetoric. She wrote, "Joseph Priestley's *Course of Lectures on Oratory and Criticism* (1777) relies on the assumption that 'two sources of the principles of human nature and pleasures of the imagination...explain the efficacy of rhetorical devices...the association of simple ideas [ad] a moderate exertion of the facilities.'"³¹⁸

³¹⁵Levere, *Transforming Matter*, 25.

³¹⁶The lecture has the character of a medieval disputation in the scholastic tradition; Cooper argued about the nature of the body's fluids through logic and rhetoric.

³¹⁷Many secondary sources explore the interesting political history of Cooper and Priestley. However, this study is mainly interested in Cooper's scientific work, which has not been the focus of other authors. See Dumas Malone's biography concerning Cooper.

³¹⁸Nan Johnson, *Nineteenth-Century Rhetoric in North America* (Carbondale: Southern Illinois University Press, 1991), 31.

Cooper's work falls into nineteenth-century rhetorical strategies regarding knowledge and logic. He tried to use simple examples that articulated his complex medical ideas so that the reader could better associate the example and the principle. Johnson wrote that Priestley's ideas were foundational in eighteenth-century rhetorical theory; since the men had a close friendship, it is not a large stretch to assume that Priestley's rhetorical ideas influenced Cooper's arguments, as well.³¹⁹

Cooper also arguing by example and analogy to clarify and reveal the connections between chemistry and medicine. He elaborated on the connection between chemistry and physiology, especially in regards to "...pathology, semeiology and therapeutics: poisons: mineral material medica: vegetables materia medica: the adulteration of medicines: pharmacy: and prescription."³²⁰ Cooper cited Dr. Priestley's experiments on respiration. He described to the reader Priestley's experiment:

...shewing the disappearance of oxygen when exposed to venous blood inclosed [sic] in a thin bladder, and the florid colour thus produced. At present, however, we know tolerable well, that the air inspired is little changed in quantity: that the oxygen is converted into carbonic acid: that a small quantity of additional moisture is contained in the expired air; and that it is thus fitted for stimulating the left ventricle of the heart. At this period, and not sooner, does the chyle assume

³¹⁹Cooper also had access to Priestley's large chemical library when they were living in Northumberland, PA. (see "Dictionary of Early American Philosophy—edited by John R. Shook, pages 244-247)

³²⁰Semeiology is, "The branch of medical science which is concerned with symptoms." From the *Oxford English Dictionary*. The quote is from Cooper, *A Discourse*, 25.

the properties of the blood; whether a repetition of this process be necessary to furnish a full share of vitality to the chyle is not yet fully known.³²¹

Like Cooper, Priestley saw the body's physiology through a humoral lens. Chyle was the nutritious fluid produced by the pancreas that re-vitalized the body in humoral theory.³²²

Cooper continued to emphasize the revision of humoral theory throughout his speech. Updating humoral theory involved a careful analysis of the body's fluids. He claimed that without the analysis, or knowledge about the "chemical formation," of "albumen" and "fibrin" from the Chyle, which would inform on the chemical composition of the blood and the Chyle, we could never truly understand the process of respiration.³²³ Chemistry was the key to revealing and understanding the fluid processes of the body, and therefore physiology. Cooper argued that "Whatever is known of these processes, we owe to chemistry, and to chemistry exclusively."³²⁴

Cooper presented several case studies in order to explore the importance of chemistry to medicine. Among those case studies were those of blood, bile, and urine. Blood, Cooper reiterated, was comprised of albumen and fibrin, of which physicians

³²¹Cooper, *A Discourse*, 25-26.

³²²Physicians measured chyle and other fluids linked with vitality at the turn of the nineteenth century (See the work of E.A. Driggers and N.G. Colley).

³²³Fibrin is, "Orig., an albuminoid or protein compound substance found in animal matter; coagulable lymph. In modern use, an insoluble protein, formed from fibrinogen during blood clotting, which polymerizes to give the network of the clot. Albumen in chemistry is, "The whitish or colourless part of the blood; serum, plasma." Therefore, according to the entries in the Oxford English Dictionary, fibrin is the reddish, thick part of the blood, while "albumen" is the colorless liquid that is mixed in the blood. The quote is from Cooper, *A Discourse*, 26.

³²⁴Cooper, *A Discourse*, 26.

could trace small amounts in the Chyle until it reached the heart. The blood contained oxygen because of its color; and a serum that conveyed waste out the body. Cooper followed the chemical work of Jöns Jacob Berzelius, a contemporary Swedish physician and chemist, who did extensive work on chemistry of vital fluids.³²⁵

Cooper's preferred method was to attempt to perform laboratory work to support and advance humoral theory. Analysis of the body's fluids, including blood, was a crucial feature of humoral pathology and understanding illness in the body. Cooper wrote,

Indeed every secreting gland is a chemical laboratory; nor is it possible to refer the changes that take place in the fluid that enters a gland, to any other than chemical and galvanic agency: for decomposition takes place, new compositions appear, with perfectly different properties, and with different chemical elements, and caloric is given out in almost every case.³²⁶

³²⁵Berzelius was an analytical chemist who corresponded and collaborated with Alexander Marcet, and both will be discussed in further detail in another chapter.

³²⁶Ibid, 27. Caloric was a nineteenth-century theory of heat, very similar to that of phlogiston. Caloric was thought to be an odorless, colorless fluid that escapes from a hot body when it cooled down. Though understanding fluids in the body is important in understanding heat production in the body, Cooper knew that there was influence from the nervous system as well. He wrote:

... whenever a fluid is converted into a solid, caloric is given out; so that the renewal of each particle of the solid parts of the body must prove a perpetual source of animal heat. But although this seems to be a full, an adequate, a reasonable source for the supply of warmth to the animal system, it is not exclusively so. The late experiments of Le Gailois, Wilson Philips, Brodie, and Earle,* shew decisively the influence of the nervous energy over the secretions and other functions of the body: and that mere chemical considerations, though indispensable to account for animal heat, will not suffice alone to explain the phenomena: unless, indeed, the nervous energy should hereafter prove to be a galvanic process, of which the evidence, as yet, is incomplete.

Cooper concluded his case study concerning blood by saying that though blood's makeup contained fibrin and albumen, it did not have any gelatin in it. However, the skin, cartilage, and other "membranes" of the body did. He hypothesized that five to six percent of carbon in the blood must be converted in the blood to gelatin. Cooper saw this as proof that chemical affinity continued to occur in the body without being "interrupted" by "vital power." The fluids and the vital processes body had to have some close relationship, much like the attraction of one substance toward another.

Cooper briefly discussed bile to make the same point he made using blood. Bile constituted two of the body's four humoral fluids (blood, yellow bile, black bile and phlegm). The "vena portuum," a large vein from the liver, brings nutrients to the internal organs (or viscus). Cooper described bile as yellow, green, or colorless. However, it is important to note that the bile was only green when disease is present. According to Cooper's own experiments and the experiments of others, green bile was an indication that someone has eaten bad food. The food was too acidic or there was some influence by the yellow bile. Cooper highlighted the value of the color of bile because of its practical benefit. Like many medico-chemists at the turn of the eighteenth century, Cooper saw the practical benefits of measuring bile and other bodily fluids because they could be early indicators of disease. Another physician, Edward Darrell Smith, saw the usefulness of studying urine because it could indicate the presence of a stone. Reading the fluids of the

Cooper was extremely interested in understanding the nervous system, and he published an edited and annotated translation of Francois-Joseph-Victor-Broussais's work on mental illness and the nervous system. Even in that later work, Cooper recorded the link between mental illness, the fluids of the body, and the nervous system. See Francois-Joseph-Victor-Broussais, *On Irritation and Insanity*, ed. Thomas Cooper (London: R. Hunter, 1833).

body is part of a much longer humoral tradition; often physicians in the Middle Ages would practice uroscopy or examine the color of the patient's feces.³²⁷

Finally, Cooper turned to the subject of urine. Urine was a fluid with many questions surrounding it. Cooper found the chemical analysis of urine important because, "To chemistry, we owe our knowledge of the general composition of healthy urine: and to chemistry, we owe all that is known of the variations that take place when urine is secreted, either from animal fluids that are morbid stimuli, or by morbid action of the kidneys from health fluids."³²⁸ Chemical analysis had revealed that urine is made of many different things: soda, potash, magnesia, etc. Chemical analysis could indicate to doctors when people were suffering from various conditions; when there was disease present, such substances as albumen, sugar, gelatin, and mucus could be found in a patient's urine. Good urine was all about balance. Having too much or too little of any substance would indicate to physicians that there might be disease present in the patient's body. Cooper and other medico-chemist were engaging in the precise analysis of the fluids of the body. Historically, they were performing uroscopy, but to these actors they were carefully quantifying the elements of the body.³²⁹

³²⁷Porter, *The Greatest Benefit*, 203 and 232.

³²⁸Cooper, *A Discourse*, 28.

³²⁹Chemistry was the perfect tool to Cooper. In the spirit of Lavoisier's analytical chemistry, Cooper mentioned a few more uses of chemical analysis. He discussed the chemical composition of the bones. Cooper used chemistry to settle disputes about the arterial coats of the body and other physiological questions. The decomposition of food is a chemical process and linked to the circulation of the fluids of the body. The fluids take food made into new compositions, and distribute it throughout the body.

Though Cooper praised the work of Edward Darrell Smith earlier in the work in regards to the revival of humoral theory and Smith's ideas about fluids circulating through the body unchanged. Cooper cited Dr. Nathaniel Chapman, a professor of

Understanding the body's fluids, especially their acidic nature, could illuminate the causes of other mysterious diseases. Cooper mentioned hemorrhoids and hysteria, two conditions that physicians had trouble fully understanding.

Hemorrhoids, Cooper argued, were caused by an acid in the body. Hemorrhoids were simply irritated areas responding to the acid produced in the body through the discharge of feces. He argued that chemistry could, "...neutralize this morbid and distressing secretion?"³³⁰

Hysteria was also a disease caused by too much acid in the body. Cooper considered the disease to be one of the stomach. Specifically, he considered it a subject of dyspepsia (or upset stomach). The disease originated either from the "primae viae" or from the "uterine sympathy." Historically, ancient physicians and philosophers speculated that hysteria was the womb wandering around the body. But Cooper broke with this tradition and aligned himself with Fernelius (Jean Fernel) in arguing that all diseases truly originate from the stomach. Fernelius supported humoral theory as well. Cooper repeated Fernelius's famous maxim, "...all morbid concoction and impurity of the humours of the body, proceeds either from a diseased affection of the stomach and viscera, or from a gross and

medicine at the Department of Medicine, University of Pennsylvania and the founding president of the American Medical Association. Chapman believed that fluids change through the body's circulation. All fluids that enter into the body turn into one "homogenous fluid" that is "bland in nature." (This quote appeared on page 31.) Then, Chapman argued that these fluids are put back together. Though Cooper points out that Chapman's ideas contradict the ideas of Smith and other physicians, he only presents Chapman's ideas. It is clear, however, that Cooper does not agree with them. And he proceeds to logically dismiss their ideas. Cooper argues that there is no proof that any fluid in the body changes into a bland substance.

³³⁰ Cooper, *A Discourse*, 26.

faulty diet.”³³¹ Cooper cited other physicians who believed that the bowels and stomach were the originators of many disorders. All problems truly originate in the intestinal canal or primae viae, and essentially spread to the fluids of the body. Acids, especially too much acid in the body, would become a key indicator of disease to Cooper.

3.5 Nature and Humoral Pathology

Another aspect of Cooper’s humoral thinking comes from the analysis of nature. Cooper was a neo-Hippocratic thinker. The canon of Hippocrates rested on humoral ideas of the body but also explained how human bodies react to nature.³³² Hippocratic theory proposes a link between disease and systems of the body, especially humoral reactions and imbalances, by exploring natural and climate-linked reactions.

The Canon of Hippocrates contains several statements about fever, humors, and nature. In the essay “Airs, Waters, and Places,” Hippocrates wrote,

Whoever would study medicine aright must learn of the following subjects. First he must consider the effect of each of the seasons of the year and the differences between them. Secondly he must study the warm and the cold winds, both those which are common to every country and those peculiar to a particularity locality. Lastly the effect of water on the health must not be forgotten.³³³

³³¹Cooper, *A Discourse*, 37.

³³²Hippocrates was an ancient Greek physician, or a group of physicians writing under the name of Hippocrates, whose work became its own system of medicine.

³³³Hippocrates, *Hippocratic Writings*, trans. J. Chadwick and W. N. Mann (New York: Penguin Books, 1978). The section “Airs, Waters, Places,” can be found on pages 148-170; this quote can be found on page 148.

Failure to ignore these natural causes of diseases could have dire consequences for the physician,

A physician who understands them well, or at least as well as he can, could not fail to observe what disease are important in a given locality as well as the nature of the inhabitants in general, when he first comes into a district which was unfamiliar to him...Being familiar with the progress of the seasons and the dates of rising and setting of the stars, he could foretell the progress of the year. Thus he would know what changes to expect in the weather and not only would he enjoy good health himself for the most part but he would be very successful in the practice of medicine.³³⁴

Cooper's work reflected a neo-Hippocratic view of disease explained by imbalances of fluids in the body. He also expressed a neo-Hippocratic view of nature and disease, "...since the changes of the seasons produce changes in diseases."³³⁵ In a sense, Cooper was using meteorology to predict disease, especially fever, in a given climate, as the body's fluids respond to natural stimuli.

Cooper linked fever to warm climates, hypothesizing that sunny, swelling systems (plethoric) near marshes filled with miasma caused some diseases that originated from the liver. Cooper reflected on constitutions. He cautioned anyone of a "sanguine temperament" to stay away. But he also linked this *natural* disease with the fluids of the body.

The liver responded to nature by secreting diseased fluids. The liver was then excited and caused other problems in the body. The acid in the stomach increased. As

³³⁴Hippocrates, *Hippocratic Writings*, 148-149.

³³⁵Hippocrates, *Hippocratic Writings*, 148-149.

these secretions continued, the body fell into further states of disease, ultimately coming to a fever. Acids affected the body and changed the bile. Bile turned green, according to chemical experiment, when fevers were present. Cooper made the point again that the color of the bile is an indicator of disease. Another indicator is a resin-like fluid produced in the sweat.

Cooper ranked fevers by their danger and intensity. Bilious fever is the highest stage of fevers. It is the most painful and the most deadly part of the disease. Cooper cited the work of physicians in New Orleans who were working with yellow fever. He explained that they found acid in the stomach of those suffering from fever. He repeated a French saying that the chattering of the teeth caused the mouth pain and further explained that the acid produced by fever also caused pain in the mouth, lips, and the teeth.³³⁶ This acid was produced in other fevers, like yellow fever. The acid was what truly caused the disease; the acid, "...acts on the stomach in yellow fever, disorganizing and destroy the coats of that organ, and converting them into the dead matter of black vomit."³³⁷

Cooper argued that this acid might hold the potential for a cure. Bilious fever resulted from acid production in the body. The acid found in the *priae viae* (large vein) came from the stomach and intestines. This morbid production was "...a train of symptoms that a recurrence to the known facts of chemical affinity will alone be competent to combat."³³⁸ Again, affinity was the chemical metaphor that articulated how fluids—or chemicals—of the body came together in a natural way.

³³⁶(agacant les dents .- excoviant le bouche/irritate the teeth/...the mouth); also translated from the French.

³³⁷Cooper, *A Discourse*, 34.

Cooper linked the acidic causes of fevers with stomach ills, like dyspepsia. Essentially, an upset stomach was a symptom of fevers. The acid produced in the stomach continued to harm the rest of the body, including the intestines. The acid from the intestines disrupted and irritated the pancreas, liver, and the lacteals of the intestines. The medicines that provided relief were also those that eased the irritations of the stomach and heartburn (cardialgia), like magnesia, soda, and lime.³³⁹

The secretion of diseased acid was to blame for other conditions, like diarrhea, dysentery, and cholera, and the excessive use of medicines exacerbated the production of diseased acids in the body. Chalk medications seem to cause the production of diseased acid in the body. Remedies like chalk stones could be the cure or the cause of disease. Cooper cautioned that "...for although the symptom be not the disease, it may when neglected, and it frequently does, become a disease itself, equal in importance to the cause that gave it birth."³⁴⁰ Proper chemical interventions like terra japonica and kino caused the acidic vessels to close and ended the symptoms of dysentery.

Cooper also pointed to hemorrhoids and to chlorosis. Considering the latter disease from a chemical perspective, it seems that the acid in the stomach caused the symptoms by irritating the bile.³⁴¹ He quoted the Fernelius's maxim *Omnis enim cacochymia, et humorum impuritas, aut ex vitiosd viscerum affectioney aut ex improba vivendi ratione, raro aids ex eausis, projiciscitur*, which he translated as "That is, all

³³⁸Cooper, *A Discourse*, 35.

³³⁹*Oxford English Dictionary*

³⁴⁰Cooper, *A Discourse*, 35-36. Also examine the footnote on page 36.

³⁴¹Cooper, *A Discourse*, 36.

morbid concoction and impurity of the humours of the body, proceeds either from a diseased affection of the stomach and viscera, or from a gross and faulty diet.”³⁴²

According to Cooper and other leading English physicians at that time, the stomach and bowels were the source of all irritation. Cooper was building on the work of William Cullen, another famous chemist.³⁴³ Cullen believed that all illnesses were the result of a natural spasm that originated in the bowels. As in the Hippocratic tradition, climate or miasma would irritate the body, producing internal responses that reflected the body’s irritation from nature.³⁴⁴

The theory of acidic irritation of the stomach and intestines applied to the case studies of gout, urinary calculi, diabetes mellitus, phthisis, rachitis, and poisons.³⁴⁵ Gout is likely Cooper’s *sine que non* example. Though Cooper had previously presented his audience with explanations as to the causes of gout, he returned to the topic to remark that the best explanation was acid irritation. Gout might arise from a patient’s family history, age, and lack of vital energy. However, gout per se was caused by an increase in morbid action of acid entering the liver and further diseased action in the stomach causing more acid to enter the body. The theory of diseased action that Cooper described was similar to concurrent theories about lack of moderation in food and drink consumption bringing on gout.

³⁴²Cooper, *A Discourse*, 37.

³⁴³Found in the volume 18, section “Humoral Pathology,” in Abraham Rees, *The Cyclopaedia, or, Universal Dictionary of Arts, Sciences, and Literature* (London: Longman, Hurst, Rees, Orme & Brown, 1819-1820.)

³⁴⁴Porter, *The Greatest Benefit*, 78-79.

³⁴⁵Cooper, *A Discourse*, 37-41.

Wine and other fermented beverages are “converted” into lithic and uric acid once consumed. These acids spread into the groin and other parts of the body. Sometimes the acid produced from the consumption of wine also produces urinary calculi. Other stones, like chalk stones, are destroyed by acid. Moreover, according to Cooper’s previous discussion of dyspepsia, physicians used chalkstones to treat excessive acids. The acid produced in the disease of gout simply dissolves these stones. Cooper argued that chemistry is the savior of man from all types of stones. He says that,

All that we know of the composition and formation of these productions of gout and gravel, we owe to chemistry alone: and, cathartics excepted, all the remedies hitherto suggested, have been furnished by chemistry, on chemical considerations : the same may be said not merely of the remedies but of the prophylactics also. In fact, without chemistry, nothing would have been known of the theory or the cure of gout, stone, and gravel; although, as I allow, other considerations may enter into our view, as gastritis, hepatitis, and nephritis, whether owing to original affection, to metastasis, or to sympathy.³⁴⁶

Cooper again disagreed with Dr. Chapman, who acknowledged that chemistry is useful in determining the nature of the composition of the stone but claimed that there was no convincing way to identify the stone. Cooper, in updating Chapman’s work with the latest chemical analysis, said that Dr. Marcet’s work in identifying stones was clearly useful in using chemistry in identifying urinary stones. Chemistry, he said, could be used to analyze not just urinary stones, but urine and bile as well.

³⁴⁶Cooper, *A Discourse*, 38.

Cooper identified chemistry as the factor that divided legitimate professional practitioners from “quacks.” He argued that, “Owing to the want of chemical as well as pathological knowledge generally, patients in this disorder have been from time immemorial the prey of quacks out of the profession and empirics within it.”³⁴⁷ Patent medicines, whether Mrs. Stephen’s medicine (which represented good medicine), or the Portland Powder (which represented the worst) was all quackery to Cooper. He cautioned that patent medicines were “...useless in the hands of skilful men, and most dangerous in the hands of common men: the best opinions and observations agree that, in every case whatever, if they shorten the paroxysm, they lengthen the disease.”³⁴⁸

Only physicians who truly understood the pathology and physiology of the body would know how to prescribe remedies. Empiricism, or experience, did not provide sufficient knowledge to prescribe medicine. Empirical knowledge used to prescribe remedies no longer fit into the current state of “medical science.”³⁴⁹ Chemical knowledge gave physicians insight into the nature of gravel and stones and an effective tool to treat them. “Caustic alakli” and other substances clearly dissolved urinary stones.

Next, Cooper turned his attention to diabetes mellitus. Diabetes mellitus literally means “to pass sugar (or sweetness).”³⁵⁰ Cooper pointed out that some thinkers, like William Hyde Wollaston, thought that there was no sugar in the blood of sufferers of diabetes. Essentially, the kidneys did not separate “saccharine fluid,” but instead formed

³⁴⁷Cooper, *A Discourse*, 39.

³⁴⁸Cooper, *A Discourse*, 39.

³⁴⁹Cooper, *A Discourse*, 39.

³⁵⁰*Oxford English Dictionary* and Cooper, *A Discourse*, 40.

it chemically by the blood traveling through the body. William Hyde Wollaston and Alexander Marcet were interested in analyzing the fluids of the body, like blood, in order to determine their roles in causing disease.³⁵¹

Cooper said that the practice of medicine needed to be transformed by ensuring that physicians be well versed in chemistry in order to safely prescribe and mix remedies; chemical remedies, both vegetable and mineral, could have a real and positive effect in treating disease. Medical journals at the turn of the nineteenth century contained medical cases that often involved chemistry. Every day, according to Cooper, chemistry and medicine were growing closer together, and medical schools needed to adapt. Cooper finished his lecture by assuring his audience that proper chemistry did not require complicated and highly technical experimental apparatuses. Complication, he believed, should never be valued over practicality, and he said:

I agree with that most able physician and chemist, Dr. Marcet (2 Med. and Chir. 'Trans, p. 358) that the large and dismal subterraneous laboratory of the old chemists, is now changed for the fire side of a comfortable study; and that under the auspices of Dr. Wollaston and two or three more of the British chemists, the analysis of small quantities of matter with neatness and accuracy, promises to give an essential impulse to the progress of analytical chemistry. In fact, the apparatus for experiments in medical chemistry ought to occupy no more space than the drawer of a book case, and the required investigations may be prosecuted without injury to a mahogany table by the fire side.³⁵²

³⁵¹The work of these two men appears later in this dissertation.

³⁵²Thomas Cooper, *A Discourse*, 47-48.

Cooper made this statement because he was impressed the aggressive collecting that Marcet and Wollaston performed with urinary stones. Analytical chemistry had changed from the large scales of Lavoisier to the small blow pipe and tongs that any medico-chemist could acquire (Marcet's analytical work is discussed in chapter five). Though the tools had been scaled down, the analytical specificity had not. And to chemists like Cooper, chemistry was really accomplished by rhetorical arguments and personal laboratory experiments.³⁵³

Cooper argued that it was divine will that the old generations would pass away and that the new generation would be smarter than his own; he hoped that he would be able to show the next generation how chemistry was "INDISPENSIBLE to medicine."³⁵⁴

3.6 Nature and Its Influence on the Fluids of the Body

Cooper was interested in explaining how society and sickness were affected by the natural world. A facet of Cooper's work with humoral theory came from examining nature in order to improve the condition of man. "It is impossible to free the condition of man from disease and death," lamented Cooper, "If nature hath ordained the laws of population to overrun, when it is unchecked, the law of production and subsistence, she must have provided also the counter balance."³⁵⁵ Cooper was reverent of the power of nature and accepting of its inevitable effect on the human condition. Throughout Cooper's other writings, it is clear that he wanted to liberate humanity from suffering

³⁵³See Cooper's geology publications that are intensive analytical pieces.

³⁵⁴Cooper, *A Discourse*, 48.

³⁵⁵Cooper, *Lectures on the Elements of Political Economy*, 335-336.

from disease through the application of chemistry to medicine, but he also accepted that he would fail. It was natural law. Still, Cooper regarded disease as something that had no value to either individuals or society, and called it “an unmixed evil.” The real duty of society was to make regulations that would diminish the effects of disease and work to eradicate disease at its sources. Cooper went on to lay out laws, often scientific, that would protect society from disease.

He used malaria as an example. Malaria was an active disease, appearing in Constantinople, Italy, and other marsh areas in and around southern Europe in addition to the marshes and swamps of South Carolina and Georgia. He advocated that cleaning up the rotting vegetable matter and pools and stagnant water could have increased the health of the peoples in those areas and prevented malaria entirely. Cooper pointed out that vegetable matter, when exposed to the hot sun in the months of August and September, produced bilious fever in warm climates, dysentery in cold climates, and yellow fever, or even the plague, in hot climates.

Unfortunately, people, according to Cooper, had a poor reputation with listening to their physicians. He complained that “People in general know so little of physiology and pathology, which the admonitions of the physician are like the prophecies of Cassandra, always unheeded.”³⁵⁶ This neglect explained to Cooper why no one drained the stagnate ponds near towns. And human inventions, like logging, continued to release miasmas from nature. Cutting down trees seemed to free miasmas to poison the atmosphere and any adjacent peoples. Cooper wrote about miasma poisoning the land in a fluid way, similar to the way he discussed poisons acting in the fluids of the body.

³⁵⁶Cooper, *Lectures on the Elements of Political Economy*, 338.

Cooper used the city of Philadelphia to illustrate his point about the spread of miasmas. There were many mud holes in the town, but if only drained, even at the risk of some initial economic loss, it would avoid a health crisis.³⁵⁷ Cooper advocated for the eliminations of milldams and ponds, as well as “water-rotting hemp,” in order to “secure the health of the vicinity.”³⁵⁸

One strategy for treating a miasma based disease like yellow fever involved containing it and then eradicating it. But miasma had to be contained in a specific way, and Cooper attempted to explain how to do so. Cooper cited the work of Dr. Samuel Jackson, “...who has shewn in what way the yellow fever can be imprisoned and circumscribed until it be eradicated.”³⁵⁹ Miasma, according to Dr. Jackson, could not travel over a “perpendicular fence” about twelve feet high. Or across an “inclined plane” about one hundred feet high. Though it had been shown that yellow fever could change from an endemic to an epidemic disease, Cooper wrote that yellow fever was “...contagious only when the patient is in a confined apartment, and the air is unchanged; but not contagious or infectious in a well aired apartment, with scrupulous attention to cleanliness”³⁶⁰ Cooper’s understanding of yellow fever argued that an individual has some control over whether or not they acquire the disease based on their habits.

Cooper then further speculated on the nature of miasmas. He suspected that some sort of animal in the miasma might cause diseases. But he saw that illness was a class

³⁵⁷Cooper, *Lectures on the Elements*, 338.

³⁵⁸Cooper, *Lectures on the Elements*, 338.

³⁵⁹Cooper, *Lectures on the Elements*, 338-339.

³⁶⁰Cooper, *Lectures on the Elements*, 339.

issue: “The crowded and dirty state of jails, hospitals, poor houses, and boarding houses, is a proper subject of municipal control, and would certainly fall within the power and jurisdiction of a board of health.”³⁶¹ Later, he said “The health of the rich, is jeopardized by the filth of the poor.”³⁶² He advocated for a board of health being able to remove sick persons from an area, much like that which occurred in Philadelphia during the yellow fever outbreak of 1819. However, Cooper did not speculate on where to put the removed sick people from the city.

One of the most interesting thoughts that Cooper included in his essays was his speculation on how miasmas caused malaria. In a footnote describing contagion, he wrote:

As the miasmata and effluvia of infectious diseases must come in contact with a body infected by them, generally by means of the Schneiderian membrane, they are, in a certain sense contagious. By contagious disorders, strictly speaking, I mean, *animal poisons communicable by contact, independent of breathing*. The more I consider this subject, the more I am persuaded that the whole tribe of infectious and contagious disorders owe their origin to animalculae; and that they have their infancy, their maturity, and their decline. The whole doctrine of equivocal generation requires to be reconsidered. Yellow fever first attacks the stomach, bilious fever the liver; black vomit examined by a microscope, presents a congeries of animalculae; the bubo of the plague is full of them; so are the pustules of psora. The rot in sheep seems to be owing to animalculae. If this

³⁶¹Cooper, *Lectures on the Elements*, 339.

³⁶²Cooper, *Lectures on the Elements*, 339.

opinion be well founded, no wonder that a chemical examination of air, cannot detect miasma which does not depend on the chemical state of the atmosphere.³⁶³ Cooper used this quotation to articulate a link between natural theories of diseases, humoral theory, and the importance of the analysis of the body's fluids in understanding disease.

3.7 Cooper's Death

By the middle of the nineteenth century, Cooper's fortunes had changed. His aggressive rhetoric made him very popular with the intellectual and political elites of the South, but his strong views about the age of the earth were too much for the Presbyterian clergy of South Carolina. Cooper resigned the Presidency of South Carolina College on November 27, 1833, amid criticism of his positions on materialism, Unitarianism, and the age of the earth. But Cooper was still busy publishing criticisms of the government and pro-South, pro-slavery literature.³⁶⁴ While working on the Status at Large for the State of South Carolina, Cooper had to give up his position because of ill health--self-described as asthma, dropsy, and failing vision.³⁶⁵ Joseph Waring recorded an excerpt from one of Cooper's last letters to Dr. M. H. DeLeon, a prominent physician in Columbia:

³⁶³ Cooper, *Lectures on the Elements*, 339-340; see the footnote.

³⁶⁴For instance, see Cooper, *A Tract on the Proposed Alteration of the Tariff* (Philadelphia: Joseph R. A. Skerrett, 1824). Also examine the works by Elizabeth Fox-Genovese and Eugene Genovese, and Freehling mentioned at the beginning of the chapter.

³⁶⁵Malone, *Cooper*, 290-391.

You and I are by this time both sensible that my leaky etc vessel has received a shot between wind and water, that leaves no alternative but whether the final submersion shall be effected by asthma or dropsy. As I have neither art nor part in this matter, I leave my two enemies to squabble in their own way. But I think I may venture to appeal to you, that however debilitated are my legs in the basement story, my brains in the attic have not received much injury.³⁶⁶

Cooper passed away in 1839.³⁶⁷ His work asserted a link between the fluids of the body and the effects of nature; he saw Hippocratic methods of treating disease as useful, such as having fresh air and avoiding the poor air coming from swamps. Humoral pathology and Hippocratic thinking about nature seemed to blend into each other at the turn of the nineteenth century. Chemistry brought the two together, as fluids became more important in the minds of medico-chemists like Thomas Cooper.

3.8 Conclusion

Thomas Cooper was committed to the incorporation of chemistry into medicine in the same way that he was passionate about other political topics. His rhetoric was aggressive. But his published speech, *A Discourse on the Connexion Between Chemistry and Medicine*, encapsulated Cooper's interest in reviving humoral pathology and bringing chemistry into medical practice.

³⁶⁶Waring, *A History of Medicine in South Carolina 1670-1825*, 202.

³⁶⁷The college, like much of Cooper's South, would go through a significant period of reconstruction, but not until the twentieth century would it regain the engagement with medicine, science, and chemistry it held when Cooper was president.

He highlighted the importance of chemistry in medicine in order to improve medicine and put it on par with the progress of scientific medicine in Europe. He particularly admired the work of British chemists like Alexander Marcet, William Hyde Wollaston, and the newly established transactions of the Medico-Chirurgical Society that contained most of the major works on chemistry and humoral pathology from the turn of the nineteenth century onward into the work of John Bostock and Thomas Thomson.

Contextualizing the body in terms of humoral pathology explained many diseases for Cooper. He saw the theory as broadly encompassing, and linked it to a natural explanation of diseases like fever and also used it to explain a contagion theory of diseases. Humoral pathology was the framework for all disease. Its required intervention was chemically based. Another physician that Cooper cited, Edward Darrell Smith, is the subject of the next chapter and the continuation of the desire to support humoral pathology with the new chemistry.

CHAPTER 4
REVISING HUMORAL PATHOLOGY:
UROLOGY IN THE SOUTH CAROLINA BACKCOUNTRY

4.1 Introduction

In 1811 the physician Edward Darrell Smith resided in the Pendleton District in the northwestern area of unsettled South Carolina. Smith had officially retired from the practice of medicine and transitioned to a focus on planting, but he still occasionally consulted when called on. In November, a man traveled from Georgia for medical advice. Smith recounted the dire situation of a child who had a complete blockage of urine. Smith would later write up the case for the first volume of the *Philadelphia Journal of the Medical and Physical Sciences*: "...the child was about five years old, that soon after his birth he was observed at times to pass his urine with difficulty, and that this affection continued to increase until about three weeks ago, when a total stoppage took place."³⁶⁸ It was clear to Smith that the child was in a lot of pain and running a fever. The child had "orifices" developing in other parts of the body, including the anus, because the urine was blocked.

³⁶⁸Edward D. Smith, "Case of Calculus in the Urethra of a Child five years old. By the late EDWARD DARRELL SMITH, M.D. Professor of Chemistry, &c. in the South Carolina College." *The Philadelphia Journal of the Medical and Physical Sciences* 1 (1820): 149.

Smith recorded his speculation about the cause of the child's suffering: "I concluded that a calculus had been expelled from the bladder into the urethra, in which it was so fast wedged, that not a drop of water could pass, and that the fistulous orifice had been formed behind it."³⁶⁹ Cases like this child suffering from a stone required all of Smith's medical knowledge to think through a course of treatment for his patient, but they also inspired him to embrace chemical analysis and revisit older medical theories.

The knowledge that Smith called on to treat the suffering child came from his medical education. His education reflected changes in late-eighteenth and early-nineteenth century medicine. Also, the boundary object status of urinary stones allowed Smith to bring in surgical and chemical interventions into his medical practice in rural South Carolina.

4.2 Humoral Pathology in Smith's Education and Early Writings

Edward Darrell Smith was born in Charleston, South Carolina, in either July of 1775 or 1778.³⁷⁰ He received his early education in Philadelphia and Charleston, then entered the College of New Jersey (Princeton University) at age fourteen and graduated valedictorian of his class. He went on to earn his master's degree there as well.³⁷¹ After

³⁶⁹Smith, "Case of Calculus in the Urethra of a Child," 150.

³⁷⁰Waring and La Borde disagree on the date of Smith's birth. Some accounts attribute Smith's birth year being 1777. Waring, Joseph I, *A History of Medicine in South Carolina: 1670-1825*, Charleston: South Carolina Medical Association, 1964), 315-316 and Maximilian La Borde and James L. Reynolds, *History of the South Carolina College: From Its Incorporation, Dec. 19, 1801 to Dec. 19, 1865*, (Charleston: Walker Evans & Cogswell, Printers, 1874), 88-94.

³⁷¹La Borde, 88-94 and Waring, 315-316.

Princeton, he returned to Charleston to apprentice under Drs. David Ramsay and William Stevens Smith, then studied for a doctorate in medicine at the University of Pennsylvania Department of Medicine.³⁷² Letters from Smith indicate that he studied under the physician-botanist Benjamin Smith Barton.³⁷³

Smith published his *Inaugural Dissertation: Being an Attempt to Prove that Certain Substances are Conveyed, Unchanged, Into the Circulation; Or, If Changed, that They are Recomposed and Regain Their Active Properties* in 1800 in Philadelphia.³⁷⁴ The dissertation was Smith's first attempt to revive humoral theory using rational physiological and chemical arguments, proposing that humoral theory might be useful in treating urinary stones.

³⁷² La Borde, 88-94 and Waring, 315-316.

³⁷³ La Borde, 88-94 and Waring, 315-316. See *Minutes of the Trustees, South Carolina College, University of South Carolina*, South Caroliniana Library. Smith dedicated his dissertation to Barton, and Barton wrote a letter of introduction for Smith that has recently been published. See Benjamin Smith Barton to Thomas Jefferson, May 27, 1802. "To Thomas Jefferson from Benjamin Smith Barton, 27 May 1802," Founders Online, National Archives (<http://founders.archives.gov/documents/Jefferson/01-37-02-0402> [last update: 2014-12-01]). Source: *The Papers of Thomas Jefferson*, vol. 37, 4 March–30 June 1802, ed. Barbara B. Oberg, (Princeton: Princeton University Press, 2010), 504.

³⁷⁴ Edward Darrell Smith, *Inaugural Dissertation: Being an Attempt to Prove that Certain Substances Are Conveyed, Unchanged, into the Circulation; Or, if Changed, That They Are Recomposed and Regain Their Active Properties*. By Edward Darrell Smith, A.M. of Charleston, South-Carolina, Member of The Philadelphia Medical Society, (Philadelphia: Way & Groff, 1800). Smith dedicated his dissertation to Dr. William Smith Stevens, who was a surgeon's mate during the revolution and surgeon-physician that Smith studied under when he returned to Charleston after his time at the College of New Jersey. Smith was also his nephew in addition to his student. I used a reprinted edition of the thesis, published in Charles Caldwell, ed. *Medical Theses, Selected from Among The Inaugural Dissertations, Published and Defended by the Graduates in Medicine of the University of Pennsylvania* (Philadelphia: Thomas and William Bradford, 1805), 229-254.

In his introduction, Smith reflects on the history of medicine. He argues that, “During the reign of Humoral Pathology, the opinion, that substances were conveyed unchanged into the circulation, was necessarily adopted by the supporters of that doctrine.”³⁷⁵ During this period of medicine, it was believed that “disease was seated in the fluids of the human body, and those medicines were valuable in proportion to their power of correcting or altering the vitiated fluids.”³⁷⁶ Physicians eventually decided that humoral theory was “not founded upon sufficient grounds” because it did not explain how medicines worked in the body.³⁷⁷ Smith summed up the philosophical rejection of humoral theory into two reasons: the first was that no active substance (medication) was ever discovered in any part of circulation, and there were never any active substances found in the stomach; the second reason was the idea that fluids, including milk, were easily “assimilated to the blood.”³⁷⁸ When milk was injected into live animals, it killed them.³⁷⁹ Philosophers thought that, when drunk, all of the noxious parts of fluids like milk were rejected in the chylopoetic viscera, allowing only the most nutritious parts of the fluid to remain and pass into the sanguiferous system, or blood.³⁸⁰ Smith points out

³⁷⁵Smith, *Inaugural Dissertation*, 231.

³⁷⁶Smith, *Inaugural Dissertation*, 231.

³⁷⁷Smith, *Inaugural Dissertation*, 231.

³⁷⁸Smith, *Inaugural Dissertation*, 231.

³⁷⁹Smith, *Inaugural Dissertation*, 231.

³⁸⁰ Smith, *Inaugural Dissertation*, 231, Chylopoietic means having to do with the chyle according to the *Oxford English Dictionary*. The chyle was important in humoral theory because it was believed to be “The white milky fluid formed by the action of the pancreatic juice and the bile on the chyme, and contained in the lymphatics of the intestines, which are hence called lacterals.” This chyme is essentially the substance that

that philosophers rejected humoral theory based on sympathy and its “vague” meanings.³⁸¹ He concedes that sympathy “...exists between certain parts of the body; but it also seems probable, that this sympathy has had too great a latitude; and that certain circumstances are referred to it, which are more easily explained on other principles.”³⁸² In Smith's professional opinion, humoral theory was rejected for philosophically unsound reasons.

In order to show that substances exist in their active states in the body, Smith reviewed unchanged substances found in the body's fluids—chyle, milk, saliva, urine, blood, and perspiration—and the “solid parts of the body[,]” including the bones.³⁸³ He framed the importance of his inquiry regarding the absorption of active substances in the body as of a “speculative nature” but of interest to the “practical physician.”³⁸⁴ He argued that if substances could be conveyed unchanged through the body, then medicines could be administered to a “diseased system” that could not be reached by any other way, especially if the patient could not take internal medicines.³⁸⁵ Smith explained:

stomach converts food into on its way to the small intestine. The liver was the crucial organ in humoral theory because this is where it vitalized the blood. And the other word, “viscera,” means the soft internal organs of the body—usually referring to those organs located in the torso. See Porter, *The Greatest Benefit of Mankind*, 73-80 about the live and humoral theory.

³⁸¹Smith, *Inaugural Dissertation*, 231.

³⁸²Smith, *Inaugural Dissertation*, 231.

³⁸³Smith, *Inaugural Dissertation*, 235.

³⁸⁴Smith, *Inaugural Dissertation*, 232; Smith declares that he is looking for the truth, and wants to avoid prejudices against previous theories.

³⁸⁵Smith, *Inaugural Dissertation*, 233.

Active medicines, taken into the circulating fluids of a nurse, will affect the child in an alarming manner. Instances of this kind are not rare. If by the collection of facts on this subject, any hints may be given, which may lead to the discovery of a solvent of urinary or biliary calculi, it would be of essentially service to mankind. That this idea is not visionary or impracticable will be allowed by those who have invested this subject with attention. Although disappointment may be frequently the rewards of our exertions, yet by persevering industry, we often accomplish our undertakings.³⁸⁶

It is likely that Smith was alluding to Joseph Black's chemical research into solvents and ultimate failure to find a palatable acid for patient consumption.³⁸⁷

Smith cited authorities from Percival to Boerhaave to provide intellectual weight to his arguments. One work of note was *Lectures on Materia Medica*, by Benjamin Smith Barton, one of Smith's teacher's at the University of Pennsylvania.³⁸⁸ Smith cited Barton's work with turpentine, a diuretic that reproduces the effects of "stranguary, diabetes &c.," when applied on the surface of the body or taken internally. Smith recorded turpentine's travels through the body and bladder, including its appearance in the

³⁸⁶Smith, *Inaugural Dissertation*, 234.

³⁸⁷Lever, *Transforming Matter*, 54-56, 74-78 and Joseph Black, "Experiments Upon Magnesia Alba, Quicklime, and Some other Alkaline Substances," in Henry Marshall Leicester and Herbert S. Klickstein, eds., *A Sourcebook in Chemistry 1400-1900* (Cambridge: Harvard University Press, 1952), 80-91.

³⁸⁸The two men shared a lively correspondence as well. Barton's lectures are cited in the footnotes of Smith's dissertation.

urine of anatomists who had washed their hands with the “spirits of Turpentine” after dealing with dead bodies.³⁸⁹

Smith studied urine in particular because so many substances found unchanged in it could be identified by their “...colour, taste, and smell, or imbue[d] it with their peculiar properties.”³⁹⁰ For example, he pointed out that the “extract of longwood” turns urine a “bloody hue.”³⁹¹ He argued that the fact that substances exist in the urine unchanged is obvious, citing the odorous effects of olives and asparagus.³⁹² Smith also describes “lithontriptic” foods—those with stone-destroying properties—such as garlic and uva ursi. Garlic travels through the body unchanged to attack stones at their source, as does uva ursi, the acid liquor of which “...attacks human calculi, diminishes them and soften the parts which it cannot dissolve.”³⁹³

The carbonate of soda, a stone remedy popularized by Joseph Priestley, was useful in alleviating the symptoms of stones because “Fixed Air” was lithontriptic.³⁹⁴ Highlighting soda’s effectiveness, Smith wrote that soda was “...equally efficacious in alleviating the distressing symptoms of symptoms of nephritis, and causing large quantities of gravel to pass off by urine.”³⁹⁵ During the time that Smith was writing his

³⁸⁹Smith, *Inaugural Dissertation* 247.

³⁹⁰Smith, *Inaugural Dissertation*, 37.

³⁹¹Smith, *Inaugural Dissertation*, 37.

³⁹²Smith, *Inaugural Dissertation*, 246-247.

³⁹³Smith, *Inaugural Dissertation*, 247.

³⁹⁴Smith, *Inaugural Dissertation*, 247.

³⁹⁵Smith, *Inaugural Dissertation*, 247.

dissertation there was still a debate about whether fixed air actually traveled unchanged through the bladder, and Smith cited several authorities who had attempted to prove that it did.³⁹⁶ When Joseph Priestley analyzed urine samples from persons taking in carbonate of soda, one fifth contained fixed air.³⁹⁷ Smith noted that Priestley hypothesized that “Drinking water containing this air may impregnate the urine with it, and make it more efficacious in dissolving calcareous matters than it would otherwise be.”³⁹⁸ The work of Mathew Dobson showed that waters “impregnated” with fixed air could dissolve stones. However, stones also dissolved after being soaked in the urine of people who drank water containing fixed air, and Sydenham speculated that beers and malt liquors could ease the pain from stones.³⁹⁹ Smith concluded from these authorities that fixed air must be “conveyed unchanged” through the urine.⁴⁰⁰

One person who disagreed with Smith was Erasmus Darwin. Smith attempted to engage Darwin in an argument, writing, “It is, however, denied, by a celebrated and ingenious writer, that active substances are conveyed through the course of the circulation

³⁹⁶For historiography about turn of the nineteenth century physicians looking for chemical cures for the urinary stone: N.G. Coley, “Animal Chemist and Urinary Stone,” *Ambix* 28 (1971): 69-93, Coley, “Medical Chemistry at Guy’s Hospital,” *Ambix* 35 (1988): 155-168, and Coley, “The Laboratories of the Royal Institution in the Nineteenth Century,” *Ambix* 27 (1980): 173-203.

³⁹⁷Smith, *Inaugural Dissertation*, 247.248, “Human calculi, by being macerated in these waters, were considerably diminished. They are also diminished by immersion in the urine of those persons, who had drunk water impregnated with fixed air; while the urine of a person in health, not using such water, had no effect in lessening their bulk.”

³⁹⁸Smith, *Inaugural Dissertation*, 247.248.

³⁹⁹Smith, *Inaugural Dissertation*, 247.

⁴⁰⁰Smith, *Inaugural Dissertation*, 248-249.

in the bladder.”⁴⁰¹ Darwin argued, according to Smith, that the “lymphatic vessels” were directly “communicating” with the intestinal “absorbents,” and through a “retrograde action” led to direct passage into the bladder.⁴⁰² The phenomenon best exemplified by Darwin’s hypothesis was diabetes. Because of the large amount of urine produced by sufferers of the diabetes, which was beyond what physicians thought the kidneys secreted, they believed that urine had to pass directly into the bladder by some other type of canal. Smith pointed out another example that supported Erasmus’s hypothesis: the passing of mineral water so quickly through the body, which, he claimed, indicated that it must pass directly from the stomach to the ureters.⁴⁰³ Unfortunately, Smith dodged the opportunity to refute Darwin’s counterexample or further engage, writing, “The limits of this essay will not allow a fuller investigation of the doctrine of the retrograde motion of the absorbent vessels; and the more especially as it is not strictly connected with the present subject of inquiry.”⁴⁰⁴

In contextualizing and measuring his own work, Smith strove to encourage the research of others. He concluded his dissertation by hoping that he had inspired “some future enterprising genius” who will likely be rewarded for his labors “in the field of science.”⁴⁰⁵ The desire to revise humoral theory and treat urinary stones continued through Smith’s work as a practicing physician in Charleston and later during his time in

⁴⁰¹Smith, *Inaugural Dissertation*, 249.

⁴⁰²Smith, *Inaugural Dissertation*, 249.

⁴⁰³Smith, *Inaugural Dissertation*, 249-250.

⁴⁰⁴Smith, *Inaugural Dissertation*, 249-250.

⁴⁰⁵Smith, *Inaugural Dissertation*, 249-250.

the Pendleton District. After Smith graduated from medical school in 1800, he returned to Charleston, and married Sarah Tucker North in 1802. He then practiced medicine with Steven and Joseph Ramsay and ran a hospital for sick slaves with Dr. John Parker Gough.⁴⁰⁶ In 1801, Smith composed a letter concerning a case of hydrocele to a Dr. Miller.⁴⁰⁷ The cause of a Charleston patient's suffering turned out to be a urinary stone, and the case was Smith's first attempt as a young physician to diagnose a patient's mysterious complaint.

Smith's first published case took place in Charleston and was his first attempt to map out hints or useful signs that other physicians could utilize to identify suffering of the stone. The case was also Smith's first attempt at the heroic practice of returning a patient's fluids back to normal circulation. The case concerned a thirty-four-year-old man known only as "Captain W." He is described as having "...a robust constitution, and florid complexion, was attacked with intermitting fever in the latter end of March."⁴⁰⁸ The captain had previously suffered from irregular "paroxysms" that he had attempted to treat himself, and he reported a total block of urination but remembered expelling

⁴⁰⁶Waring, 315. Living in the South during different periods of his life, Smith had mixed views about slavery; Smith comments about slavery in the Pendleton District in David Ramsay's *The History of South Carolina, From Its First Settlement in 1670 to the Year 1808 in Two Volumes* in 1809.

⁴⁰⁷Edward Darrell Smith, "A Singular Case of HYDROCELE: Communicated in a Letter from EDWARD DARRELL SMITH, M.D. of Charleston (South-Carolina), to Dr. MILLER, DATED May 30, 1801" *Medical Repository* 5 (1802): 134-136.

⁴⁰⁸Smith, "A Singular Case of HYDROCELE," 134.

something while urinating.⁴⁰⁹ The expulsion cut his urethra, producing blood; his scrotum began to “tumify;” and the urine output diminished.⁴¹⁰

The Captain came to see Dr. Stevens, with whom Smith was acquainted. The patient had a fever and dysury, but the swelling was not significant. Dr. Stevens administered diuretics and mercury without success.⁴¹¹ The Captain also had a “quick” pulse, had not urinated in forty-eight hours, and had a scrotum that was very inflamed and swollen to the “size of a man’s head.”⁴¹² Stevens administered cathartics to the patient without success and invited Smith to see him. Smith wrote, “Upon examining the parts, we found that in the most depending operation of the scrotum, on the left side of the raphe, a gangrenous spot, of the size of a dollar, had made its appearance, although not visible in the morning. In this spot a lancet was introduced to a considerable depth, and the puncture enlarged afterwards, without the patient’s being at all sensible of the wound.”⁴¹³ Drs. Stevens and Smith consulted with Dr. David Ramsay after the patient discharged large amounts of putrid fluids.

⁴⁰⁹Smith, “A Singular Case of HYDROCELE,” 134.

⁴¹⁰Smith, “A Singular Case of HYDROCELE,” 134.

⁴¹¹ Smith, “A Singular Case of HYDROCELE,” 135; The Captain received mercury because this would “...excite the absorbents into action, and carry off the effused fluid in that manner; but the tumor continued to increase...”

⁴¹²Smith, “A Singular Case of HYDROCELE,” 135.

⁴¹³ Smith, “A Singular Case of HYDROCELE,” 135. According to the *Oxford English Dictionary* a raphe is, “A seam-like line or ridge, esp. between the two halves of a bilaterally symmetrical organ or part of the body...”

The three physicians decided to give the patient medicine in the form of bark for his scrotum and “solutions of sacch. saturini” applied to the inflamed parts.⁴¹⁴ These remedies seemed to work: the gangrenous area on the Captain’s scrotum healed, the areas around the scrotum were no longer inflamed, and the penis returned to a normal size.⁴¹⁵ Smith finished the article with an attempt to explain what brought on the Captain’s condition. First, Smith surveyed illnesses that could have possibly brought on the Captain’s condition: “...venereal affection, hydropic, diathesis, hernia, &c.”⁴¹⁶ He felt strongly that only one illness could have made such an opening in the scrotum, a calculus. He noted that the patient had “gravel symptoms” but had never passed any of those gravel particles out. The patient experienced blocked urination for a couple of days. A violent expulsion was further evidence of a calculus. Finally, Smith argued that the Captain was experiencing a stone because of a lack of further problems with gravel or urinating after the conclusion of the case.

4.3 Medico-Chemistry and the Backcountry

Between 1807 and 1811, Edward D. Smith traveled to the newly-settled upcountry of the state, practicing farming in the Pendleton District.⁴¹⁷ It is unknown exactly why Smith moved from the coastal city of Charleston to the interior of South

⁴¹⁴“solutions of sacch. saturini” might refer to a pain killer of some type.

⁴¹⁵Smith, “A Singular Case of HYDROCELE,” 135.

⁴¹⁶Smith, “A Singular Case of HYDROCELE,” 136.

⁴¹⁷This is where Waring and La Borde disagree about their dates.

Carolina. Smith engaged in agriculture, but he still practiced medicine when called.⁴¹⁸

Most of the medical cases Smith later published occurred in Pendleton. Smith also faced personal hardships during his time in Pendleton; in 1807, his eldest daughter died of unknown causes.⁴¹⁹

When Smith practiced medicine in Pendleton, he saw some horrific cases of urinary stones. One case involved a woman living in the Pendleton district in 1808.⁴²⁰ The case, entitled “A Case of Dysuria,” appeared in 1820 in *The Philadelphia Journal of the Medical and Physical Sciences* and concerned a woman Smith visited who could not urinate and had two years' history of difficult urination. Other physicians had visited the woman, but none had provided her any relief. In Smith's published case histories, he provided his readers with vivid descriptions of patients' pain, appearance, and ability to pass fluids. In describing the woman in this case, he noted that she had deteriorated from a “stout and healthy appearance to a feeble and declining state: she had borne several children, but none since the commencement of her present complaint, nor could she assign any particular circumstance as giving origin to her malady.”⁴²¹ The emphasis on

⁴¹⁸Though La Borde says that Smith mostly focused on planting, and engaged in medicine when called, pg. 97.

⁴¹⁹George Howe, *History of the Presbyterian Church in South Carolina*, Volume II, (Columbia: W. J. Duffie, 1883), 260-261.

⁴²⁰Edward D. Smith, “*Case of Dysuria*. By the late Edward D. Smith, M.D. Professor of Chemistry, &c. in the South Carolina College,” *The Philadelphia Journal of the Medical and Physical Sciences* 1 (1820): 147-149.”

⁴²¹ Smith, “*Case of Dysuria*. 147-148.

description was reminiscent of the importance of describing the patient's constitution in humoral medicine. Michel Foucault argues that,

This new structure is indicated—but not, of course, exhausted—by the minute but decisive change, whereby the question: ‘What is the matter with you?’, with which the eighteenth-century dialogue between doctor and patient began (a dialogue possessing its own grammar and style), was replaced by that other question: ‘Where does it hurt?’, in which we recognize the operation of the clinic and the principle of its entire discourse.⁴²²

“A Case of Dysuria” illustrated heroic treatment coupled with humoral medicine. Martin S. Pernick argued that heroic medicine was part of a nineteenth-century physician's professional identity and quoted a contemporary of Smith concerning the cosmology of physicians practicing heroic medicine: “In Rush's estimation, the first duty of a doctor was action—“heroic” action—to fight disease. Rush regarded a physician who killed a patient through overdosing as perhaps overzealous, but one who allowed a patient to die through insufficiently vigorous therapy was both a murderer and a quack.”⁴²³ In the proto-professional world in which Smith practiced medicine, it was better to kill his patient through well-intended effort than to let her die from inaction.⁴²⁴ It is clear from

⁴²²Michel Foucault, *The Birth of the Clinic: An Archeology of Medical Perception*, trans. by A. M. Sheridan Smith (New York: Vintage Books, 1975), xvii.

⁴²³Martin S. Pernick, *A Calculus of Suffering: Pain, Professionalism, and Anesthesia in Nineteenth Century America* (New York: Columbia University Press, 1985), 20.

⁴²⁴Pernick, *A Calculus of Suffering*, 19-21. Also see note #9 for sources about the professional world of nineteenth century medicine.

the way that Smith framed his narrative that he immediately took action on the woman in question. And Smith was not practicing medicine in a time where physicians obeyed any type of oath, including the Hippocratic Oath.

Smith administered “cathartic medicine” to ease her pain and “common diuretics” in an attempt to restore urine flow.⁴²⁵ These measures were ineffective. Next, Smith wanted to place a small bougie into the woman to allow for urination and perform an “ocular examination,” but the patient refused this, and he respected her wishes.⁴²⁶ Before Smith left, he administered more palliative measures to the patient and did not see her again for several weeks. The patient returned to an excruciating state, and Smith looked to the next course of treatment,

Apprehending that there might be some mechanical obstruction, such as a small calculus in the urethra, which might require removal, I directed the patient to be laid upon a table as in the operation for the stone, and passing the fore finger of the left hand up the vagina, I introduced at the same time the end of a small probe into the orifice of the urethra. The probe stopped about midway of the canal, but the resistance to its passage did not indicate the obstruction to be caused by a solid body.⁴²⁷

Smith continued engage in “heroic” action. He recorded that the probe could not continue through the woman’s vagina until he inserted his finger, which helped him insert the

⁴²⁵Smith, “Case of Dysuria,” 148.

⁴²⁶Smith, “Case of Dysuria,” 148.

⁴²⁷Smith, “Case of Dysuria,” 148.

probe into the bladder.⁴²⁸ At the turn of the nineteenth century, it was believed that a woman had a longer urethra than a man and often did not require a lithotomy. Physicians believed that to cure a woman of the stone, the physician was better off retrieving the stone manually than with surgery.⁴²⁹

After Smith inserted his finger, regular urine flow returned. He inserted a thick bougie to continue to drain her urine. After Smith dilated the woman's urethra, he noticed that "fleshy excrescences" appeared which were similar to swelling.⁴³⁰ He used "mechanical compression" to treat the swelling.⁴³¹ Lastly, Smith attached a smooth cane reed to the bladder to continue to drain the urine. The case ends with Smith proposing that his hypothesis of a stone causing the patient pain was correct because the patient had a child the next year. In Smith's mind, the woman's body returned to balance because her body performed a normal function, reproduction. He published the case in order to supply a "...useful hint to other practitioners..."⁴³²

Published in the same volume of a "A Case of Dysuria" was "A Case of Calculus in the Urethra of a Child Five Years Old."⁴³³ The man's son was approximately five years

⁴²⁸Smith, "Case of Dysuria," 148.

⁴²⁹Alexander Marcet explains this in his *Essay* discussed in the last section of this article.

⁴³⁰Smith, "Case of Dysuria," 148.

⁴³¹Smith, "Case of Dysuria," 149.

⁴³²Smith, "Case of Dysuria," 149.

⁴³³Edward D. Smith, "Case of Calculus in the Urethra of a Child five years old. By the late EDWARD DARRELL SMITH, M.D. Professor of Chemistry, &c. in the South Carolina College." *The Philadelphia Journal of the Medical and Physical Sciences* 1 (1820): 149-151.

old and had a history of troubled urination. The boy's problems began shortly after his birth, but recently the urination had stopped altogether; he continued to experience fevers and "extreme agony."⁴³⁴ Smith wrote that no previous physicians could do any good for the child, perhaps to highlight the "heroic" character of his medical practice.

The narrative included a robust description of the child's condition: "...a small hole was formed in the urinary canal, near to the anus, from which orifice the urine flowed out, and an abatement of the symptoms immediately took place."⁴³⁵ The hole described to Smith by the boy's father grabbed Smith's attention. The father described all other parts of the boy's body as damaged. As in the previous case, Smith began to hypothesize. He speculated that a stone had traveled from the bladder to the urethra and was wedged there preventing urination. There was a fistulous orifice behind the blockage described that allowed the urine to escape the body. The father brought his child to see Smith two weeks later.

When the child arrived in Pendleton, Smith confirmed his hypothesis. He found that, "...[t]here was a fistulous opening in the perinaeum, within a few lines of the verge of the anus; and I remarked that air seemed to come occasionally through this opening, which caused me to apprehend that there might be a communication betwixt the rectum and the bladder."⁴³⁶ Smith probed the child's orifice as he did in "Case of Dsyuria." He

⁴³⁴Smith, "Case of Calculus in the Urethra of a Child," 149.

⁴³⁵Smith, "Case of Calculus in the Urethra of a Child," 149-150.

⁴³⁶Smith, "Case of Calculus in the Urethra of a Child," 150.

was convinced there was a stone. Smith observed urine trapped in the child's scrotum because of its distended nature.⁴³⁷

Smith used a lance to create an opening, which contained pus and "blood water."⁴³⁸ Smith then applied "Saturine applications."⁴³⁹ The inflammation and pus subsided, allowing Smith to continue the operation. He next put his probe into the incision in order to enlarge the opening to remove the stone. With forceps, Smith extracted the stone while the patient admirably "tolerated" the pain.⁴⁴⁰ He estimated the stone size equivalent to two drachms, or about the size of a hazelnut.⁴⁴¹

Smith checked up on the patient two days after the operation. The child was without fever, but there was a new "communication" between the rectum and the bladder, allowing faeces to flow through the wound made in the scrotum. Smith applied compression on the perinaeum and told the patient to follow an "abstemious diet."⁴⁴² Two days later the patient no longer had feces passing through the bladder, and he had urine coming out "the natural passage."⁴⁴³ At a check-up six weeks later, Smith judged the child well.

⁴³⁷Smith, "Case of Calculus in the Urethra of a Child," 150.

⁴³⁸Smith, "Case of Calculus in the Urethra of a Child," 150.

⁴³⁹Smith, "Case of Calculus in the Urethra of a Child," 150.

⁴⁴⁰Smith, "Case of Calculus in the Urethra of a Child," 150-151.

⁴⁴¹Smith, "Case of Calculus in the Urethra of a Child," 151.

⁴⁴²Smith, "Case of Calculus in the Urethra of a Child," 151.

⁴⁴³Smith, "Case of Calculus in the Urethra of a Child," 151.

Smith interpreted his intervention effective because the child "...was become a stout and ruddy boy, able both to walk and run, which he never could do before."⁴⁴⁴ Smith had taken drastic heroic action, and, as a result, he successfully returned the flow of bodily fluids to normal.

After Smith's time practicing medicine in Pendleton, he took up the professorship of chemistry at South Carolina College. At the end of his career, Smith vocalized how chemical knowledge could contribute to the proper treatment of urinary stones, providing physicians another tool to treat those patients suffering from stones. There was a noticeable transition in his practice from an emphasis on treating stones to one on trying to diagnose and prevent them utilizing chemistry, presumably motivated by the traumatic cases of stones he witnessed in Charleston and Pendleton.

4.4 Smith and Medico-Chemistry at South Carolina College

The state government of South Carolina had established South Carolina College in 1801. Maximilian La Borde, a nineteenth-century historian of South Carolina College, wrote that Smith was considered exceptionally qualified to teach there eleven years later because of his medical training.⁴⁴⁵ While there, he pursued several academic interests and contributed to the leadership of South Carolina College. He served as the secretary of the faculty and withdrew from the formal practice of medicine.⁴⁴⁶ He was active in

⁴⁴⁴Smith, "Case of Calculus in the Urethra of a Child," 151.

⁴⁴⁵La Borde, 98-99.

⁴⁴⁶Except for a return to medicine during the winter epidemic mentioned later in this article.

publishing chemical memoirs and case histories concerning medicine; he published most of his Pendleton cases before his death in 1819. But he was still active in discursive societies about medicine, as he served as secretary of the South Carolina Medical Society.⁴⁴⁷ He translated the two volumes of *The Surgical Works of P.J. Desault*, volumes containing information and memoirs about the diseases of the soft parts, urinary passages, lithotomies, the stone, and gynecology.⁴⁴⁸ In his translator's preface, Smith praised the work of Desault and highlighted the helpful hints that the work might hold to the reader, "Such as the work is, I hope that it will be useful; and that a well meaning, if it be an imperfect attempt, will meet the requisite indulgence from the candid reader."⁴⁴⁹ Smith was always on the lookout for useful hints from any discipline to improve his medical practice.

As a chemistry professor, he attempted to introduce students to the latest chemical theories. Smith educated students in the subjects of electricity, chemistry, hydrostatics, magnetism, and pneumatics.⁴⁵⁰ His name continually appeared in the records of the

⁴⁴⁷La Borde, 88-94 and Waring, 315-316.

⁴⁴⁸Edward Darrell Smith, trans. *The Surgical Works, or Statement of the Doctrine and Practice of P.J.. Desault, Surgeon in Chief of the Great Hospital of Humanity, at Paris By Xavier Bichat* (Philadelphia: Thomas Dobson, 1814). The work is spread across two volumes; this volume was viewed at the University of South Carolina School of Medicine Library, Charles S. Bryan History of Medicine Reading Room.

⁴⁴⁹Smith, trans. *The Surgical Works Translator's Preface*, iii.

⁴⁵⁰John Morril Bryan, *An Architectural History of the South Carolina College: 1801-1855* (Columbia, SC: University of South Carolina Press, 1976): 59-61 and *Minutes of the Trustees*, South Caroliniana Library. Smith often negotiates with the Trustees for his needs for experimental supplies. It appears that sometimes Smith received the money and other times he does not. But by 1817, Smith is receiving money to buy new equipment and he is attempting to win Trustees over to the idea of building a special building devoted to chemistry. *The Minutes of the Trustees* contain a rich narrative of

college encouraging the Trustees to maintain, repair, and buy the latest chemical equipment from Philadelphia and “northern cities,” devices like gasometers, galvanic batteries, and pneumatic pumps.⁴⁵¹ Smith seems to have had both positive and negative relationships with the legislature of the state in regards to his performance as a professor, but it approved his requests for chemical lab space and equipment.⁴⁵² Still, Benjamin Silliman, famous chemist working at Yale, received complaints from Smith about his frustrations with the legislature and the quality of scientific life in the South.⁴⁵³ Smith continued his chemical work and its medical applications. While he embraced a very descriptive form of medicine, humoral theory, he ran a lab in which he worked diligently to quantify the fluids of the body. Smith was trying to rationalize a qualitative theory of medicine while engaging in debates regarding the new chemistry that focused on

Smith’s time, and related events, at South Carolina College: see Volume 1 pages: 232-239, 245-249, 252-253, and 262. See Volume 2: 9-12, 50-51, 62-63, 68-69, 70-73, 79-80, 87-88, 90-91, 94-95, 98-99, 115-116, and 119-120. And for Smith’s comments on buying equipment see *Silliman Family Papers* MS 450 at Yale University, Series II: General Correspondence, 1796-1885 (Viewed through ILL microfilm). Edward Darrell Smith has letters in the collection in Box 21, Folder 60 (letters from 1818-1819), and Box 18, folder 10 (1814-1817). For ILL request rolls 9 and 12. In addition, see Chandos Michael Brown, *Benjamin Silliman: A Life in the Young Republic* (Princeton: Princeton University Press, 1989), specifically pages 279, 283, 296, 302, 304-307, and 294-296 for a discussion of the Silliman-Smith correspondence.

⁴⁵¹See note above.

⁴⁵²See note above.

⁴⁵³See *Silliman Family Papers* reels 9 and 12, at Yale University (viewed through ILL, see note 90). There are also several manuscripts between the two in Pennsylvania Historical Society in their card catalogue: Letter Edward Darrell Smith to Benjamin Silliman June 30, 1817 in *Simon Gratz Collection* Box 256 Folder 58 and April 8, 1819, in Box 7/25 in Folder 3 of *American Scientists*. There is another letter to Edward Darrell Smith to Samuel Latham Mitchell from May 13, 1816 in *Simon Gratz Collection* Box 256, Folder 58.

intensive quantification of any fluids found in nature. He wanted to navigate Lavoisier's notion of chemistry within a neo-Galenic worldview. The Royal Institution (RI) in Great Britain published a letter from Smith in the *Halifax Nova Scotia Weekly Chronicle* on June 15, 1819: "On the Use of Prussic Acid in Consumptive Cases."⁴⁵⁴ Smith was working with his friend, Dr. James Davis, examining the effects of prussic acid on consumption.

A sense of professional obligation inspired Smith to publish his letter, in which Smith admits that he has stepped away from medical practice to focus on chemistry: "I am now debarred from any regular exercise of the profession, and therefore have not the opportunity of making much experimental investigation of medical subjects."⁴⁵⁵ But he had periodically practiced medicine while at South Carolina College; Dr. Davis acknowledged Smith's temporary return to medicine during the outbreak of croup in Columbia during the winter of 1815-1816.⁴⁵⁶

⁴⁵⁴Edward D. Smith, "On the Use of Prussic Acid in Consumptive Cases," the *The Quarterly Journal of Science, Literature, and the Arts* 9 (1820): 418-420.

⁴⁵⁵Smith, "On the Use of Prussic Acid."

⁴⁵⁶In the write up of the winter epidemic Davis later publishes he states that, "I am happy to be able to add that Doctor. E. D. Smith, professor of Chemistry in the South-Carolina College who during my own illness with the disease, was necessary drawn into the practice for several weeks from the scarcity of medicine aid, and to whom I showed this communication confirms the statements I have made as accordant with his own observations and experience." James Davis, "Account of the Winter Epidemic of 1815-1816, as it appeared in and adjacent to Columbia, S.C. By Dr. JAMES DAVIS. Pamphlet; Printed at Columbia, S.C. 1816," *The Journal of Foreign Medical Science and Literature* 7 (1817): 169.

Smith was inspired to try prussic acid after reading the work of a Dr. Majendie of Paris, a physician who also wrote about gravel (urinary stones).⁴⁵⁷ Felix Louis L’Herminier, an immigrant from the French Caribbean living in Charleston, manufactured the prussic acid for Smith.⁴⁵⁸ The supply he received from L’Herminier ran out, and Smith had to manufacture more using the methods found in Thomas Thomson’s *System of Chemistry*.⁴⁵⁹

Prussic acid was a very tricky chemical remedy. Describing its dangerous nature, Smith comments that, “As to the nature of this substance, it is a most virulent poison, and in this respect you will recognise its analogy to some of our most effectual remedies.”⁴⁶⁰ Citing the work of the turn-of-the-nineteenth-century authority on poisons, Mathieu Orfila, Smith referred his reader to Orfila’s work on “poisonous qualities, the symptoms, &c....”⁴⁶¹

In treating consumptive cases, Smith prescribed three drops of prussic acid for adults, taken with water, over the course of twenty-four hours. The patient can increase

⁴⁵⁷His work appears in *The London Medical and Physical Journal* disseminated and quoted under the title “Physiological and Medical Researches on the Causes, Symptoms, and Treatment of Gravel; by F. Majendie, M.D. &c. &c.” Majendie (or the alternative spelling Magendie) published many articles concerning the incorporation of chemistry into medicine and physiology.

⁴⁵⁸Felix Louis L’Herminier immigrated to Charleston from Guadeloupe in 1815. L’Herminier was the curator of the museum in Charleston, but later returned to France. Waring writes up a short biographical entry for L’Herminier on page 254 in *A History of Medicine in South Carolina 1670-1825*.

⁴⁵⁹Smith used Volume II, page 224 of the edition likely edited by Thomas Cooper.

⁴⁶⁰Smith, “On the Use of Prussic Acid,” 419.

⁴⁶¹Smith, “On the Use of Prussic Acid,” 419.

the dosage to eight to ten drops, but no one had ever taken a dose larger than ten drops. After two months, eight or nine cases, except for one severe case, recovered. As for the most severe case that did not recover, "...the distressing cough, copious expectoration, and wasting hectic were for weeks kept at bay, and the patient so much re-animated as to induce a hope of recovery; but this finally proved delusive."⁴⁶² Smith added that the acid was a good palliative and had not caused any injuries. The complications that did emerge in patients were stricture sensation in the breast, blood emerging from the lungs, and some effects on the brain, which were relieved after discontinuation of the acid.

Smith used chemical analysis to engage in the new chemistry of intense quantification while furthering his knowledge of the body's fluids. In July of 1818 he traveled to the head of the French Broad River in North Carolina, where the Mineral Springs of Buncombe were located, in order to study the supposedly healing waters there.⁴⁶³ Smith recorded a few temperature readings and offered some thoughts about the effects of the water on diseases caused by imbalances of the fluids of the body. He recommended that no one with "pulmonic" or "dropsical afflictions" should use the springs.⁴⁶⁴ Dropsy is the buildup of fluids in cavities or the "connective tissue of the body," and pulmonic disease is a disease of the lungs.⁴⁶⁵ Given Smith's humoral

⁴⁶²Smith, "On the Use of Prussic Acid," 419-420.

⁴⁶³Edward D. Smith, "An account of the Warm Springs, in Bun-come County, state of North-Carolina; by the late Edward D. Smith, M.D. and Professor of Chemistry and Mineralogy in the South-Carolina College." *The American Journal of Science and Arts* 3 (1821): 117-125.

⁴⁶⁴Smith, "An account of the Warm Springs," 119.

⁴⁶⁵*Oxford English Dictionary*

background, he cautioned sufferers of these diseases against bathing in the springs because of the risk to their constitution by the rise in body temperature. The physicians speculated that the constitution of the human body was often affected by climate, temperature, and water. Hippocrates mentioned these ideas in his “Airs, Waters, Places.”⁴⁶⁶

Smith also used qualitative methods in analyzing the springs; he described the water as limpid, with bubbles continuing to the surface, and the taste of the water as “insipid” and hot.⁴⁶⁷ The water lacked a distinctive smell. Around the springs, there was an unpleasant smell, especially in water that was stagnating or near vegetable matter. Smith carefully added chemicals, like sulphuric and nitric acids and “Sirup” of violets, to the water and recorded the reactions that took place. Since Smith had seen bubbles in the spring water, he tested Limewater against common water to determine if fixed air was present in the sample. Smith attempted the experiment multiple times, seemingly confirming the idea that there was carbonic acid in the water.⁴⁶⁸ He was looking for fixed air in order to explain the assumption that the spring waters contained health benefits, especially for those patients suffering from stones.

According to an unnamed gentleman, the water had a “brisk cathartic effect for a day or two, and after that produced no sensible result.”⁴⁶⁹ The water could possibly have

⁴⁶⁶J. Chadwick, *Hippocratic Writings*, 148-170.

⁴⁶⁷Chadwick, *Hippocratic Writings* This theory was postulated by another South Carolina physician, Dr. Mc Bride, who had tested the waters in 1816.

⁴⁶⁸Chadwick, *Hippocratic Writings*, 120.

⁴⁶⁹Chadwick, *Hippocratic Writings* 124-125.

provided relief for "...rheumatism, palsy, or loss of motion from other causes."⁴⁷⁰ The springs were an exciting possibility for Smith as he hoped the water could free blocked bodily fluids and return circulation to normal.

Smith's final article, though, is his most significant. "On the Application of the Medico-Chemistry to Calculous Affections" was published in 1821, approximately two years after his death.⁴⁷¹ Silliman included a note in Smith's article explaining why the article was published in 1821: "This is the last communication for this Journal with which the editor was favoured by the respectable and estimable author of this memoir; it was transmitted a little before his death, but it has not been convenient to publish it before."⁴⁷² The thesis of Smith's last article is his most sophisticated chemical argument.

The article emphasized striking new developments in chemistry's effect on living systems, not just changing dead matter. Smith explained that, "For, although it must be confessed that a rash enthusiasm may have unwisely attempted to explain the mysteries of some Phenomena, that are observed in the living system, by the analogy of the results of the action of chemical agents upon dead matter, it must be granted that there are cases, in which the useful application of chemical knowledge is conspicuous."⁴⁷³ In the same

⁴⁷⁰Chadwick, *Hippocratic Writings*, 125. *OED*. The origin of rheumatism coming from a humoral root was obsolete by the seventeenth century but the idea of a humoral balance can be seen in the idea of stiffness, or lack of rheum flowing to the muscles that characterize its use in the seventeenth and eighteenth century.

⁴⁷¹Smith, "On the Application of Medico-Chemistry to Calculous Affections: by the late Edward D. Smith, M. D. Professor of Chemistry and Mineralogy, in the South-Carolina College," *American Journal of Science* 3 (1821): 300-310.

⁴⁷²Smith, "On the Application of Medico-Chemistry," 300, note.

⁴⁷³Smith, "On the Application of Medico-Chemistry."

manner of his dissertation, Smith compiled information from authorities like Scheele and William Hyde Wollaston but incorporated his own experiences. Their work, he wrote, has led to:

...a light that is very cheering to the friends of science and humanity. We are now enabled to take a clear and satisfactory view of timidly grouping in the blind paths of empiricism, we may walk boldly upon the highway of correct principles. This is the sure road, and if we are careful not to deviate from it, must gradually conduct us towards the attainment of our object.⁴⁷⁴

Smith saw the treatment of urinary stones guided not solely by the experiences of a physician but by general chemical principles. The *Edinburgh Review* was highlighted in the article because the editors promoted the search for solvents to cure the stone as “...one of the noblest problems in practical chemistry, and among the best services that science could render to the healing art.”⁴⁷⁵

Citing the failure of eminent physician Joseph Black, Smith hypothesized that humanity would never find a solvent to treat urinary stones in a living system. Chemistry had never produced a remedy for the stone, but chemists had produced a means of preventing the stone.⁴⁷⁶ William Brande and Sir Everard Home were two chemists making progress in that area. They had found that stones were not all the same, and identifying a stone's composition helped determine the correct “preventive remedy.”⁴⁷⁷

⁴⁷⁴Smith, “On the Application of Medico-Chemistry,” 300-301.

⁴⁷⁵Smith, “On the Application of Medico-Chemistry,” 300-301.

⁴⁷⁶Smith, “On the Application of Medico-Chemistry,” 301.

⁴⁷⁷Smith, “On the Application of Medico-Chemistry,” 301.

Smith posited that analyzing urine is where chemistry "...is of signal benefit and affords us clue in a labyrinth, that would otherwise be impervious."⁴⁷⁸ Close analysis of patient urine gives off "premonitory symptoms of threatening dangers," which if responded to, can lead to the prevention of the stone.⁴⁷⁹ Smith and other physicians believed that urine was made up of acids and alkalies, and in a healthy state the ratios ("combinations") are uniform, while disease, such as stones, occurs when there is an "undue predominance of acid or alkaline matter," which resembled the interpretation of humors.

Chemical analysis provided the means of determining which ratio was out of balance, thus advising the physician as to the course of treatment. Disease most often occurred when there was too much uric acid in the urine. Neutral salts countered excess acid in the body, and the acids that escaped the salt ended up in the bladder. When excess acid had the potential to cause the patient problems, there were signs in the urine: irritation of the patient's urinary passages or small sand-like crystals in the urine. When there were excessive alkaline salts, white sand appeared in the urine. Knowing how to identify problems could stop the stone at its "germ."⁴⁸⁰ Smith was making strong arguments for humoral theory in the hope that the identification of imbalances in the urine would lead to the prevention of stones from forming in the first place.

⁴⁷⁸Smith, "On the Application of Medico-Chemistry," 301.

⁴⁷⁹Smith, "On the Application of Medico-Chemistry," 301.

⁴⁸⁰Smith, "On the Application of Medico-Chemistry," 302, "A previous knowledge of the subject and a proper attention to these indications will generally enable us to apply correct remedies and thus to destroy in the germ what would be irremediable at maturity.

Smith returned to the work of Erasmus Darwin that he had briefly explored in his dissertation. Although he did not know whether there was a “communication” between the bladder and the stomach through some type of “retrograde action of the absorbents,” “substances” that entered into the stomach could have effects on the urine.⁴⁸¹ The stomach is where chemists and physicians could manipulate the balance of acids.

Calculus complaints required the physician’s judgment in determining the nature of the stone. If the physician was ignorant, he could aggravate the patient’s suffering and even harm him. Smith cautioned, “To this difference in the constitution of calculous matter it is owing that both the strong and the weak acids have sometimes been used with eminent benefit; and yet the indiscriminate prescription of acids would frequently produce the most serious injury.”⁴⁸² Smith even warned against the fashion of drinking soda water to increase health, as experiments had shown that soda increased the speed of deposited phosphates in the body, leading to stones.

After examining the literature, Smith suggested magnesia in cases “which need alkaline remedies,” but cautioned that this remedy could not be used in cases where there was a lack of acid.⁴⁸³ In those cases, Smith recommended using the “the carbonated alkalies” because they would prevent phosphate from building up in the bladder but did not work well in the stomach. The editor, Benjamin Silliman, corrected this comment by adding the note “We presume that the writer intended to restrict this remark to the uric-

⁴⁸¹Smith, “On the Application of Medico-Chemistry,” 302.

⁴⁸²Smith, “On the Application of Medico-Chemistry,” 302.

⁴⁸³Smith, “On the Application of Medico-Chemistry,” 303.

acid, for it is notorious that the carbonate &c. neutralize and remove acids in the stomach.”⁴⁸⁴

Smith then went on to cite empirical cases, most notably his own self-treatment. Though Smith remonstrated against a physician needing experience to treat the stone, he privileged his own experience because it confirmed his chemical ideas. Recounting an experience with a stone in 1817, Smith turned himself into a character in his article, much like he did with his Pendleton case studies. He first gave a history of the stone forming and its potential causes. He recounts that he lived in a “sedentary manner,” closely confined in a “new brick building” (possibly the new chemistry building at South Carolina College) which was neither “well ventilated nor warmed.”⁴⁸⁵ He had “paroxysms,” but he treated himself with wine, which removed his symptoms.⁴⁸⁶ He also had “violent, flatulent cholick” with “frequent shooting and lancinating pains down the right thigh urethra, &c.” Smith self-administered “enemas” and “embrocations” (lotions).⁴⁸⁷ Exposure to the cold seems to have exacerbated his symptoms. After consulting a fellow physician in Columbia, he was advised that his fluids were in a state of “acrimony,” and if he did not solve his fluid problem, it would surely “terminate” as a

⁴⁸⁴Smith, “On the Application of Medico-Chemistry,” Note on 304.

⁴⁸⁵Smith, “On the Application of Medico-Chemistry,” 304.

⁴⁸⁶Smith, “On the Application of Medico-Chemistry,” 304.

⁴⁸⁷Smith, “On the Application of Medico-Chemistry,” 304-305. From the *Oxford English Dictionary*.

urinary stone.⁴⁸⁸ Again, Smith linked a problematic state of fluids to the formation of a stone.

In the article, Smith sought the chance to call for the revival of humoral theory. He argued that the return of humoral pathology could demystify the phenomena of the stone. Humoral theory, according to Smith, might have been given up too quickly:

The extravagance of theorists, in almost any department of science, has sometimes carried them so far beyond the bounds of rational induction, as to involve in one common condemnation both truth and error; and this perhaps, has been the fate of the Humoral Pathology. Very lately this subject has been ably treated by Professor Cooper, of Philadelphia in his ingenious discourse upon the connection of chemistry with medicine, and in which it has been plainly shewn that the application of chemical science throw much light upon the reprobated doctrine.⁴⁸⁹

Smith referred back to his work in his dissertation concerning substances conveyed unchanged in the body's circulation. The unfolding of Smith's theory was that humoral pathology was important to understanding how substances could travel through the body, which could be useful to the physician in manipulating acidic and alkaline fluids to prevent the stone. Through empirical and close chemical analysis, Smith attempted to merge the new chemistry with the old humoral pathology.

⁴⁸⁸Smith, "On the Application of Medico-Chemistry," 305.

⁴⁸⁹Smith, "On the Application of Medico-Chemistry," 306.

Smith argued that chemistry is useful and crucial to the physician's healing art but that the physician must be careful about which chemical interventions to use.⁴⁹⁰ Doctors needed to know chemistry in order to treat stones in the fluids of the living body before they fully formed. Chemistry revealed the changes occurring in the body and the potential formation of stones. The "progress of medical science," he emphasized, must focus on the judicious selection of alkaline remedies.⁴⁹¹ The incorrect remedy could produce an equal and opposite negative outcome for the patient without careful judgment. Smith cited the work of a Mr. Brande, a chemist-apothecary, and a Dr. Wollaston, a physician-chemist.⁴⁹² These two men, like Smith, were interested in using chemistry to treat and understand stones produced in the body.⁴⁹³ A transatlantic conversation also developed between Smith and Alexander Marcet focused on how to use chemistry to treat illnesses, especially those involving stones. Marcet was a Genevan physician who immigrated to Britain after imprisonment as a political prisoner during the Napoleonic wars.⁴⁹⁴ Marcet,

⁴⁹⁰Smith, "On the Application of Medico-Chemistry," 306-307.

⁴⁹¹Smith, "On the Application of Medico-Chemistry," 307.

⁴⁹²Smith, "On the Application of Medico-Chemistry," 307 and *Oxford Dictionary of National Biography*.

⁴⁹³For instance, see William T. Brande, "Observations on the Effects of Magnesia in Preventing An Increased Formation of the Uric Acid," *Philosophical Transactions* (1810); or William Hyde Wollaston, "On Cystic Oxide, A New Species of Urinary Calculus," *Philosophical Transactions* (1808). Often there were review essays that appeared in medical journals. See "ART. VIII. A Letter on the Differences in the Structure of Calculi, Which Arise from their being formed in different Parts of the Urinary Passages," *Edinburgh Review* 17 (1810): 155-167. This article was essentially a collection of reprinted essays.

⁴⁹⁴Louis Rosenfeld, "The Chemical Works of Alexander and Jane Marcet," *Clinical Chemistry* 47 (2001): 784-792, N.G. Coley, "Alexander Marcet (1170-1822), Physician and Animal Chemist," *Medical History* 12 (1968): 394-402, and Louis

like Smith, was a physician who eventually turned away from medical practice to investigate chemistry full-time.

In 1817 he published much of his clinical and chemical observations in *An Essay on the Chemical History and Medical Treatment of Calculous Disorders*.⁴⁹⁵ The essay explained why different types of stones formed, what populations were affected, treatments, and recommendations for chemical analysis of stones. Smith was able to comment on Marcet's work based on a review he had read.⁴⁹⁶ Smith was particularly interested in Marcet's work on analyzing the ages, sex, and location of calculus sufferers. Smith commented that, according to Marcet, women suffered from stones comparatively less often than men. He presented the idea that women suffered less frequently than men do because they were more restrained in diet but at the same time that they should suffer more from the stone because they live more sedentary lives than men. Smith was skeptical that any anatomical differences could account for the "disproportion" of male sufferers of the stone compared to women.⁴⁹⁷

Rosenfeld, *Four Centuries of Clinical Chemistry* (New York: Routledge, 1999), 48-51, and there is information about Marcet in the National Dictionary of Biography under his wife, Jane Marcet, entry.

⁴⁹⁵Alexander Marcet, *An Essay on The Chemical History and Medical Treatment of Calculous Disorders* (London: Longman, Hurst, Rees, Orme, and Brown, 1817).

⁴⁹⁶Smith cited the *The London Medical and Physical Journal*, but he could have read the review found in Volume 39 on page 313-321 or the review that appeared in the *Edinburgh Review* 13 (1819): 418-430, but this review came out during the end of Smith's life and these are only speculations. Smith did not cite any specific review.

⁴⁹⁷Smith, "On the Application," 309.

Smith concluded with speculation on other precursors to stones. Climate might influence the living systems that produced calculous material. He reflected that stones are rare in countries that are very hot or very cold. Diet or sedentary lifestyle might influence calculous productions, he posited, though he was influenced by his own speculations that his physically sedentary lifestyle indoors caused his body to start showing stone-like symptoms. Finally, he proposed that chemicals that modify fluids could also be useful in preventing stones, but further research would be necessary.

During the summer recess of July of 1819, Smith left Columbia for the western part of America. Smith was part of a company that purchased some land near the Missouri territory.⁴⁹⁸ In one of his letters to Benjamin Silliman, Smith was deciding between two trips, one to the north and this one to the west; it seemed that Smith chose the latter because of his desire to move to the Missouri territory in order to avoid a sedentary lifestyle and improve his health, most notably his stone troubles. He was hoping, too, to escape frustrations with the state of South Carolina: “__ I have even contemplated a final residence in that country, in the course of two or three years__ on the grounds, that my health is injured by a sedentary life, our institution not being conducted in a manner that I can relish, & an ardent desire to escape from a State, so debased by Slavery, as ours is__”⁴⁹⁹ Smith died from bilious fever at a friend’s house in Missouri in 1819.⁵⁰⁰

⁴⁹⁸La Borde, 88-94 and Waring, 315-316.

⁴⁹⁹Edward D. Smith to Professor Benjamin Silliman April 8, 1819. Letter from the Historical Society of Pennsylvania, *American Scientists* in *Simon Gratz MSS* Folder 3 Box 7/25. This letter was written when Smith was visiting Charleston.

⁵⁰⁰La Borde, 88-94, Waring, 315-316, and Howe, 260-261.

4.5 Conclusion

The case of the child with a calculus in his urethra was one case study of Smith's use of humoral theory in medical practice. Smith knew that the child was having a problem because there was a blockage in the fluids of the body; Smith removed the blockage to return the child back to proper health. He thought that urine needed to circulate through the body; when urine was retained there was a problem that needed to be addressed. Humoral theory has ceased to be an effective medical theory, but it was still useful in medical practice by physicians like Smith at the turn of the nineteenth century.

New advances in chemistry, starting in the late eighteenth century with the so-called chemical revolution, allowed physicians interested in humoral theory to argue for its usefulness. Physicians like Smith argued that the emphasis on analytical precision was useful in medical practice as they could use it to improve his understanding of the body's fluids. Physicians could analyze urine on its chemical levels. With improved chemical knowledge, physicians like Smith could explain formerly unanswerable questions related to humoral theory, like how drugs worked in the body. Smith further linked chemical analysis with humoral medical practice when he applied chemical analysis to healing waters. If physicians could analyze nature chemically, they might gain further insights into how to improve a patient's constitution.

Smith saw the new chemistry as improving medical practice. Involving more chemical analysis into medical practice made medicine more into a science and prevented it from relying too much on empiricism. With changes in chemistry at the turn of the nineteenth century, Edward Darrell Smith and other medico-chemists reintegrated humoral theory into urological practice.

However, the incorporation of chemistry into healing treatments was not limited to physicians. Surgeons were interested in avoiding the dangerous lithotomy on patients suffering from the stone. Physicians wanted to collaborate with surgeons in order to get access to the stones removed from former patient. The type of manual extractions that Smith performed on his patients were seen as the most successful moment of chemical medicine. The stone could be shrunk down to a small size, then could be removed with the practitioner's hands. Chemistry and medicine, with the later inclusion of surgery, strove for this outcome.

CHAPTER 5
THE ARTIFICIAL LINE:
SURGERY, MEDICINE, AND CHEMICAL ANALYSIS

5.1 Introduction

Alexander Marcet published *An Essay on the Chemical History and Medical Treatment of Calculous Disorders* in 1817.⁵⁰¹ The *Essay* appeared later in French and German editions.⁵⁰² The *Essay* was an attempt to discuss the chemical causes and natural history of calculi that occur in the body, and it aimed to instruct the physician in performing simple chemical analyses to determine the type of stone a patient was suffering from. Calculi were not, however, a disease that interested only medico-chemical practitioners. Surgeons also had a long history of treating stones in the body through lithotomy, a surgical operation that removed the stone through cutting or manual removal. Lithotomies were very painful and required an experienced surgeon. The original Hippocratic Oath prohibited physicians from practicing the craft because of its high mortality rates.

⁵⁰¹Alexander Marcet, *An Essay on the Chemical History and Medical Treatment of Calculous Disorders* (London: Longman, Hurst, Rees, Orme, and Brown, 1817)

⁵⁰²*Chemische Untersuchungen über die Harnsteine* von Alexander Marcet in 1820 and *Essai sur l'Histoire Chimique des Calculs et sur le Traitement médical des Affections Calculeuses* in 1823

Marcet saw his work as not only useful to the physician and the chemist, but to the surgeon as well. Marcet shared a close friendship with Astley Cooper, a distinguished surgeon at the turn of the nineteenth century. Marcet believed that the long historical and professional boundary line between medicine and surgery was artificial, and that each could benefit from each other, a belief perhaps bolstered by this friendship. Stones of the body were an exemplary case where collaboration was crucial to treatment.

Collaboration in regards to urinary calculi, and chemical analysis of the fluids of the body, was not strictly limited to physicians or chemists. Surgeons were also interested in understanding the fluids of the body. Cooper often cited chemical analyses from medico-chemists in his published lectures and he sent specimens to Marcet for analysis. Marcet received most of the stones that he analyzed in his *Essay* from surgeons and cited their empirical work. Surgeons' offerings, primarily those from Cooper, made up the crucial specimen collection that facilitated the construction of Marcet's book.

Cooper and Marcet were able to collaborate because bodily stones, in many cases urinary stones, served as boundary objects. Starr and Griesemer argued that heterogeneous boundary objects required members of different communities to: "...translate, negotiate, debate, triangulate, and simplify in order to work together."⁵⁰³ Working together creates new scientific knowledge and allows for its translation into communities who view objects differently. Often, for actors to create more scientific authority, they have to recruit allies from other fields.

⁵⁰³Susan Leigh Star and James R. Griesemer, "Institutional Ecology, 'Translations' and boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39," *Social Studies of Science* 19 (1989): 388-389.

In the case of stones at the turn of the nineteenth century they take on a new significance because of the use of Lavoisier's chemistry to analyze the stones. For medico-chemists like Marcet, stones were a perfect object to demonstrate the analytical power of chemistry and its value to medicine. But for Marcet, he needed to enlist surgeons like Astley Cooper to provide case summaries, stones for analysis, and knowledge capital to bolster his own understanding of stones, and authority as a chemist. Cooper also agreed to collaboration not only to advance the effectiveness of surgery in treating stones, but also to advance ideas about useful humoral practices in surgery. Both men worked together to make sense of an object that had a diverse set of meanings between the medical and surgical communities.

Surgery and medicine have a complex historiographical relationship. There were contentious occupational divides in the history of medicine in Britain. Some surgeons remained skeptical of chemical interventions for stones all the way up to until 1965. Articles like "Use and Abuse of Clinical Chemistry in Surgery" reveal this.⁵⁰⁴

The history of medicine has often slighted the scientific contributions of surgeons, starting with John Hunter. Hunter was an anatomical teacher, surgeon, collector of anatomical specimen, and prolific writer during the eighteenth century.⁵⁰⁵ William Bynum and Roy Porter have railed against medical historians that overly emphasize the dichotomy between medicine and surgery. They caution that, "Several contributors argue

⁵⁰⁴A. M. Bold, "Use and Abuse of Clinical Chemistry in Surgery," *British Journal of Medicine* (1965): 1051-1052.

⁵⁰⁵Ernest Alfred Gray, *Portrait of a Surgeon: A Biography of John Hunter* (Ann Arbor: University of Michigan Press reprint of Hale edition, 2007).

that historians often hamper themselves with anachronistic or inappropriate models of medicine, implicitly borrowed from the nineteenth century.”⁵⁰⁶

Historians have also been portraying surgeons as producers of knowledge. In “Enlightenment Science? Surgery and the Royal Society” Phillip Wilson asserts that the scientific contributions of surgery to medicine begin before Hunter.⁵⁰⁷ However, little attention has been paid by historians to what is exactly what the relationship between scientific and surgical communities at the turn of the nineteenth century. Wilson points to the significant number of papers about surgery in submissions to the *Philosophical Transactions*, even though editors later reduced surgeons’ participation in the journal and empirical papers ceased appearing in the journal.⁵⁰⁸ Most of the empirical articles by surgeons concerned calculi and lithotomies. Wilson claims that empirical articles about stones waned in the journal because society members thought that the literature concerning lithotomies was oversaturated.⁵⁰⁹

However, stone cases, as this chapter explores, were of interest to physicians, chemists, and surgeons alike, an interest that migrated into the research and efforts of medico-chemists and their receptive societies. Bodily stones acted as boundary objects

⁵⁰⁶William Bynum and Roy Porter, eds. *William Hunter and the Eighteenth-Century Medical World* (Cambridge: Cambridge University Press, 1985), 3.

⁵⁰⁷Phillip Wilson, “Enlightenment Science? Surgery and the Royal Society” in Roy Porter, ed. *Medicine in the Enlightenment* (Atlanta, GA: Rodopi, 1995), 360-386.

⁵⁰⁸Wilson, “Enlightenment Science?,” 360-386.

⁵⁰⁹Wilson, “Enlightenment Science?,” 362.

between medicine and surgery. An examination of how Marcet and Cooper each analyze stones demonstrates their boundary object status.

5.2 Alexander Gispard Marcet

Alexander Gispard Marcet was born in Geneva, Switzerland in 1770.⁵¹⁰ His family was of Huguenot decent. Marcet was originally destined for a career in business and commerce, as his father apprenticed him to a merchant. However, with his father's approval, he left commerce and pursued his desire to study science. After the Revolution in France, the Directory, a leadership group of France's new Revolutionary government, annexed Geneva as part of the newly established Republic of France.⁵¹¹ Marcet served in the national guard of Geneva. After Robespierre lost power, Marcet was exiled from Geneva in 1794 for approximately five years. Marcet was not alone in his sentence, his childhood friend Charles Gaspard De Le Rive suffered the same fate for serving in the National Guard as well. The two men traveled to the University of Edinburgh to study medicine, receiving their Medical Doctorates on June 24, 1797. Marcet wrote his doctoral thesis on diabetes.⁵¹²

⁵¹⁰A biographical narrative was constructed from N. G. Coley, "Alexander Marcet (1770-1822), Physician and Animal Chemist" *Medical History* 12 (1968): 394-402, Louis Rosenfield "The Chemical Work of Alexander and Jane Marcet," *Clinical Chemistry* 47 (2001): 784-792, *Oxford Dictionary of National Biography*. "Alexander Marcet," 290-298 in *The Annual Biography and Obituary, for the Year 1823* (London: Longman, Hurst, Rees, Orme, and Brown, 1823), was most informative.

⁵¹¹See the note above.

⁵¹²See the note above.

After graduation, Marcet traveled to London to practice medicine. He became an assistant physician at the public dispensary on Carey Street. He received his “Licentate” from the Royal College of Physicians on June 25, 1799.⁵¹³ Marcet married Jane Haldimand, the daughter of the wealthy Swiss merchant Anthony Francis Haldimand in 1799. The pair had three children, including François Marcet, who also became a physician. Marcet received British citizenship in 1800 and by 1804, he was admitted to Guy’s Hospital. In 1808, he became a fellow of the Royal Society.⁵¹⁴

During the Napoleonic Wars, Marcet worked in a military hospital in Portsmouth. While treating soldiers Marcet came down with a fever, but recovered. His obituary summarizes the difficulties of his experiences with wartime medicine,

At the time when the Walcheren fever was committing dreadful ravages among our troops on their return from the expedition to Holland, in 1809, the want of additional medical assistance being urgently felt, Dr. Marcet volunteered his services, and was appointed to the superintendence of the General Military Hospital at Portsmouth; a duty which he performed with unremitting zeal, and which was interrupted only by himself becoming the subject of a similar disease.

He was very severely affected, and recovered from it with great difficulty.⁵¹⁵

Marcet was able to balance his wartime service with teaching responsibilities at Guy’s Hospital. He taught at Guy’s between 1807 and 1820.⁵¹⁶ His teaching responsibilities

⁵¹³See the biographical note above.

⁵¹⁴See the biographical note above.

⁵¹⁵*Annual Obituary*, 296.

⁵¹⁶*Annual Obituary*, 296.

mostly included lecturing on chemistry. During his time teaching, he befriended many chemists, including J. J. Berzelius. In 1817, Marcet published an essay about urinary calculi and the related chemistry of the stones. *An Essay on the History and Medical Treatment of Calculous Disorders* was useful to both the investigative and theoretical chemist, as well as the medical practitioner. The book went through many editions in French, German, and Swedish.

After the death of his father-in-law, Marcet received a large inheritance and planned to retire from teaching. Marcet, however, died in 1822 from stomach disease in England after returning from a trip in Scotland. He was buried in Battersea, along with one of his sons who had preceded him in death.⁵¹⁷ Jane Marcet, his wife, continued to work and publish after his death. She published *Conversations on Chemistry* in 1832. She died in 1858.⁵¹⁸

5.3 *An Essay on Calculous Disorders*

The *Essay on Calculous Disorders* reflected many of Marcet's interests: unique and mysterious cases dealing with urine and stones, the acids of the body, and cooperation between medicine and surgery. The text encouraged chemists to investigate the unknown causes and nature of stones and provided physicians information and insight into understanding and treating stones. Questions related to calculi offered opportunities for physicians and surgeons to collaborate and mutually improve practice. Chemistry was

⁵¹⁷*Annual Obituary*, 290.

⁵¹⁸Susan M. Lindee, "The American Career of Jane Marcet's *Conversations on Chemistry*, 1806-1853," *Isis* 82 (1991): 8-23.

an investigative tool that both physicians and surgeons which promised to provide insight into the nature of the stones. Marcet readily cites the work of many surgeons in this work aimed primarily at physicians. However, by the early nineteenth century there was considerable overlap among the groups⁵¹⁹ For instance, Marcet's close friend and colleague Astley Cooper was a surgeon interested in chemistry.

Marcet dedicated the work to the medico-chemist William Hyde Wollaston. The dedication, written on September 11, 1817, highlighted Wollaston's contribution to medicine and chemistry, and crowns Wollaston as the perfecter of chemical research related to concretions. Wollaston approved of his work, as the two men worked together in the administration of the Medico-Chirurgical Society.⁵²⁰ Marcet and Cooper were among the seven original trustees that formed the Medico-Chirurgical Society in 1805, and both men had papers that appeared in the first issues of the *Transactions of the Medico-Chirurgical Society*.⁵²¹ The Medico-Chirurgical Society became the Royal Medico-Chirurgical Society and eventually the premier professional society for medicine in the United Kingdom. Marcet and Cooper's participation in the Medico-Chirurgical Society is analyzed in more detail in the final chapter of this dissertation.

In his introduction, Marcet frames the text as a work for the "medical profession."⁵²² Marcet knew that successful medical treatment had limits. No matter how

⁵¹⁹Marcet, *Essay*. This table was constructed through a tabulation and brief journal research in the *Medico-Chirurgical Transactions* to determine what typology each character fit into.

⁵²⁰Penelope Hunting, *The History of the Royal Society of Medicine* (London: The Royal Society of Medicine, 2002).

⁵²¹*Medico-Chirurgical Transactions* 1 (1809): 1-12 and 77-82.

successful physicians could become at treating stones, their interventions would be palliative at best, and lithotomy was the only true cure. However, if treatment led to relief that was also positive:

But if the progress of the disease may be arrested in its earlier stages, and if the pain and danger of a formidable operation can be averted*; or if after the operation, the tendency to a relapse may be effectually checked, enough, no doubt, will be gained to entitle the subject to our most serious attention.⁵²³

For Marcet the point of examining the chemical nature of stones was not to determine a cure per se, but to provide the best palliative nature for patients and prevent a relapse.

When he wrote his *Essay*, Marcet was a lecturer in chemistry at Guy's Hospital, in London, England. Marcet wanted to teach students about the “novel” chemistry of stones, and he felt students ought to know about stones and their related chemistry.

Teaching future physicians about the chemistry of stones was the future of medicine:

The practical utility of the pursuit, and the great facility with which these bodies may now be analyzed and discriminated from each other even by persons unaccustomed to chemical manipulations and the remarkable simplicity which modern chemistry has introduced in the history of calculi, compared to the singular scantiness of information which prevailed in this respect twenty or thirty years ago...⁵²⁴

⁵²²Marcet, *Essay*, vii.

⁵²³Marcet, *Essay*, viii-x.

⁵²⁴Marcet, *Essay*, xi-xii.

Future physicians needed to understand the latest chemical knowledge. Marcet argued that, beyond the importance of chemistry into treating and understanding stones, any boundary young practitioners might perceive between medicine and surgery was permeable.

He defended collaboration between surgery and medicine, claimed each had something to gain from the other: “This tract can scarcely be viewed, even by those who wish to preserve with the strictest rigour the artificial line by which the different departments of the profession are circumscribed, as a encroachment upon the practice of surgery.”⁵²⁵ Marcet saw each occupation benefiting from the other and working for a common good in the treatment of the patient: “Indeed such is the unavoidable and constant dependence of the professions of medicine and surgery on each other, that any apology on the subject would, in my opinion, be a kind of insult to the sense, or candour of my medical brethren.”⁵²⁶

Marcet disagreed with intellectual boundaries and offered no direct prohibitions restricting practice, “Whatever advantage may arise from dividing and circumscribing the labours of the two professions, in practice, the greatest benefit may be expected, in science, from combining the studies of both.”⁵²⁷ He practiced dissections and offered patients small surgical interventions himself.⁵²⁸ Marcet promoted the idea of permeability by stating that,

⁵²⁵Marcet, *Essay*, xii.

⁵²⁶Marcet, *Essay*, xii.

⁵²⁷Marcet, *Essay*, xiii.

⁵²⁸See Alexander Marcet Papers at the Royal College of Surgeons.

A physician, if conversant with surgeon, will direct the effects of medicine with greater certainty and success while a surgeon will derive incalculable advantages in the treatment of local diseases from the knowledge he may have acquired of pathological principals. And the latter will soon learn in studying the phenomena and treatment of diseases, the fallacy and danger of the popular notion that the knowledge of the structure of the body is sufficient to enable us to obviate the disease to which it is liable.⁵²⁹

The introduction of his *Essay* implied that stones were a serious problem, and a problem that both healing occupations had to deal with successfully. It was in both groups' mutual interest to cooperate. Marcet praised Astley Cooper for his expertise and the expressed gratitude for access to some of his private collection of stone specimens. The two would collaborate repeatedly over the course of their lives.

The final point that Marcet wanted to make in the introduction was more subtle than the other two points. Marcet saw a difference in the ways stones affected men and women. He foresaw a future that women would be free from any calculous complaints and would not need surgery for the stone (lithotomy). Marcet presented these ideas, however, largely in the footnotes of his book.

Lithotomies were dangerous business. About one in five patients died from the procedure. A third of all hospital cases were thought to be cases of stones, or about four hundred cases of the total admissions to the Norfolk and Norwhich hospitals according to the samples that Marcet examined. However, Marcet found that women represented a

⁵²⁹Marcet, *Essay*, xiii.

disproportionately low number of the total suffers and of the patients undergoing lithotomies. His information led him to believe that the “female sex” will be “exempt” from “that operation [lithotomy].”⁵³⁰ The physiology of women, Marcet argued, allowed them to escape the need for surgery when suffering from the stone,

The remarkable degree to which the urethra in females is capable of being dilated by well known mechanical means, renders it practicable in every instance to extract from their bladder, without the assistance of the knife any calculus of moderate size; and even stones of a very considerable bulk in a few instances, been extracted in that manner.⁵³¹

Marcet, however, pointed out that Cooper, “Mr. Thomas,” and physicians like John Yelloly were reviving the technique by discussing it in the medical literature, including the *Medico-Chirurgical Transactions* published by the Medico-Chirurgical Society.⁵³² The claim that women will be exempt from the lithotomies appears in many places throughout his text. Marcet advocated this theory because he thought that chemical remedies would advance to destroying stones before they would need to be extracted, or manual extraction would remove stones not destroyed by chemistry.

⁵³⁰Marcet, *Essay*, ix-x

⁵³¹Marcet, *Essay*, ix.

⁵³² The Medico-Chirurgical Society appears more in depth in the final chapter of this study.

5.4 Marcet's Chemical Synthesis in the *Essay*

Marcet included a comprehensive discussion of the chemical composition of stones in his *Essay*. The first part of Marcet's discussion of stones was a natural and descriptive history of stones in the body, specifically stones in the urinary passages. First Marcet defined urinary stones,

The formation of concretions in the urinary passages being occasioned by the separation and consolidation of certain ingredients contained in the urine, and being independent of any specific agency of the urinary organs themselves calculi are liable to form in any of the cavities o which the urine has access.⁵³³

Stones appeared in the kidneys, the ureter tubes, the bladder, and the urethra. Stones formed naturally or morbidly. The kidneys were the place where stones originated. Urine was "secreted" in the "emulgent vesssels" and then traveled to the "infudibula," then to the pelvis (or large "cavity of the kidneys," to the ureters, where urine was double filtered.⁵³⁴ The filtering in the ureters explained why stones appeared there, "...which is highly favorable to the deposition of any undissolved calculous matter."⁵³⁵ Concretions developed in other areas of the body as well, including the pelvis or the kidneys.

⁵³³Marcet, *Essay*, 1.

⁵³⁴Marcet, *Essay*, 2.

⁵³⁵Marcet, *Essay*, 2.



Figure 5.1 Plate from the *Essay*

Marcet offered illustrations throughout his essay. The first plate he presented showed many stones that pressed against each other. Usually the stones were expelled naturally out of the kidney through the urine. Somehow, stones are stuck in the body, because of either some “morbid affection,” or the numbers of them increases as to cause a problem.⁵³⁶ Marcet included other plates that illustrated different areas of the body where stones could become trapped.⁵³⁷ The plates appear below:



Figure 5.2: A Display of Plates

Calculi might be lodged in different parts of the body, like the ureters, but Marcet thought that they did not generate there. Marcet argued that the bladder was the “seat” of

⁵³⁶Marcet, *Essay*, 2.

⁵³⁷Marcet included several plates at the end of his *Essay*.

calculi.⁵³⁸ Marcet thought that once stones traveled from the kidneys to the bladder they caused problems for the patient. The kidneys were the seat of disease for Marcet.

Throughout his *Essay*, he shared stories of patients who suffered from exceptional cases of stones. Although he often used these cases to make philosophical points, they work primarily as pedagogical pieces. Marcet disseminated his experience as well as chemical knowledge. For instance, Marcet shares the story of a gentleman who suffered from the irritation of the urinary passages for approximately ten years.⁵³⁹ He occasionally discharged gravel, accompanied with mucous “streaked” with blood.⁵⁴⁰ But the patient did not display the usual “diagnostic symptoms” related to stones. These symptoms included trouble urinating, pain in the penis (specifically the glans), and he was never sounded (where a probe is inserted into the bladder to explore the area to determine if there were any stones). Unfortunately, the patient died in extreme pain and agony. When the patient was dissected Marcet found an “imbedded pouch,” which contained a stone that weighed three thousand and eighty three grains, even though Marcet determined that it did not obstruct the urine.⁵⁴¹

Marcet elaborated a set of general symptoms of the stone. These symptoms were numerous including the wasting away of organs, pain in the kidneys, and odorous urine with lots of blood in it.⁵⁴² Pain occurred when the stone traveled from the kidney to the

⁵³⁸Marcet, *Essay*, 5.

⁵³⁹Marcet, *Essay*, 7-8.

⁵⁴⁰Marcet, *Essay*, 7.

⁵⁴¹Marcet, *Essay*, 8.

⁵⁴²Marcet, *Essay*, 8.

bladder. More pain occurred in the lumbar region and when the stone traveled to the ureters there was pain in the testicles, numbness in the thigh, and pain in the affected side of the body. The urine often turned red and there were strong urges to urinate, but the amount of urine produced was comparatively small.

Marcet pointed out that most of the pain for the patient occurred when the stone traveled through the ureters; but when it came to actually discharging the stone from the body, the patient might be completely unaware. Thick mucus with a rope-like character was often voided. Sometimes a patient that suffered from a stone simply had inflammation. Marcet thought that symptoms for the stone could be mysterious and inconsistent.

Irritation was a problem for patients suffering from stones. Sufferers could exacerbate their symptoms by riding horseback or in a “rough carriage.” When the bladder was irritated, it further affected the body, and could possibly cause the stomach to die. Inflammation from stones could cause tumefaction in the urethra. When a stone was found in the prostate, the sufferer could experience irritation and difficulty urinating as well.

Irritation was a term common in humoral pathology. Francois Joseph Victor Broussais, a physician interested in mental illness, laid out a discussion of irritation and humoral pathology.⁵⁴³ Thomas Cooper translated the original edition into English. Broussais believed that irritation was mapped onto humoral pathology when it was translated through various cultures and languages beginning with the “Arabians,” who

⁵⁴³Francois Joseph Victor Broussais, *On Irritation and Insanity*, trans. By Thomas Cooper (Columbia, S.C.: J. M^CMorris, 1831), 26.

explained it through occult forces.⁵⁴⁴ The theory was later refined and named by Jerome Fracastorius who “...spoke of the irritation produced by the humours on the solids...”⁵⁴⁵ The idea was later discussed by all manner of chymists. Irritation, or the nervous fluid, caused inflammation in the body, produced disease, caused fevers, and caused further systemic problems in the stomach, heart, and brain. Irritation was thought to belong to the “elementary and humoral pathology.” Marcet was building on the idea that the fluids of the body irritate the system, and these irritating fluids caused the formation of stones in the body.

5.5 Collecting Occurrences of Stones

Marcet wanted to know if and how stones’ occurrences were affected by country, age, climate, habit, or situation. When Marcet attempted to collect information concerning numbers of lithotomies or mortalities from surgery, he found that almost no hospital collected this type of information with the exception of two hospitals in Norwich and Norfolk, England. Both hospitals had information about surgeries going back to about forty-four years prior, with surgical outcomes listed and many of the actual calculi from the lithotomies.

Marcet attempted to understand the rates at which men, women, and children underwent lithotomies through contacting surgeons to get access to their notes. He

⁵⁴⁴Broussais, *On Irritation*, 26.

⁵⁴⁵Ibid. Also see Bruce T. Moran, *Distilling Knowledge: Alchemy, Chemistry, and the Scientific Revolution* (Cambridge: Harvard University Press, 2005)

noticed that more men than women underwent surgery, and there was a high mortality rate for lithotomies overall.⁵⁴⁶ At Norwich, there were 18,859 patients between 1772 and 1816, or an average of four hundred and twenty eight persons admitted to the hospital annually. In 44 years, 506 persons were admitted for lithotomy, or about one in thirty eight admissions.⁵⁴⁷ Marcet broke down the total lithotomies per year:

Table 5.1 Lithotomies

Years at Norwich	Lithotomy Numbers
1772-1782	100
1782-1792	120
1792-1802	116
1802-1812	137

The trend to perform lithotomies seemed to increase over time. Marcet then attempted to gather similar information about other medical institutions. Often he requested information from surgeons who provided their best guesses. When Marcet encountered difficulties in collecting information from surgeons he tried to consult the Sisters who worked at Guy's Hospital in London. He guessed that Guy's Hospital admitted about one in three hundred patients for a lithotomy.

⁵⁴⁶Marcet, *Essay*, 25-27.

⁵⁴⁷Marcet, *Essay*, 25-27.

RETURNS of the CASES of LITHOTOMY in the NORFOLK
and NORWICH HOSPITAL, from 1772 to 1816; making
a period of 44 years.

	Number of Operations,			Deaths.		
	Children under 14.	Adults.	Total.	Children.	Adults.	Total.
Males.....	227	251	478	12	56	68
Females ...	8	20	28	1	1	2
	235	271	506	13	57	70

Figure 5.3 Lithotomies

Marcet hypothesized that stones occurred in higher frequencies in some areas and climates. He reported on other physicians' experiences in the tropics and noted that the climate did have an effect on people developing stones.⁵⁴⁸ It seemed to him that in hotter climates stones were much less common. And he was suspicious that diet or drink contributed to the formation of urinary stones but was unable to determine those facts at the time of the publication of the *Essay*. Marcet went on to explore stones of the intestines and their relationship to diet, and did eventually speculate on the effect of diet on urinary stones at the conclusion of the *Essay*.

He called for the chemical analysis of collections of stones as well. He argued that collecting stones by uniting small assemblages of stones from physicians and surgeons with large institutional collections was both a "public" good and valuable for the "advancement of science."⁵⁴⁹ The chemical analysis of stones required only small fragments and did not compromise the collections. He wrote:

⁵⁴⁸Marcet, *Essay*, 43-44.

⁵⁴⁹Marcet, *Essay*, 26.

Any small fragment detached from one of these portions, or merely the sawings of the calculus, will in most every instance, be sufficient for chemical examination; and while the remaining half will afford a much more instructional preparation than the calculus in its entire state, the portion encroached upon will still furnish an useful duplicate.⁵⁵⁰

It would improve "...the pathology and treatment of this [urinary stones] obscure disorder."⁵⁵¹ Chemical analysis filled the knowledge gaps where Marcet could not understand his numerical information.

5.6 Marcet's Chemical Classification

In order to justify the importance of chemical analysis to identify, diagnose, and treat stones, Marcet has to overhaul the previous system of identifying and understanding stones. The older system was based on the stone's location in the body: the renal, cystic, or urethral calculi, which were analogous to the kidney, bladder, or urethra. Marcet dismissed the previous system based on location with the idea that urine could travel anywhere in the body, and based this assertion on observation. For instance, lithic stones, though they often originated in the kidneys, could be located in many places.

Marcet described the five existing types of chemical components of stones discovered "by the labours of the philosophers..."⁵⁵² The five types of substances in urinary calculi were *lithic/uric acid, phosphate of lime, Ammoniaco-Mangesian*

⁵⁵⁰Marcet, *Essay*, 26.

⁵⁵¹Marcet, *Essay*, 26.

⁵⁵²Marcet, *Essay*, 62.

Phosphate, Oxalate of Lime, and Cystic Oxyd. Marcet added more combinations of substances and commented that stones consisted of a combination of substances, and the substances did not often appear “singly.”

Stones made up of lithic acid had a hard concretion, they were brownish-fawn colored, and broke into yellow particles when they separated. These stones dissolved easily in the “fixed alkalies,” and they precipitated into white powder.⁵⁵³ When exposed to the blowpipe they turned black and an animal smell occurred when the chemist burned them. A crackling sound could also be heard when these stones were exposed to the blowpipe, and they often broke into small fragments.



Figure 5.4 Bone Earth Calculi

The phosphate of lime calculi was commonly known to chemists as the “bone earth calculus.”⁵⁵⁴ (Figure 5.4) Stones of this nature were difficult to dissolve, and the chemist had to use either muriatic or nitric acid. Stones turned from black to white in the blowpipe. The stone often resisted fusing with other stones because of the lime in the stone, but it could be part of the layers of other stones.

⁵⁵³Marcet, *Essay*, 65.

⁵⁵⁴Marcet, *Essay*, 63.



Figure 5.5 Triple Calculus

Ammonia-Magnesian Phosphate stones, or what Marcet nicknamed a “Triple Calculus,” (Figure 5.5) because it was composed of three types of salts, were often made up of sparkling crystals. An ammonia smell originated from the blowpipe. The stone could be decomposed into phosphate and magnesia.

Fusible calculi were the most commonly occurring stones according to Marcet; this type of stone was a literal fusion of the other stones mentioned. When a chemist handled a fused stone, it left a chalky white dust in the fingers. These stones commonly appeared in the bladder, like in the case mentioned above. The triple phosphate stone was an example of a fused stone, which turned into a “vitreous globule” in the blowpipe. An example of a fusible stone came from the work of Sir James MacGregor. A soldier fighting in the battle of Waterloo was shot in the bladder. A surgeon later removed the bullet and the concretion appeared “...covered with a thick incrustation...”⁵⁵⁵

Mulberry calculus was a stone containing the oxalate of lime, lithic acid, and the phosphate of lime. It was soluble in nitric and muriatic acid. The stone was identified by pulverizing it and exposing it to heat. This stone could produce quicklime. The stone was nicknamed mulberry because its resemblance to the berry. The dark color of the stone

⁵⁵⁵Marcet, *Essay*, 75.

resulted from the blood that covered it, and the stone's surface irritated the patient. However, the sample analyzed was small, as Marcet could not obtain any samples bigger than a pea. A rendering of the stone appears below, from Marcet, alongside a picture of a mulberry fruit.⁵⁵⁶



Figure 5.6: Mulberry Calculi

The cystic oxyd stone looked like the triple phosphate stone, but was more compact and lacked distinct laminae. The stone appeared yellowish and semitransparent. It had a glistening luster and produced a distinct “foetid smell” when distilled in a “close vessel.”⁵⁵⁷



Figure 5.7 Cystic Oxyd

When exposed to heat the stone remnants produced a spongy, coal-like mass. Many chemicals except for alcohol, tartaric acid, critic acid, and the carbonate of ammonia destroyed the stone. The stone was named cystic oxyd because of it was made up of acids

⁵⁵⁶The picture of the Mulberry comes from an agricultural extension website: http://www.extension.iastate.edu/forestry/iowa_trees/trees/red_mulberry.html

⁵⁵⁷Marcet, *Essay*, 80.

and alkalies, it contains oxygen, and carbonic acid. Marcet received most of his information about this stone from surgeons.

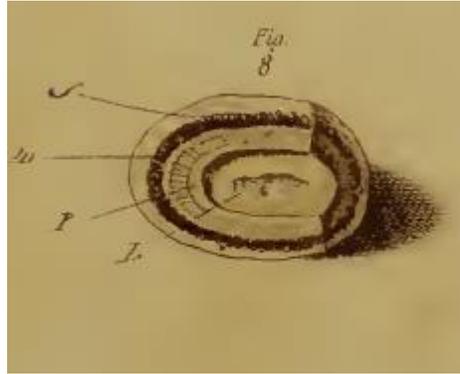


Figure 5.8 Compound Calculi

The compound stone was made up of distinct layers and often contained a “common nucleus.” Most all stones that Marcet examined fall into this category. The alternating layers often confused identifiers.⁵⁵⁸ Chemistry was the tool to control the unknown and could be a useful tool for identifying, and hopefully treating, stones that physicians could not previously identify.

Marcet’s *Essay* also explored the phenomenon of stones in the prostate. Often the symptoms of prostate stones were mistaken for those of the bladder stone or the lithic acid stone. However, chemical analysis allowed the medico-chemist a way to distinguish

⁵⁵⁸Marcet still promoted chemistry as a tool to gain insight into identifying stones: “This alternation of different species of calculi, at first sight appear to throw great difficulties in our attempt to cure this disorder upon chemical principles. But, on the other hand, it is somewhat encouraging to observe that since occasioned variations in the state of the body can produce a total change in the nature of the urinary secretions, medicines may in all probability effect similar changes, and that therefore, it is not unreasonable to hope that we may, at some future period, acquire a considerable control over those morbid secretions.”

stones. The stones of the prostate were composed of phosphate of lime and appear yellow brownish in color. The stones often appeared in a cyst in the prostate.

The last stone that Marcet identified and discussed was the stone of the “urat of ammonia” The stone category was debated by other chemists like Wollaston and William Brande. Marcet had observational evidence of this stone, as he had access to the Royal College of Surgeon’s calculi collection through his relationship to aforementioned stone collector and future president of the College, Astley Cooper. Through an examination of a “large species of serpent,” Marcet observed the stone in the urine of the “*Boa constrictor*.”⁵⁵⁹ Though the stone often appeared in the urine of animals, it was also found in human beings.⁵⁶⁰

The tools needed to determine chemical nature of stones were a blowpipe, tongs, and a candle (or heat lamp).⁵⁶¹ Marcet included a plate to display the tools needed for the analysis along with diagrams of the stones. In the illustration, a common glass blowpipe, tongs, a tray with various test bottles and tubes, support to hold “watch-glasses,” cups that are held with a hand over the heat, a lamp, a spirit lamp, and various other glass vessels and supports for testing were all depicted.

⁵⁵⁹Marcet, *Essay*, 94.

⁵⁶⁰Marcet’s interest in stones was not limited to urinary passages. Stones were a problem of the whole body. Calculi, specifically the phosphate of lime, were found in the pancreas, pineal gland (beyond the mesenteric glands), spleen, uterus, and the lungs. Marcet explained that stones appeared in the lungs in the form of “pulmonary concretions,” which were made up of the carbonate of lime. Marcet wrote that, “I have also a portion of the lungs of a negro, (which was given by Dr. Wollaston) on the surface of which there is a white incrustation of triple phosphate.”

⁵⁶¹66; also see plate in the back of the *Essay*, which illustrates the necessary tools of analysis on page 242. The plate appears in the body text of this chapter as well.

Marcet offered a description of the ideal lab bench, but did not provide a complete inventory in the text. Because he wanted to argue that only basic tools were needed to perform analysis, he chose not to overwhelm the student with all of the supplies potentially needed for the analysis of stones.

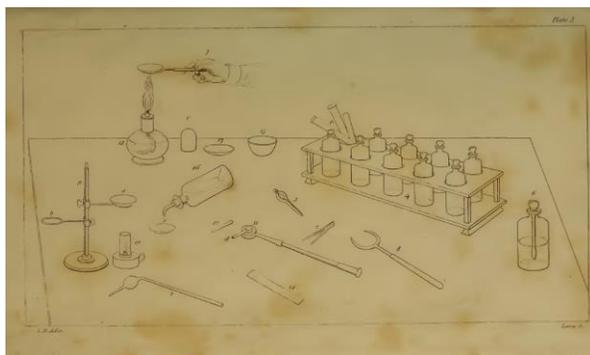


Figure 5.9 Tools of Analysis

Marcet concluded the chapter with the following reminder:

It is not with pretension of offering anything new or important, to professed experimental chemists that I have introduced these details; but merely to enable those who may feel inclined to avail themselves to these hints, to select and procure, at the smallest apparatus necessary for carrying on experiment of this kind; and to obtain with great ease useful practical knowledge, upon a subject which commonly supposed to present greatest difficulties and to require considerable chemical information.⁵⁶²

Anyone, specifically any physician, could carry out the analyses that Marcet described. A practitioner simply needed Marcet's book. With Marcet's endorsement of surgeons in this book, it was likely read by surgeons as well.

⁵⁶²Marcet, *Essay*, 122-123.

5.7 Chemical Treatments

Marcet concluded his work by discussing "...The Chemical and Physiological Principles to be Attended to in the Treatment of Calculous Disorders."⁵⁶³ He reiterated his statement that solvents would never cure a patient of stones. He affirmed that, "The only benefit which we may with any confidence expect from medicine in this disease, either to prevent the increase of calculi already formed, or what is still more important, to guard the constitution of those who are subject to the disorder against the prevalence of the particular diathesis from which it arises."⁵⁶⁴ Though surgery was the only known cure, chemical treatments could be palliative, as Marcet had discussed at the beginning of the book. He situated the importance of chemistry in treatment:

At all events, since in attempting to remove calculi, we have to contend against unorganized bodies, which, though contained in living parts, do not obey the laws of the living principles, it may be fairly concluded, that, unless surgical aid be resorted to, it is in a great measure from principle principles that our views of treatment must be derived.⁵⁶⁵

The analysis of urine, Marcet contended, was "indispensable." However, in order for chemical analysis to be useful, Marcet needed to describe healthy and unhealthy urine.

⁵⁶³Script changed from all caps to title case. It comes from the title of the final chapter of the book.

⁵⁶⁴Marcet, *Essay*, 143.

⁵⁶⁵Marcet, *Essay*, 144.

Healthy urine was acidic. Upon sitting out one to two days, urine would create ammonia, which “neutralizes” acid.⁵⁶⁶ Urine kept even produced “earth salts.” However, with the addition of another acid, even an acid like vinegar, lithic acid appeared. With a few drops of ammonia, a “white cloud appears” resulting in the production of ammoniac-magnesia phosphate (a type of substance of one of the stones mentioned above).

Limewater added to the urine produced phosphoric and lactic acid. When those acids were “held in solution” of the urine they produced additional phosphate. The point that Marcet was trying to make was that the mixing of substances in the urine produced stones. Chemical treatment rested on those ideas. Marcet reiterated that, “Whenever the lithic secretion predominates, the alkalies are the appropriate remedies; and the acids, particularly the muriatic, are the agents to be restored to, when the calcareous or magnesia salts prevail in the deposit.”⁵⁶⁷

Marcet was hopeful that chemical knowledge could aid the patient suffering from a calculous complaint. Chemistry was useful in checking the stone, and Marcet was hopeful further experimentation could ultimately rebut his earlier claim about the failure of solvents. “There is abundant evidence to prove that we are able in many instances to produce an effect sufficient to check the prevailing diathesis, and even sometimes to bring on a calculous deposit depending upon an opposite state of the system; a change which I have myself repeatedly witness.”⁵⁶⁸ Correcting the acids in the body could be a useful check against stones.

⁵⁶⁶Marcet, *Essay*, 146.

⁵⁶⁷Marcet, *Essay*, 148.

⁵⁶⁸Marcet, *Essay*, 150.

He was skeptical that solvents could reach the urinary passages, but he believed it was possible for some remedies to affect the fluids of the body resulting in a neutralization of the “morbid excess of acid,” in the area of the body known as the *primae viae* (the passage from the beginning of the mouth to the anal area).⁵⁶⁹ Medicines could check the secretions of the body that lead to stones; soda water was such a medicine. Soda water had been a widely used lithontriptic remedy by Priestley and Benjamin Franklin.⁵⁷⁰ Marcet was suspicious of magnesia medicines, as he accused the public of abusing such drugs. He advised that alkaline remedies could “allay irritation” in areas of the body because in the bladder they promote urinate flow, and they acted as a palliatives when the physician added opium. Marcet was interested in other treatments, proposing that the mucous that accompanies the expelling of a stone was important. However, his section concerning the treatment of stones is disproportionately smaller than his other sections. In the conclusion, Marcet knowingly leaves much discussion of stones, especially their treatment, to future physicians who read his book.

5.8 Surgery, Stones, and Chemistry

Astley Cooper was born in Norfolk in 1768. As a child, Cooper had a reputation for being both a prankster and an unfocused student.⁵⁷¹ However, two events focused his

⁵⁶⁹Marcet, *Essay*, 153-154.

⁵⁷⁰ Stanley Finger, *Doctor Franklin's Medicine* (Philadelphia: University of Pennsylvania Press, 2006).

⁵⁷¹Biographical summary was composed using the following sources: *Oxford Dictionary of National Biography*, Barnsby Blake Cooper, *The Life of Sir Astley Cooper, Bart.: Interspersed with Sketches from his Note-Books of Distinguished Contemporary*

studies and brought Cooper to surgery as his profession; watching a surgeon treat a relative after an accident, and later, observing a lithotomy.

Cooper became a student of the famous surgeons John Hunter and William Cline. During his studies with these surgeons, Cooper came down with a case of fever in 1787. While he was convalescing in Edinburgh, he attended the lectures of Joseph Black, William Cullen, James Hamilton, and James Gregory. By 1788, Cooper had recovered from his fever, and returned to his education with Hunter and Cline. From 1789 to 1791, Cooper was a member of the Company of Surgeons, which later became the College of Surgeons in 1800.⁵⁷²

In 1791, Cooper was practicing surgery, lecturing in anatomy, and married Anne Cock. Famously, Cooper delivered his anatomical lecture on the evening of his wedding. Cooper traveled often, and in 1792, was in France during the Revolution. In 1794, Cooper's first child, Anna Marie died, but he and Anne adopted two children, including his own nephew and namesake, Astley. He taught anatomy and surgery at Saint Thomas's Hospital. Cooper was elected to Guy's Hospital in 1800, where he shared institutional space with Marcet. These two men would found the Medical and Chirurgical Society in 1805.⁵⁷³

Characters (London: John W. Parker, 1843), both Volumes 1 and Volume II, and Astley Cooper, *The Lectures of Sir Astley Cooper on the Principles and Practice of Surgery* (London: Thomas and George Underwood, 1824-1827), Volumes I-III, and Wendy Moore, *The Knife Man: Blood, Body Snatching, and the Birth of Modern Surgery* (New York: Broadway Books, reprint edition 2006), and Susan C. Lawrence, *Charitable Knowledge: Hospital pupils and Practitioners in Eighteenth-Century London* (Cambridge: Cambridge University Press, 1996).

⁵⁷²Biographical Note Above.

⁵⁷³Biographical Note Above.

Cooper attained significant fame with the publication of the outlines of his lectures on surgery in 1820. By 1839, his lectures had gone through ten editions. Cooper's lectures appeared in the first issue of *The Lancet*, a famous medical and surgical journal, still being published today.⁵⁷⁴ In 1827, after the death of his first wife, he retired from surgery for a time. He married Catherine Jones in 1828 and returned to the practice of surgery, and participated in several medical societies such as the Physical Society of Guy's Hospital, Pow-Wow, and the Medical Chirurgical Society. In 1841, Cooper died. Upon his death, Cooper wished to have his body dissected and the autopsy report published.

Marcet and Cooper were often cited in each other's publications. Marcet included a chapter on the investigation into the chemical nature of two stones that did not match any of the taxonomies of stones that existed. Marcet received a stone from Cooper that was described as, "...a spherical calculus of the size of a large pea, to which were annexed the words [from Cooper], 'Is it cystic or Uric?'"⁵⁷⁵ The stone was described as yellow-brownish in its external color and made of a hard animal matter. Its texture was similar to bee's wax. It was fibrous and when exposed to fire it had a terrible smell, not like any of the other stones that Marcet had tested. It was also insoluble in water and acid. Marcet named it a "fibrinous calculi."⁵⁷⁶

Cooper mentioned Marcet in his surgical notes that serve as a major training manual for surgeons in the nineteenth century. His publications made Cooper a well-

⁵⁷⁴Biographical Note Above.

⁵⁷⁵Marcet, *Essay*, 101.

⁵⁷⁶ Marcet, *Essay*, 104.

known surgeon, beyond his success in practice. He often appeared in the “case” discussion of his surgical notes regarding stones. Cooper provided the reader with several cases of the renal calculi, including one involving Marcet, “A person came to consult me from the country with two openings, one above and one below the last rib, through which three calculi had been discharged. Dr. Marcet analyzed these, and found them to be composed of the ammoniac-magnesium phosphate.”⁵⁷⁷ Marcet and other medico-chemists’ ideas inspired Cooper, but he shared their same concerns about the value of chemistry for treatment:

With respect to the medical treatment of calculi, I do not believe in the power of chemistry to dissolve a stone in the bladder, if it acquire any considerable magnitude. The medicines, given for this purpose, become so much changed in their passage through the circulating and secreting system, that their chemical influence is in a great measure destroyed. They may alter the surface of a stone, so as to render it soft and less irritating; but they do not prevent a calculous secretion.⁵⁷⁸

Cooper believed, like Marcet, that chemistry could alleviate irritation from stones but not cure them. Cooper, like Marcet, was knowledgeable of chemical remedies and their use in alleviating the discomfort of urinary stones. Cooper took a swipe at some of the physicians who believed that chemistry could cure stones when recounting a case where only chemical remedies were offered:

⁵⁷⁷Astley Cooper, *The Lectures of Sir Astley Cooper on the Principles and Practice of Surgery* (London: Thomas and George Underwood, 1824-1827), Volume II, 168.

⁵⁷⁸Cooper, *The Lectures*, 181.

I had a patient in Guy's Hospital with a stone in his bladder, in whom various experiments were tried to dissolve the stone by chemical menstrua. A catheter was introduced into the bladder, and through it injections were thrown; thus an opportunity was given for a direction application of the menstruum to the stone. After a lapse of time, I said to this man, "Well, have my medical friends dissolved the stone?" his answer was, "No, Sir, and I have given up all the injections except opium, from which I received considerable relief." The patient died in the Hospital, and, on examination after death, a stone was found in his bladder.⁵⁷⁹

Cooper discussed palliative remedies including magnesia and soda, diluents, and other stomach medicines. Cooper suggested alkaline medicines in order to prevent the return of stones. Knowing the chemistry of stones helped the surgeon know how likely the stone complaint was to return. In the importance of the chemical makeup of the stone, Cooper writes that, "The uric acid and oxalate of lime calculi return less frequently than the triple phosphate, which are very often reproduced."⁵⁸⁰

Cooper involves Marcet in his lecture about the chemical nature of stones. The chemical analysis of stones was important to the surgeon. Cooper used case studies to illustrate the importance of chemistry to surgery, but he also used cases with his established peers to illustrate the principles he was attempting to teach budding surgeons. Cooper recounts a case where Marcet participated in the analysis of a stone prior to its removal:

⁵⁷⁹Cooper, *The Lectures*, 181

⁵⁸⁰Cooper, *The Lectures*, 183.

Admiral Douglas was the subject of stone; I sounded him, and in the evening of that day a portion of the stone was discharged by the urethra, and I sent it to my friend Dr. Marcet for analysis, who found it to be oxalate of lime; I therefore gave him acids, but he was not relieved by their use; he then took subcarbonate of soda 3ss. Four times in the day, in some water.⁵⁸¹

Though Cooper highlighted the importance of chemical analysis of stones and the attempt to give the patient relief through acid remedies, Cooper followed up with the patient and recounted it for the reader to underscore his skepticism about remedies being curative.

Some months afterwards I was requested to meet Dr. Reynolds and Sir Everard, “he expressed himself well from some medicine you ordered him.” I called in consequence on the Admiral at his hotel; when he said, “You saw me in dreadful agony, unable to cross a room; but since I have taken the soda, I went from Yarmouth, in Norfolk, to Portsmouth, by land, and bore the journey well; and I could now go down a country dance.” Yet the stone still existed in his bladder; but the soda had lessened its sensibility, so as to enable him to bear the complained without much suffering, and only a little inconvenience from the stone, which still occasionally stopped the flow of urine.⁵⁸²

Like the writings of physicians at the turn of the nineteenth century, surgeons also focused on humoral irritations and treating the patient using vestiges of humoral theory. Cooper discussed these concerns when he analyzed the causes of “...death from the

⁵⁸¹Cooper, *The Lectures*, 182.

⁵⁸²Cooper, *The Lectures*, 182.

operation [lithotomy].”⁵⁸³ Several of the reasons Cooper described for death utilizing principles from humoral pathology, and specifically included the nervous irritability, peritoneal inflammation, haemorrhage, and visceral disease.⁵⁸⁴ The other conditions were irritated conditions that came from blocked fluids, like extravasation of urine, scrotal issues, ulceration of the bladder, and diseased kidney.

In the case of nervous irritability, Cooper explained that children often died from the operation because their system became so irritated it was overwhelmed. He wrote that they went pale and “comatose,” their eyes rolled they were restless and extremely weak. Calomel and opium were the only remedies that Cooper called for in order “...to revile this irritable state...”⁵⁸⁵ There was the inflammation of the peritoneal cavity (which is the abdominal cavity). The symptoms of such inflammation included vomiting, bladder tenderness, abdominal tension, and difficulty moving. Cooper called for Calomel and purges. He advised his students to use fomentations, leeches, and blisters applied directly to the abdominal area.

Other humoral pathological interventions included bleeding the arm and a warm bath.⁵⁸⁶ Surgeons, as evidenced by Cooper’s writings, recommended humoral treatments. Furthermore, Cooper worried about the patient’s fluids. He described hemorrhage as a condition that could be extremely deadly. He had seen this condition “repeatedly destroy

⁵⁸³Cooper, *The Lectures*, 200, changed from all caps.

⁵⁸⁴Cooper, *The Lectures*, 200.

⁵⁸⁵Cooper, *The Lectures*, 200.

⁵⁸⁶Cooper, *The Lectures*, 200.

life,” but he had not heard it mentioned as a cause of death often enough.⁵⁸⁷ Contrary to other humoral theorists, like Benjamin Rush, Cooper argued that the bleeding should be stopped before the surgeon left his patient. He cautions that the surgeon, “...should not quit his patient until the bleeding caused by the operation has ceased: the patient should not be put to bed whilst any hemorrhage continues; and when in bed he should be very lightly covered for some time.”⁵⁸⁸

He mentioned gangrene of the scrotum as another cause of death, which often attacked those patients who were weak because of their age or because they were “intemperate” in their habits. Urine was thought to irritate the scrotum, and lead to its inflammation, swelling, and eventually to gangrene. The cellular tissue was irritated by urine. Offensive urine could irritate the bladder, as could other fluids of the body like mucus, pus, and blood itself, and lead to a “fatal issue” after the surgery for a stone.

The last cause of death that Cooper mentioned was “visceral disease.”⁵⁸⁹ These diseases typically refer to problems inside the body’s main cavity. He linked diseases of the liver to fatal episodes after surgery. He argued that patients died from problems that occur in the lungs, heart, or changes in the pulse. Cooper wrote that visceral disease included the : “...morbid state of the liver; dyspnea from some chronic affection of the lungs; palpitation of the heart; irregular or intermitting pulse; which tend to destroy the powers of restoration.”⁵⁹⁰ The liver was the seat of the vital powers in humoral theory and

⁵⁸⁷Cooper, *The Lectures*, 201.

⁵⁸⁸Cooper, *The Lectures*, 200.

⁵⁸⁹Cooper, *The Lectures*, 202.

⁵⁹⁰Cooper, *The Lectures*, 202.

surgeons like Cooper linked deaths in his patients with the problems both in the fluids of the body and the humoral system itself.

Cooper also saw problems with stones related to the patient's constitution. Cooper treated women as a special class and wrote about them in a subsection in one of his lectures. Cooper's thoughts on women needing lithotomies were similar to that of Marcet, "Lithotomy is much less frequently required in the female than in the male, probably on account of the meatus readily permitting the escape of materials which would have become the nuclei of stones in the male, be they portions of gravel, of blood, inspissated mucus, or extraneous bodies."⁵⁹¹ Cooper was concerned that women suffered more pain from stones than men and that women often made themselves "subjects of lithotomy from perverse and unnatural propensities."⁵⁹² These unnatural propensities included putting a pebble into their own "metatus urinarius."⁵⁹³ Cooper shared with the reader that from his own experience: "I have known women introduce extraneous substances into the vagina, to invite the operation for the stone."⁵⁹⁴ However, Cooper has no published cases that he could either cite or that he had published himself. It seems that this statement is Cooper engaging in speculation regarding cases in which he could not explain why a female patient was suffering from a stone.

⁵⁹¹Cooper, *The Lectures*, 224.

⁵⁹²Cooper, *The Lectures*, 224.

⁵⁹³ Cooper, *The Lectures*, 225, and according to the *Oxford English Dictionary*, it refers to the urinary passages.

⁵⁹⁴Cooper, *The Lectures*, 225.

Cooper further cautions that, “It might be thought that solvents could with advantage be injected, but the patients cannot bear them, and will not submit to their use, as they irritate excessively.”⁵⁹⁵ The sex of the patient was a separate and important consideration that the surgeon needed to be aware of, which was much reminiscent to a constitutional concern. In another lecture, Cooper wrote that the retention of urine could lead to hysteria in women.⁵⁹⁶ He explained that the danger of the retention of urine not due only to stones, but also caused by inflammation, ovarian enlargement, the retroversion of the uterus. The blockages of urine could also cause hysteria by the “Loss of power from uterine affection, a species of hysteria.”⁵⁹⁷ The blockage of the body’s fluid was one of the basic framing tenants of humoral pathology in explaining disease.

Cooper notes in a separate section that calculi could also form in the submaxillary duct.⁵⁹⁸ The stones in this area of the mouth were known to be very painful and often times are in existence before the sufferer realizes its presence.⁵⁹⁹ Another surgeon, Mr. Cline, serves as the historical case for the reader. Cline and Cooper knew each other, and Cline also appeared in Marcet’s book. In his autobiographical writings, Cooper writes of his time living with Cline,

...[H]e used frequently to say, “I have a spasm in my mylohyoideus muscle,” and it was usually at the time of eating that he made this observation: at length he

⁵⁹⁵Cooper, *The Lectures*, 226.

⁵⁹⁶Cooper, *The Lectures*, 230.

⁵⁹⁷Cooper, *The Lectures*, 228.

⁵⁹⁸Cooper, *The Lectures*, 228.

⁵⁹⁹Cooper, *The Lectures*, 228.

said, “I have discovered the cause of the uneasiness [sic?] and spasm under by tongue, it arises from a stone in the submaxillary duct,” which he desired me to feel, and which I removed from him...⁶⁰⁰

Cooper mentioned in this section that traveling to the coast could alleviate the stone of the mouth. Salt water was another method of treating stones.⁶⁰¹ The stones hindered the fluids of the body, specifically the saliva. Cooper wrote that the stones were found at the “trunk” of the duct, and in its “branches.”⁶⁰² The salivary stones could be as large as an almond, and were made of the phosphate of lime.⁶⁰³ The stones were removed, however, with surgery. Surgeons used hooks to draw the cheek open, while the surgeon and his assistant applied pressure to the duct. The stone was cut and broken under the tongue, which opened the submaxillary duct, and the stone was exposed and then retrieved.⁶⁰⁴ If the stone was deep, forceps were required.

5.9 Conclusion

A boundary object, in this case, a stone facilitated collaboration and cooperation between medicine and surgery. Urinary stones specifically were of interest in the fields of medicine and surgery because they were a problem that needed to be understood using

⁶⁰⁰Cooper, *The Lectures*, 228.

⁶⁰¹See the final chapter of this dissertation. Sailors were believed to suffer comparatively less from stones.

⁶⁰²Cooper, *The Lectures*, 228-229.

⁶⁰³Cooper, *The Lectures*, 229.

⁶⁰⁴Cooper, *The Lectures*, 229.

chemistry. Medico-chemists like Marcet desired chemical knowledge about stones in order to perfect their chemical taxonomies and advance treatment, a goal surgeons like Cooper shared. Cooper continued to maintain an interest in reviving humoral practice because he found it useful to explain difficult cases of the stone.

Alexander Marcet and Astley Cooper collaborated and engaged in the chemical analysis of the morbid concretions of the body. Alexander Marcet tried to systematize and explain chemical analyses of the stones of the body to physicians. However, because of personal friendships, Marcet was able to collaborate in regards to chemical research with Astley Cooper. Cooper was also interested in chemistry in treating concretions and problems in the body's fluids. Both Marcet and Cooper shared a belief that higher proportions of men than women were afflicted by urinary stones. The chemistry of the stone was a safe, discursive space for men from different professions to work in together at the turn of the nineteenth century.

Lithotomies were seen by surgeons and physicians as an important and pressing problem at the turn of the nineteenth century. Large mortality rates encouraged physicians and surgeons to seek out better treatment options. Patients complained and were discouraged by the dangerous operation for the stone. Any option that physicians or surgeons could offer for palliative measures or a potential cure would be significant in a medial marketplace that offered physicians few options.

CHAPTER 6
CHEMISTRY, MEDICINE, AND SOCIETIES IN CHARLESTON,
PHILADELPHIA, AND LONDON

6.1 Anglo-Atlantic Boundary Objects

The cities of London, Charleston, and Philadelphia were home to societies where calculi were discussed by medico-chemists and surgeons. Boundary objects like calculi offered a way for discussions to transcend geographical boundaries as they were studied on both sides of the British Atlantic. By examining societies, colleges, and other organizations across these three cities I will further illustrate how stones transcend occupational boundaries. Scholars in Atlantic studies have already shown how following the concept of empire broadens our discussion of science and medicine.⁶⁰⁵

⁶⁰⁵Joyce E. Chaplin, *An Anxious Pursuit: Agricultural Innovation and Modernity in the Lower South, 1730-1815*. Chapel Hill: University of North Carolina Press, 1993), Londa L. Schiebinger, *Plants and Empire: Colonial Bioprospecting in the Atlantic World* (Cambridge, MA: Harvard University Press, 2004), James Delbourgo, *A Most Amazing Scene of Wonders: Electricity and Enlightenment in Early America* (Cambridge, MA: Harvard University Press, 2006), Neil Safier, *Measuring the New World: Enlightenment Science and South America* (Chicago: University of Chicago Press, 2008), Susan Scott Parish, *American Curiosity: Cultures of Natural History in the Colonial British World* (Chapel Hill: University of North Carolina Press, 2006) and Christopher P. Iannini, *Fatal Revolutions: Natural History, West Indian Slavery, and the Routes of American Literature* (Chapel Hill: University of North Carolina Press, 2012), James Delbourgo and Nicholas Dew, *Science and Empire in the Atlantic World* (New York: Taylor & Francis, 2007), 4.

In this chapter I will attempt to demonstrate how calculi transcended not only intellectual and occupational boundaries for individuals but for societies as well. Chemical research on stones was becoming institutionalized at this time. This transition appeared in the work of members of the Chemical and Columbian Societies of Philadelphia and in the curation of the Hunterian Museum at the Royal College of Surgeons in London. Societies like the Literary and Philosophical Society in Charleston were spaces where medico-chemists interested in stones interacted with other intellectuals (like lawyers, planters, naturalists, and theologians). The Medico-Chirurgical Society in London was, at the same time, publishing its discussions around the chemical investigations of stones.

6.2 The Chemical Society of Philadelphia

The Chemical Society of Philadelphia was founded in 1789, but disbanded shortly after. A second version of the society formed in 1792 and was most active around 1800.⁶⁰⁶ Members of the society contributed publications in many venues: these included newspapers, inaugural dissertations from medical students, and stand-alone books and pamphlets.⁶⁰⁷

John Penington, a Philadelphia physician, founded the society. He was a student of Benjamin Rush and published two works on chemistry. The first was his dissertation

⁶⁰⁶Wyndham Miles, "Early American Chemical Societies: 1. The 1789 Chemical Society of Philadelphia 2. The Chemical Society of Philadelphia," *Chymia* 3 (1950): 95-113.

⁶⁰⁷See quotation above.

on the topic of fermentation, and he later published a book promoting chemistry, *Chemical and Economical Essays*, which was published in 1790⁶⁰⁸. He received his medical doctorate from the University of Pennsylvania in 1790 as well.⁶⁰⁹ Pennington had a short life, passing away at the age of twenty five in 1793. He was in the last class to which Rush taught chemistry before moving to medicine. His works on chemistry received praise, including notice from Thomas Jefferson.⁶¹⁰ After he concluded his medical studies, he traveled to Europe to further his chemical education. He studied with Joseph Black, which included discussion around the dinner table in Black's home.⁶¹¹

While in Europe, he met with future professor of chemistry at the University of Pennsylvania John Redman Coxe.⁶¹² Back in Philadelphia in 1793, Pennington perished while treating patients in the great yellow fever epidemic. Rush wrote (emotionally) about the tragedy of Pennington's death. Pennington's role as founder of the Chemical Society begins to connect Philadelphia to the medico-chemical work being performed in London.

⁶⁰⁸John Pennington, *Chemical and Economical Essays* (Philadelphia: Joseph James, 1790).

⁶⁰⁹William D. Williams and Wyndham Miles, "Old Chemistries: John Pennington's 'Chemical and Economic Essays,'" *Bulletin of the History of Chemistry* 8 (1990): 18-22.

⁶¹⁰Williams and Miles, "Old Chemistries," 18-22.

⁶¹¹Williams and Miles, "Old Chemistries," 18-22.

⁶¹² Williams and Miles, "Old Chemistries," 18-22.

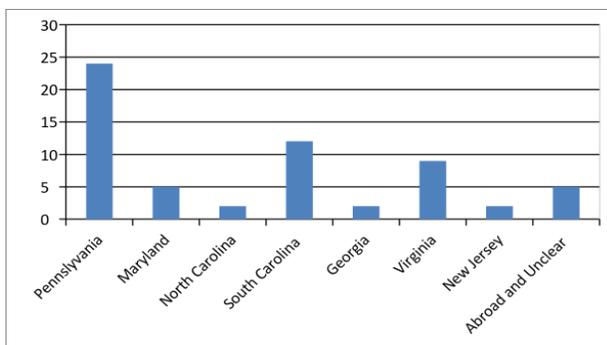


Table 7.1: Membership of the Chemical Society of Pennsylvania

The membership of the society was quite diverse, including members several American states, and some foreign countries. The society included both formal members and members who identified themselves as honorary members.⁶¹³ Most of the membership cited their home state as Pennsylvania, but perhaps surprisingly the state with the second largest number of members was South Carolina. If the Northern and Southern regions of

⁶¹³I used the *Early American Imprints: Series I and II* to track down the thesis and other literary works of the members listed by Miles. However, his list was not complete; and I have included an short list, with the member's affiliated region: Philadelphia members (included those from greater Pennsylvania) included William Bache, Edward Cutbush, Robert Black, Samuel Jones, John Church, John Moore, Samuel Gartley, John C. Otto, John Church, Samuel Cooper, John Hahn, William Brown, Samuel Gartley, John Redman Coxe, Thomas Horsfield, William Shaw, Phineas Jenks, James Woohouse, James Hutchinson, Nathaniel Chapman, Robert Hare, By John Syng Dorsey, Felix Pascalis, and Adam Seybert. Maryland Members (including Baltimore) included Henry Disborough, Robert J. King, Colin Mackenzie, Grafton Duvall, Thomas Semmes. North Carolina Mathias E. Sawyer, James Norcom. Virginia members (including Richmond) included Henry Rose, Robert Berkeley, Henry Wilson, John C. Geddy, Austin Brockenbrough, Jun., Robert Berkeley Lockette, John Claiborne, Joseph Trent Washington Watts, John H. Foushee New Jersey: Thomas Rowan, Thomas Rowan. Georgia: Henry Jackson (later chemical professor), William Wyatt Bibb, South Carolina (including Charleston and Gorgetown): Philip Gendron Prioleau, John Skottowe, Joseph Glover, Bellinger, Joseph Jonson, William Allston, John Oswald, George Logan, Peter Foissin, Edward Brailsford, Simons, Gough, Europe and the Caribbean: William G. Chalwill, of Tortola, and Benjamin G. Hodge, of the West-Indies, Patrick Kerr Rogers, formerly of Ireland, William Stephen Jacobs, of Brabant, Thomas Brown, Jonathon Murdock

America were compared, the society has a makeup of 48% versus 52% respectively. Southern Americans seem to be interested at chemistry at a high rate. Some of the members would become instructors of chemistry in the South at colleges that were established in the nineteenth century.

Physician James Woodhouse was president of the Philadelphia Chemical Society. It is unclear how long Woodhouse served as president of the organization.⁶¹⁴ The history of the Philadelphia Chemical Society is not well established, and scholars often present conflicting information about it⁶¹⁵ Woodhouse was born in Philadelphia on November 17, 1770, and died in 1809.⁶¹⁶ Like Pennington, both men were young when leading the society. Young leadership defines the society as a student run organization.

Woodhouse had served as surgeon in “St. Clair’s army,” fighting American Indians in the Western part of the new United States and was professor of chemistry at the University of Pennsylvania from 1795 to 1809.⁶¹⁷ Woodhouse was a passionate proponent of chemistry. He was active in debates with Joseph Priestley regarding the theory of phlogiston. Woodhouse was also convinced of the importance of chemistry in

⁶¹⁴Edgar Fahs Smith, a historian of chemistry at the turn of the twentieth century pointed to Woodhouse as a founder of the Chemical Society. Also Henry Jackson was the first professor of chemistry at the University of Georgia at Athens. Edgar Fahs Smith, *James Woodhouse: A Pioneer in Chemistry, 1770-1809* (Philadelphia: John C. Winston Company, 1918) and *Chemistry in America: Chapters from the History of Science in the United States* (New York: D. Appleton and Company, 1914).

⁶¹⁵Ibid. This note needs to refer to both of the authors Smith and Miles who disagree about the society.

⁶¹⁶See Edgar Fahs Smith note above.

⁶¹⁷See Edgar Fahsm Smith note above.

medicine, and the importance of young students pursuing chemistry. Woodhouse advocated his ideas in a speech given at the Chemical Society.⁶¹⁸

James Woodhouse's address to the chemical society was published in the *Philadelphia Gazette* on June 21, 1797.⁶¹⁹ Most of his speech consisted of "secrets" which he shared with the audience. Society was being ruined by clergymen, and good men like Priestley and Samuel Coats, while they do good deeds, were being rebuffed by conservative, religiously-controlled institutions.⁶²⁰ He also criticized "old men" who wanted to hold back the power of young minds.⁶²¹

Woodhouse was also writing against the physicians of Philadelphia who opposed students of medicine studying chemistry.⁶²² Woodhouse wrote that "Some of the Physicians of thi[s?] [sic] city, who are persuading you from studying chemistry, have the appetite without the wing, others have neither the wing nor the appetite. You, gentlemen, have wings, and the old men would cut theirs off, if they could."⁶²³ Woodhouse told students to study chemistry like it was a woman. He explained his metaphor:

⁶¹⁸See note number 9.

⁶¹⁹Appeared on June 21, 1797 in the *Philadelphia Gazette* as the article "Extracts from an Extempore Address, Delivered before the Chemical Society of Philadelphia, on Saturday the 17th of June by James Woodhouse, M.D., professor Chemistry in the University of Pennsylvania, President of this Society &c." Found in "American's Historical Newspapers" database.

⁶²⁰*Philadelphia Gazette*, June 21, 1797

⁶²¹*Philadelphia Gazette*, June 21, 1797

⁶²²*Philadelphia Gazette*, June 21, 1797

⁶²³*Philadelphia Gazette*, June 21, 1797

I have found out a sweet heart for you all. Court miss Chemistry; she is a young lady, professed of an amiable disposition. Rival each other in attention to her, and she will crown you with laurels. Marry her as soon as possible, she will not quarrel with you a few months after entering to the conjugal state. You will never divorce her, and the honey moon will last for life. I have set you the example, for I love this lady to distraction. Let every individual of our society then, despite the contemptible passion of love, and cry out, Hail! Ambition, thou art my god.⁶²⁴

Woodhouse continued his arguments against physicians who did not support instruction in chemistry for medical students. He equated the teaching of chemistry in America to its national prominence.⁶²⁵ Woodhouse considered objections from the medical community “a little breeze,” which could not stop the momentum of the Chemical Society. Following a pattern, Woodhouse used female metaphors to explain the project of building a pharmacopeia: “The member of the college has told us, that his brethren have conceived a design of publishing a Pharmacopœia. I can inform him, that the brat has been in the womb ten years, and by this time has certainly perished.”⁶²⁶

The Chemical Society of Philadelphia was poised to play an important role. The stakes were high, especially in terms of national power. He reminded the society that, “If we do not succeed in becoming the fathers of chemistry in the United States of America, I will like Paracelsus, retire to cave, weary of the vices of follies of mankind.”⁶²⁷

⁶²⁴*Philadelphia Gazette*, June 21, 1797

⁶²⁵*Philadelphia Gazette*, June 21, 1797

⁶²⁶*Philadelphia Gazette*, June 21, 1797

⁶²⁷*Philadelphia Gazette*, June 21, 1797

Woodhouse represented the optimism chemist felt for their ability to understand nature. The same optimism of Woodhouse was brought to the analysis of calculi.

Wydehma Miles published a list of dissertations by medical students affiliated with the Chemical Society.⁶²⁸ However, Miles's list was not comprehensive and did not list where the students were from. A majority of the members were from Southern states, as further research revealed their background and names omitted from the list.⁶²⁹ The large number of Southern students attending and/or affiliating with the society could be due to an interest in chemistry in medical practice.

Felix Pascalis served as the Society's vice president around the turn of the nineteenth century. Pascalis was from Provence, France.⁶³⁰ Pascalis graduated from Montpellier; thereafter he traveled to St. Domingo. He witnessed the Haitian Revolution while he was practicing medicine in 1793. He fled St. Domingo for Philadelphia and eventually died in New York in 1833.⁶³¹ He was active in American medicine, becoming co-editor of the *Medical Repository*. He published several pieces on yellow fever, including a chemical analysis of the fever.⁶³² He published his own case of liver diseases in *The Philadelphia Medical Museum*, where he was attended by Benjamin

⁶²⁸Miles, "Early American Chemical Societies."

⁶²⁹See the chart, with note above.

⁶³⁰ Howard A. Kelly and Walter L. Burrage, *A Cyclopedic of American Medical Biography* (Baltimore: The Norman Remington Company, 1920), Volume 1, pg. 894 has a full biography about Pascalis.

⁶³¹Kelly and Burrage, *A Cyclopedic of American Medical Biography*, 894.

⁶³²Pascalis was extremely interested in the chemical nature of yellow fever, especially its causes and spread.

Rush, Phillip Syng Physic, and Caldwell (another Philadelphia based physician) in 1805.⁶³³ He was also a corresponding member of the South Carolina Medical Society.⁶³⁴

Pascalis gave the annual oration at the Chemical Society of Philadelphia in 1802.⁶³⁵ In his oration, Pascalis discussed vegetable chemistry, agriculture, mineralogy, and other fields. He advocated for the improvement of medicine through advances in chemistry. Medicine was in a poor state until the turn of the eighteenth century when physicians were no longer hostage to “absurd systems.”⁶³⁶ Pacaslis could be criticizing humoral pathology, but he does not specifically refer to it. Along with more emphasis on physiology, medicine imitated chemistry. Pascalis, pointing to the progress of medicine writes that,

At last, in imitation of chemistry, the spirit of analysis has prevailed in all the braches of natural philosophy, and consequently the friends of the healing art, who wished independently and usefully to pursue the career of their labour, have renounced all logical systems, and composed their institutes of medicine of such facts of aphorisms of the ancient and modern, that experience had rendered

⁶³³Pascalis, “Account of An Abscess of the Liver Terminating Favorably by the Evacuation Through the Lungs,” *Medical Repository* 5 (1805).

⁶³⁴Joseph Ioor Waring, *A History of Medicine in South Carolina: 1670-1825* (Charleston: South Carolina Medical Association, 1964). Waring has a brief mention of Pascalis on page 349 as a corresponding member of the South Carolina medical society.

⁶³⁵Felix Pascalis-Ouviere, *Annual Oration, Delivered Before the Chemical Society of Philadelphia, January 31st, 1801* (Philadelphia: John Bioren, 1802).

⁶³⁶Pascalis-Ouviere, *Annual Oration*, 38.

inconvertible with all the results that physical laws and analytic animal chemistry, could consistently offer to their medical investigations.⁶³⁷

Pascalis reminded his audience that many theories were "...mistaken for physiologician and Chemico-medical improvements."⁶³⁸ It was clear to Pascalis that there was a connection between animal chemistry and medicine, and he praised the chemists working at the turn of the nineteenth century, writing:

I do not pretend to controvert here the supposed discoveries of Girtanner, of Beddoes, Davis and others, who with so rapid strides through the scabrous path of science, have promised to themselves and the public, to open a new Æra, and to dispel from among making all the diseases they were necessary subject to.⁶³⁹

Chemical analysis held promise, as "important discoveries have been made and many more are to be expected, in medical science, from Analysis and animal Chemistry."⁶⁴⁰

Along with observing fevers the "Analysis of animal solids and fluids" was important. Along with the study of gases in animal life, "Animal acids chiefly, and other primarily combinations in the blood, in the bile, in the bones, in earthy concretions and others, do form, Gentlemen, the most precious collection of facts and observations, that ever medical science could be improved with, for the relief and cure of a great many diseases."⁶⁴¹

⁶³⁷Pascalis-Ouvriere, *Annual Oration*, 38.

⁶³⁸Pascalis-Ouvriere, *Annual Oration*, 38-39.

⁶³⁹Pascalis-Ouvriere, *Annual Oration*, 39.

⁶⁴⁰Pascalis-Ouvriere, *Annual Oration*, 39-40.

⁶⁴¹ Pascalis-Ouvriere, *Annual Oration*, 39-40.

Chemistry provided a way out of “the dregs of quackery and ignorance” that had historically marred pharmacy.⁶⁴² Pascalis concluded his speech by also pointing to the properness of chemistry’s “flourishing cultivation in the Universities and Colleges of this great Republic.”⁶⁴³ It was likely that he included this point to encourage the medical students and other societies members affiliated with the academy to continue to engage with chemistry.

Pascalis was an active chemical investigator and his investigations often involved medical practice. Like Benjamin Rush, he believed that the dark skin color of Africans was caused by chemistry and the fluids of the body. In an 1818 Pascalis article, “Desultory Remarks on the Cause and Nature of the Black Colour in the Human Species; Occasioned by the Case of a White Women Suddenly Turned Black” in *Medical Repository of Original Essays and Intelligence*⁶⁴⁴ He pointed to the older authority Van Swieten, who had also written about a woman who turned black for one year. Pascalis wrote that it was not unreasonable to admit that, “This fact seems to have researched a equal change to that of an opposite change from black to white in the human species.”⁶⁴⁵ Pascalis discussed the case of Mary Gaillard, a seventy-year-old woman from France who turned black for a brief time. She had previously been free of diseases, but she had

⁶⁴²Pascalis-Ouvriere, *Annual Oration*, 45.

⁶⁴³Pascalis-Ouvriere, *Annual Oration*, 47.

⁶⁴⁴Pascalis, “Desultory Remarks on the Cause and Nature of the Black Colour in the Human Species; Occasioned by the Case of a White Women Suddenly Turned Black” *Medical Repository of Original Essays and Intelligence* 4 (1818): 366-371. This citation was found on page 419 in Linda L. Barnes *Needles, Herbs, Gods, and Ghosts: China, Healing, and the West to 1848* (Cambridge, MA: Harvard University Press, 2005).

⁶⁴⁵Pascalis, “Desultory Remarks,” 366.

changes in her circumstances. She fell into poverty; she had no home, and had to beg. Her daughter had to care for her children while at work, and the children became sick. The daughter blamed the mother for their illness and accused her giving them syphilis. These events led the mother to a deep grief. The daughter threw herself out of a window, with her two children in her arms, and died. Mary Gillard then turned black from her head to her feet.⁶⁴⁶

Gillard was admitted to the infirmary of La Salpêtrière on October 28, 1817, but the doctors could not find any appearance of disease. The black color of Gillard's skin was not the same intensity on her hands, face, groin, and feet, she was darkly black on her abdomen and limbs. Her legs, however, retained a white color. Pascalis noted that the patient was in an intense state of suffering.⁶⁴⁷

The patient experienced a "blistering plaster," which caused "a large venesection..."⁶⁴⁸ A fluid appeared out of the venesection, which Pascalis described as "...the cuticle, and the cellular tissue were all blackish, as it happens on the skin of the negroes."⁶⁴⁹ He continued to draw the attention of the reader to the fluids drawn out of the body. Pascalis described the "incisions" that were performed on the patient's skin, which produced "...rete mucosum which constituted the black color."⁶⁵⁰ Mary Gillard died and upon autopsy there were no "material alterations," except for what was

⁶⁴⁶Pascalis, "Desultory Remarks," 366.

⁶⁴⁷Pascalis, "Desultory Remarks," 366.

⁶⁴⁸Pascalis, "Desultory Remarks," 366.

⁶⁴⁹Pascalis, "Desultory Remarks," 366.

⁶⁵⁰Pascalis, "Desultory Remarks," 367.

presumed to have ended her life “...a considerable effusion of bilious and purulent matter.”⁶⁵¹

In his remarks on the case, he wrote, “That the secretion of *black matter* exists in the white race, can be proved by numerous facts in the heathy as well as in the morbid condition of the same.”⁶⁵² The white race had had this black matter in their body since their time as a fetus. Pascalis calls this matter “*meconium*.”⁶⁵³ Black matter could still be found in the adult’s retina and hair. The matter from the air can be “pressed out” into “white linen.” The black matter can also be found in the “*grandulae renales*” and “*bronchiales*.”⁶⁵⁴ Cathartics, specifically very strong ones, could remove the matter from the stomach and intestines through “intestinal secretions.”⁶⁵⁵ Black matter was a root of disease. Pascalis pointed to it as causing most bowel complaints, and calomel could be used to treat related disease. Black matter might have been at the root of yellow fever as well:

Medical practitioners have sometimes supposed that certain medicines, especially calomel could effect a change of colour in the alvine secretions, and of bile. But in the yellow fever this secretion becomes fatal, and is the most universal and

⁶⁵¹Pascalis, “Desultory Remarks,” 367.

⁶⁵²Pascalis, “Desultory Remarks,” 367.

⁶⁵³Pascalis, “Desultory Remarks,” 368.

⁶⁵⁴Pascalis, “Desultory Remarks,” 368.

⁶⁵⁵Pascalis, “Desultory Remarks,” 368.

dreaded symptom, for it is produced by it in such a quantity as to astonish, and to bespeak the dissolution of the whole blood.⁶⁵⁶

The black matter might have also been related to "...pulmonary disease or consumption, forming tubercles in the substances of the lungs, that are black and carbonaceous."

Pascalis thinks of the black matter as being similar to the yellow liquid that seemed to appear under the skin in sufferers of yellow fever. Black matter was black bile discussed in more sophisticated chemical and medical language.

The blood was important in understanding how black matter was a part of the body, a "...natural secretion of the blood, more or less necessary for certain purposes."⁶⁵⁷ But according to Pascalis black matter was more abundant in the "African race than in the white race," due to the high levels of carbon in white blood. Africans absorbed carbon better in response to hot climates.⁶⁵⁸ Though the amount of carbon in the blood was nearly equal in both races, respiration was more difficult in the "burning" or "torpid" climate of Africa. The excess carbon was therefore "deposited" on the skin of Africans. Moreover, through "violent causes," the black matter could disappear from Africans or even in whites. Pascalis concludes that, "...as in the case of the unfortunate *Mary Gaillard*, and others of the same nature, whose lungs have been by some cause prevented from secreting the carbon of the venous blood."⁶⁵⁹ Like Benjamin Rush, Pascalis saw the

⁶⁵⁶Pascalis, "Desultory Remarks," 368.

⁶⁵⁷Pascalis, "Desultory Remarks," 368-70.

⁶⁵⁸ Pascalis, "Desultory Remarks," 371.

⁶⁵⁹ Pascalis, "Desultory Remarks," 371.

fluids of the body as capable of producing disease and constitutional changes, which could have obvious and visible indicators, like one's race. Pascalis also associated the black race with sickness, rather than hereditary inferiority.

The Philadelphia Chemical Society was a space where medicine and chemistry intersected at the turn of the nineteenth century. Some of its leaders, like Pascalis, were interested in understanding the body fluid processes. Blockages that were similar to those caused by concretions in the body caused other diseases, like healthy white people having their skin turn black.

6.3 The Columbian Chemical Society

In 1811, Thomas D. Mitchell and George F. Lehman created the Columbian Chemical Society.⁶⁶⁰ The two men were both physicians and had been students of Benjamin Rush, and following Rush's interest in chemistry and medicine. As a young man Mitchell had worked in a drug store and in the chemical laboratory of Dr. Edward Parrish. Mitchell enrolled in the University of Pennsylvania and graduated with a doctorate in medicine in 1812. Much later in his life, he received an honorary Master of Arts degree from Princeton University in 1830.⁶⁶¹

After graduating from the University of Pennsylvania, Mitchell served as professor of "animal and vegetable physiology" at St. John's Lutheran College. While

⁶⁶⁰A published volume of papers that were curated from the society members were published in 1813 in *Memoirs of the Columbian Chemical Society of Philadelphia* (Philadelphia: Isaac Pierce, 1813). The only secondary work on the society was published by Wyndham D. Miles, "The Columbian Chemical Society," *Chymia* 5 (1959): 145-154.

⁶⁶¹Kelly, *A Cyclopedia of American Medical Biography*, Volume 1, pg. 805-806.

working at St. John's he published a book on chemistry and medicine in 1819.⁶⁶² After his time at the college he moved his medical practice to Frankford, Pennsylvania until 1831.⁶⁶³ Mitchell published several works on chemistry and medicine.⁶⁶⁴ Texts included chemical commentary and popularizations, material medica, medical education, and did editorial work for the *Western Medical Gazette* and the *Journal of Medical and Associate Sciences*. He died in Philadelphia in May 1865.⁶⁶⁵

In 1837, Mitchell discussed the value of chemistry to medicine in *A Cursory View of the History of Chemical Science, and Some of Its More Important Uses to the Physician*. After a discussion of the history of chemistry, Mitchell highlighted the America epoch of chemistry, reminding the students in his introductory lecture that, "Though last, not least, our own beloved country claims a share in the need of praise, awarded to the cultivators of science."⁶⁶⁶ Mitchell cautioned his students that even after they graduated university, they might be "embarrassed" by a "tradesmen" or even the "female sex" who might have more chemical knowledge than do.⁶⁶⁷ In fact, chemistry contributed positively towards many areas of life, and others besides chemists and

⁶⁶²Kelly, *A Cyclopedia of American Medical Biography*, Volume 1, pg. 805-806.

⁶⁶³Kelly, *A Cyclopedia of American Medical Biography*, Volume 1, pg. 805-806.

⁶⁶⁴Kelly, *A Cyclopedia of American Medical Biography*, Volume 1, pg. 805-806.; most of these pieces are published lectures. They are available at the archives at Jefferson Medical College in Philadelphia. Get these footnotes in proper form. Next one too. Note that the Ibid refers to Kelly here.

⁶⁶⁵Thomas Jefferson University Archives and Special Collections, MS 060, Thomas D. Mitchell Papers (1837-1862)

⁶⁶⁶Mitchell Papers

⁶⁶⁷Ibid.

physicians should study chemistry. Knowledge of chemistry would refine one's character, provide manufacturing profits, improve agriculture, and keep a physician from prescribing medicines incorrectly. Improving chemical knowledge in physicians' training also promised to raise the nation's scientific prominence.⁶⁶⁸

George F. Lehman was the namesake of his father, a well-known "linguist and surgeon," who held a medical degree.⁶⁶⁹ The younger Lehman was born in 1793, and eventually sent to study with Benjamin Rush as a "private student."⁶⁷⁰ He received his Medical Doctorate from the University of Pennsylvania in 1813. Rush and his Penn colleague Nathaniel Chapman got Lehman appointed as physician to the Lazaretto, a hospital meant to house sufferers of yellow fever that was away from the city of Philadelphia.⁶⁷¹ The Lazaretto was established during the 1793 epidemic.⁶⁷² The Philadelphia Lazaretto was a special hospital, taking its name after the parable of Lazarus whom Jesus revived from the dead in the *New Testament*, where yellow fevers were admitted and segregated. Hospitals like the Pennsylvania Hospital, would not admit yellow fever sufferers.⁶⁷³ Appointed at just 21 years of age, Lehman was the youngest

⁶⁶⁸Ibid.

⁶⁶⁹*Postal Guide, Philadelphia Post-Office: Containing Postal Information by the United States Post Office* (Philadelphia: Howard March, 1900). His biography appears on page 9.

⁶⁷⁰Ibid.

⁶⁷¹David S. Barnes, *The Great Stink of Paris and the Nineteenth-Century Struggle against Filth and Germs* (Baltimore: Johns Hopkins University Press, 2006.). Barnes is preserving the Philadelphia Lazaretto.

⁶⁷²*Postal Guide, Philadelphia Post-Office:*

⁶⁷³Stacey Peeples, *Tour of the Pennsylvania Hospital.*

physician at the Lazaretto and became the Quarantine Master in 1817.⁶⁷⁴ He was employed by the Lazaretto for twenty five years. His treatments were recognized by the Council of Philadelphia and the Board of Health in the treatment of fevers and smallpox.

Lehman wrote about yellow fever, the influence of climate on disease, and disease of the urinary organs. He was interested in the calculi of the body, and the subject of his thesis at the University of Pennsylvania in 1813, was “An Inquiry into the Causes, Symptoms and Cure of Biliary Calculi.”⁶⁷⁵

In his dissertation, Lehman began with a discussion of the liver. Lehman quoted from an unnamed author that the liver took materials that were not “animalized” or “digested,” but turned secretions into blood. Lehman argued that “This theory of the liver, which has been said to be only chimerical will be in a very short time generally adopted. It is simple and satisfactory.”⁶⁷⁶ He added that like the liver, the gallbladder and the spleen also served as “waste gate[s].”⁶⁷⁷ But the focus of his dissertation was biliary calculi. Lehman offered a historical literature review of biliary calculi. He wrote that a famous physician stated that one of his largest regrets in life was not writing more about the subject of biliary calculi.⁶⁷⁸

⁶⁷⁴*Postal Guide, Philadelphia Post-Office:*

⁶⁷⁵George F. Lehman, “An Inquiry into the Causes, Symptoms and Cure of Biliary Calculi,” Thesis at the University of Pennsylvania, written 1813. Viewed at University of Pennsylvania Rare Books Room.

⁶⁷⁶Lehman, “An Inquiry into the Causes,” 3.

⁶⁷⁷Lehman, “An Inquiry into the Causes,” 4.

⁶⁷⁸Lehman, “An Inquiry into the Causes,” 5.

Lehman saw the body as a whole of connected parts, and relied on sympathies between parts of the system. He defended the concept by saying that it would eventually be proven true and that, “The human body is one great whole, so intimately connected that no particular part can act with regularity with consent of the others. Stimuli on impressions applied to one part producing motion, will excite it on others.”⁶⁷⁹ For instance, “Stimuli take into the stomach,” “excite” the whole system and was “...distributed” to “different parts of the body...”⁶⁸⁰ And the liver could experience disease in “low latitudes” because the “dampness” and “heat” affected the whole body, because the liver receives “...diminutive portion of oxygenated blood, and passes little vitality or excitability.” Lehman asserted that the “accustomed function” of the liver was “hard to regain.”⁶⁸¹ Liver problems led to the production of biliary calculi.

The bile given off from the liver traveled to other parts of the body, including the “heptic duct” and the gall bladder, where experienced “stagnation” and resulted “...from the torbid state of the stomach...[,]” resulting in stones.⁶⁸² Lehman included this explanation taken from the work of George Cheyne Shattuck, who had published work on biliary concretions. The concretions were the heavier matter not conveyed in circulation, and could remain in the body for years.⁶⁸³ Lehman cited a case where Shattuck had cut into a deceased patient to find his gallbladder full of stones. And Lehman had

⁶⁷⁹Lehman, “An Inquiry into the Causes,” 6.

⁶⁸⁰Lehman, “An Inquiry into the Causes,” 6.

⁶⁸¹Lehman, “An Inquiry into the Causes,” 7.

⁶⁸²Lehman, “An Inquiry into the Causes,” 7.

⁶⁸³Lehman, “An Inquiry into the Causes,” 8.

experiences with analyzes the stones of the gallbladder. One of his friends had opened a gallbladder to find “twenty seven concretions,” and subjected them to chemical analysis.⁶⁸⁴ The calculi were destroyed by the “pressure of the fingers,” and were quickly “melted” by their exposure to fire, producing a “wax[y]” state.⁶⁸⁵ Similar experiments done both others furthered the idea that biliary stones were caused by “...the stagnation of bile.”⁶⁸⁶

Concretions could also form by irregularities in blood circulation, use of liquors, women over the age of fifty, and due to states of extreme passion because the body relies on “sympathies.”⁶⁸⁷ The circulation of the body declined over a lifespan, especially in women over the age of fifty; Lehman claimed that anyone with any “physiological knowledge,” knew that.⁶⁸⁸ Concretions rarely occurred in young people.

Lehman examined the chemical nature of bile, thought to be instrumental in the production of calculi. He cited authorities like Fourcroy and William Saunders (the first president of the Medico-Chemical Society).⁶⁸⁹ He defined bile: “It is of a yellowish green colour, of a bitter taste secreted from the blood by the liver.”⁶⁹⁰ Scholar have considered many purposes for the bile, as Glane’s thoughts of bile as “excrementations,” or other

⁶⁸⁴Lehman, “An Inquiry into the Causes,” 9.

⁶⁸⁵Lehman, “An Inquiry into the Causes,” 9.

⁶⁸⁶Lehman, “An Inquiry into the Causes,” 9.

⁶⁸⁷Lehman, “An Inquiry into the Causes,” 9.

⁶⁸⁸Lehman, “An Inquiry into the Causes,” 9.

⁶⁸⁹Lehman, “An Inquiry into the Causes,” 12.

⁶⁹⁰Lehman, “An Inquiry into the Causes,” 12.

physicians like Lister thinking that the bile was "...of no use at all."⁶⁹¹ The chemical make up bile was made up of "...water[,] yellow insoluble matter [,] yellow matter in a solution[,] albumen[,] resin[,] soda[,] phosphate of soda[,] sulphate of soda[,] muriate of soda[,] phosphate of lime[,] [and] oxide of iron."⁶⁹² Lehman cites the decomposition of the bile as explained in the work of Thomas Thomson. Thomson was a synthesizer of chemical knowledge, publishing *A System of Chemistry*. A professor at the University of Edinburgh, Thomson had an interest in the morbid concretions of the body.⁶⁹³

Like other similar works studying calculi or concretions in the body, Lehman categorized biliary stones. He argued that there were six genres of stones: bilious-hepatic, hepatic-adipocious, cystic bilious, cortical, cystic adipocious, and mixed cystic (also known as adip-bilious calculi).⁶⁹⁴ Cystic adipoceros calculi mostly appeared in women.⁶⁹⁵

Lehman concluded with a discussion of potential remedies for stones. He broke up his account into three groups of remedies: those useful at the very beginnings of disease; the paroxysms; and those that would cure. At the onset of disease, laudanum, warm baths, and purges were useful. In treating the paroxysm. Lehman recommended bloodletting, as it "...is of extreme importance, and should be resorted to immediately

⁶⁹¹Lehman, "An Inquiry into the Causes," 12.

⁶⁹²Lehman, "An Inquiry into the Causes," 13-14.

⁶⁹³Lehman, "An Inquiry into the Causes," 12.

⁶⁹⁴ Lehman, "An Inquiry into the Causes," 23.

⁶⁹⁵He debated William Saunders, *A Treatise on the Structure, Economy, and Disease of the Properties and Component Parts of the Bile and Biliary Concretions* (London: W. Phillips, 1803).

provided the pulse is tense.”⁶⁹⁶ Bloodletting caused the problem duct to undergo sufficient relaxation, and cause the stones to pass into the intestines.⁶⁹⁷ Bloodletting relieved the inflammation and the spasm occurring to the intestines by sharp stones.⁶⁹⁸ Opium and warm baths could also be administered in addition to glisters (enemas) and purging medicines and were good in Lehman’s opinion.⁶⁹⁹

In the third class, which Lehman called the cure, he found that the medicines could be “...divided into Mechanical, and Chemical and consist of all the remedies which have been communicated, in conjunction with others.”⁷⁰⁰ Mechanical remedies included emetics, cathartics, stimulants, and sedatives and were meant to cause the physical evacuation of stones.⁷⁰¹ Chemical remedies were few and needed to be used cautiously, and only when “symptoms are moderate.”⁷⁰² The chemical remedies were thought to work slowly and needed to work their way through the system, including the liver, to have the desired efficacy. Lehman’s discussion of alkali remedies and their effect on

⁶⁹⁶Lehman, “An Inquiry into the Causes,” 28.

⁶⁹⁷Lehman, “An Inquiry into the Causes,” 28.

⁶⁹⁸Lehman, “An Inquiry into the Causes,” 28.

⁶⁹⁹Lehman, “An Inquiry into the Causes,” 28.

⁷⁰⁰Lehman, “An Inquiry into the Causes,” 29.

⁷⁰¹Lehman, “An Inquiry into the Causes,” 29.

⁷⁰²Lehman, “An Inquiry into the Causes,” 33-34.

calculi was similar to the treatment of urinary stones.⁷⁰³ He cited the work of Fourcroy and Thomson in the chemical dissolution of calculi and bile.⁷⁰⁴

Lehman was a leader of the Columbian Chemical Society, and brought his interest in stones to the community. While writing his dissertation, Lehman was a member of the Columbian Chemical Society. Historian Miles points out that, “We do not know what led Mitchell and Lehman to organize a new society, but a logical assumption is that they received their inspiration from the early Chemical Society of Philadelphia. Several members of the new organization—Edward Cutbush, John Redman Coxe, Adam Seybert, Charles Caldwell, John Syng Dorsey, Robert Hare, Henry Jackson and Robert Patterson—had belonged to the old society, and some of the young members were native Philadelphians who had undoubtedly watched the old society in the years when they had growing into manhood.”⁷⁰⁵ Miles also highlighted members of both the Columbian Chemical Society and the Philadelphia Medical Society.⁷⁰⁶

After the society published a collection of papers, it had no other known activities after 1813.⁷⁰⁷ Miles offers four main reasons behind the fall of the Society: problems with personal leadership, the dissipation of members after graduation, the war of 1812 that siphoned off members, and the financial difficulties from publishing memoirs. However,

⁷⁰³Lehman, “An Inquiry into the Causes,” 34.

⁷⁰⁴Lehman, “An Inquiry into the Causes,” 36.

⁷⁰⁵Miles, “The Columbian Chemical Society,” 153-154.

⁷⁰⁶Miles, “The Columbian Chemical Society,” 146.

⁷⁰⁷Miles, “The Columbian Chemical Society,” 146.

the Columbian Chemical Society changed venues and this was a critical development overlooked by Miles. Many of the questions related to chemical knowledge, the stones of the body, and other aspects of medico-chemistry, were absorbed into Medical Department at the University of Pennsylvania and at another teaching site in Philadelphia, the Pennsylvania Hospital.⁷⁰⁸ Penn hired Robert Hare a professor of chemistry after Benjamin Rush and Thomas Cooper, and the university continued to build a solid chemistry department with the addition of Casper Wistar. The Pennsylvania Hospital also offered clinical chemical instruction and many of the trainees at the hospital published chemical articles in medical journals.⁷⁰⁹

6.4 Charleston Literary and Philosophical Society

Charleston at the turn of the nineteenth century was a port city that was populated with people from Europe, Africa, and the Caribbean. It was the fourth largest city in the new United States of America. New denizens of the port city were eager to construct an intellectual culture and engage one another. Physicians were poised to play an important role in creating intellectual life and many were interested in chemistry and wrote about the stones of the body. Many of their speeches promoted chemical knowledge and its application to medicine, and this topic provided central attractor to build community. Charleston was a site of boundary objects work. Members of intellectual organizations like the Literary and Philosophical Society had members who were interested in stones

⁷⁰⁸Robert Harte, *Compendium of the Course of Chemical Instruction in the Medical Department* (Philadelphia: J. G. Auner, 1836).

⁷⁰⁹A simple search of the journal literature yields lots of results.

and discussed the usefulness of chemistry in medicine. The Literary and Philosophical Society was another place where practitioners, some from outside of medicine, had to negotiate and incorporate calculi as objects of knowledge.

John Linnaeus Edward Whitridge Shecut, often abbreviated as J. L. E. W., was a physician, pharmacist, and historian. His Huguenot family was originally from France, who settled in Switzerland, and eventually immigrated to the established Huguenot low country of South Carolina. He apprenticed as a physician with David Ramsay, a family friend. He attended the Medical Department of the University of Pennsylvania, but Joseph Waring argues that Shecut did not complete his medical degree because he was absent from the rolls of the South Carolina Medical Society.⁷¹⁰ As prodigious writer, Shecut published works on botany like *The Flora Carolinaensis, or a Historical, Medical, and Economical Display of the Vegetable Kingdom according to the Linaean of Sexual System of Botany*. Shecut wrote on electricity, the history of Charleston, yellow fever, and compiled theories of infection and contagion in his 1819 *Medical and Philosophical Essays*.

In his *Medical and Philosophical Essays* he sketches the geography and history of Charleston. Shecut was disappointed that Charleston's intellectual life was not as focused on science in the same manner as it was on trade. He lamented that,

It is a source of sincere regret to the lovers of science, that its progress has not been as rapid as the progress or topographical improvement of the city, with respect to its trade and commerce For upwards of a century from its first

⁷¹⁰Joseph Ioor Waring, *A History of Medicine in South Carolina: 1670-1825* (Charleston: South Carolina Medical Association, 1964), 303 and see 371.

settlement, science and literary may be said to have continued in a very languishing condition in Carolina. And although its history has recorded men of the first talents in the field and cabinet; and also several men of eminence in the science of medicine, there are but few moments of their literary labours, that have been preserved for succeeding ages.⁷¹¹

In Shecut's analysis of his own society's history, he praised the Medical Society, founded in 1789, because it generated other intellectual and social improvement societies, including the "...Humane Society, the Charleston Dispensary for the Poor, and the Botanic Garden."⁷¹² Shecut cited the publications of John Drayton to frame the medical heritage of South Carolina. In 1802, he published *A View of South Carolina*, which preserved some of the work one of the most well-known physicians in South Carolina and his past teacher, David Ramsay.⁷¹³

A chemist was at the helm of the first Literary and Philosophical Society in 1809. The founding president was Charles Dewar Simons. Simons would become the first professor of chemistry at the South Carolina College in Columbia, preceding Edward Darrell Smith in the role. Simons drowned in 1812, along with one of his slaves while returning from Columbia to Charleston.⁷¹⁴ Shecut bragged that, "The Society, soon

⁷¹¹J. L. E. W. Shecut, *Medical and Philosophical Essays* (Charleston: A. E. Miller, 1819) 39.

⁷¹²Shecut, *Medical and Philosophical Essays*, 43.

⁷¹³Shecut, *Medical and Philosophical Essays*, 45 and John Drayton, *A View of South Carolina, As Respects Her Natural and Civil Concerns* (Charleston: W. P. Young, 1802)

⁷¹⁴See the chapter of this dissertation on Edward Darrell Smith.

became highly respectable, with a large increase of members.”⁷¹⁵ The society held lectures in natural history and experimental philosophy that were attended by a large number of Charlestonians. Shecut pointed out that Simons likely received the professorship in chemistry in Columbia from his work at the Society.

Another medico-chemist member of the Literary and Philosophical Society was Alexis De Carendeffez, also known as Baron De Carendeffez. He was interested in stones and a prominent chemist from who traveled from San Domingo to New York and eventually resided in Charleston.⁷¹⁶ De Carendeffez, served with French forces during the American Revolution while he was fifteen. Carendeffez was made legendary by the Charleston physician Alexander Garden in his *Anecdotes of the Revolutionary War in America*.⁷¹⁷ Garden writes that Carendeffez was tasked to travel to the magazine to bring powder to the French artillery unit, but,

...while seated on a barrel of powder, saw a shell from the enemy fall within two feet of his position. The Soldiers who were in the Battery, expecting immediate explosion, ran off in every direction. The intrepid you remained unmoved. The expected catastrophe, however, did not follow—the fuse of the shell was, in its light, extinguished. This being perceived by the fugitives, the Battery was immediately reoccupied, when Captain Lemery, the commanding Officer, addressing himself to the youth, who still retrained his seat, said—“You young

⁷¹⁵Shecut, *Medical and Philosophical Essays*, 47-48.

⁷¹⁶Waring, *History of Medicine in South Carolina, 1670-1825*, biography on page 184.

⁷¹⁷Alexander Garden, *Anecdotes of the Revolutionary War in America* (Charleston: A. E. Miller, 1822), 207.

rogue, why did not you not fly the impending danger? Why not embrace a change for life? “Because, Captain,” he heroically replied, “my duty required that I should make a distribution of ammunition, and not desert my post, and fly like a poltroon!”⁷¹⁸

Carendeffer was interested in chemistry, particularly for manufacturing. For instance, he published experiments with paints.⁷¹⁹ He worked with James Woodhouse, the president of the Philadelphia Chemical Society, on the analysis of water. However, Baron de Carendeffer was a physician, and also published several papers in the *Medical Repository*. One paper focused on the morbid concretions of the body, “An Analytical Description of certain Stony Concretions (Phosphate of Lime), coughed up from the Lungs, by Joseph Shildigger, a Patient in the New-York Hospital, with Practical Remarks on their Formation.”⁷²⁰

In *An Analytical Description* Carendeffer determines that the stones found in the lungs of a patient bore a chemical resemblance to those found in the bladder and the kidneys. Carendeffer read a paper describing the chemical analysis of these pulmonary stones in October of 1802, as a member of the Physical Society of New York. He saw a “stone-cutter” who was brought into the hospital suffering from “phthisical symptoms.”⁷²¹ The patient was suffering from symptoms which included “...great

⁷¹⁸Garden, *Anecdotes*, 207.

⁷¹⁹Alexander Carendeffer, “An Account of a Rouge or Red Pain for the Use of the Toilet,” *Medical Repository* 10 (1807): 304-306

⁷²⁰Carendeffer, “An Analytical Description of Certain Stony Concretions,” *Medical Repository* 6 (1803): 258-261.

⁷²¹Carendeffer, “An Analytical Description,” 258.

difficulty breathing, violent cough, expectoration of pituitous and purulent matter, sometimes mingled with blood, considerable emaciation and night sweats.”⁷²²

Carendeffer described the patient coughing up of “small stones,” estimated at over two hundred in number.⁷²³ The large amount of stones coming up from his body produced relief in his opinion. Carendeffer reported, that, “A suspicion had arisen that these stony concretions were formed from the dust, inhaled while he was at working in shaping quarry-stones, by his mallet and chisel, for the purposes of architecture.”⁷²⁴

Carendeffer was given stones by his friend Dr. Mitchell; likely Samuel Latham Mitchell the editor of the *Medical Repository*. Samuel Latham Mitchell (1764-1831) edited the *Medical Repository*, a well-known medical journal, from 1797 to 1824. Mitchell was born in North Hempstead, NY and was a professor of “Lavoisierian Chemistry” at Columbia University. He wrote about topics like mineralogy, vegetable physiology, and geography. He corresponded with Joseph Priestley, David Ramsay, and Felix Pascalis. He was also a practicing physician at the New York Hospital.⁷²⁵

Mitchell and Carendeffer work regarding stones represents an exchange regarding boundary objects. Mitchell gave Carendeffer’s the stones.⁷²⁶ Carendeffer analyzed the stones chemically that were “spit up,” and wrote to the Physical Society of New York. Carendeffer’s chemical analysis of the stones was very similar to the analysis of other

⁷²²Carendeffer, “An Analytical Description,” 258.

⁷²³Carendeffer, “An Analytical Description,” 258.

⁷²⁴Carendeffer, “An Analytical Description,” 259.

⁷²⁵Kelly, *A Cyclopaedia of American Medical Biography*, Volume 1, pg. 807.

⁷²⁶Carendeffer, “An Analytical Description,” 259.

calculi. He subjected the stones to an acid test, observing that they changed their composition and color. He subjected the stones to fire and found that they crumbled and parts of them turned to glass. The calculi were weighed after his chemical tests and determine that they were three grains lighter, because the stones had had their “animal gluten” destroyed through his tests.

After adding sulfuric acid to the remaining decomposed powder, and the mixture dried. It resulted in a substance, which he tasted, finding that it had “...a sour but agreeable taste.”⁷²⁷ He successful precipitated the mixture with lime, and realized that the stones were made of a phosphate of lime. The oxalate of lime, known to decompose stones that were made of a phosphate of lime, worked very well as a testing agent.⁷²⁸

Carendeffez concluded that his tests revealed “...*that these pulmonary stones or concretions are true PHOSPHATE OF LIME.*”⁷²⁹ He then made recommendations to prevent such stones from occurring in the body. Calculi like those that Carendeffez examined were thought be caused by excess amounts of “calcareous salt” in the bodily system. This salt was found in both vegetable and animal foods. Carendeffez cautioned that it had to be dissolved in the fluids of the body, that the “...constitution ought to be supplied with a surplusage of phosphoric acid.”⁷³⁰ When there was too little natural “phosphoric menstruum,” “concretions” would form in the in the body.⁷³¹ Carendeffez

⁷²⁷Carendeffez, “An Analytical Description,” 260.

⁷²⁸Carendeffez, “An Analytical Description,” 260.

⁷²⁹Carendeffez, “An Analytical Description,” 261.

⁷³⁰Carendeffez, “An Analytical Description,” 261.

⁷³¹Carendeffez, “An Analytical Description,” 261.

concluded the article by highlighting the importance of the phosphoric acid: “Hence, when there is no excess of phosphoric acid in the blood and secretions, we so often find concretions similar to these in the kidneys, in the bladder, in the bronchia, and in the lungs, and in other places.”⁷³² He argues that the pulmonary calculi were chemically similar to those of the kidneys, bladder, and other parts of the body.

Carendeffez spurred the community of journal readers to continue examining the importance of phosphoric and oxalic acid. “Chemical experiments” demonstrated that concretions like those he analyzed failed to form in the body when exposed to phosphoric or oxalic acid.⁷³³ Subjecting the stones to acids and recording their results reveals the type it was to the chemist. Examples of acid tests were seen in this dissertation from the work of Smith and Marcet. He referred to earlier studies of stones from the kidneys and bladder.

All these facts which I have seen and derived from my own experiences, in submitting these concretions to the action of different acids, and all the others which I have gathered from experiments made on calculi of the kidneys and bladder, convince me that most reliance is to be place on The ‘OXALIC and PHOSPHORIC ACIDS for destroying these terrible concretions.’⁷³⁴

Though these acids were different than those recommended by the French chemists (nitric and muriatic acids), Carendeffez recommended a course of the oxalic and phosphoric acids, even though they had a “disagreeable taste.” They were “more

⁷³²Carendeffez, “An Analytical Description,” 261.

⁷³³Carendeffez, “An Analytical Description,” 261.

⁷³⁴Carendeffez, “An Analytical Description,” 261.

stimulating upon the living parts, without having a proportional action upon the stones...I therefore recommend them to their notice and trial, as promising to do much in the cause of humanity, both in the form of drinks and injections.”⁷³⁵

The Literary and Philosophical Society continued to grow and attract new members. Membership was heterogeneous, including physicians, clergy, political leaders, planters, and lawyers. Shecut reported that the Literary and Philosophical Society became larger, growing to 138 members in 1819.⁷³⁶ He also highlighted the lavish library and museum collection.

The Literary and Philosophical Society was a site of boundary object discussion. Not only were there discussions about the stones of the body, but other objects were circulating through the Literary and Philosophical Society. This was true with society constructing a museum collecting. Objects were intellectual capital in the society, and members like Carendeffez saw calculi as an intellectually relevant object, and chemistry as a useful to analyze them.

The Literary and Philosophical Society also inspired younger members to found the “Junior Literary Society” in 1814, which they later re-named the Barlow Literary Society. Unfortunately, Shecut reports that the junior society was dissolved in 1819.⁷³⁷ However, Dr. Ramsay attempted to revive intellectual life for the children of Charleston

⁷³⁵Carendeffez, “An Analytical Description,” 261.

⁷³⁶For a relatively complete list of members, see South Carolina Historical Society: “Literary and Philosophical Society of Charleston. Lists of members of the Literary and Philosophical Society, 1832 Feb. 8. (43/527) South Carolina Historical Society.

⁷³⁷Or at the time of Shecut publishes in essay collection.

by establishing the Ramsay Library Society, which also failed to thrive. Shecut points to these societies not as failures but as evidence of the “thirst” of Charleston’s youths for intellectual life.⁷³⁸ He concluded his third sketch of Charleston by linking the promotion of intellectual life to national power.⁷³⁹ He argues that proper intellectual life in Charleston will:

...prove to the world, that her soil is by no means unfavorable to the generation or cultivation of the arts and science, and that her sons want but the appropriate stimulus to their labours, that of public patronage, to shield them from loss, while endeavoring to raise her literary fame to a level with that of the most favoured nations, examples are yet to be seen in the most unpardonable apathy and shameful neglect of her citizens....Until the Carolinians are aroused to the formation of a permanent national character; and until the utility and vital importance of the arts, sciences and literature, form a predominant feature of that character, these things must and will remain, the reproach of South-Carolina.⁷⁴⁰

British chemists like Thomas Thomson saw intellectual life, especially chemistry, as important in re-establishing national character against other competing nations like France. Building intellectual life, including chemistry, was important to physicians like Shecut, and the project of the Literary and Philosophical Society was framed and promoted to citizens who wanted to build an improved society in the United States.⁷⁴¹

⁷³⁸Shecut, *Medical and Philosophical Essays*, 54-55.

⁷³⁹Shecut, *Medical and Philosophical Essays*, 54-55.

⁷⁴⁰Shecut, *Medical and Philosophical Essays*, 54-55.

The Literary and Philosophical Society of South-Carolina had its first official meeting on June 30, 1814.⁷⁴² Stephen Elliott, a physician and botanist, was the first president of the third version of the intellectual organization. Elliott was born in 1771 in Beaufort, South Carolina. He earned a bachelor's degree from Yale in 1791, and, late in his career, an honorary medical degree from the newly established Medical College of South Carolina in 1824 or 1825.⁷⁴³ In 1825 he was among the first group of professors appointed to the newly established Medical College of South Carolina.

Elliott died in 1830. However, his legacy would be continued in 1853, when the South Carolina Literary and Philosophical Society dissolved and reformed itself into the Elliott Society for Natural History in 1853.⁷⁴⁴ Elliott was passionate about the arts and sciences, and published a comprehensive botanical survey entitled *A Sketch of the Botany of South Carolina of Georgia* and edited the *Southern Review*.

During his presidency, Elliott gave one of the first speeches of the society, which was published in August 1814.⁷⁴⁵ The sciences, according to Elliott, were imperative to

⁷⁴¹See the work of Lester Stephens: *Science, Race, and Religion in the American South: John Bachman and the Charleston Circle of Naturalists, 1815-1895* (Chapel Hill: University of North Carolina Press, 2000), and John Lauritz Larson, *Internal Improvement: National Public Works and the Promise of Popular Government in the Early United States* (Chapel Hill: University of North Carolina Press, 2001) and Lewis A *Democracy of Facts*.

⁷⁴²Shecut, *Medical and Philosophical Essays*, 105.

⁷⁴³Waring, *A History of Medicine in South Carolina, 1670-1825*, 211.

⁷⁴⁴Waring, *A History of Medicine in South Carolina, 1670-1825*, 211.

⁷⁴⁵Stephen Elliott, *An Address to the Literary and Philosophical Society of South Carolina; Delivered in Charleston, On Wednesday, the 10th of August, 1814* (Charleston: W. P. Young, 1814).

every economic, political, and social aspect of life. It was societies like his own that promoted the pursuit of science. Cultivating the sciences and arts were important to the development of national strength. Elliott compared his society's work to European scientific societies, but also justified the broad spectrum of interests held by the Literary and Scientific Society:

In Europe, where the pursuit of science has long been a cherished, and a fashionable occupation, and where the humbler of literary and scientific men has become so great as almost to crowd and jostle on the road, societies have been formed to promote the study of each distinct branch of knowledge. But with us it has been deemed advisable to unite in one Society all who should be willing to associate in our labors; while by arranging our members into different classes, and assigning to each class distinct and determinate objects, each individual will find himself co-operating with associated, having common views and occupation.⁷⁴⁶

Elliott's definition of science is wide and extensive. Elliott attempted to justify the importance of each of the "classes" of science. These classes included mathematics and mechanics, chemistry (under which he bundled electricity, galvanism, and mineralogy), zoology, and botany; anatomy, surgery, physiology, and medicine; agriculture and rural economy; commerce, manufactures, and internal navigation; history, geography, topography, and antiquities; belles lettres, ancient and modern languages, public and private education; and the fine arts.⁷⁴⁷ Elliott saw each of these classes as integral to the

⁷⁴⁶Elliott, *An Address*, 3-4.

⁷⁴⁷Elliott, *An Address*, 16.

other and forming a “FABRIC OF MODERN SCIENCE.”⁷⁴⁸ Throughout his oration, he explicated the idea that “KNOWLEDGE IS POWER,” and was therefore paramount to national reputation and power.⁷⁴⁹

Elliott highlighted the value of gas chemistry in this section as well. Physicians in Charleston and elsewhere were convinced that the atmosphere contributed to the appearance of yellow fever.⁷⁵⁰ In his discussion of gas chemistry Elliott postulated that the atmosphere could be manipulated, especially with the aid of electricity:

Chemistry ascertains the nature and properties of those airs or gases, which exist in the atmosphere, and perhaps pervade all nature, it analyses the composition of the atmosphere and endeavours to elucidate its changes. Hence those modifications of the air, which constitute the science of meteorology, the result of combinations of the gaseous fluids, varied probably by electric and magnetic influence, become objects of chemical enquiry.⁷⁵¹

⁷⁴⁸ Elliott, *An Address*, 16.

⁷⁴⁹ Elliott, *An Address*, 16.

⁷⁵⁰ See their respective bodies of literature concerning yellow fever: John L. E. W. Shecut, Archibald Edward Miller, and Henry William Ducachet. *An Essay on the Prevailing, or Yellow-Fever, of 1817: Together with Preliminary Observations, and an Enquiry into the Causes Which Produced It : Also, a Brief View of the Effect of Certain Poisons on the Animal Economy, Compared with Those of the Specific Gaseous Poison of the Yellow-Fever* (Charleston: Printed by A.E. Miller, 1817) and Felix Pascalis-Ouviere, *Medico-Chemical Dissertations and the Cause of the Epidemic Called Yellow Fever and on the best Antimonial Preparation for the Use of Medicine* (Philadelphia: Snowden & M^cCorkle, 1796).

⁷⁵¹ Elliott, *An Address*, 5.

By 1837, the Literary and Philosophical Society turned its attention to proslavery arguments and slavery apologetics. J. H. Guenebaut translates Julien-Joseph Virey's *Natural History of the Negro*. Guenebaut includes a substantial notice to the Society.⁷⁵² With Guenebaut's translation the Literary and Philosophical Society engaged in the intellectual project to protect and encourage the institution of slavery from an intellectual standpoint.⁷⁵³

The Literary and Philosophical Society brought together many types of intellectuals in Charleston. Intellectuals like Cardeffezz and Elliott saw the value of chemistry in medicine. Boundary objects were important to the society, as seen in Cardeffezz's work on stone. But also the acquisition of a museum collection in Charleston as well. The Literary and Philosophical Society sought to establish intellectual bodies like those they knew of in Europe. Cultivating intellectual discussions of science, medicine, and stones were seen as an important point of culture.

6.5 The Medico-Chirurgical Society of London

The Medico-Chirurgical Society was founded in 1805 by Alexander Marcet, John Yelloly, and its first president, William Saunders. Members of the society who have been discussed in this dissertation include Alexander Marcet, Astley Cooper, William Saunders, John Bostock, William Hyde Wollaston, Thomas Thomson, and its "foreign"

⁷⁵² J.-J Virey, *Natural History of the Negro Race*, trans. by J. H. Guenebaut (Charleston: D.J. Dowling, 1837). See Columbia Rare Books and Special Collection at the University of South Carolina.

⁷⁵³ See the work of Fox-Genovese and Lacy Ford. The note was listed above.

member Benjamin Rush.⁷⁵⁴ The society was formed in response to leadership issues at the major medical association in eighteenth century London, the London Medical Society. Its president, James Sims, had been president for about twenty years and would not cede the office. The Medico-Chirurgical Society was created to be more equitable and terms of administrative service had limits.⁷⁵⁵ Membership was open to surgeons, physicians, and apothecaries, and chemists were also welcome. Meetings included administrative business, committee business, and then the reading of several medical papers and with discussions following.⁷⁵⁶

Many of the early members were connected to Guy's Hospital, and were also involved in chemistry. Saunders founded a school of chemistry at Guy's Hospital.⁷⁵⁷ The society became more affluent by 1810, adding permanent quarters, a library, and increasingly larger meetings... The Medico-Chirurgical society became quite popular and merged with the London Medical Society in 1808. The society began publishing its *Transactions* in 1809. The society received a royal charter from William IV in 1834.⁷⁵⁸ The society would become one of the major professional organizations in the twentieth century,⁷⁵⁹

⁷⁵⁴Penelope Hunting, *The History of the Royal Society of Medicine* (London: The Royal Society of Medicine Press, 2002), 1-67.

⁷⁵⁵Hunting, *The History of the Royal Society of Medicine*, 1-67.

⁷⁵⁶Hunting, *The History of the Royal Society of Medicine*, 1-67.

⁷⁵⁷Hunting, *The History of the Royal Society of Medicine*, 1-67.

⁷⁵⁸Hunting, *The History of the Royal Society of Medicine*, 1-67.

⁷⁵⁹Hunting, *The History of the Royal Society of Medicine*, 1-67.

The Medico-Chirurgical Society discussed many topics related to the fluids of the body, including blood transfusions, urine, and morbid concretions. The society facilitated networking between members, which lead to detailed accounts of lithotomies, the collecting of stones, and their chemical analysis. Networking activities can be understood through the example of John Yelloly, and beyond the society, with its members in the Royal College of Surgeons.⁷⁶⁰

6.6 John Yelloly

John Yelloly was born to a merchant in Northumberland, England in 1774. Yelloly was orphaned after the death of his father, and raised up his uncle, Nathaniel Davidson, an English representative to Egypt. He received a medical doctorate from the University of Edinburgh in either 1796 or 1799. Yelloly arrived in London around 1800, where he eventually came to work at the dispensary at Aldersgate. While working at the dispensary he joined the Medical Society of London, and was later hired to work at the London Hospital. Yelloly was later involved in working on a pharmacopeia and educating aspiring physicians at the London Hospital.

Yelloly knew members of the Medico-Chirurgical Society socially, including Astley Cooper and Alexander Marcet. All three men interacted in the Edinburgh Club and Pow-Wow, two clubs for physicians.⁷⁶¹ Astley Cooper visited Yelloly sometime

⁷⁶⁰Zachary Cope, *The Royal College of Surgeons of England* (London: Anthony Blond, 1959)

⁷⁶¹N. G. Coley, "The Animal Chemistry Club; Assistant Society to the Royal Society," *Notes and Records* 22 (1967): 173-185.

between 1833-1834 while on tour in the Suffolk area.⁷⁶² After Marcet died, Yelloly and Cooper were given Marcet's books and papers. Yelloly gave his share of the papers to Marcet's son Feauris Marcet in Geneva. Yelloly was in Norfolk with John Bostock, and the two men operated in similar social circles.⁷⁶³ The same can be said for Thomas Thomson and William Saunders.

Yelloly, along with his colleagues in the Medico-Chirurgical Society, discussed concretions at several meetings. In 1815 Yelloly published a paper entitled "Particulars of a Case of Which A Very Large Calculus Was Removed from the Urethra of a Female without Operation; With Examples of Analogous Cases" in the *Transactions of the Medico-Chirurgical Society*⁷⁶⁴ Yelloly's case presentation was like other cases of calculi that appear in this dissertation. Yelloly recounted to his readers that at a meeting after first reading his paper, he had brought the removed calculus to show the members.

The Medico-Chirurgical Society was a venue where boundary objects, like stones, were discussed. The papers were read aloud and often included objects that were discussed with the general body. The body of the society was made up of several medical occupations which included surgery, pharmacy, and medicine. Chemists were also present at the meeting and many of the members had an interest in chemistry. Read

⁷⁶²See biographical sources about Cooper in the previous chapter.

⁷⁶³Gudrun Richardson, "A Norfolk Network Within the Royal Society," *Notes and Records of the Royal Society of London* 56 (2002): 27-39.

⁷⁶⁴John Yelloly, "Particulars of a Case of Which A Very Large Calculus Was Removed from the Urethra of a Female without Operation; With Examples of Analogous Cases," *Medico-Chirurgical Transactions* 6 (1815): 574-676.

papers were where the negotiations occurred, and the published article represented agreements about the knowledge surrounding stones.

He presented the remarkable case secondhand, but he had interviewed a physician-surgeon who tended to the patient, a Mr. Hopke. The patient, named “J.M.” had a previous history of irregular urine. She had, since the age of seven, had blood in the urine after “...considerable exertion in jumping.”⁷⁶⁵ J.M. continued to have irregular urine until her twentieth year and when she was married, but never noticed pain during urination and was otherwise healthy.⁷⁶⁶ But J.M. experienced irregular urine after she became pregnant. The urine did not contain blood, but was “of a purulent appearance,” which was initially thought to be gonorrhea affecting the vagina, but her attending physician did not know for sure.⁷⁶⁷

After her third pregnancy, she experienced painful urination which as initially thought to have been produced by gonorrhea. The patient was described as “She had a very good time [Yelloly was referring to her experience during pregnancy], but could never afterwards retain her water, which she had, up to this period, always been able to do.”⁷⁶⁸ She continued to experience severe pain in her bladder that could only be treated with laudanum. And though laudanum dulled her pain, and the discharge shrank, she had still “always [had] a considerable deposit of a purulent appearance in the urine, as was

⁷⁶⁵Yelloly, “Particulars of a Case,” 575.

⁷⁶⁶Yelloly, “Particulars of a Case,” 575.

⁷⁶⁷Yelloly, “Particulars of a Case,” 575.

⁷⁶⁸Yelloly, “Particulars of a Case,” 575.

observed likewise to have been the case in her third pregnancy.”⁷⁶⁹ Yelloly described J.M.’s discharge for the reader: “She now passed, with temporary relief, several substances [calculi] of more than half an inch in length and described as resembling the fur from the inside of a tea-kettle.”⁷⁷⁰ After the patient continued to suffer attacks Mr. Hopke found a “small calculus” when he inserted a probe near the urethra. The calculus was removed without difficulty with forceps. The stone was quite large, measuring about “eighteen grains,” and was described as “...rather flat, and was somewhat of an oval form, having the longest diameter rather more than six-eighths of an inch in length, and the shortest about five-eighths.”⁷⁷¹ And Hopke continued to find stones: “He found by means of a probe induced into the bladder, and also by the finger introduced into the vagina, that there was a very large stone in the bladder.”⁷⁷²

But relief for J. M. was only temporary. She continued to suffer from pain, and later the patient reported to Hopke that she felt like she was about to pass a stone through her urethra. When Hopke examined the patient

...per vaginam, he found the calculus sticking in the urethra, but there was no opening between the urethra and vagina; and remarked at the time, that if there had been such an opening, he would have felt himself warranted in the enlarging it, for the purpose of removing the stone.⁷⁷³

⁷⁶⁹Yelloly, “Particulars of a Case,” 575-576.

⁷⁷⁰Yelloly, “Particulars of a Case,” 576.

⁷⁷¹Yelloly, “Particulars of a Case,” 576.

⁷⁷²Yelloly, “Particulars of a Case,” 576.

⁷⁷³Yelloly, “Particulars of a Case,” 576-577.

Hopke, along with a surgeon from London Hospital, Mr. Headington, saw the stone and with the surgeon, the stone was removed with the “fore-fingers” and in the patient’s body they found that there was “...no communication existed between the urethra and vagina.”⁷⁷⁴

The patient afterwards was relieved and her symptoms seemed to improve: no discharge or pain, “...but she continued to pass her urine involuntarily.”⁷⁷⁵ And when she became pregnancy two years later the pain returned. However, the patient explained the pain because of the “pressure” the child was exerting on her pubis. J. M. brought the child to term but was reported to have come down with a cold after the child was born; her milk decreased, she became weaker, and died on December 25, 1813, approximately three weeks after giving birth.

Yelloly reported the chemical analysis of the stone that was removed from the patient. He described the stone physically: “...of an irregular surface, and of a flattened oval shape, having two little rounded projections at the extremity by which it passed from the urethra.”⁷⁷⁶ It was about three ounces and “It is composed principally of uric acid, disposed in close concentric lamellae, having no perceptible nucleus; and a considerable portion of its surface is covered with a mixture of phosphate of lime, and ammoniaco-magnesian phosphate.”⁷⁷⁷

⁷⁷⁴Yelloly, “Particulars of a Case,” 577.

⁷⁷⁵Yelloly, “Particulars of a Case,” 577.

⁷⁷⁶Yelloly, “Particulars of a Case,” 578.

⁷⁷⁷Yelloly, “Particulars of a Case,” 578.

Yelloly shared other cases in the Royal Society's *Philosophical Transactions* where women experienced remarkably large stones. Yelloly argued against the common thesis that "...the parietes of the urethra, in all such cases, are injured by ulceration, which by making an opening from this tube into the vagina, facilitates the exit of the calculus."⁷⁷⁸ He argued that "enuresis [sic]" occurred because of the damage to the neck of the bladder and the urethra, and opening between the urethra and the vagina.⁷⁷⁹ Yelloly shared Marcet's argument that women would no longer need lithotomies because of the usefulness of manual extraction:

when we consider the shortness of the female urethra, the thickness of its parietes, the want of resistance from contiguous parts, and the facility with which it has in many instances been distended by mechanical means*, it is the less to be wondered, that the long continued of a calculus if the female has often produced a sufficient dilation for the removal.⁷⁸⁰

Yelloly uses an analogy from stones in the biliary ducts, writing that "we have the great dilatibility of the biliary ducts evinced by the magnitude of the concretions which have passed through them into the duodenum."⁷⁸¹ These facts, Yelloly highlighted, were important in cases of lithotomy, as surgery could be avoided.

This case seems to inspire Yelloly's interests in quantifying and describing remarkable cases of stones in order to determine frequency, and eventually causation, to

⁷⁷⁸Yelloly, "Particulars of a Case," 581.

⁷⁷⁹Yelloly, "Particulars of a Case," 581.

⁷⁸⁰Yelloly, "Particulars of a Case," 582.

⁷⁸¹Yelloly, "Particulars of a Case," 582.

the production of stones in humans. He was particularly interested in quantifying stones in women. He published his findings from the collection of calculi at the Norwich Hospital in two papers: *Remarks on the Tendency to Calculous Disease: With Observations on the Nature of Urinary Concretions, and An Analysis of a Large Part of the Collection Belonging to the Norfolk and Norwich Hospital* (1828) and *Sequel to a Paper on the Tendency to Calculous Diseases, and on the Concretions to Which Such Diseases Give Rise* (1830)⁷⁸²

Yelloly wanted to determine how many cases of calculus occurred, what populations or predispositions were vulnerable to stones, and why stones occurred. Based on his work in Norwich, and further estimates on large populations, such as London's, Yelloly estimated stones to affect 1 in 188,000 people generally in England and Wales. Norwich seems to have a higher instance of about two cases per 21,000 persons, and London 1 in 38,000. While compiling information about patients suffering from the stone, Yelloly admits that there is difficulty understanding susceptible populations or causes of the stone in general:

I regret that but little advances have been made, in a knowledge of the circumstances on which a tendency to calculus complains depends; and I am not aware of such differences of air, water, soil, or habits of life having yet been

⁷⁸² "Remarks on the Tendency to Calculous Disease: With Observations on the Nature of Urinary Concretions, and An Analysis of a Large Part of the Collection Belonging to the Norfolk and Norwich Hospital," *Philosophical Transactions of the Royal Society of London* 119 (18/29): 55-81, and "Sequel to a Paper on the Tendency to Calculous Diseases, and on the Concretions to Which Such Diseases Give Rise," *Philosophical Transactions of the Royal Society of London* 120 (1830): 415-428.

detected, as can justify us in attributing the prevalence of stone, in the Norfolk district, to any of those causes.⁷⁸³

Yelloly supposed that there was some underlying predisposition that caused stones. Citing an idea from humoral theory, Yelloly invoked the idea of a constitution yielding certain populations more susceptible to various diseases: “A constitutional predisposition to the occurrence of calculus diseases unquestionably exists in certain families.”⁷⁸⁴ He cited the work of Dr. Prout, who watched three generations of one family need to be cut for the stone.⁷⁸⁵

The underlying argument in Yelloly’s project is the idea that if data were kept in sufficient number, physicians could further understand what caused the stone. Marcet had been frustrated with the difficulty of acquiring figures concerning those suffering from stones. Yelloly’s suggestion to improve information collection was:

If I might venture, however, to make the suggestion, I would respectfully submit, how subservient our public hospitals, the boasts and ornaments of the countrymen might be made to important statistical inquiries, by a more extended system of registry, than is at present usually adopted, either in the metropolis, or in the country; and how conducive to pathological improvement, the information would be, which they might be so readily enable to furnish.⁷⁸⁶

⁷⁸³Yelloly, “Remarks on the Tendency to Calculous Disease,” 64.

⁷⁸⁴Yelloly, “Remarks on the Tendency to Calculous Disease,” 64.

⁷⁸⁵Yelloly, “Remarks on the Tendency to Calculous Disease,” 64.

⁷⁸⁶Yelloly, “Remarks on the Tendency to Calculous Disease,” 67.

One part of reaching a better understanding about the prevalence of stones was creating a registry, but the other part was chemistry. In discussing the “diathesis” or the constitutional disposition of populations towards stones, he links scrofula with the production of stones:

In the instances which I have mentioned, it would therefore appear, that the tendency to produce calculous complains, is greater in towns than in the country; and if this should prove to be the cases generally, it would seem to indicate the existence, in children more particularly, of a connection between some diathesis which prevails in towns, (probably the scrophulous,) and the tendency to the secretion or deposition of lithic acid, on which the origin of the urinary calculi so much depends. I have not had it in my power to ascertain, whether the greater disposition of towns to calculous complaints, applies more extensively than I have mentioned.⁷⁸⁷

Yelloly took Marcet and Wollaston’s approach to the chemical analysis of stones and classified each stone in the Norwich collection into its chemical group based on the identification of their deposits: lithic acid, oxalate of lime, phosphate, and mixtures of other substances. But he thought his chemical analysis was more robust than Marcet’s:

I found, however, that none of the calculi contained in it [Marcet’s *Essay*] were divided, and that the experiments instituted by our laments colleague (of which an account was published in his work on Calculous Diseases,) were therefore

⁷⁸⁷ Yelloly, “Remarks on the Tendency to Calculous Disease,” 66. According to the *Oxford English Dictionary*, “scrofula,” historically referred: “A constitutional disease characterized mainly by chronic enlargement and degeneration of the lymphatic glands.”

necessarily confined to the outer surface, except in cases where the calculus had been broken in the extraction, and its interior structure thus allowed to be seen.⁷⁸⁸ He analyzed 330 calculi, some of which had been divided and broken. He compared his work to that of William Brande, Wollaston, Fourcroy, Henry, and Prout.⁷⁸⁹

Yelloly identified a rare chemical substance identified in one of the stones, which he named *silex*. In describing the stone he presented the context of the discovery and listed other places where that type of stone was chemically identified. He gave a short history of the discovery to protect “medical men” from being “...deceived, by the mistakes of patients, or their friends, in matters of an unusual nature.”⁷⁹⁰ But Yelloly was intrigued by the novelty of a new type of chemical substance that formed a stone:

And as if the love of exciting surprise and admiration by the marvelous, were not confined to the traveler, there is sometimes found in patients, however singular the fact may appear, an inclination to impose on their professional attendants, by the description or exhibition of something strange and anomalous.⁷⁹¹

He mentioned in the footnote that sometimes pieces of coal, brick, “sea shingle,” and even “common gravel” had been found in the urine.⁷⁹² Yelloly thought that medical anomalies needed to be communicated to the medical profession.

⁷⁸⁸Yelloly, “Remarks on the Tendency to Calculous Disease,” 69.

⁷⁸⁹Yelloly, “Remarks on the Tendency to Calculous Disease,” 79.

⁷⁹⁰Yelloly, “Sequel to Paper,” 419.

⁷⁹¹Yelloly, “Sequel to Paper,” 419.

⁷⁹²Yelloly, “Sequel to Paper,” Note on page 419.

The *silex* stone was rare, and Yelloly did not realize he had a stone of that type until he analyzed it.⁷⁹³ The stone was old, and it had been removed from a nine year old boy years prior. The calculus was dark brown in appearance, which caused Yelloly to think that it might be an oxalate of lime stone. The stone was small, about five grams. It had hard but clear crystals. Yelloly could only perform one test, as his sample was very small.

Yelloly worked with Michael Faraday to analyze the stone in London. Faraday was in social circles with many members in the Medico-Chirurgical Society, including Alexander Marcet and John Bostock, who nominated Faraday for membership in the Royal Society. Faraday and Yelloly corresponded a few times related to this research at the Royal Institute. Yelloly sent Faraday calculi for analysis, Faraday acknowledged receipt of the stones from the Norwich collection on March 7, 1831. Yelloly would report on these stones in the *Philosophical Transactions of the Royal Society*:

Both Yelloly and Faraday performed a chemical analysis of the stone. The stone was subjected to heat, the oxalate of lime separated, and other parts were destroyed by heat and muriatic acid. However, some granules, about nine in number, remained. The granules could scratch glass, and were not damaged by nitric and the muriatic acid. The remaining granules were heated and exposed to soda and potash, causing their “Evaporation,” leaving other materials that eventually cooled and resulted in “gelatinized silica.”⁷⁹⁴ Then silica was produced by further chemical refinement. The silica granules were compared to sand granules and determined to be the same substance. Yelloly then

⁷⁹³Yelloly, “Sequel to Paper,” 419.

⁷⁹⁴Yelloly, “Sequel,” 419.

pointed to other chemical literature involving the analysis of urinary gravel where “silicaeous[sic] gravel” was discovered.⁷⁹⁵ Hutchinson speculated, in reference to Yelloly’s work, that stones were thought to cause by a constitutional disposition, or “diathesis,” and that stones could be related to scrofula.⁷⁹⁶ Sailors were thought not to suffer from scrophulous, and sea air and bathing in the sea were the best remedies, and were thought to explain why the stone was rare among sailors.⁷⁹⁷

But at the conclusion of his article, Hutchinson explained why statistical inquiry was important to curing the stone:

The statistical inquiries on the subject of urinary calculi which have been published in this country within in the last fourteen years, by Drs. Marcet and Prout, my Messrs. Richard Smith, Martineua, Crichton, Liston, and lastly, by Dr. Yelloly, cannot but be highly useful to the future inquirer, and throw light upon the nature of this extraordinary disorder. I feel assured, indeed, with my lamented friend, Dr. Marcet, that it is chiefly in this way that the true pathology of the disease can ever be obtained, and consequently, the most efficacious mode of treatment.⁷⁹⁸

The Medico-Chirurgical Society was a site of a debate about the chemical nature of the stone, but part of determining how to solve the problem of the stone was the need to have

⁷⁹⁵ Yelloly, “Sequel to Paper,” 419.

⁷⁹⁶*The Oxford English Dictionary* defined scrofula as: “A constitutional disease characterized mainly by chronic enlargement and degeneration of the lymphatic glands.” It was also known as the King’s Evil.

⁷⁹⁷Yelloly, “Sequel to Paper,” 102.

⁷⁹⁸Yelloly, “Sequel to Paper,” 119-120.

a proper accounting of the stone. Networks that the society was built upon could furnish this type of information about collections in order to understand the frequency, and possibly the reason for why the stone appeared in people. Those stones could then be gathered and chemically understood. Calculi were boundary objects that required discussion and negotiations.

6.7 William Clift and the Morbid Concretions in the Hunterian

The Medico-Chirurgical Society had a history of cooperation with the Royal College of Surgeons. For instance, Peter Roget, a prominent member of the Medico-Chirurgical Society, communicated with William Clift, the main curator of the College, concerning specimens. On July 13, 1816, Roget wrote to Clift stating that:

I am instructed by the President & Council of the Medical +[sic] Chirurgical Society to send you the accompanying preparation of a monstrous fetus, which we transmitted to them by Professor Maumoir [sic] of Geneva, of which an account is just published in the seventh Volume of the Medico-Chirurgical Transactions, +[sic] which they have the honor to present, in the name of the Society, to the Royal College of Surgeons,

I have the honor to be

Sir, your most obedient servant

P. [Peter] M. [Mark] Roget, (Secretary.)⁷⁹⁹

⁷⁹⁹Peter Roget July 13, 1816 to William Clift; Royal College of Surgeons, Museum Letters 1816 RCS-MUS/5/6/6, letter 128.

William Clift was an illustrator and printed many of the plates found in the *Transactions of the Medico-Chirurgical Society*. Yelloly helped Clift get access to the Library of the Medico-Chirurgical-Society.

The Royal College of Surgeons split from the previous Barber-Surgeons organization, much like a royal guild, that had barbers and surgeons sharing one royally-chartered organization. Much like the Medico-Chirurgical Society, the Royal College of Surgeons was a break away from a major organization of practitioners that eventually sought and received royal patronage. The Royal College of Surgeons received its Royal Charter in 1800. Much of its political success could be traced to John and William Hunter and their successful surgical practices. The Hunters' successful surgical practice produced many specimens that would serve as the basis of the Hunterian Museum; the College's large teaching collection and museum. William Clift was its first curator, and as mention above, participated in both the Royal College of Surgeons and the Medico-Chirurgical Society.⁸⁰⁰

Clift was elected an honorary fellow of the Medico-Chirurgical Society in 1835.⁸⁰¹ He had been born in 1775 in Cornwall. Clift was a surgical trainee of John Hunter⁸⁰² Hunter and Clift had a special arrangement; Clift would not have to pay Hunter a fee for his apprenticeship and Hunter would receive Clift's anatomical drawings

⁸⁰⁰See biographical note below, note 262.

⁸⁰¹See *Medico-Chirurgical Transactions*, Volume 31 and Penelope Hunting's study.

⁸⁰²Caroline Grigson, *The Life and Poems of Ann Hunter: Hayden's Truneful Voice* (Liverpool: Liverpool University Press, 2009).

without fee. The apprenticeship in surgery lasted six years and both men got along well. When Hunter died in 1793, and his nearly 20,000 piece collection of anatomical specimens, including calculi, were willed to his executors, Hunter's wife and brother in law, a future president of the Royal College of Surgeons (and eventual plagiarist of most all of Hunter's unpublished writings) Everard Home.⁸⁰³ Hunter's heirs wanted Clift to safeguard the collection. Eventually, Clift facilitated the sale of Hunter's collection to Parliament. For his successful work with the collection, Clift was made "Conservator of the Hunterian Museum," and was paid for his work. Clift kept detailed diaries and records concerning the collection: including new acquisitions, master lists, and personal thoughts related to the collection.⁸⁰⁴

Throughout his career Clift served as an illustrator, sometimes credited but often not, for many important physiological and anatomical texts published in the nineteenth century. Clift was also involved in paleontology and worked with John Bostock and the Geological Society. Clift retired in 1842 and died in 1849. His death was mourned in many of the major periodicals of the time including *The Lancet* and in the *Phil Trans* of the Royal Society.

Catalogues at the Royal College of Surgeons list detailed descriptions of several types of stones, both animal and human. Clift purchased new specimens for the collections throughout his time as curator. In 1806, for instance, he purchased several

⁸⁰³Jessie Dobson, *William Clift* (London: Heinemann Medical Books, 1954) and *Conservators of the Hunterian Museum* (London: Royal College of Surgeons, date unknown). The later source was viewed at the Royal College of Surgeons. Also see *Oxford Dictionary of National Biography*.

⁸⁰⁴Also see the Library Collection at the Royal College of Surgeons.

items from the Leverian Museum collection, including: elephant tusks, Lot 661, which was “Seven various concretions ^{^v[sic]} from the Bladders and stomachs of Quadrupeds”. The purchase also included “remark[ble] concretions.”⁸⁰⁵ Clift included a note concerning the purchase in the margin:

Several of the Concretions were broken into Lamina or Concentric Shells and all the Sections and pieces were counted singly. These have been since mended (1821) and sections brought together which were in different lots:--and two of them were rounded flint-pebbles which had some appearance of calculi. One other was a bad Cast of a Calculus in plaster of Paris. By this means the number has been considerably reduced.—to 30 Boxes.⁸⁰⁶

Part of Clift’s role at the museum was culling the collection to make sure the specimens represented what the collectors thought would educate surgeons and make the collection as comprehensive as possible without being overwhelming. But the Royal College of Surgeons constantly received donations of calculi, often in large quantities. During meetings of the Royal College of Surgeons, the College would be presented with more calculi. For instance, in 1807, Everard Home gave the College “A box containing 307 [...] Calculi, from a man age 77. Which weighted 9oz. 7 ½ drachms; and also Seven small ones which passed before alkalies, were used.”⁸⁰⁷

⁸⁰⁵William Clift, “Rough Copy of Purchases of Specimens of Natural History & By the College for the Museum,” Held at the Royal College of Surgeons.

⁸⁰⁶Clift, “Rough Copy of Purchases of Specimens of Natural History & By the College for the Museum.”

⁸⁰⁷“Presents to the Museum, From the Year 1802 to 1816; Inclusive; Now Called Donations,” see page 35. Source held at the Royal College of Surgeons.

Clift described the urinary calculi for the museum, and had William Thomas Brand at the Royal Institution analyze the stones chemically. Brand performed experiments at Clift's request and was sent a list of several specimens of calculi in 1833.⁸⁰⁸ Much of the chemical analysis accompanying a detailed published account of the collection would come from Brand's chemical analysis, as well as from the calculi that William Blizard presented the College during his time there. One example is stone 16, or number 306 in the Hunterian collection, described as "An oblong intire [sic] calculus (about 2 ounces 'in weight. 'From M^{rs}. Bliss' Presented by Sir W^m. Blizard 1811. Selected for analysis Aug. 29. 1833."⁸⁰⁹ A handwritten note indicates that it contained an "oxalate[sic] nucleus."⁸¹⁰

Clift selected samples to be representative of common cases, but also stones that seemed mysterious or were debated. For instance, stone 14 (or stone number 170 in the Hunterian collection) is described as "An undivided Calculus of 'Oxalate of Lime.' Not so. (Selected for Analysis Aug 29. 1833.)"⁸¹¹ It appears that a "WTB" (Brande) left his initials on the resulting analysis and agreed that the calculi might consist of another chemical.⁸¹²

⁸⁰⁸William Clift, "Specimens of Calculi 1833," Royal College of Surgeons MS 0007/1/6/1/18

⁸⁰⁹William Clift, "Specimens of Calculi 1833," Royal College of Surgeons MS 0007/1/6/1/18

⁸¹⁰ William Clift, "Specimens of Calculi 1833," Royal College of Surgeons MS 0007/1/6/1/18

⁸¹¹William Clift, "Specimens of Calculi 1833," Royal College of Surgeons MS 0007/1/6/1/18

In 1839, Clift gave a report about the chemical analysis of the stones to the Board of Trustees of the Hunterian and proposed the results of the classification of the stones in the collection. He reported to the Trustees:

That the Chemical Analysis and descriptive Catalogue of the Hunterian Collection of Calculi and Concretions of the Human Subject have been so nearly brought to a completion as to admit of a general Comparison and Classification of these productions; and that the following Scheme has been adopted as the basis of this Arrangement:___⁸¹³

Clift classified the stones by their chemical composition, dividing them generally into eight classes: Uric Acid, Urate of Ammonia, Oxalate of Lime, Ammonia and Magnesia, Phosphate of Lime, both Phosphate of Lime and Ammonia, Cystic Oxide, Xanthic Oxide.”⁸¹⁴ The Hunterian Museum’s display of calculi was organized based on the stone’s chemical composition. Clift’s report recorded on May 1st, 1839, discusses the new organizational scheme of the museum:

And That certain alterations of the Cabinets destined for the reception of the Calculi, with trays of an uniform pattern and appropriate sizes have been ordered, and are in progress, so as the better to adapt them for the display and arrangement of the Calculi, corresponding to the preceding Classification; and that the Board

⁸¹²William Clift, “Specimens of Calculi 1833,” Royal College of Surgeons MS 0007/1/6/1/18

⁸¹³William Clift, “Classification of Calculi,” At Royal College of Surgeons MS 0007/1/6/1/21

⁸¹⁴William Clift, “Specimens of Calculi 1833,” Royal College of Surgeons MS 0007/1/6/1/18

[sic] Committee entertain the expectation that this part of the Catalogue will be in the Press, and the arrangement of the Calculi completed before the next Meeting of the Trustees.⁸¹⁵

In his cataloging, Clift also included the history of the stones and medical oddities that he was aware of, and disseminated that information to others. On June 28, 1816, Clift wrote to a Mr. Jenkinson (presumably a surgeon) at the London Hospital of the autopsy of “Tera Poo,” whose body contained “...almost universal enlargement and induration of the lymphatic glands, particularly those of the Mesentery.”⁸¹⁶ Particularly of the lungs, Clift conveyed information about concretions found in them, “The natural structure of the Lungs had been almost entirely destroyed the substance was filled with Tubercles which varied... from the Size of a Pea to that of a Walnut, and many of these had proceeded to a State of Suppuration.”⁸¹⁷

The collections of Calculi that the Royal Society had received since John Hunter were recorded in handwritten catalogues by Clift, which were continued through the conservatorship of Richard Owen. The Royal College of Surgeons published the three volume *A Descriptive and Illustrated Catalogue of the Calculi and Other Animal Concretions Contained in the Museum of the Royal College of Surgeons in London*

⁸¹⁵William Clift, “Specimens of Calculi 1833,” Royal College of Surgeons MS 0007/1/6/1/18

⁸¹⁶June 28, 1816; William Clift to Mr. Jenkinson. Royal College of Surgeons Museum Letters 1816 RCS-MUS/5/6/6

⁸¹⁷June 28, 1816; William Clift to Mr. Jenkinson. Royal College of Surgeons Museum Letters 1816 RCS-MUS/5/6/6

complete with engravings.⁸¹⁸ Other surgical organizations like the Royal College of Surgeons in Edinburgh also detailed its collections of concretions from the human body, including intestinal and urinary concretions, in 1836.⁸¹⁹ And the Royal College of Surgeons published a general catalogue of their museum that included morbid concretions but it was not principally devoted to their chemical analysis. Clift published a catalogue of the Hunterian collection in 1830 that detailed the parts of their collection that were related to “Diseases of the Urinary Organs,” but they were contained in a general catalogue divided medically, but lacking chemical analysis.⁸²⁰ Clift was one of the advocates for a chemical description of the collections.

The first volume contained a summary of the urinary calculi that were in the collection. The second volume contained mostly animal material and their related calculi, and the third contained other morbid concretions from the human body that the College had in their museum.⁸²¹ Many of the specimens originated from the collection of William Blizard. These volumes are an extensive narrative of chemical analysis and chemical

⁸¹⁸Victor Negus, *History of the Trustees of the Hunterian Collection* (Edinburgh and London: E. & S. Livingstone LTD, 1966), 32-36. And see *A Descriptive and Illustrated Catalogue of the Catalogue of the Calculi and Other Animal Concretions Contained in the Museum of the Royal College of Surgeons in London*. Royal College of Surgeons: RCS-MUS/7/19/1; the full three volumes were published by 1845.

⁸¹⁹*Catalogue of the Museum of the Royal College of Surgeons of Edinburgh* (Edinburgh: Neill and Company, 1836); this catalogue was also published in multiple parts.

⁸²⁰See William Clift, “Catalogue of the Contents of the Museum of the Royal College of Surgeons in London,” RCS-MUS/7/9/1.

⁸²¹For instance see William Clift MS 0007/1/2/2/15 “List of Specimens Proposed to be Taken by the RCS, 1835;” This is extremely clear when the Letter folios concerning the calculi collection are read. There are several of these folders at the Royal College of Surgeons. Also see the minutes from the Board; there are extensive files about their desires to collect stones.

knowledge. The first volume was published in 1842, before Clift retired and as the Royal College of Surgeons' collections were transitioning to the stewardship of Richard Owen.⁸²² Richard Owen was elected an honorary fellow in the Medico-Chirurgical Society in 1847.⁸²³ In his own publications describing the general collection of the Hunterian, Owen describes several concretions from crawfish.⁸²⁴

The preface to the first volume lists two general classificatory scheme that “calculous concretions,” can be placed into: “...first, an excessive, or an altered and vitiated secretion; and secondly, substances introduced with the food, and retained in the different parts of the alimentary canal. To the former class belong, not only the products of the true glandular organs, as the liver and kidney, but also those of the mucous and synovial surfaces.”⁸²⁵Of the second categories are, “...namely those which are to be traced in the different parts of the alimentary canal.”⁸²⁶The most common stone of the first class is the “chalk” stone, found in sufferers of gout. And in the second class, the stone that was most common were those with have a foreign body in their core.

⁸²²Cope, *The History of the Royal College of Surgeons* and also *Oxford Dictionary of National Biography*.

⁸²³*Medico-Chirurgical Transactions*, Volume 33.

⁸²⁴Richard Owen, *Descriptive and Illustrated Catalogue of the Physiological Series of Comparative Anatomy Contained in the Museum of the Royal College of Surgeons in London, Volume III Part II: Connective and Tegumentary Systems and Peculiarities*; RCS-MUS/7/11/7 ; see page 303

⁸²⁵*A Descriptive and Illustrated Catalogue of the Catalogue of the Calculi and Other Animal Concretions Contained in the Museum of the Royal College of Surgeons in London*; Volume I: preface.

⁸²⁶*A Descriptive and Illustrated Catalogue*, iii-iv.

The first volume's preface tries to explain to the reader why John Hunter did not subject the collection to chemical analysis. The preface explained that, "Owing to the imperfect state of chemical knowledge at that period, Mr. Hunter attempted no further arrangement of these bodies, than by simply referring them to the different organs from which they were taken."⁸²⁷ Later on, chemistry was seen by Clift and other catalogers of the Royal College of Surgeons' collection as an organizing principle.

The Royal College of Surgeons' collection was the product of the donation of specimens from surgeons like William Blizard, the donations of collections from chemists like Brand, and the acquisition of collections from the British Museum and other private collectors.⁸²⁸ The collection was meant to be encyclopedic, as it mentioned that all these donations, "...have rendered the Collection of Human Urinary Calculi nearly complete."⁸²⁹

The collection was written about extensively, especially in regards to its chemical component. William Brande had published his initial analyses in the *Philosophical Transactions* in 1808, and between 1834 and 1838 the collection was thoroughly re-

⁸²⁷*A Descriptive and Illustrated Catalogue*, v.

⁸²⁸*A Descriptive and Illustrated Catalogue*, v.

⁸²⁹*A Descriptive and Illustrated Catalogue*, v.

analyzed by Thomas Taylor.⁸³⁰ Taylor was elected a fellow of the Medico-Chirurgical Society in 1845.⁸³¹ The preface proclaims that Taylor brought order to the collection:

Within the last four years the entire Collection has undergone a complete revision, and the calculi have, for the first time, been arranged in a systematic order. Every specimen has undergone individual examination, as far as that could be done without injury to the calculus. The accomplishment of this undertaking was confided to Mr. Thomas Taylor, a member of the College, whose fitness for the task is proved in the manner of its execution; and the Council have much gratification in acknowledging the value of his services.⁸³²

In addition to being a member of the Medico-Chirurgical Society, Taylor was a lecturer in chemistry at the Middlesex Hospital Medical School in Cavendish Square.⁸³³

It was initially unclear to the cataloguers (presumably the group the Trustees appointed) if any chemically useful information would come out of re-analyzing the collection because, “The composition of urinary calculi from the human subject has been of late years so thoroughly investigated, that it was scarcely to be expected that much additional information would be gained by the examination of that part of the Collection.”⁸³⁴ However, there was useful information that came out of the new analysis

⁸³⁰See William Brande, “A Letter on the Differences in the Structure of Calculi,” *Philosophical Transactions of the Royal Society* 98 (1808): 223-243, and then Everard Home, “Some Observations on Mr. Brande’s Paper on Calculi,” *Philosophical Transactions of the Royal Society* 98 (1808): 244-248.

⁸³¹*Medico-chirurgical Transactions* 30 (1847): xxvii

⁸³²*A Descriptive and Illustrated Catalogue*, vi

⁸³³*Medico-chirurgical Transactions* 40; see page 53.

of the collection, such as the frequency of the nine types of chemically identified calculi. The display of stones in the museum fit these chemical descriptions. The organization of the book fits the scheme of William Clift's 1839 order for calculi.

The museum, in efforts to be encyclopedic, has all of the known types of urinary calculi except one. The end of volume contains one entry for "Carbonate of Lime. Of this species of calculus the Museum poses no specimen."⁸³⁵ The first volume contained a rich selection of prints of the various calculi.

In 1845, the second and third volumes were released in a single book. The second book contains the museum's extensive collection of calculi from birds, and other animals like snakes (serpents), oxen, dogs, and horses, and other more exotic animals like whales, iguana, ostriches, monkeys, and sturgeons.⁸³⁶ This volume contains specimens collected by William Clift, such as "P 5. Dried masses of the semifluid urine of the Boa Constrictor. This substance consists principally of suburate of ammonia. *Presented by W. Clift, Esq.*"⁸³⁷

Through chemical analysis, stones that were thought to come from humans were removed and re-classified. In the case of "P8. This calculous was placed by Mr. Hunter among the human urinary concretions, but as it only differs in size from the two last

⁸³⁴ For Taylor's work, see the example on page 380 in the Volume 58 Issue 1468 on October 18, 1851 by Taylor "Middlesex Hospital: Abstract of the Introductory Lecture..."

⁸³⁵ *A Descriptive and Illustrated Catalogue of the Catalogue of the Calculi and Other Animal Concretions Contained in the Museum of the Royal College of Surgeons in London*; Volume I: vi.

⁸³⁶ *A Descriptive and Illustrated Catalogue*, Volume 2; 135-136 and *Ibid.*, 133.

⁸³⁷ *A Descriptive and Illustrated Catalogue* 141.

descried specimens, it is most probable that it has also a similar origin.”⁸³⁸ This similar origin is that of the “Urate of Potass,” are most often found, with comparisons in the collection, to those found in the bladder of the South American Iguana.⁸³⁹

The third volume contains the museum’s biliary, salivary, intestinal/stomach, lachrymal duct, lungs/bronchi, joints, and vein calculi from humans.⁸⁴⁰ Because of the extensive collection of biliary stones, following the chemical work of Thomas Thomson, they were arranged into five classes. However, it still took an attentive practitioner to identify a stone by its appearance in places where there were stones with chemical similarities. Stones are presented by William Blizard in this volume as well, such as “Two impure cholesterine calculi, taken from the same gall-bladder. One is oblong and flattened at either end; the other is angular.”⁸⁴¹

The final part of the final volume discusses the concretions that often do not fit in other categories and are difficult to identify. The volume describes those concretions that appear in the eyes (lachrymal duct) and lungs/bronchi. The group appointed by the Trustees to write the catalogue knew that these stones existed because of the chemical literature, but they had no stones from the eyes. There was one example of the stone of the lungs: “B1. A stone spit out of a women’s lungs. From Dr. Grew’s Collection.—

⁸³⁸*A Descriptive and Illustrated Catalogue*, 141.

⁸³⁹*A Descriptive and Illustrated Catalogue*, 141.

⁸⁴⁰*A Descriptive and Illustrated Catalogue of the Catalogue of the Calculi and Other Animal Concretions Contained in the Museum of the Royal College of Surgeons in London [Part II Calculi from the Urinary Organs of the Lower Animals and Part III Concretions found in Other Parts of the Body]*. At the Royal College of Surgeons; RCS-MUS/7/19/4; published in 1845.

⁸⁴¹*A Descriptive and Illustrated Catalogue*, 171.

Sloanian Ms. Catagloue. Phosphate and carbonate of lime. *British Museum*.⁸⁴² The largest part of this section of the collection, however, were the gout concretions, noted and first studied under Dr. Wollaston. However, there were only four examples in the collection. Concretions in the veins, due to their rarity, were not in the collection either.⁸⁴³

6.8 Conclusion

Urinary stones, uterine stones, pulmonary stones, and other calculi were of interest to physicians, surgeons, and chemists at the turn of the nineteenth century. Calculi were boundary objects, as their importance cut across occupational lines. Medico-chemists wanted to bring in French analytical chemistry to create taxonomies of stones and understand why stones formed in the body. Physicians wanted to advance their own chemical knowledge and improve medical practice. Doctors felt that they did not have many treatment options for patients, and they wanted to expand their options. Surgeons wanted to participate in chemical research regarding stones because they thought they could improve the outcomes of lithotomies by chemically treating stones, but they also felt that they had something to offer to others in these communities: stone collections. The occupational boundaries at play were dismissed in favor of building increased knowledge about stones.

⁸⁴²*A Descriptive and Illustrated Catalogue*, Volume 3; 156.

⁸⁴³*A Descriptive and Illustrated Catalogue*, 264.

Stones, as boundary objects, made negotiations, cooperation, and exchange necessary in order to reconcile their meaning.⁸⁴⁴ To not only have effective treatments but to also understand the causes and types of stones was important. In order to accomplish a larger goal of building knowledge about stones, chemists, physicians, and surgeons had to work together across both their occupational and geographical lines.

The societies in Charleston, Philadelphia, and London became spokes on a wheel that was turning towards increased knowledge regarding calculi. The Literary and Philosophical Society in Charleston was a space where physicians, lawyers, planters, chemists, and other intellectuals engaged in analytical chemistry and discussed its value in treating medical conditions like stones. General interest intellectual groups like the Literary and Philosophical Society were places where medico-chemists interested in studying stones were welcome and integrated themselves into groups that seemed to share their interests.

Philadelphia was a city that engaged in medical research. It was a city of medico-chemical practitioners, such medical professors like Benjamin Rush. The two chemical societies in Philadelphia analyzed urinary stone as well as other natural objects that chemists sought to understand, like minerals or water. Bodily stones were just another natural phenomena to be analyzed and understood. But both the Philadelphia Chemical Society and the Columbian Society had membership that included medical students. Chemistry was a part of medical investigations and medical education in Philadelphia at the turn of the nineteenth century.

⁸⁴⁴*A Descriptive and Illustrated Catalogue*, 264.

London's Medico-Chirurgical Society offered a discursive space in which papers about stones were read and audience members could argue and negotiate. Many of its members, such as Marcet, Cooper, Yelloly, and Bostock, were interested in performing chemical analysis on stones and sharing their conclusions. Edward Darrell Smith and Thomas Cooper read literature produced by members of the Medico-Chirurgical Society about stones and tried to integrate it into their own practices in South Carolina. Eventually, the Medico-Chirurgical Society would become the premier professional society in Britain. As the society continued to explained through the middle of the nineteenth century membership continued to engage in the study of bodily calculi in its *Transactions*.

Calculi as knowledge objects cut across boundary lines intellectually. The curator of the Hunterian Museum at the Royal College of Surgeons oversaw a collection of a large number of various calculi which helped to fill the needs of surgeons, and offered teaching specimens. The hope being that study would offer the improvement of lithotomies. The organization of the Museum's collection required chemists to identify the stones. Surgeons came to medico-chemists to help sort and organize their collections. Medico-chemists also came to surgeons to get access to their private stone collections and for unique specimens. Collaboration and negotiation in discussing boundary objects like calculi were socially-based and grew out of individual friendships, though they gradually became institutionalized.

The study of morbid concretions moved from experiential accounts in medical journals and societal publications to consolidated collections in museums and their catalogues, readily available for both public and professional consumption. This move

highlighted the epistemic significance of calculi. Discussions of calculi were not only held in physical localities but in print as well, crossing geographical borders through the published word.

CHAPTER 7

CONCLUSION

7.1 Calculi

Morbid concretions, or calculi, appeared in the lungs, bladder, uterus, intestines, and in other organs. Calculi were of concern to physicians, surgeons, and chemists at the turn of the nineteenth century, as all three occupations found themselves incapable of successfully curing patients suffering from stones. Any helpful insight was embraced with desperate optimism. Chemistry was viewed by stumped practitioners as a new investigative tool as the chemical knowledge produced in the wake of the Chemical Revolution seemed to offer another approach to a perplexing problem. Analytical chemistry emphasized decomposition, or the chemical reduction of compounds into elements. Chemists and physicians analyzed calculi in order to determine what the stones consisted of in order to find effective solvents and develop theories of why calculi formed. The goal was to complete a chemical taxonomy of calculi, and then to develop a variety of treatments based on that taxonomy.

Calculi also functioned as boundary objects, and therefore spurred questions that overlapped the healing and scientific disciplines. Understanding and treating calculi led to a development of intellectual, and occupational, prestige as physicians, chemists, and surgeons published their findings. Eventually, chemistry became their common tool and

language, allowing them to interpret stones and intervene in the body. However, even as chemical knowledge about stones increased, patients continued to suffer.

Physicians and surgeons described the harmful effects of calculi using the language of humoral pathology. Patients suffered from imbalanced fluids, namely they had too much or too little urine or the flow of bile was blocked. It was thought that the body's internal fluids were not circulating correctly because a calculus was blocking their flow. Physicians thought humoral language was the most productive way to discuss calculi in the body, as there was a lack of a separate or clearly defined theory explaining why stones formed, and how to treat them. Humoral pathology explained disease as an imbalance of the body's fluids, or humors. These "humors" originally included blood, phlegm, yellow and black bile, but the language of humoral pathology was extended to all of the body's fluids, including urine. Blocking the natural flow of fluids was dangerous for the whole body and the effects of blockages cascaded through the body.

Humoral medicine was not, nor had it ever been, static. The basic premise of humoral medicine remained crucial to the communities of physicians, medico-chemists, and surgeons in the nineteenth century: that is, the need for balance. Past determinations of balance, primarily measurements of how much fluid there was, or how the fluid appeared, were now not the only indicators of an imbalance. Developments in chemistry allowed for even more exploration regarding balance; namely, the quantities of different elements within the fluids themselves. Examining bodily fluids could indicate when a stone was present in the patient, even if the patient appeared asymptomatic. Exposing urine, for example, to chemical analysis alerted the physician that a urinary, bladder, or kidney stone was forming as some stones were believed to be a result of excessive acid in

the urine. Physicians, using a humoral approach, gave the patient recommendations intended to reduce the amount of acid in the urine.

Physicians initially embraced the idea that when a patient ingested a substance that substance did not change, and so theoretically a medication could be administered orally and reach the stone to dissolve it. The idea that substances did not change in the body was one aspect of humoral theory that had been previously dismissed due to a lack of evidence. However, medico-chemists were able to detect the presence of medicines in the urine, which re-validated the theory. It would take robust taxonomies and close scrutiny of bodily fluids in order for physicians, surgeons, and chemists to determine which chemical medicines could treat calculi.

7.2 Overarching Thesis and Claims of this Dissertation

This dissertation argued that the discussions of calculi at the turn of the nineteenth century involved the integration of analytical chemistry into medicine at that time, and that debates about both the nature and treatment of stones were framed in terms of humoral pathology. The diversity of stones, and the fact that no one occupation had a monopoly on medical and chemical knowledge related to stones, made it easy for that knowledge to transcend the intellectual boundaries between surgery, medicine, and chemistry. However, each set of actors wanted to investigate and understand calculi for their own ends, with the common and transcendent goal of relieving patient suffering. Calculi straddled the boundaries of each trade, and in some cases extended those boundaries.

The historical actors were part of a pre-professional landscape, and while they were privileged citizens who populated elite circles, there was no clear hierarchy of the medical, surgical, or even chemical occupations.⁸⁴⁵ These individuals were able to work without conflict with other practitioners studying calculi. Societies were open to most any white, literate and educated male interested in the study of medicine, surgery, or chemistry. Practitioners often had multiple affiliations and used different investigative strategies to study stones. The fact that these three major disciplines were focused on determining a better understanding and treatment of stones highlights the importance of the problem. These cross-occupational discussions, which took place in intellectual societies or were published in journals, reveal the importance of calculi as both medical and scientific objects of great interest.

7.3 Surgery

Surgical interventions for calculi were a source of pride, as surgeons were the only practitioners that could provide a true cure for the sufferer. The education of surgeons included learning the types of stones that patients presented with, and surgeons eagerly acquired more chemical knowledge in order to better educate surgical students.

While the main surgical intervention to successfully remove a calculous was a lithotomy,

⁸⁴⁵The rich literature of professionalization was addressed in the introductory chapter of this dissertation. For other sources see Toby Gelfand, *Professionalizing Modern Medicine: Paris Surgeons and Medical Science and Institutions in the 18th Century* (Westport, Connecticut: Greenwood Press, 1980) and Joseph M. Gabriel, *Medicinal Monopoly: Intellectual Property Rights and the Origins of the Modern Pharmaceutical Industry* (Chicago: University of Chicago Press, 2014). Also see Jeremy A. Green, *Prescribing by the Numbers: Drugs and the Definition of Disease* (Baltimore: Johns Hopkins University Press, 2008) and *Generic: Unbranding of Modern Medicine* (Baltimore: Johns Hopkins University Press, 2014).

these were risky procedures that often resulted in long-term complications, like urinary incontinence, reproductive damage, and in many cases, even death. Chemical interventions that could shrink the stone prior to a lithotomy were appealing to surgeons and promised to increase overall success rates of lithotomies. The hope of surgeons like Astley Cooper was that a stone could be shrunk using chemical solvents to such a size that the surgeon could then manually extract it, and avoid performing a lithotomy which required cutting. Other surgeons were skeptical that chemistry would provide a cure, but still agreed that chemical interventions could offer a palliative measure, potentially explain why stones formed, and prevent future stones in individuals with a history of calculi.

Surgeons recognized calculi as phenomena that would allow them access to occupational prestige and legitimacy. This desire to make surgical practice more scientific explained why Astley Cooper frequently mentioned knowledge obtained through chemical analysis in his lectures. The desire to legitimize surgery intellectually led Cooper to jointly found the Medico-Chirurgical Society, which tried to establish a discursive space welcoming to both surgeons and physicians, and continue to participate in the Royal College of Surgeons, itself a developing professional group. Other surgeons published descriptions of calculi and their experiences treating difficult cases, and also participated in societies like the Medico-Chirurgical Society, often accepting leadership positions alongside their physician counterparts. Cooper and his peers participated in collaborative work examining strange and uncategorized stones.

Surgeons collected the materials that medico-chemists were eager to analyze in order to establish a comprehensive taxonomy of all the types of stones that presented in

patients. Engaging in chemical investigations related to stones provided intellectual capital for physicians as well as surgeons, as the ability to converse in chemical arguments made both groups more respectable in the eyes of their scientific peers. It also allowed for physicians and surgeons to cooperate and develop more treatments. Partnerships between physicians, like Alexander Marcet, and surgeons, like Astley Cooper, were established for mutual benefit. Cooper collected the calculi removed from his patients. The collections were decomposed chemically by Marcet and organized into categories of shared chemical composition. The Royal College of Surgeons desired to build a taxonomy for surgical reference and published a three volume listing of every type of stone that was known to exist in both man and animal. The Hunterian Collection, housed at the Royal College of Surgeons was established from the personal collection of John Hunter.⁸⁴⁶ The College built a grand museum where preserved organs, diseased bodily tissues, and skeletons could be displayed for students and fellows looking to increase or polish their practical knowledge. The Hunterian Museum was also a source of occupational prestige and was a physical bank of knowledge.⁸⁴⁷

7.4 Physicians

Calculi were challenging for physicians because they did not have effective remedies to eliminate stones. They also could not tell the patient why they were suffering

⁸⁴⁶ John P. Blandy, *The Royal College of Surgeons of England: 200 Years of History at the Millennium* (London: Royal College of Surgeons and Blackwell Science, 2000).

⁸⁴⁷ Paula Findlen, *Possessing Nature: Museums, Collecting, and Scientific Culture in Modern Italy* (Berkeley: University of California Press, 1996).

from the stone, whether the stone would terminate safely, and whether or not they would have another occurrence of the stone. Doctors were at a real impasse when it came to treating patients suffering from calculi. Physicians like Edward Darrell Smith combined the chemical and surgical approaches. Smith engaged with the literature of the Chemical Revolution, which emphasized the testing of chemical solvents on stones. He tested his own urine in a laboratory and analyzed his results using published accounts of the chemical makeup of urine. Smith then wrote a journal article about the best solvent to use if the reader thought they might be suffering from the early symptoms of calculi. Alternatively, the physicians Alexander Marcet and John Yelloly thought that a quantitative accounting of the frequency of stones would be a good first step in understanding why calculi occurred. Yelloly and Marcet determined a number of stone types by analyzing existing collections maintained by surgeons whom they knew socially. Then they calculated frequencies and tried to develop reasons as to why people suffered from stones based on external information, such as an individual's geographical location or lifestyle. Physicians were inspired by the Enlightenment desire to quantify as a means to understand phenomena.⁸⁴⁸

Doctors corresponded with each other and shared case studies that they deemed successful in the treatment of calculi. Physicians communicated anecdotes and research in dissertations, medical journals, and at society meetings. George Lehman, a medical

⁸⁴⁸For other works beyond those mentioned in the introduction of this dissertation, see the work of Lorraine Daston, *Classical Probability in the Enlightenment* (Princeton: Princeton University Press, 1988), Gerd Gigerenzer, *The Empire of Chance: How Probability Changed Science and Everyday Life* (Cambridge, UK: Cambridge University Press, 1989), and Theodore M. Porter, *The Rise of Statistical Thinking, 1820-1900* (Princeton: Princeton University Press, 1986)

student, constructed a robust dissertation concerning biliary stones, which included case studies and chemical analyses of stones, and his was not the only one. Societies served as discursive spaces where studies about calculi could be presented and debated. Physicians actively sought out knowledge about chemistry in order to broaden their ability to analyze stones that the patient passed. Some physicians, including Edward Darrell Smith, even left medicine to concentrate on chemistry full time.

7.5 Chemistry

Chemists were eager to understand calculi and complete their own analyses of stones in order to define the natural world and understand chemical processes surrounding diseases. Historically, chemists had wanted to understand why stones formed because their cause was utterly unknown.⁸⁴⁹ Eighteenth century chemists, including Carl Wilhelm Scheele, were eager to analyze calculi in order to understand their chemical properties. In his *Elements of Chemistry*, Lavoisier writes about his experiments on urine to determine the chemical properties of substances found in human and animal bodies.⁸⁵⁰ The first translated English edition was updated to include sections on the chemical analysis of stones for an audience that would be interested in reading about the newest information about their chemical properties. His audience would be the nineteenth century medico-chemists who would use Lavoisier's work to further develop their own questions and methods for understanding calculi.

⁸⁴⁹Chemists, and even alchemists had a long history of examining and thinking about the causes of stones. The writings of Paracelsus include discussions of stones. See the writings of Walter Pagel.

⁸⁵⁰See the introduction to this dissertation.

Medico-chemists like Alexis De Carendeffez and Alexander Marcet claimed that stones with the same chemical composition were related to each other, even though they could come from different parts of the body. Stones found in the lungs could potentially have the same chemical composition as those found in the bladder, and therefore could have a common cause. Chemists found themselves acting as researchers for physicians and surgeons, who eagerly awaited their findings. The information obtained from chemistry was enticing for physicians and surgeons as they tried to integrate solvents into their treatments for patients.

7.6 Humoral Pathology

It is difficult to comprehensively discuss calculi at the turn of the nineteenth century without laying out theories of humoral pathology, and it is hard to historicize calculi without investigating what turn of the nineteenth century physicians, surgeons, and chemists believed about humoral pathology. Explanations of why calculi formed were rooted in theories about the body's fluids. Physicians, surgeons, and chemists all attempted to understand why changes in bodily fluids produced calculi. Investigators saw commonalities in their studies of the body's fluids to past discussions of the humors. They explained bodily fluids and their relationship to disease through what they considered humoral theory, later called "humoral pathology" because "pathology" referred specifically to disease. While humoral theory has always been a dynamic theory, without a simple or timeless coherence, its basis was and has remained an interest in balance. Balance of the humors of the human body, balance of the temperaments, and balance in the earthly environment. The relationship of calculi to the bodily fluids, and to

disease, can be understood through humoral pathology as a double cause and effect. The causes of calculi relate to an imbalance of elements within the fluids of the body, and calculi could then cause diseases due to altering the amounts of fluid circulating through the body, primarily through blockages. Benjamin Rush wrote specifically about the cause and effect relationship between the fluids of the body and calculi: “The NEPHRITIC state of fever is often induced by calculi, but it frequently occurs in the gout, small-pox, and malignant states of fever.”⁸⁵¹ Calculi could cause constitutional problems and therefore affected the whole body. Blockages of bodily fluids caused the body to be in flux, and, in turn, caused disease. Bodily fluids becoming imbalanced through some external or internal force was at the root cause of disease, however, developments in chemical analysis also demonstrated that an imbalance of the elements that made up bodily fluids could also cause calculi, diseases, and other problems.

By 1861 humoral pathology had become incorporated as a subset of the definition of pathology. William Thomas Brande published a *Dictionary of Science and Literature*, along with the Reverend George W. Cox. Under the heading of pathology, humoral pathology was annotated,

An important branch of pathology is that which treats of diseases of the fluids of the body, and more especially of the disordered states of the blood and the urine (humoral pathology). This science has made rapid strides during the last half

⁸⁵¹Benjamin Rush, *Medical Inquiries and Observations*, Volume IV (Philadelphia: Mathew Carey, 1809), 171. This quotation came from the third edition.

century, owing chiefly to the advance of animal chemistry, and to the application of the microscope in the examinations of diseased secretions and excretions.⁸⁵²

Humoral pathology was a mode of thinking that was useful in the investigation of calculi, as an imbalance, or “disordered state,” of bodily fluids was causing stones, and those stones could in turn cause other diseases.

7.7 Humoral Pathology, Calculi, Chemistry, and Medicine

The excitement concerning analytical chemistry and the desire to understand calculi has not received adequate study. Historians of chemistry have engaged in a robust discussion about the nature of the Chemical Revolution.⁸⁵³ But the historiography of the Chemical Revolution has not yet offered an analysis as to why physicians, surgeons, and

⁸⁵²William Thomas Brande and Reverend George W. Cox, ed. *A Dictionary of Science, Literature, & Art*, Volume III (London: Longmans, Green, and Co., 1866), 835. The dictionary also defines humoral pathology on page 155, “The doctrine which refers disease to a morbid condition of the humours or fluids of the body, as opposed to *nervous pathology*, which refers them to the nervous energy resident in the solids.”

⁸⁵³This has been an interesting discussion in the historiography of chemistry; see Evan M. Melhado, “Chemistry, Physics, and the Chemical Revolution,” *Isis* 76 (1985): 195-211, Arthur Donovan, *Lavoisier and the Origins of Modern Chemistry*, *Osiris* 4 (1988): 214-241, Robert Siegfried, “The Chemical Revolution in the History of Chemistry,” *Osiris* 4 (1988): 34-50, Mathew Daniel Eddy, Seymour H. Mauskopf, William R. Newman, “An Introduction to Chemical Knowledge in the Early Modern World,” *Osiris* 29 (2014): 1-15, John G. McEvoy, “Continuity and Discontinuity in the Chemical Revolution,” *Osiris* 4 (1988), 195-213, Arthur Donovan, “Lavoisier as Chemist and Experimental Physics: A Reply to Perrin,” *Isis* 81 (1990): 270-272, Federic L. Holmes, “The ‘Revolution in Chemistry and Physics,: Overthrow of a Reigning Paradigm or Competition Between Contemporary Research Programs?” *Isis* 91 (2000): 735-753, and Paul Thagard, “The Conceptual Structure of the Chemical Revolution,” *Philosophy of Science* 57 (1990): 183-209, and C. E. Perrin, “Chemistry as Peer of Physics: A Response to Donovan and Melhado on Lavoisier,” *Isis* 81 (1990): 259-270. Also see the introduction of this dissertation and John G. McEvoy’s book mentioned in the introduction of this dissertation as well.

chemists were all interested in analyzing calculi. The emphasis on calculi began in analytical work shortly after Lavoisier and continued well into the nineteenth century. Analytical tools that emerged from the Chemical Revolution were brought to bear on patients suffering from calculi in America and Britain.

The developmental trajectory of humoral pathology across the centuries has not been mapped out and is not well understood, and it belongs to a complex, dynamic, and even longer legacy of humoral theory across millenia. Studying the chemical analysis of calculi reveals why and how an older theory of medicine could break new ground and gain intellectual traction. An examination of the analyses of calculi also shows how medical theories can seemingly break down, but fragments and elements endure when paired with new evidence or methods.

Calculi are objects that easily cross disciplinary boundaries and focusing in on them historically reveals how chemists, surgeons, and physicians investigated a painful and difficult health problem at the turn of the nineteenth century. Studying how each community treated and studied calculi reveals much about their investigative processes. Calculi brought communities together to cooperate on understanding the causes and types of stones in order to develop courses of treatment. Overall, calculi allowed members of apparently distinct communities to collaborate and engage with each other's work. The study of calculi helped spur a small intellectual revolution in medicine. It brought about a revival of humoral thinking about the relationship between the body's fluids and disease, which was dependent upon new developments in chemical analysis. What emerged from the chemical study of the body's fluids was a laboratory of humoral pathology based on attempting to understand not only the potential imbalances of the fluids in the human

body, but also the potential imbalances of the elements within the fluids themselves. Vestiges of this remain in medicine in today's simple CBC, or complete blood count, which measures the components and features of the blood as a means to review one's overall health and seek any underlying medical conditions.

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