Edinburgh and *Vibrio cholera* in the 19th Century

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Dedication

To my mother … the 'perpetual student' may finally be finished ….

I would like to express my thanks to Drs. Colin Nicolson and Jacqueline Jenkinson for their support during this project. I would also like to thank my reviewers Mr. Jacques Kerr and (soon-to-be-doctor) Rebecca Main for their helpful critiques and comments.

Additionally, I would like to thank my Viva reviewers whose comments, both critical and supportive provided for a much better final thesis.

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I appreciate all of your efforts and patience.

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Abstract

The battle against cholera in various British towns as well as the terror from this disease has been the topic of multiple, academic papers and books. All provide historical accounts of the varying efforts both to understand and ultimately stop the dreaded epidemics that seemed to elude medicine, science, society and government. However, many of these historical works may not fully appreciate the complexities of the disease of cholera and the causative bacterium *Vibrio cholera*. Particular amongst these are the full extent of *Vibrio's* abilities to change, hide and adapt; the subsequent effect on understanding the varying theories of cholera infection that were present in the 1800s; questions about the methods used by doctors and if they were, indeed, 'quackery' or actually effective; societal changes regarding an understanding of the poor and their role in assisting the poor for the betterment of all and, finally, governmental efforts to contain and/or avoid the disease via public health measures.

This thesis will address theses matters with a more thorough examination of the complex biology of *Vibrio cholera*, a better understanding of 'infection' and how it fostered these theories, a re-thinking of the medical principles behind the various treatments, an appreciation for the cause for and history of an altered attitude by the upper classes regarding poverty and the emergence of both governmental powers but also the will to use them in increasing public health efforts. While focusing on Edinburgh's fight against cholera including an indepth look at the 1866 epidemic that struck the city, this thesis will also attempt to readdress the question asked by all the preceding authors: what actually helped to stop cholera epidemics in Edinburgh as well as the rest of Britian and most of the rest of the world?

Introduction to Cholera and its Epidemics

Defeating Cholera in the 19th Century?

The word 'cholera' is believed to be derived from the Greek chole (χολή) meaning bile and rein (ροή) meaning flow or, probably more directly, from the Greek word cholera (χολέρα) meaning gutter in reference to the copious flow of diarrhoea like rain in a gutter.[1] Several diseases that cause abdominal pain, vomiting and diarrhoea have been labelled throughout history as 'cholera' (instead of the more generic 'gastroenteritis') although the term 'cholera' is now exclusively used for the disease caused by infection by the bacterium *Vibrio cholerae*.[2] There is abundant evidence, including texts in ancient Sanskrit, that the disease of cholera has been endemic in India for two to three thousand years although more recent studies indicate it could have been present in other parts of Asia before that time. It is generally believed that cholera spread from the Indian subcontinent in the 19th century via increased trade and military movements and India is the almost certain source of the four epidemics that struck the UK and other parts of the world.[3] In total, seven, major, cholera epidemics have been noted, including one still ongoing in the present day.[4]

The disease of cholera produces symptoms including almost uncontrollable rice-water diarrhoea, cramping and severe abdominal (and often muscular) pains, coldness and blue skin colour and shrunken features (Figure I-1). However, it is the often rapid, indiscriminate and apparently random ways that cholera attacks its victims that have produced terror around the world.[5] Rich and poor, old and young, healthy and unhealthy, clean and unclean, god-fearing or heathen, cholera could strike and kill all equally and from the 1830s to the 1860s, no one could seemingly stop it.

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[1] E.E. Mazokopakis, "Cholera in the Corpus Hippocraticum," *Arch Hellen Med* 2021, no. 12 October, 2022 (2019), https://www.mednet.gr/archives/2019-6/830abs.html; Antonis A. Kousoulis, "Etymology of Cholera," *Emerging Infectious Diseases* 18, no. 3 (2012), 540; R. R. Colwell, "Global Climate and Infectious Disease: The Cholera Paradigm," *Science* 274, no. 5295 (1996), 2025.

[2] C. Hamlin, *Cholera: The Biography*, Biographies of Disease (Oxford; New York: Oxford University Press,, 2009), 19.

[3] E.T. Ryan, "Eyes on the Prize: Lessons from the Cholera Wars for Modern Scientists, Physicians, and Public Health Officials," *American Journal of Tropical Medicine and Hygiene* 89, no. 4 (2013), 610.; R. J. Morris, *Cholera, 1832: The Social Response to an Epidemic*, Croom Helm Social History Series (London: Croom Helm, 1976), 21.

[4] Ryan, "Eyes on the Prize: Lessons from the Cholera Wars for Modern Scientists, Physicians, and Public Health Officials", 610; S.M. Kavic, E.J. Frehm, and A.A. Segal, "Case Studies in Cholera: Lessons in Medical History and Science," *Yale Journal of Biology and Medicine* 72, no. 6 (1999), 396-397; Colwell, "Global Climate and Infectious Disease: The Cholera Paradigm", 2025; T. Ramamurthy and S.K. Bhattacharya, "Chapter 1. General Introduction," in *Epidemiological and Molecular Aspects on Cholera: Infectious Disease*, ed. T. Ramamurthy and S.K. Bhattacharya (New York, NY: Springer New York, 2011), 1-4.

[5] I.W. Sherman, "Cholera," in *Twelve Diseases That Changed Our World* (Washington, DC: ASM Press, 2007), 33; Morris, *Cholera, 1832: The Social Response to an Epidemic*, 16.

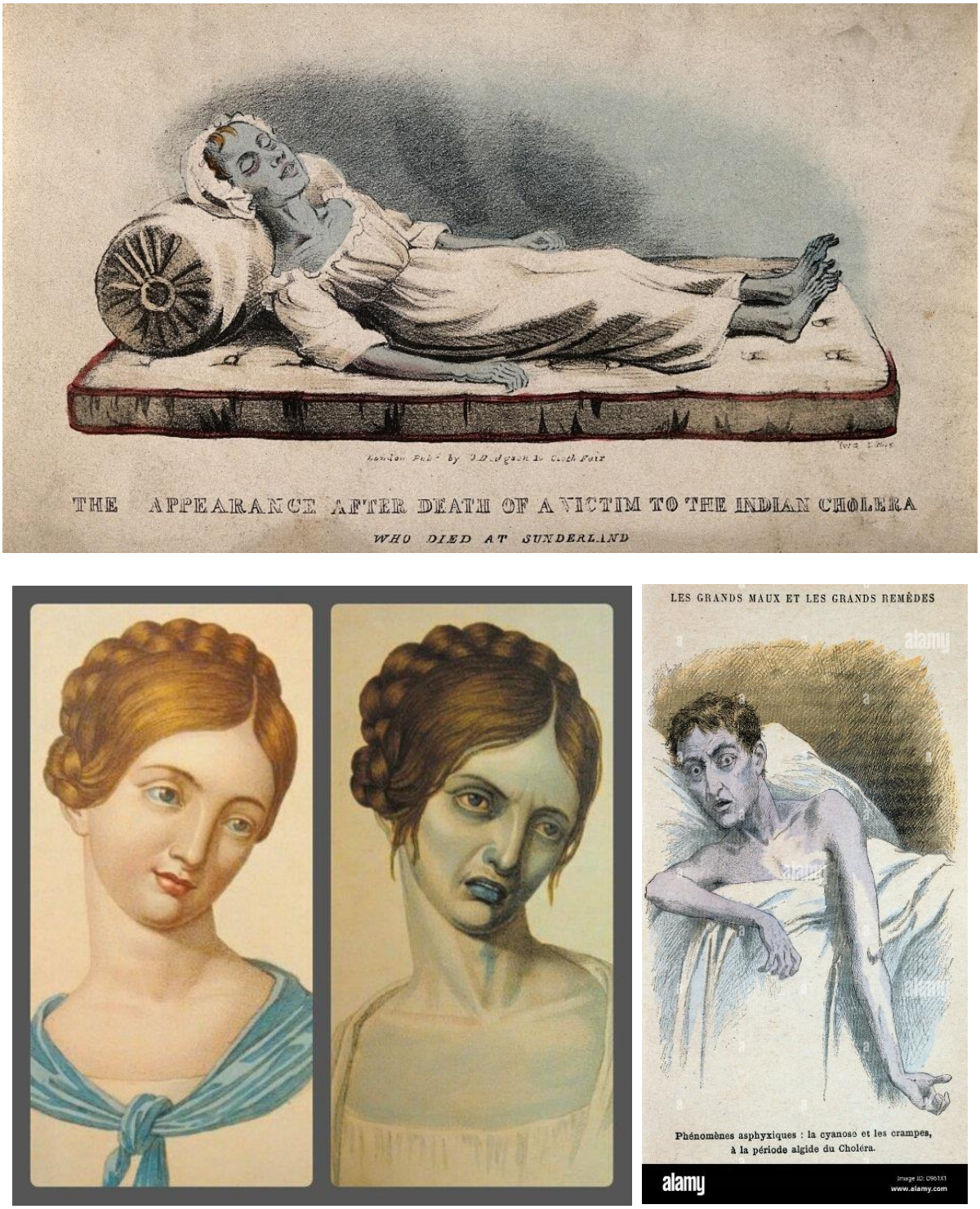

Figure I-1. Examples of Contemporary Lithographs of 'Blue' Cholera Patients.[6]

[6] A. Faherty, "Part 4. The Colonist Who Faced the Blue Terror," Wellcome Collection, https://wellcomecollection.org/articles/WsT4Ex8AAHruGfWj, Accessed 5 Mar, 2023; R. McNamara, "The Cholera Epidemic of 1832 (Ann Ronan Pictures/Print Collector/Getty Images)," ThoughtCo., https://www.thoughtco.com/the-cholera-epidemic-1773767, Accessed 5 Mar, 2023.

Several authors present a history of a multi-factorial response to try to defeat cholera, some successful and some not.[7] All the authors address in varying ways the complexities of the scientific and medical aspects; the financial, political and social support; the govenmental programs and the efforts by officials and individuals during the four, British, cholera epidemics. For this thesis, Morris's saga of failure in Sunderland (as well as intermittent successes in other British towns and cities), Cawood and Upton's tale of cooperation and success in Birminham and, finally, Shapter's unique acount of Exeter's epidemic as an 1800s physician via contemporary official and unofficial publications provide representative examples of the spectrum of efforts by cities in Britain and the rest of the world.[8] Hamlin, Irwin, Thomas, Pollitzer and Rosen, among others, provide a more general review of the British and worldwide efforts while Gilbert and Dingwall provide insight into the medical struggle in England and in Scotland, respectively.[9]

But, as Morris writes, 'Science, especially medicine and statistics, even the skills of theology and morals, were turned endlessly on the problem – all produced a chaos of ill-sorted fact and theories supported more by assertion than evidence.'[10] This counterplay between all these factors actually make the separate, excellent histories of Sunderland, Birminham and Exeter and, indeed, other towns' fights against cholera very, very similar despite differing specific results. Failures or successes of these responses are seen to be directly related to the uncooperative versus cooperative nature of this relationship of each town. The conclusions of each of these authors appear well justified and, in many ways, directly relatable to any other town or city suffering the ravages of cholera, including Edinburgh. However, there seems to be a missing piece or pieces in those works that, although not dramatically changing any of the conclusions, does potentially taint a story that is not quite complete, not quite appreciated and not quite fully understood.

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[7] C. Hamlin, "'Cholera Forcing' the Myth of the Good Epidemic and the Coming of Good Water," *American Journal of Public Health (1971)* 99, no. 11 (2009), 1946-1954; *Cholera: The Biography*; Sherman, "Cholera", 34; A.J. Thomas, "An Ancient Disease," in *Cholera - the Victorian Plague* (Barnsley, South Yorkshire: Pen & Sword History, 2020).

[8] Morris, *Cholera, 1832: The Social Response to an Epidemic*, 1-228; I. Cawood and C. Upton, "Divine Providence: Birmingham and the Cholera Pandemic of 1832," *Journal of Urban History* 39, no. 6 (2013), 1106-1124; T. Shapter, *The History of the Cholera in Exeter in 1832*, [1st ed. reprinted] / with a new introduction by Robert Newton. ed., Urban History Series (Wakefield: S.R. Publishers, 1971), 1-297.

[9] Hamlin, *Cholera: The Biography*; 33-47; A.J. Thomas, *Cholera - the Victorian Plague* (Barnsley, South Yorkshire: Pen & Sword History, 2020); R. Pollitzer, "Cholera Studies. 1. History of the Disease," *Bulletin of the World Health Organization* 10, no. 3 (1954), 421-461; G. Rosen, Fee, E. & Morman, E.T., *A History of Public Health* (Johns Hopkins University Press, 1993), 251-254, 261-266 & 295-296; J.G. Hanley, "Cholera and Nation: Doctoring the Social Body in Victorian England (Review)," (Baltimore: Johns Hopkins University Press, 2009); H.M. Dingwall, *A History of Scottish Medicine: Themes and Influences* (Edinburgh: Edinburgh University Press, 2003), 165-166, 170-171 & 177.

[10] Morris, *Cholera, 1832: The Social Response to an Epidemic*, 17.

Beyond the abject fear, perhaps most evident in all of the histories about cholera is the relative confusion and resulting feeling of utter helplessness that people in the 19th century felt about the disease of cholera. Did these feelings come from a misunderstanding of how cholera affects its target host? Although many medical and scientific writers wrote about the disease mechanism, cholera always seemed to break any rules that were set. Did these feelings come from simply not yet knowing 'Germ Theory', the idea that infective elements like bacteria, viruses and fungi exist, or the fact that methods in what is now called public health were not yet developed? There were, in fact, many 'contagionists' who spoke and wrote about this very idea but, with cholera, they could never prove their point. Many looked at the filthy water and streets and lanes and houses as the cause but cholera came back even if the town was scrubbed with lime and the water was plentiful and pure. On the almost opposite end of the spectrum were the miasmatists, proponents of rotting, organic material and bad smells being the sole cause of cholera disease. But even when odorous, refuse dumps and dung hills were removed, cholera seemed to come and go as it pleased. Did the doctors' treatments cause more harm than good? At least according to their many reports, cholera seemed to respond quite well to these efforts, except when it did not.

Sunderland had its failure, Birmingham had its success, Exeter came out somewhere in the middle and in other places like London people died around the Broad Street pump. But why did cholera keep coming back even after lessons were supposedly learned and success could be claimed? What, in fact, defeated cholera in the 19th century? The answer is it was not. In fact, cholera is still raging in certain parts of the world in what is considered the seventh, worldwide, cholera epidemic. In just the year 2017, the World Health Organization developed yet one more effort to try to defeat cholera but, in 2020 alone, 323,369 cases with 857 deaths in twenty-four countries were still recorded. In 2023, WHO reported on yet more outbreaks of cholera in the world.[11] We now know which bacterium causes cholera, have multiple treatments (both prophylactic and curative) against bacteria in general, methods to insure clean and sanitary water and proper collection and elimination of refuse and proper handling of human waste (although admittedly not available to all) and governmental and private agencies to monitor public health throughout the world (and try to respond to any acute crises). But the disease of cholera rages on and seems to be only contained (barely).

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[11] WHO, "Cholera" (30 Mar, 2022, https://www.who.int/news-room/fact-sheets/detail/cholera#:~:text=During%20the%2019th%20century%2C%20cholera,and%20the%20Americas%20in%201991, Accessed 12 Aug, 2023; WHO, "Disease Outbreak News; Cholera - Global Situation (1 Feb, 2023)," https://www.who.int/emergencies/disease-outbreak-news/it,em/2023-DON437, Accessed 24 Jun, 2023; "Cholera Annual Report 2020," in *Weekly Epidemiological Record 37* (2021), 445-460.

So, what is missing in the previous histories? What is it about cholera that we do not yet understand? What will it take to defeat the disease? Or is that even possible? Perhaps we need to look again at cholera, its bacterium and how it lives, thrives and dies and what many of the efforts, successful and unsuccessful, actually did in the 19th century and even today. Only a few of the above historians, most notably Thomas and Hamlin, expound to any extent on some of the complexities of the bacterium and the disease.[12] So, while a few of these treatises have explored some of the scientific and medical complexities, another theme emerges from many works – that of a very misunderstood bacterium and, along with it, a 19th century, scientific and medical community.[13] And that, in turn, complicated (and complicates) society's views and responses.

First among these misconceptions is that cholera infections are solely about an unfortunate victims struck by a simple bacterium living in tainted water. In fact for some time, one problem faced by many of these communities, if not most of the United Kingdom and western world, was a denial of the very existence of cholera, or at least a deadly form.[14] As will be dicussed further in Chapter 1, *Vibrio cholera* and the disease of cholera are both extremely complex and complicated and trying to understand how the bacteria caused epidemic/pandemic disease requires more of an understanding than just a simple, human host and a bacteria in diarrhoea-polluted water.

Second is what the predominant theories of infection that were proposed and prominent in the 18th and 19th centuries actually meant in the context of this complex bacteria. Humours, miasma and contagion theories as well as ones involving the nerves, galvanism, elevation, and the wrath of God are all seen during this time.[15] Although most would suggest that 'infection' (but not 'contagion') ultimately won out and helped develop the current ideas of so called 'Germ Theory' and treatments thereof, this is a rather simplified view. In fact, a more comprehensive understanding of what was actually meant by 'humours' or 'miasma' or 'contagion' suggests that components of all three theories were in many ways correct. These main theories are discussed in Chapter 2.

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[12] Thomas, *Cholera - the Victorian Plague*, 129-161 & 191-203; Hamlin, *Cholera: The Biography*, 6, 12, 21, 25, 30-32, 35, 128, 147, 180-191, 196-197 & 248; Shapter, *The History of the Cholera in Exeter in 1832*, x-xi.

[13] Thomas, "An Ancient Disease", 19-28.

[14] Morris, *Cholera, 1832: The Social Response to an Epidemic*, 11-15 & 48-49; Shapter, *The History of the Cholera in Exeter in 1832*, 2-3; Hamlin, *Cholera: The Biography*, 34 & 49.

[15] H.L. Gibbs, "Observations on Cholera," *Edinburgh Medical and Surgical Journal* 36, no. 109 (1831), 395; W. Ainsie, "Observations on the Cholera Morbus of India," *Oriental Herald and Journal of General Literature* 6, no. 19 (1825), 160-161; J. Kennedy, *The History of the Contagious Cholera with Facts Explanatory of Its Origins and Laws and of a Rational Method of Cure* (London: Waterloo-Place, Pall-Mall: James Cochrane and Col, 1831), 1-39; W. Cowper, "Epidemic Cholera," *Edinb Med J* 3, no. 5 (1857), 472-473; Thomas, "An Ancient Disease", 18-23; Hamlin, *Cholera: The Biography*, 24-28, 71-78, 145, 152-162 & 255-266; Pamela K Gilbert, *Cholera and Nation: Doctoring the Social Body in Victorian England* (Albany, New York: State University of New York Press, 2008), 17-28.

Third, there is also a need to understand the basis for the various medications and treatments that were being tried when, indeed, they could have been efficacious. With regards to medical treatments used by physicians in the 1800s, there are several prominent, probably unfounded, criticisms in the literature. Howard-Jones, in an otherwise stellar review of cholera treatments, starts his article by saying, 'In the whole of the history of therapeutics before the twentieth century there is no more grotesque chapter than that on the treatment of cholera, which was largely a form of benevolent homicide.'[16] Sherman writes of 'a variety of nostrums and quack remedies'.[17] Hamlin notes that 'Poisoning is an ugly word, but medical intervention probably did contribute to many cholera deaths.'[18] Thomas talks about the relative ineffectiveness of brandy and other alcoholic means to treat cholera patients.[19] But, most, if not all, of the treatments had some kind of scientific and/or medical basis and reports of their good effect(s), including some possibly being curative, cannot be discounted or disregarded. Importantly, these were the only treatments available and, in fact, 21st century medicine has not yet added much more to the treatment of cholera. The medical treatements employed during the four, 1800s, cholera epidemics will be covered in Chapter 3.

Although abundantly discussed in previous, historical works, the role of emerging public health discussed in Chapter 4 is also important. The now commonplace concepts of clean air and water, plentiful light, efforts to combat overcrowding, and the proper handling of refuse, airborne pollution and sewage or tainted water were then in their infancy. While this thesis will not attempt to simply repeat these historical reviews, it will endeavor to examine the progression, spurred on in a great part by infections like cholera and other infective diseases, of these basic public health principles along with societal and government development and advancement in Great Britain, Scotland and specifically Edinburgh.[20]

Edinburgh and Cholera in the 19th Century

In the 1830s a pandemic of cholera spread throughout the world and, for the first time, reached the UK, including Edinburgh. The city suffered three more epidemics in 1848/49, 1853/54 and, finally, 1866. With the exception of a fairly short, website summary and an excellent albeit unpublished high school report, no one has looked specifically into Edinburgh's cholera

[16] N. Howard-Jones, "Cholera Therapy in the Nineteenth Century," *Journal of the History of Medicine and Allied Sciences* 27, no. 4 (1972), 373.
[17] Sherman, "Cholera", 47.
[18] Hamlin, *Cholera: The Biography*, 84-85.
[19] Thomas, *Cholera - the Victorian Plague*, 31-59.
[20] D.L. Taylor et al., "The Impact of Water, Sanitation and Hygiene Interventions to Control Cholera: A Systematic Review," *PloS One* 10, no. 8 (2015), e0135676-e0135676.

experiences.[21] With the impact of the Scottish Enlightenment which gave it the title 'Athens of the North', the fame of its medical school and community, a somewhat unique geography that includes several types of water sources, as well as notable promotors of public health concepts such as William P. Alison, Henry Littlejohn and William Chambers, among others, Edinburgh could be expected to provide an additional, important insight into how these changes worked together to help end cholera epidemics in Britain after 1866. To address the question of how Edinburgh put an end to cholera afflicting the city more directly, a detailed examination of the 1866 epidemic through an analysis of death certificates and other specific data is the subject matter of Chapter 5.

Thus, this thesis will be a critical re-examination of the cholera bacterium, concept of cholera infection and disease theories and the progressive efforts in Edinburgh for all four cholera epidemics that struck the city from 1832 to 1866. But this thesis is not intended to be simply a discussion of the science and medicine of cholera. It is also a re-examination of how the people in these communities, with specific focus on Edinburgh, lived, died, succeeded, failed, thought, fought and endured during those four epidemics. More importantly, though, an increased understanding of the disease and its history will help further illustrate how a myriad of complexities of a disease called cholera confounded theories, proposals, efforts and treatments by individuals and groups in Edinburgh who gradually found the answers and means to at least control cholera.

[21] J. Hamilton, "Edinburgh's Epidemics of the 19th Century," WS/The Signet Library, https://www.wssociety.co.uk/features/edinburghs-epidemics-of-the-19th-century, Accessed 24 Nov, 2021; M. L. Campbell, "Cholera in Nineteenth Century Edinburgh," (Edinburgh: Boroughmuir High School, 1983).

Chapter 1. The Science of Cholera Infection

A Short Introduction

Despite the disease cholera and the causative bacterium *Vibrio cholera* persisting for thousands of years with the first European pandemics occurring almost two hundred years ago, much is still unknown about this very complex organism and the way it produces the disease.[22] Indeed, the classical model of is single-cell bacterium with one, 'tail' flagellum (Figure 1-1) infecting the human digestive tract and secreting a toxin that leads to copious production of rice-water diarrhoea is a far too simple one. *Vibrio cholera's* life-cycle, defences, multiple modes of pathology and varying methods of changing to match its environment present a fascinating example of the power of nature. This complexity partly explains why the disease of cholera was so difficult to observe, track, diagnose, treat and begin to combat in the 19th century and why the disease of cholera is still very much present today. More importantly, it is why the people who suffered through the epidemics in Edinburgh (and elsewhere) in the 19th century found the disease so difficult to understand and act against.

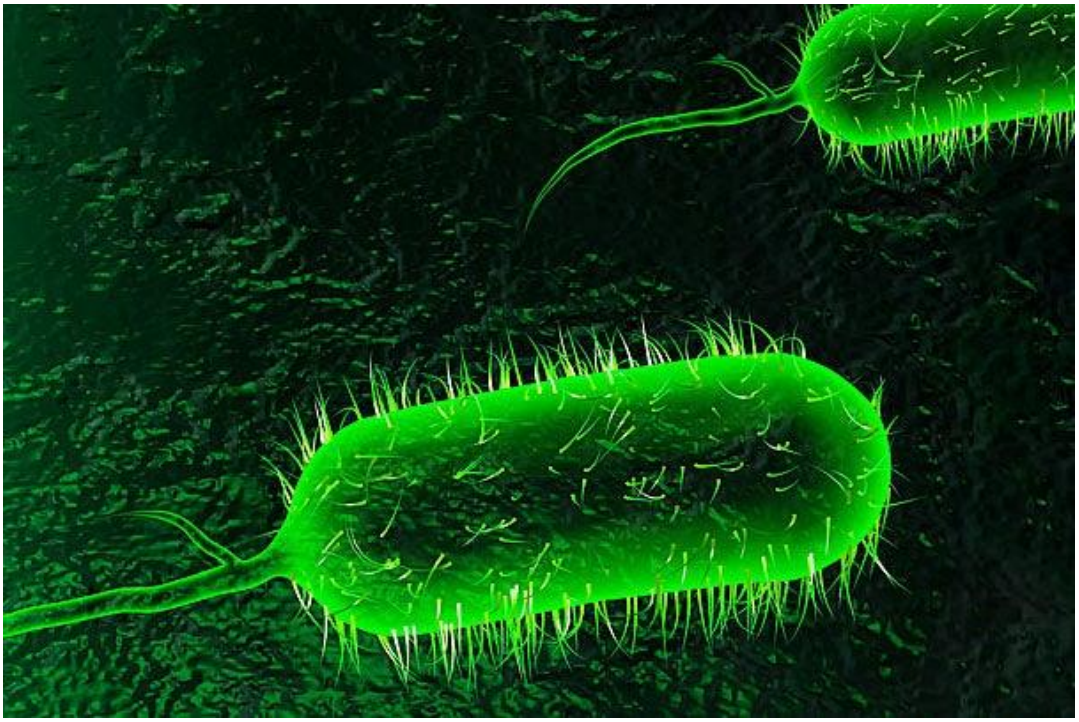

Figure 1-1. Electron Micrograph of *Vibrio cholera*[23]

[22] Pollitzer, "Cholera Studies. 1. History of the Disease", 421-461; Thomas, "An Ancient Disease", 15-30.
[23] Taken from R. Neal, "Cholera Strain Tied to South Asia," *Harvard Medical Gazette: Health and Medicine* (2010).

The bacterium was first isolated and identified by the Italian scientist and physician Filippo Pacini in 1854 who bestowed the name of '*Vibrio'* (Latin for 'quivering') due to its flagellum-driven motility.[24] Pacini did not have the means to publicise his discovery widely and the world as a whole would have to wait for 1884 when Robert Koch's well-financed team separately isolated the bacterium. Koch termed the name *kommabazillen* (comma bacteria) due to its classic comma-like shape although he later changed it to *Vibrio cholera* in deference to Pacini's earlier discovery.[25]

Vibrio cholera is categorised based on large, complex, sugar molecules (the 'O-antigen') on its surface which help binding of the bacteria to intestinal cells.[26] There are four, O-antigen types but only the O1 (or 'Classical') and the non-O1/non-O139 (a large, varied, collection of 'other' O-antigen types; hereafter, 'non-O1/O139') are considered to have been present during the worldwide pandemics of the 1800s.[27] Studies have shown that an infection by one type does not provide any significant, immunological protection against another type.[28] As such, for this historical examination of the Edinburgh cholera epidemics only the O1 and non-O1/0139 types are considered.

Overall Pathology of *Vibrio* Infection

Vibrio cholera is classically considered to be transmitted from host to host by a faecal-oral route, that is ingestion of any substance, especially water, contaminated with faeces that contains *Vibrio*.[29] The bacterium travels through the stomach to the small intestine and initially attaches to but does not invade the outer layer of cells via the aforementioned O-antigen. The bacterium then secretes a protein called 'Cholera Toxin [CT].[30] CT binds to specific, sugar molecules on the intestinal cell and, after being internalised into that cell, activates two enzymes that leads to a blockage of absorption of the body salts [ions] sodium [Na^+] and potassium [K^+] into the cell and a marked increase of

[24] Kavic, Frehm, and Segal, "Case Studies in Cholera: Lessons in Medical History and Science", 397; Ryan, "Eyes on the Prize: Lessons from the Cholera Wars for Modern Scientists, Physicians, and Public Health Officials", 611.

[25] R. Koch, "An Address on Cholera and Its Bacillus," *Brit. Med. J.* 2 (1884), 611.

[26] J.J. Mekalanos, "Chapter 6. The Evolution of Vibrio Cholerae as a Pathogen," in *Epidemiological and Molecular Aspects on Cholera: Infectious Disease*, ed. T. Ramamurthy and S.K. Bhattacharya (New York, NY: Springer New York, 2011).

[27] The other two O-antigen types include El Toro (first seen in 1961) and O139 (first seen in 1992 and responsible for current, ongoing infections).

[28] A.K. Mukhopadhyay and T. Ramamurthy, "Chapter 2. Asiatic Cholera: Mole Hills and Mountains," in *Epidemiological and Molecular Aspects on Cholera: Infectious Disease*, ed. T. Ramamurthy and S.K. Bhattacharya (New York, NY: Springer New York, 2011).

[29] N.C. McNamara, *Asiatic Cholera: History up to July 15, 1892, Causes and Treatment* (London: MacMillan and Co, 1892), 45.

[30] Kavic, Frehm, and Segal, "Case Studies in Cholera: Lessons in Medical History and Science", 401-403; T. Ramamurthy et al., "Virulence Regulation and Innate Host Response in the Pathogenicity of Vibrio Cholerae, Ed. Jo Brzostek," *Front. Cell. Infect. Microbiol.* (2020).

secretion of chloride [Cl^-], bicarbonate [HCO_3^-] and water [H_2O] out of the cell.[31] Overall, a significantly increased secretion of ions and water out and a decreased (albeit to a lesser degree) absorption of ions and water into the small intestine cells results (Figure 1-2). Interestingly, Koch suggested in his 1884 presentation that cholera was caused by such a CT factor and not the bacterium itself although it would not be until 1959 that this was convincingly shown.[32]

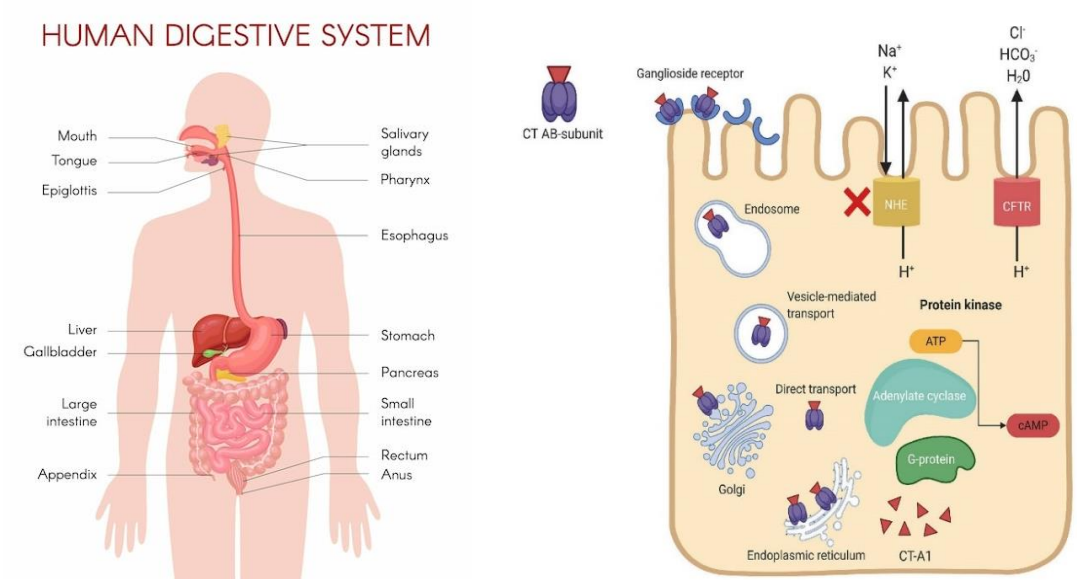

Figure 1-2. Overview of the Human Digestive System showing the stomach and small intestine where Vibrio cholera strikes (left) and the molecular pathology on the small intestine cell. Stylized, endothelial cell with top protrusions representing the cell surface of the inside of the intestine where sugars, proteins, fats, ions, etc are absorbed/secreted. Bottom of the cell is the location of absorption of nutrients, etc by blood vessels (not shown). Sides of the cell would be other, identical endothelial cells making the inner tubing of the intestine. Key: CT – Cholera Toxin, CT-A1 – Cholera Toxin A Subunits only, Sodium - Na^+, Potassium - K^+, Chloride - Cl^-, Bicarbonate - HCO_3^-, H^+ - Hydrogen, Water - H_2O, ATP – Adenosine Triphosphate, cAMP – cyclic Adenosine Monophosphate, NHE – Sodium/Hydrogen Exchanger, CFTR - Cystic Fibrosis Transmembrane Conductance Regulator.[33]

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[31] Ramamurthy, et al., "Virulence Regulation and Innate Host Response in the Pathogenicity of Vibrio Cholerae, Ed. Jo Brzostek"; Kavic, Frehm, and Segal, "Case Studies in Cholera: Lessons in Medical History and Science", 398-401.

[32] Ramamurthy et al., "Virulence Regulation and Innate Host Response in the Pathogenicity of Vibrio Cholerae, Ed. Jo Brzostek"; K. Walia and N.K. Ganguly, "Chapter 15. Toxins of Vibrio Cholerae and Their Role in Inflammation, Pathogenesis, and Immunomodulation," in *Epidemiological and Molecular Aspects on Cholera: Infectious Disease*, ed. T. and S.K. Bhattacharya T. Ramamurthy (New York, NY: Springer New York, 2011).

[33] Adapted from Freepik Company, "Digestive System," https://www.freepik.com/premium-vector/anatomy-human-digestive-organs-with-description-corresponding-functions-internal-organs-anatomical-illustration-flat-style-isolated-white-background_16501112.htm#query=digestive%20system&position=25&from_view=keyword&track=ais, Accessed 29 Aug, 2023; Ramamurthy et al., "Virulence Regulation and Innate Host Response in the Pathogenicity of Vibrio Cholerae, Ed. Jo Brzostek".

The net result is the secretion of copious amounts of fluids (water and ions) by the infected cells, often with white flecks that has led to the cholera-defining term 'rice-water diarrhoea.' Studies have shown that from fifteen to twenty litres of fluid a day may be secreted with initial losses sometimes exceeding a litre an hour. The colon can only absorb up to four to six litres of water a day and is, thus, overwhelmed by the effects of cholera resulting in an 'overflow diarrhoea.' If untreated, this diarrhoea and the associated losses can lead to death.[34] An inflammatory reaction is also seen in the cell walls of blood vessels and may lead to leakage of red and white blood cells and plasma.

Not Just Watery Diarrhoea

Cholera patients do not solely suffer, as is often suggested, from 'dehydration', a deficiency of water, but rather from severe 'volume-depletion', the loss of water plus essential ions.[35] Although dehydration is serious, losses of the ions noted above adversely affect the body's energy production and muscular contraction (arms and legs, intestines, blood vessels and heart). In addition, low or high levels of potassium can directly lead to abnormal heart beats and death. Low potassium is known to be a direct result of cholera infections.[36] Finally, bicarbonate is essential for the regulation of the acid level in the body. The kidneys and lungs help eliminate acid by producing urine and eliminate bicarbonate by exhaling carbon dioxide. But, in a severely dehydrated and volume-depleted, exhausted, often semi-comatose, cholera patient, urine output is decreased and increased respiratory rates can usually only be sustained a short while. If these two methods of regulation of acid levels fails, a state of severe and possibly fatal acidosis (too much acid) can quickly develop.[37]

A Readily Changing Bacterium

Like viruses and some other bacteria, *Vibrio cholera* can readily change its DNA between other *Vibrio* bacteria as well as other organisms and may even have a 'storage place' for extra DNA it may need in the future. This ability to exchange DNA leads to a huge number of subtypes. In fact, approximately 250 subtypes of O1 *Vibrio* have now been defined.[38] Even more, non-definable

[34] Kavic, Frehm, and Segal, "Case Studies in Cholera: Lessons in Medical History and Science", 399-401.
[35] Ibid, 399.
[36] P. Dutta, D. Sur, and S.K. Bhattacharya, "Chapter 19. Management of Cholera," in *Epidemiological and Molecular Aspects on Cholera: Infectious Disease*, ed. T. Ramamurthy and S.K. Bhattacharya (New York, NY: Springer New York, 2011); Kavic, Frehm, and Segal, "Case Studies in Cholera: Lessons in Medical History and Science", 400.
[37] J.R. Ingelfinger, "From Alchemy to Fluid, Electrolyte, and Acid–Base Disorders," *New England Journal of Medicine* 371, no. 15 (2014), 1457-1458.
[38] R.R. Colwell, "Infectious Disease and Environment: Cholera as a Paradigm for Waterborne Disease," *International Microbiology* 7, no. 4 (2004); Mekalanos, "Chapter 6. The Evolution of Vibrio Cholerae as a Pathogen", 97-114.

subtypes exist as so-called viable but non-culturable [VBNC] forms – they exist in nature and are alive and well but cannot be grown in a laboratory.[39] VBNCs are seen in several bacteria but were first discovered in *Vibrio cholera* and are more prevalent in the O1-antigen type responsible for the 1800s epidemics.[40] They cause cholera disease either as VBNCs or after changing back to the O1 type.[41] The change back, called 'resuscitation', seems to be related to variations in seasons but also environmental parameters including temperature, the availability of nutrients, salinity (the amount of salt in water) and the amount of oxygen available, etc.[42] Besides the change to and from VBNCs, *Vibrio* can also readily change its DNA. This can be done in four, separate ways.

1. 'Integrating Conjugative Elements [ICE]': Small, self-transmissible pieces of DNA found in most *Vibrio* types inside and outside the laboratory and implicated in changes of the O-antigen molecule and in antibiotic resistance.[43]
2. 'Integrons': Pieces of DNA called found in several *Vibrio* types. These Integrons can be passed from *Vibrio* to *Vibrio* but also can be acquired from other bacteria and often provide antibiotic resistance or affect infectivity.[44]
3. 'Phages': Pieces of DNA from a virus that exists inside the *Vibrio* cell but outside the nucleus/DNA. Five different phages are believed to have directly led to the effectiveness of the CT and, therefore, the toxicity of the cholera bacteria.[45]
4. 'Plasmids': Small, circular pieces of DNA found in many bacterial species whose role is poorly understood but various *Vibrio* types can readily transfer plasmids between themselves offering another method to get new genes and their associated capabilities.[46]

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[39] Colwell, "Infectious Disease and Environment: Cholera as a Paradigm for Waterborne Disease"; Mukhopadhyay and Ramamurthy, "Chapter 2. Asiatic Cholera: Mole Hills and Mountains".

[40] A. A. Huq, C.J. Grim, and R.R. Colwell, "Chapter 18. Aquatic Realm and Cholera," ibid ; E.V. Monakhova, "Chapter 4. Phenotypic and Molecular Characteristics of Epidemic and Non-Epidemic Vibrio Cholerae Strains Isolated in Russia and Certain Countries of Commonwealth of Independent States (Cis)," ibid .

[41] A. Huq, Grim, and Colwell, "Chapter 18. Aquatic Realm and Cholera".

[42] Colwell, "Infectious Disease and Environment: Cholera as a Paradigm for Waterborne Disease"; A. Huq, Grim, and Colwell, "Chapter 18. Aquatic Realm and Cholera".

[43] S. Sozhamannan and F.H. Yildiz, "Chapter 8. Diversity and Genetic Basis of Polysaccharide Biosynthesis in Vibrio Cholerae," ibid ; V. Burrus, "Chapter 9. Significance of the Sxt/R391 Family of Integrating Conjugative Elements in Vibrio Cholerae," ibid ; Ramamurthy and Bhattacharya, "Chapter 1. General Introduction".

[44] Burrus, "Chapter 9. Significance of the Sxt/R391 Family of Integrating Conjugative Elements in Vibrio Cholerae"; Mekalanos, "Chapter 6. The Evolution of Vibrio Cholerae as a Pathogen"; A. Ghosh and T. Ramamurthy, "Chapter 17. Integron-Mediated Antimicrobial Resistance in Vibrio Cholerae," ibid .

[45] Colwell, "Infectious Disease and Environment: Cholera as a Paradigm for Waterborne Disease"; L. Williams et al., "The Role of Risk Perception in Reducing Cholera Vulnerability," *Risk Management (Leicestershire, England)* 12, no. 3 (2010).

[46] Burrus, "Chapter 9. Significance of the Sxt/R391 Family of Integrating Conjugative Elements in Vibrio Cholerae"; Ghosh and Ramamurthy, "Chapter 17. Integron-Mediated Antimicrobial Resistance in Vibrio Cholerae".

But more subtle changes in the O-antigen also serve another role for *Vibrio cholera*. These smaller changes in *Vibrio* help the bacteria evade detection by the human host's immune system (known as 'antigen switching') making it harder for the body to mount a defence against a cholera infection. The non-O1/O139 types also seem to play a specific role in this swapping of DNA (e.g., ICEs or Integrons), not necessarily as bacteria that cause disease but almost as a DNA library for use by its more virulent cousins. These changes are also strongly involved with production of CT.[47] Some of these means of DNA transfer (e.g., ICEs) also seem to be reversible (e.g., acquired antibiotic resistance seems to disappear after the offending antibiotic is gone).[48]

The result of all these methods is a 'pick-and-play' arrangement incorporating any number of genes from a variety of organisms *Vibrio* may need and discarding them when no longer needed. While this is readily seen in the bacterial world, *Vibrio* seems to have acquired multiple versions and fine-tuned its ability to utilise all of them. The many ways of using and discarding DNA helps to ensure the survival of least one bacterium to infect another victim. Edinburgh physicians/scientists were dealing with a bacterium that is not only difficult to characterise but that changes at any time in several ways. But *Vibrio's* complexity goes far beyond being able to switch DNA back and forth.

Flagellum, Pilus and Other Factors

Each *Vibrio* bacterium has a 'tail' flagellum for motility both outside and inside its host (Figure 1-1).[49] But beyond its function in movement, the flagellum is also a part of the infection and lifecycle process. *Vibrio* has five flagellum subtypes (most bacteria only have one) that all may cause their own inflammatory reaction in the host, including diarrhoeal symptoms, and may also help the bacteria 'hide' from the host's immune system.[50] *Vibrio* can also lose its flagellum and simultaneously turn off several genes that provoke the host's immune response thus allowing it to hide/escape. This form can also remain and 'colonise' a host to wait until an opportune moment (e.g., in response to environmental changes) to become infective again and spread. Studies show that the *Vibrio* that finally emerges in human stool is usually the tail-less, non-motile type. The exact roles of the different flagella subtypes (and their 'sheaths') are still under investigation.[51]

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[47] Sozhamannan and Yildiz, "Chapter 8. Diversity and Genetic Basis of Polysaccharide Biosynthesis in Vibrio Cholerae"; K.A. Syed and K.E. Klose, "Chapter 11. Vibrio Cholerae Flagellar Synthesis and Virulence," ibid, ed. T. Ramamurthy S.K. Bhattacharya .

[48] Ramamurthy and Bhattacharya, "Chapter 1. General Introduction".

[49] Mekalanos, "Chapter 6. The Evolution of Vibrio Cholerae as a Pathogen"; Syed and Klose, "Chapter 11. Vibrio Cholerae Flagellar Synthesis and Virulence".

[50] Mekalanos, "Chapter 6. The Evolution of Vibrio Cholerae as a Pathogen".

[51] S.M. Faruque, G.B. Nair, and Y. Takeda, "Chapter 7. Molecular Epidemiology of Toxigenic Vibrio Cholerae," ibid ; Syed and Klose, "Chapter 11. Vibrio Cholerae Flagellar Synthesis and Virulence".

A pilus (also known as a fimbrium) on a bacterium is a hair-like, protein appendage (Figure 1-1). These structures form an integral part of attachment and transfer of DNA between *Vibrio*, possibly through the previously described 'phages' mechanism. *Vibrio* probably has more than one type of pilus but one has been found to be particularly involved in efficient, CT action, making the pilus part of the infection. This same pilus is also involved in the non-infective, colonisation process described above. Finally, changes in pili/fimbria are thought to help allow release of the bacteria from the endothelial cell; once the infection is complete, the *Vibrio* can travel to the next host.[52]

Until recently, *Vibrio* disease was believed solely due to the actions of CT. Several other factors, produced by the bacterium at varying times and for varying purposes, are now known to also support virulence. One of these factors, creatively named 'Alarmone,' is expressed by *Vibrio cholera*, to sound 'the alarm' to help *Vibrio* survive stresses such as nutritional scarcity and may also assist the bacteria in going through the stomach's highly acidic environment. Other factors have proposed roles in *Vibrio's* pathology and lifecycle including facilitating CT, causing a milder diarrhoeal disease, modulating the host immune response and helping attachment/detachment from epithelial cells.[53]

The Emerging Importance of non-O1/O139 Types

It has been generally thought that only the O1 type could have caused the disease of cholera in the 1800s but even that is changing. Researchers now know that non-O1/O139 can both acquire the DNA necessary for infection and cause an epidemic-like, usually non-fatal diarrhoea (known as 'cholera-like diarrhoea'). Some of these non-O1/O139 types have specific, infective genes, including the virulent, CT genes and 'Other Factors' that can cause cellular damage.[54] However, antibiotic resistance seen in the O1 type is not prevalent in non-O1/O139 types.

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[52] Mekalanos, "Chapter 6. The Evolution of Vibrio Cholerae as a Pathogen"; M. Ehara and M.J. Albert, "Chapter 12. Filamentous Phages of Vibrio Cholerae O1 and O139," ibid .

[53] Walia and Ganguly, "Chapter 15. Toxins of Vibrio Cholerae and Their Role in Inflammation, Pathogenesis, and Immunomodulation"; Kavic, Frehm, and Segal, "Case Studies in Cholera: Lessons in Medical History and Science"; Ramamurthy and Bhattacharya, "Chapter 1. General Introduction"; Mekalanos, "Chapter 6. The Evolution of Vibrio Cholerae as a Pathogen"; Faruque, Nair, and Takeda, "Chapter 7. Molecular Epidemiology of Toxigenic Vibrio Cholerae"; R.K. Bhadra, S. Shah, and B. Das, "Chapter 10. Small Molecule Signaling Systems in Vibrio Cholerae," ibid ; K.K. Banerjee and B. Mazumdar, "Chapter 16. Vibrio Cholerae Hemolysin: An Enigmatic Pore-Forming Toxin," ibid ; Ramamurthy et al., "Virulence Regulation and Innate Host Response in the Pathogenicity of Vibrio Cholerae, Ed. Jo Brzostek".

[54] Mukhopadhyay and Ramamurthy, "Chapter 2. Asiatic Cholera: Mole Hills and Mountains"; Sozhamannan and Yildiz, "Chapter 8. Diversity and Genetic Basis of Polysaccharide Biosynthesis in Vibrio Cholerae"; Faruque, Nair, and Takeda, "Chapter 7. Molecular Epidemiology of Toxigenic Vibrio Cholerae"; Monakhova, "Chapter 4. Phenotypic and Molecular Characteristics of Epidemic and Non-Epidemic Vibrio Cholerae Strains Isolated in Russia and Certain Countries of Commonwealth of Independent States (Cis)"; Burrus, "Chapter 9. Significance of the Sxt/R391 Family of Integrating Conjugative Elements in Vibrio Cholerae".

These findings have potentially interesting implications. Genetic analysis shows O1 is very similar to non-O1/O139 types and that non-O1/O139 types may have originally arisen from an early O1 type.[55] The possibility then exists that 'British cholera' was the non-O1/O139 strain, known by Edinburgh physicians as easily treated and normally survivable.[56] Alternatively, the O1 strain, newly arrived from Asia ('Asiatic cholera') would be far more serious and only known to Edinburgh physicians with military service in India. But why would two, separate, *Vibrio* lineages seem to have resulted? One theory suggests that each type adapted to its specific environment by acquiring what genes it needed to survive. The Epidemic O1 (Asiatic?) causes pandemic, severe, often fatal disease but can also seemingly change into a different phase where they colonise or become non-virulent, in essence choosing when to be fatal and when not. Endemic, non-O1/O139 (British?) can infect but only causes long-standing, mild disease. How better to spread oneself via faeces than to cause just a bit of diarrhoea but not kill? All types can apparently share DNA with other subtypes and types and non-O1/O139 may be a permanent 'library' of 'other' genes. The abrupt change of a bacterial strain when a bacterium was not known could have caused the abject confusion and variable effect of treatments seen in the 1832 epidemic in Edinburgh and, in fact, the entire UK and the world. In fact, both listings of 'British cholera' and 'Asiatic cholera' are seen in Edinburgh death certificates.[57]

Not Only Humans

Man is often considered the only host for *Vibrio* and public health attempts are often directed almost solely at human waste control. However, *Vibrio cholera* has also been found in many other, extremely varied organisms. Plankton, which grow in brackish water like found around Edinburgh, can carry large amounts of *Vibrio cholera* (ingesting only one to ten plankton can lead to disease). Of note, the VBNC forms have been found in this plankton presenting a possible place to 'hide out' until favourable, environmental conditions resuscitate it (possibly related to the seasonal growth of plankton, specifically for the non O1/O139 types).[58] Cuttlefish and nautilus, more prominent in the north and west waters of Scotland, feed on the same plankton and have been found infested with *Vibrio*.[59]

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[55] S. Amit, K.N. Ranjan, and C.G. Asoke, "Chapter 13. Pathogenic Potential of Non-O1, Non-O139 Vibrio Cholerae," ibid .

[56] Kavic, Frehm, and Segal, "Case Studies in Cholera: Lessons in Medical History and Science", 397.

[57] L.W. Janson, Personal observations.

[58] Amit, Ranjan, and Asoke, "Chapter 13. Pathogenic Potential of Non-O1, Non-O139 Vibrio Cholerae"; Monakhova, "Chapter 4. Phenotypic and Molecular Characteristics of Epidemic and Non-Epidemic Vibrio Cholerae Strains Isolated in Russia and Certain Countries of Commonwealth of Independent States (Cis)".

[59] Amit, Ranjan, and Asoke, "Chapter 13. Pathogenic Potential of Non-O1, Non-O139 Vibrio Cholerae"; Ryan, "Eyes on the Prize: Lessons from the Cholera Wars for Modern Scientists, Physicians, and Public Health Officials".

Vibrio has also been found directly associated with shellfish (e.g., shrimp, crabs, oysters, clams and mussels) potentially having more pertinence to eastern Scotland and the Edinburgh cholera epidemics; even today, cholera death is a concern for those eating raw oysters and clams or raw seafood.[60] In fact, *Vibrio's* association with shellfish confers upon it several additional characteristics that improve its ability to adhere to and infect the human intestine. *Vibrio* has an enzyme called 'chitinase' that helps it grow on the surfaces of shells and which can also break down the shell allowing it to enter and infect the animal. But what would be seen as a harmful action to the shellfish may be just the opposite as some researchers feel that *Vibrio cholera* and shellfish actually have a commensurate relationship and that *Vibrio* in the oceans and seas co-developed with shellfish.[61] Attachment to chitin actually seems to prompt some of the aforementioned gene changes; this chitin-induced transfer of genetic information seems particularly involved in antibiotic resistance.[62] Another example is *Vibrio's* acquisition from mussels of the enzyme called 'mucinase' that can allow the bacteria to penetrate the mucous layer on cells of the human small intestine.[63]

There is also conjecture that *Vibrio* found in cuttlefish and nautilus is simply due to their ingestion of shellfish. *Vibrio* has also been found attached to or inside the eggs of many of the cephalopods noted above. The O1 type, present in the 1800s, is extremely good at adhering to cuttlefish and nautilus and some evidence points to an increase in cholera infections when cuttlefish/nautilus numbers rise.[64] Besides the above animals, *Vibrio* has been identified in turtles, seagulls, and water-associated midges. *Vibrio* has also been found in various domesticated animals, insects, some aquatic plants (e.g., seaweed) and, in the laboratory, it easily infects rabbit intestine.[65] Most of these non-human carriers harbour the non-O1/O139 type.

Vibrio seems also to associate with infections by parasites, particularly those responsible for *Giardia*, *Ascaris* (a parasitic, roundworm that infects the lungs and intestines) and *Entamoeba*

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[60] Amit, Ranjan, and Asoke, "Chapter 13. Pathogenic Potential of Non-O1, Non-O139 Vibrio Cholerae"; Ryan, "Eyes on the Prize: Lessons from the Cholera Wars for Modern Scientists, Physicians, and Public Health Officials".

[61] Colwell, "Infectious Disease and Environment: Cholera as a Paradigm for Waterborne Disease"; Amit, Ranjan, and Asoke, "Chapter 13. Pathogenic Potential of Non-O1, Non-O139 Vibrio Cholerae".

[62] Sozhamannan and Yildiz, "Chapter 8. Diversity and Genetic Basis of Polysaccharide Biosynthesis in Vibrio Cholerae"; A. Huq, Grim, and Colwell, "Chapter 18. Aquatic Realm and Cholera".

[63] Amit, Ranjan, and Asoke, "Chapter 13. Pathogenic Potential of Non-O1, Non-O139 Vibrio Cholerae".

[64] Colwell, "Infectious Disease and Environment: Cholera as a Paradigm for Waterborne Disease".

[65] Mukhopadhyay and Ramamurthy, "Chapter 2. Asiatic Cholera: Mole Hills and Mountains"; Amit, Ranjan, and Asoke, "Chapter 13. Pathogenic Potential of Non-O1, Non-O139 Vibrio Cholerae"; Syed and Klose, "Chapter 11. Vibrio Cholerae Flagellar Synthesis and Virulence"; G. G. Kolaye et al., "Mathematical Assessment of the Role of Environmental Factors on the Dynamical Transmission of Cholera," *Communications in Nonlinear Science & Numerical Simulation* 67 (2019); Ramamurthy and Bhattacharya, "Chapter 1. General Introduction"; Kavic, Frehm, and Segal, "Case Studies in Cholera: Lessons in Medical History and Science".

histolytica (causative organism of the disease Amoebiasis) but in a peculiar way.[66] Co-infection of *Vibrio cholera* with these parasites decreases the immune response to the cholera vaccine. Although the mechanism is not understood, this effect may allow non-toxic types of *Vibrio* to hide out in cholera-immunised human hosts and pass through the environment via faeces for years. These 'co-host,' non-O1/O139 types may play an important role in both acute infections but also in establishing a huge and wide-spread 'environmental reservoir' for other *Vibrio* types.

Thus, cholera has learned very well to live outside of humans and water, attached or inside a variety of water- and non-water organisms. The question arises if a similar series of events and effects could have occurred off the shores of the UK and Edinburgh and infected the people living there by simply eating the seafood that was often a major part of their diet?

Water, But Also More

Cholera is often considered to solely be a water-borne infection.[67] But *Vibrio's* life is not that simple. The bacterium is often found in water, especially with some dissolved salt, and some microbiologists suggest it originated and evolved in the deep sea. In fact, species similar to *Vibrio cholera* have been found in deep-sea vents in the eastern Pacific Ocean.[68] The same researchers suggest that *Vibrio's* connection with plankton found in 'riverine, brackish and estuarine ecosystems' directly implies that *Vibrio* has been a natural inhabitant of these waters and an integral part of their ecosystems. They further suggest that cholera has probably never been an eradicable disease since it is a natural and wide-spread organism. Others note that 'the non-toxigenic strains are so numerous that they are considered as representatives of indigenous microflora' although a dissenting group feels less enthusiastic and suggest simple 'long-existing temporary natural foci of infection in some cholera-prone areas.'[69] Thus, 'defeating' cholera by eradication may be an impossible task.

Vibrio seems also to be able to live and infect outside of the aqueous environment. Non-O1/O139 types have been isolated on various foods including vegetables and fruits. *Vibrio* has also been found in human infections outside the intestines to include blood (e.g., immunocompromised patients), wounds, the ear, bile, sputum and cerebrospinal fluid and these extra-intestinal infections are often

[66] Mukhopadhyay and Ramamurthy, "Chapter 2. Asiatic Cholera: Mole Hills and Mountains", Ibid.
[67] J. Snow, "On the Mode of Communication of Cholera, 1856," *Edinburgh Medical Journal* 1, no. 7 (1856); L. Ball, "Cholera and the Pump on Broad Street: The Life and Legacy of John Snow," *History Teacher (Long Beach, Calif.)* 43, no. 1 (2009).
[68] Colwell, "Infectious Disease and Environment: Cholera as a Paradigm for Waterborne Disease".
[69] Monakhova, "Chapter 4. Phenotypic and Molecular Characteristics of Epidemic and Non-Epidemic Vibrio Cholerae Strains Isolated in Russia and Certain Countries of Commonwealth of Independent States (Cis)"; Amit, Ranjan, and Asoke, "Chapter 13. Pathogenic Potential of Non-O1, Non-O139 Vibrio Cholerae".

fatal.[70] These infections also suggest a possible 'carrier' role for humans, including those in the unsanitary conditions of 1800s Edinburgh. Although exposure to water could have initially caused infestations/infections, it appears that some *Vibrio*, particularly the same non-O1/O139, 'environmental reservoir' types, can definitely live outside of water at least for a period of time.

In the same vein, *Vibrio* in a non-aqueous situation such as in the air or on cloth and solids must be considered. All liquids and solids 'aerosolise' – that is, become airborne - to some extent. Environmental factors like temperature, humidity, air pressure and wind can determine the extent that aerosolization and its spread occurs. In fact, smell is simply detecting aerosolized particles of a particular item traveling to the nose which are then detected by the olfactory nerve. The air is filled with a 'soup' of particles and molecules of everything we live around and can also deposit on solids – like dust settles on furniture. One could even surmise that, if these particles were infectious in sufficient quantity and near a suitable host in a crowded tenement, they could cause disease - perhaps even in a 'miasmatic way' (Chapter 2). It has also been shown above that *Vibrio* can live in several environments, aqueous and non-aqueous, and in a number of organisms, humans being only one. So, cholera-laden, faeces-stained clothes or bedding (e.g., after a cholera victim's diarrhoea) could also be a source of infection.[71] The same faeces contamination could be in the corners of buildings, squares, rooms, streets – pretty much anywhere either humans, animals (e.g., pigs and cows) or flowing water go (e.g., Edinburgh Old Town Closes). For cholera, it is water, but also more.

A Matter of Environment

A large part of *Vibrio's* complexity is its apparent ability to change according to its environmental need. *Vibrio* is classically defined as a water-borne bacteria and Colwell has done extensive research on *Vibrio's* life in water to include its ability to adapt to water temperature and salinity. She has defined a range of salinity and also a wide temperature range for optimum *Vibrio* growth and has also mapped variations in *Vibrio* concentration in the same body of water with higher percentages of the bacteria in lower salinity and warmer waters.[72] Table 1-1 from her work shows the ranges that *Vibrio* can endure. Ryan has also noted, 'With the right temperature and nutrient profile,' *Vibrio* also thrives in fresh water.[73] Added research shows the existence of *Vibrio* in water sources in parts of

[70] Amit, "Chapter 13. Pathogenic Potential of Non-O1, Non-O139 Vibrio Cholerae"; Ramamurthy and Bhattacharya, "Chapter 1. General Introduction".

[71] "Cholera Brought to Edinburgh from Musselburgh on Clothes," *Scotsman*, 7 Mar 1832, 3; "Musselburgh Town Council - Burned Clothes of Cholera Patients," *Scotsman*, 11 Dec 1866, 4; "Cholera in Clothes," *Scotsman*, 14 Aug 1865, 3.

[72] Colwell, "Infectious Disease and Environment: Cholera as a Paradigm for Waterborne Disease".

[73] Ryan, "Eyes on the Prize: Lessons from the Cholera Wars for Modern Scientists, Physicians, and Public Health Officials"; A. Huq, Grim, and Colwell, "Chapter 18. Aquatic Realm and Cholera".

Russia, Uzbekistan, Kazakhstan, Tajikistan, Kirgizia where it should, theoretically, not be able to live long-term due to severe climate conditions.[74] Whether the bacteria have adapted to these harsh environments or have simply been carried in by humans is still to be seen.

Experimental setting	Temp (°C) (study range)	Salinity (g/l) (study range)
Laboratory microcosm		5, 10
Laboratory microcosm		15
Laboratory microcosm	20, 25	15, 25
Chesapeake Bay (estuary)	15–20	4–12
Chesapeake Bay (estuary)		4–17
Southern California (coastal areas)	No preference	1–10
Louisiana (coastal areas)	Depended on salinity (18–30)	<1
Florida (estuary) and laboratory microcosm	20–35	12–25, 10–25
England (river and marsh ditch)		3–12
Japan (rivers and coastal areas)	ca. 21[c]	

[a] *V. cholerae* was detected at temperatures above 10°C.
[b] Highest temperatures occur in August.
[c] *V. cholerae* was detected at temperatures above 7°C.
[d] The detection range was 0.4–32.5 g/l.

Table 1-1. Ranges of temperature and salinity tolerance of Vibrio cholerae.[75]

Vibrio can adapt to other 'environmental' stresses as well. The presence of potentially lethal antibiotics seems to turn on some of the gene-sharing mechanisms already discussed above. It has also been shown that the bacterium changes as it passes from the stomach into the small intestine becoming seven hundred times more infective by the process.[76] The production of CT and the flagellum proteins has also been shown to be dependent on acid levels, salinity, temperature and food availability.[77] The availability of 'solid' structures like plankton and chitin-containing shellfish promotes certain *Vibrio* types to 'shut down and roost'.[78] Virulent types can change to non-virulent, colonising types or become 'Vital but not Culturable' [VBNC] and then 'resuscitate' apparently per the environmental need. Seasonal variations also seem to affect the amount of *Vibrio* present,

[74] Monakhova, "Chapter 4. Phenotypic and Molecular Characteristics of Epidemic and Non-Epidemic Vibrio Cholerae Strains Isolated in Russia and Certain Countries of Commonwealth of Independent States (Cis)", 54.
[75] Colwell, "Infectious Disease and Environment: Cholera as a Paradigm for Waterborne Disease".
[76] Merrell D.S. et al., "Host-Induced Epidemic Spread of the Cholera Bacterium.," *Nature (London)* 417 (2002).
[77] Monakhova, "Chapter 4. Phenotypic and Molecular Characteristics of Epidemic and Non-Epidemic Vibrio Cholerae Strains Isolated in Russia and Certain Countries of Commonwealth of Independent States (Cis)".
[78] T. Ramamurthy and S. K. Bhattacharya, *Epidemiological and Molecular Aspects on Cholera*, ed. T. Ramamurthy and S.K. Bhattacharya, Infectious Disease (New York, NY: Springer New York, 2011); Colwell, "Infectious Disease and Environment: Cholera as a Paradigm for Waterborne Disease".

including the amount of rain, hours of sunlight available and increased water temperature, possibly due to their effects on plankton growth as previously discussed.[79] Researchers have also seen changes in the above as climate change, including global warming, has occurred. Thus, the need to travel through an acidic stomach to the small intestine of a host, to live in varying levels of salt in water and/or to survive on a frozen or hot summer day seems to help *Vibrio* to decide when it is time to be virulent and when it is time to not. All are pertinent for Edinburgh in the 1800s and the link between weather and season were considered by several people of that time.[80]

Time to Hide

Vibrio cholerae's environmental capabilities go even farther yet as the bacteria can actually 'hide away' in something like a hibernation state by forming a 'biofilm' in water environments.[81] Biofilms have been found to be the 'predominate lifestyle' for aquatic bacteria like *Vibrio* instead of being 'free-swimming'.[82] Biofilms also have been shown to provide protection against oxidants, heavy metals, antibiotics, UV light, and being eaten by other organisms while still allowing nutrients to be absorbed through the film and into the masses of bacteria. Biofilms form most readily when *Vibrio* is attached to structures like plankton and shells but also water hyacinth, insects and plants. Not surprisingly, decreased motility contributes inversely to biofilm production since a motile bacterium would not want a biofilm.[83] The formation of the biofilm by *Vibrio* has been well studied, including the initial attachment by the flagellum and pili, the formation of single, bacterial layers but then three-dimensional aggregates with water channels built in and finally a complex, multi-part covering.[84] Several of the 'Other Factors' discussed earlier have been implicated in this process. Evidence of biofilm formation has also been seen as the way *Vibrio* survives the stomach's acidic environment.[85]

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[79] A. Huq, Grim, and Colwell, "Chapter 18. Aquatic Realm and Cholera"; Monakhova, "Chapter 4. Phenotypic and Molecular Characteristics of Epidemic and Non-Epidemic Vibrio Cholerae Strains Isolated in Russia and Certain Countries of Commonwealth of Independent States (Cis)".

[80] "Cholera Brought on by Unfavorably Hot Weather," *Scotsman*, Jul 4 1832, 2; "Suggestion of Cold, Spring Winds Being Cause of Cholera," *Scotsman*, Apr 11 1832, 3; "Weather Effects on Cholera (Dr Stark)," *Scotsman*, Oct 6 1855, 3; "Cholera Deaths - Effects of Low and High Temperatures (Registrar General)," *Daily Scotsman*, Feb 25 1859, 2.

[81] Colwell, "Infectious Disease and Environment: Cholera as a Paradigm for Waterborne Disease".

[82] A. Huq, Grim, and Colwell, "Chapter 18. Aquatic Realm and Cholera".

[83] Syed and Klose, "Chapter 11. Vibrio Cholerae Flagellar Synthesis and Virulence".

[84] Sozhamannan and Yildiz, "Chapter 8. Diversity and Genetic Basis of Polysaccharide Biosynthesis in Vibrio Cholerae"; Syed and Klose, "Chapter 11. Vibrio Cholerae Flagellar Synthesis and Virulence"; A. Huq, Grim, and Colwell, "Chapter 18. Aquatic Realm and Cholera".

[85] Bhadra, Shah, and Das, "Chapter 10. Small Molecule Signaling Systems in Vibrio Cholerae"; A. Huq, Grim, and Colwell, "Chapter 18. Aquatic Realm and Cholera"; Colwell, "Infectious Disease and Environment: Cholera as a Paradigm for Waterborne Disease".

Batten Down the Hatches and Set Watch

Vibrio has two more protective measures that allows it to hide/hibernate and remain safe but also to monitor the surrounding environment until virulence is once again a choice. *Vibrio* can physically change from its natural 'Smooth' appearance to a 'Rugose' one (Figure 1-3).[86] This can occur when nutrients are low, antibiotics are around or when *Vibrio* is in a biofilm. Rugose bacteria have also been found in human stool and can cause disease. Multiple, biological mechanisms, including actions of the flagellum, have since been found that controls this change.

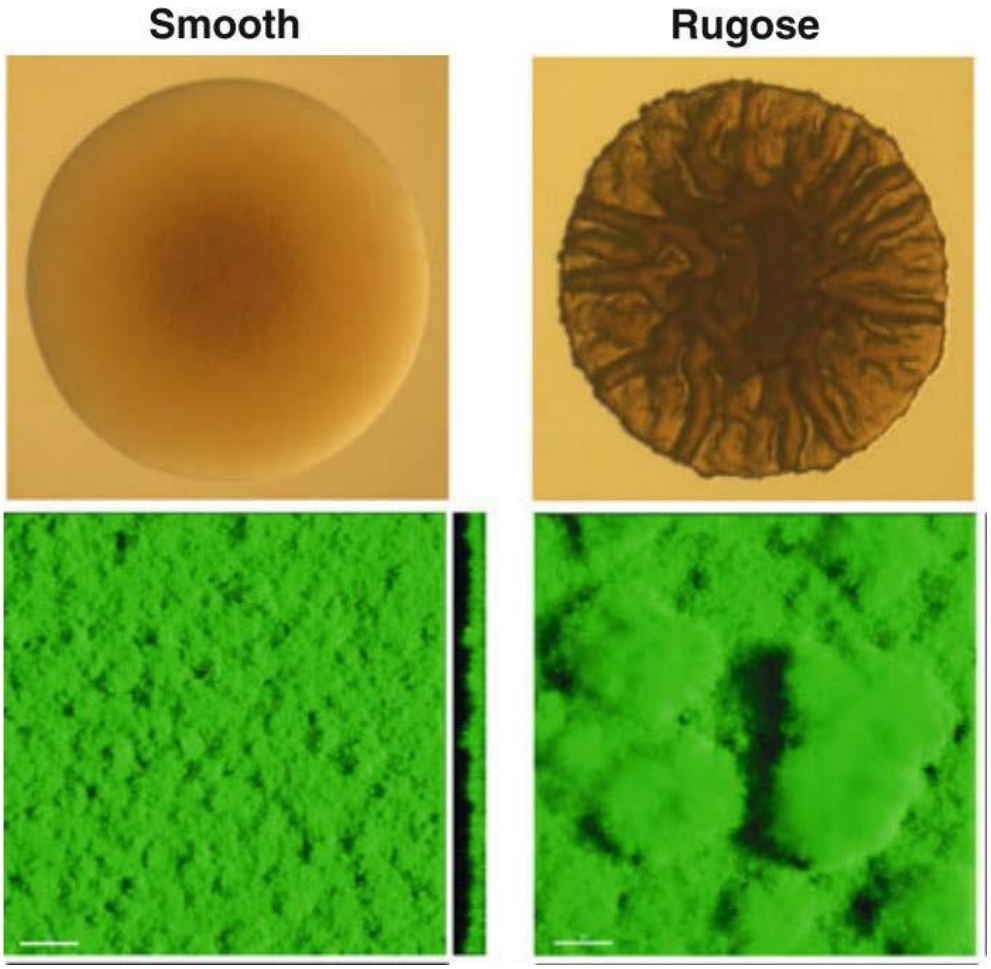

Figure 1-3. Smooth and Rugose Forms of *Vibrio cholera*. The top panels show tissue culture plates showing the gross appearance of the two smooth (left) and rugose (right) forms of the bacteria. The lower panels show a low-magnification view of the changes in the smooth (left) and rugose (right) bacteria's physical appearance. Small white bars in the bottom panels = 30 µm.[87]

[86] Sozhamannan and Yildiz, "Chapter 8. Diversity and Genetic Basis of Polysaccharide Biosynthesis in Vibrio Cholerae".
[87] Ibid.

Change to the rugose form seems to provide added protection from chlorine, hydrogen peroxide, high concentrations of salt, osmotic and oxidative stresses, antibiotics and against predators, the latter the major reason why bacteria die when in a watery environment.[88] The rugose form also makes a thicker biofilm providing added protection versus that of the smooth form.[89] Some of the 'Other Factors' noted above seem involved in the changes between the two forms.[90]

The last form of protection available to *Vibrio cholera* is what is called 'quorum sensing.'[91] While in the biofilm, *Vibrio* constantly secrete a 'sensing' molecule to tell how many other *Vibrio* are present to control bacterial density (to ensure enough food and water) but also if there are any non-*Vibrio* predators about. When the concentration of this sensing molecule reaches a certain level, the bacteria can revert back to the active, potentially infective form by activation of particular genes.[92] Quorum sensing may also play a role in the initial infection of the small intestine and to chitin-containing shells, in essence, making sure not too many *Vibrio* attach at the same location.[93]

Summary

The usual story of *Vibrio* infections is a simple one of a bacterium living in faecally-contaminated water that is somehow ingested by a human, its exclusive, infected host. The bacterium travels to the small intestine where it secretes a cholera toxin (CT) which produces copious amounts of a rice-water diarrhoea. A multitude of symptoms can present and, if unchecked, can lead to death.

But *Vibrio's* biology and pathology are nowhere near as simple. There were potentially two, different subtypes of *Vibrio* attacking Edinburgh (O1 and non-O1/)139) with very different activities; one was potentially the milder, British cholera (non-O1/O139) that also served as a 'library' of DNA but the other was a new, potentially fatal Asiatic strain (O1) thought to only exist in the India/southeast Asia. These bacteria could readily change DNA amongst itself (in more ways than most bacteria) and then switch back at will. *Vibrio* also could have been switching DNA between

[88] Sozhamannan and Yildiz, "Chapter 8. Diversity and Genetic Basis of Polysaccharide Biosynthesis in Vibrio Cholerae"; A. Huq, Grim, and Colwell, "Chapter 18. Aquatic Realm and Cholera".
[89] Sozhamannan and Yildiz, "Chapter 8. Diversity and Genetic Basis of Polysaccharide Biosynthesis in Vibrio Cholerae".
[90] Bhadra, Shah, and Das, "Chapter 10. Small Molecule Signaling Systems in Vibrio Cholerae"; A. Huq, Grim, and Colwell, "Chapter 18. Aquatic Realm and Cholera".
[91] Colwell, "Infectious Disease and Environment: Cholera as a Paradigm for Waterborne Disease"; Sozhamannan and Yildiz, "Chapter 8. Diversity and Genetic Basis of Polysaccharide Biosynthesis in Vibrio Cholerae"; Bhadra, Shah, and Das, "Chapter 10. Small Molecule Signaling Systems in Vibrio Cholerae"; S. Shinoda, "Chapter 14. Proteases Produced by Vibrio Cholerae and Other Pathogenic Vibrios: Pathogenic Roles and Expression," ibid ; A. Huq, Grim, and Colwell, "Chapter 18. Aquatic Realm and Cholera".
[92] Bhadra, Shah, and Das, "Chapter 10. Small Molecule Signaling Systems in Vibrio Cholerae".
[93] A. Huq, Grim, and Colwell, "Chapter 18. Aquatic Realm and Cholera".

other, completely-unrelated organisms. Temperature changes could influence virulence with each passing season or weather front possibly bringing a change to one or both subtypes or yet a third VBNCs version.[94] The tail (five different subtypes), sheath and pili further complicated the bacterium's 'type' of infection and response of the immune response. Often the tail would fall off after the initial infection and create a 'hibernating' bacterium that could either colonise its host or just bide its time until another infection was prudent. And since the bacteria would look different pre-infection and post-infection, trying to microscopically prove their existence would be further complicated (Chapter 2). In addition, the bacteria could also form rugae and biofilms and use quorum sensing and other factors like Alarmone to choose its time and place to infect.

Beyond these molecular and physical changes, the bacteria could hide out in several different forms of water from the somewhat clean River Esk to the heavily polluted Water of Leith to the salt water of the North Sea to the brackish water of the Firth of Forth to the pools of water on the cobbled streets, by changing its form to adapt to the changing water conditions. Beyond water, *Vibrio* could easily hide in the solids found in the rubbish and refuse in the streets of Edinburgh, including the faeces tossed out the windows of the crowded tenement buildings that then ran down or collected in the lanes and closes. These solids could have aerated and spread to the people but also onto the surfaces of the poorly ventilated homes. The bacteria could have been harbouring in several types of seafood (many found in Leith, Portobello, Musselburgh and other coastal towns directly adjacent to the city), plankton (in which the VBNC and non-O1/O139 types are known to be prevalent), turtles, seagulls (and their ever-present excrement), midges, parasites, dogs and cats and even cattle, rabbits and pigs.[95] Beyond these animal hosts, *Vibrio* could potentially be either on or in vegetables and fruits as well as wounds, blood, bile, sputum and cerebrospinal fluid. The complexities of how, when, where and what caused the infection made it harder for the immune system to mount a notable and consistent response (thereby potentially creating differing symptoms in each Edinburgh patient). All would also confuse the attempts to understand the infection.

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[94] Although no definitive proof is available, it is important to note that the 1832 epidemic persisted throughout all of 1832 but peaks were seen at the onset of Spring (April), Summer (July) and Autum (October); the 1848/49 epidemic at the onset of Autumn 1848 (October) and then again at Autumn 1849 (September); the 1854/55 epidemic at the start of Autumn/Winter 1853 (October/November) and then again at Autumn 1854 (September) and the 1866 epidemic at the end of Summer/start of Autumn (some in July/August but peaking in September), Campbell, "Cholera in Nineteenth Century Edinburgh" and this author's own observations of the 1866 Death Certificates.

[95] Although *Vibrio* infection is theoretically possible in these various animals, no evidence of infections from them was ever noted in Edinburgh between 1820 and 1870 via *Scotsman* and other articles and writings. See for example "Refute of 'Hog Cholera'," *Scotsman*, Aug 26 1863, 1; "Experiment to Give Sheep Cattle Plague," *Scotsman*, Oct 23 1865, 2.

Chapter 2. History of Infection Theories in Edinburgh

Introduction

As discussed in Chapter 1, *Vibrio cholera* is not just a simple bacterium that lives in 'contaminated water', affects solely a human host, causes huge amounts of 'rice water' diarrhoea and which can be rapidly fatal.[96] Even by today's standards, when scientists can actually look directly at and rigorously test an offending organism*, Vibrio* is an extremely complex bacterium.[97] Thus, a multitude of varying risks were present that could lead to cholera disease: what infective 'state' *Vibrio* was in (whether it had or did not have essential infective DNA or could readily get it); whether it had its flagellum or pili or other factors and/or whether it was dormant or hibernating due to adverse conditions (including cold/heat, salinity and nutrients); what subtype of *Vibrio* it was (the more deadly Asiatic or more benign British cholera) and from where it could infect humans (including varying fluids, solids and possibly even the air but also several animal and plant reservoirs). But these were only the factors from *Vibrio's* side and do not include those from the humans who were infected and, in a sometimes-bewildering fashion, either getting a mild version of the disease, a serious version that they may recover from or a rapidly fatal one that may take only hours to kill.

In this context one must consider what the scientist and physician were facing in the 19th century. The basic attributes of the human body had just begun to be understood on a very gross level but doctors were still at a very big loss with regard to understanding disease pathology and treatments. Progress towards the actual cause of infections and disease was lacking and lacking badly. But questions were starting to be asked. Why did open wounds fare worse? Why did some surgical wounds fare better than others? Why did recovery in hospitals often lead to worse results? The ideas of 'bacteria' and 'infection' and need to be 'sterile' was still several years away in the world of medicine but various theories were being suggested as all tried to understand disease processes and, pertinent to this chapter, how individuals could become afflicted by a disease.[98]

The multiplicity of effectors and modes of cholera infection noted in Chapter 1 most certainly augmented the confusion and bewilderment of the general public and the medical and governmental officials that were trying to acutely treat patients but also prevent the epidemic infections. A lithograph from the early 1830s illustrated the position that all were faced with in regards to efforts not to catch cholera (Figure 2-1). Paramount to these efforts was the search for a

[96] H. Mehlhorn, "Cholera (Blue Skin Disease) and Its History," *Parasitology Research Monographs* (Cham: Springer International Publishing, 2019); ibid, 148-149.
[97] Ramamurthy and Bhattacharya, *Epidemiological and Molecular Aspects on Cholera*.
[98] A. J. Youngson, *The Scientific Revolution in Victorian Medicine* (London: Croom Helm, 1979) 35-38.

consistent and uniformly supportable theory that would help establish these acute treatments and prophylactic measures.

Figure 2-1. 'Portrait of a Man Protected from Cholera.'[99] Similar lithographs were prevalent in other parts of Europe/the UK (see translation from German below[100])

[99] B. E. Keene, "Portrait of a Man Protected against Cholera. Colored Lithograph, by Moritz Saphir Published in Der Deutsche Horizont, Munich, Germany in the Early 1830s," *Journal of the History of Medicine and Allied Sciences* 37, no. 4 (1982), 449.

[100] The preventative measures include 'a skin of rubber that has been patched with tar, over this a wrapping of six yards of flannel, and on his heart a copper plate. On his chest there should be a large sack filled with warm sand and around his neck a double bandage filled with juniper berries and peppercorns. In his ears two pieces of cotton soaked in camphor, hanging on his nose a bottle of smelling salts, and in his mouth a cigar. Over the bandages … a shirt soaked in lime chloride, over that a cotton jacket, on top of that a warm rooftile, and finally, a vest soaked in lime chloride. He should also wear flannel knickers, stockings of twine boiled in vinegar, and wool socks soaked in camphor. On his feet, two copper flasks filled with hot water and … overshoes over all. Behind his legs … hang two water jars. Then … a large woolen overcoat soaked in chloride and over the entire outfit a coat made of oiled linen and on his head a dito hat … On top of his hat he should have a soup bowl of barley broth. In the left hand … an entire juniper bush and in the right a cup of vinegar and cloves. And behind him, tied to his body, … a cart in which can be found a bathtub, fifteen yards of flannel, a vaporizer, a fumigator, eight brushes, eighteen rooftiles, two furs, a comfortable chair and a chamber pot. Finally, over his face he must also have a mash of peppermint dough.'

This chapter will begin with a discussion of the basic aspects of an infection and the resulting disease as per Figure 2-2. Next, the historical basis of each of the major theories that presided in 19th century Britain and in Edinburgh will be discussed from a biological but also a social aspect in the context of Figure 2-2 and why actually all the theories may have some merit.

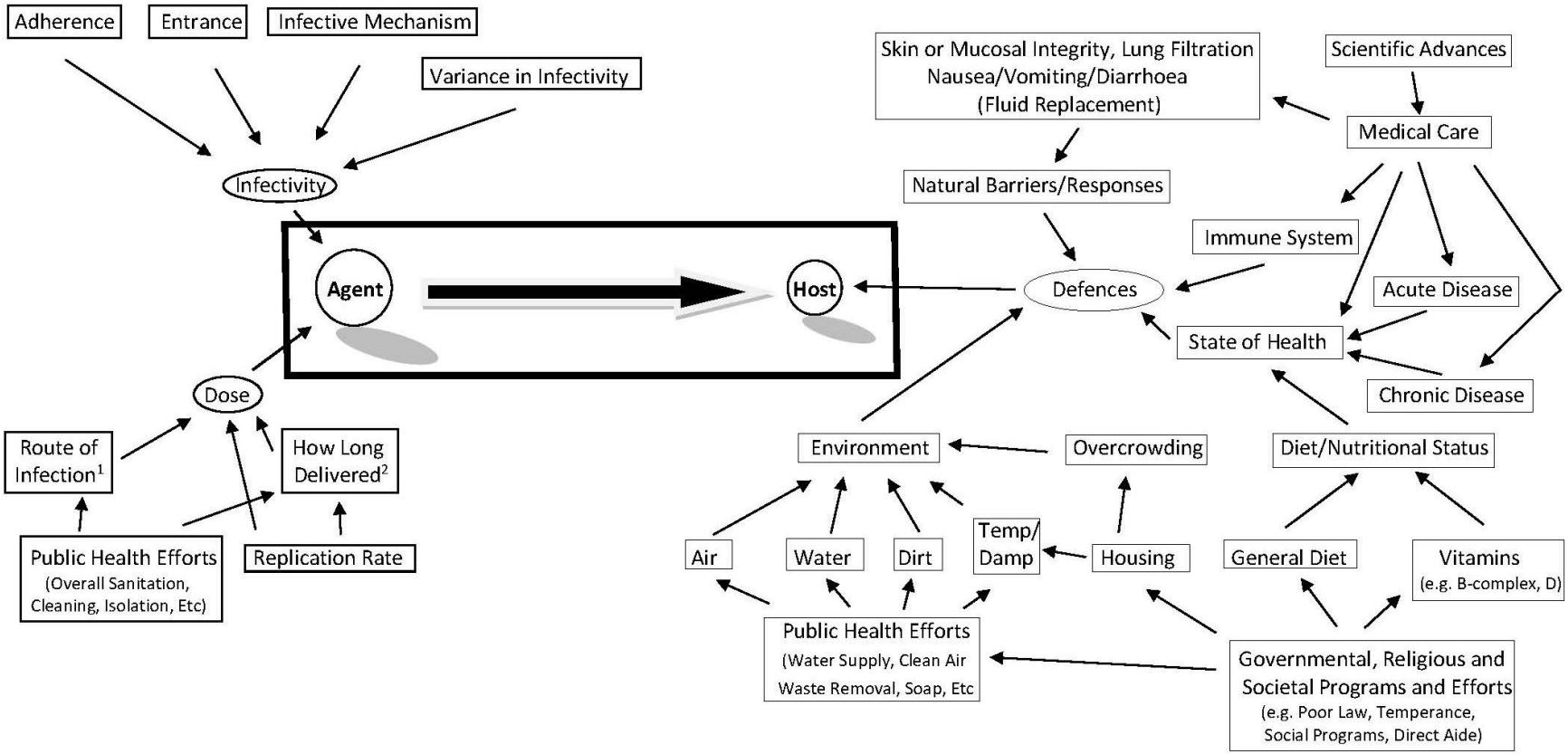
Basic Infection

As per Figure 2-2 (next page), 'infection' occurs when the bacterial, viral or fungal 'agent' enters or attaches to the 'host' and causes an inflammatory and/or immunological response. This process is dependent on the agent's 'dose' and 'Infectivity' and the host's 'defences'.

Firstly, a certain amount or dose of the infective agent is required. A few bacteria can usually be eliminated or neutralised by the host's defences (see next paragraph) but a large, sustained attack of agents, especially at a point of the host that is particularly vulnerable can lead to disease. For example, Mehlhorn notes a comparative study of bacterial dose showing that the bacteria Shigella needs only ten organisms while Salmonella needs ten thousand to one-hundred thousand and cholera around one-hundred million bacteria (depending on the strain) to produce true, symptomatic disease.[101] The host's relative vulnerability of any dose of a bacteria is dependent on a) how and where the agent attacks the host, b) how long the agent is attacking the host and c) the replication rate of the bacteria (e.g., how well it can replenish bacteria that have already attacked the host). Secondly, the infectivity or ability of the infective agent to cause disease is affected by several factors including mechanism and variance of infection as well as the means of entrance or attachment of that agent. The left side of Figure 2-2 illustrates these factors of infectivity.

The host's 'defences' include natural and anatomical barriers to an infective agent (e.g., a sneeze or cough, unbroken skin, hairs in the nose and breathing tubes that help filter or actively move agents out, the acidic environment of the stomach, etc). The host's defences are also dependent on the health of their immune system (the part of the body that fights infection) and the general state of health. Both of these measures of health are dependent on acute and chronic diseases suffered by the host (and the medical care received to optimise care) but also the host's diet and nutritional status. Finally, the environment is an important host defence with regards to clean water and air, waste and sewage disposal, personal hygiene and the living environment (including exposure to other sick persons). Programs providing public health and sanitary improvements help the host's defences. The right side of Figure 2-2 illustrates these varying factors.

[101] Mehlhorn, "Cholera (Blue Skin Disease) and Its History", 146.



[1] Route of Infection can include through the skin (cuts or absorbed), faecal-oral, blood, absorbed through the mucosal membranes or active binding to some extra-cellular receptor. This would impact how much can be acutely delivered to the host.

[2] How much can be delivered over an extended period of time? Does the infective agent stay, replicate or go away after the initial infection.

Figure 2-2. Outline of Infection, created by the Author. See text for further description.

But why would this matter to an historical essay on 19th century, cholera infections? Because by understanding the factors involved in an infective disease, the deficiencies and merits of each of the prevalent theories in the 1800s can be better appreciated and, indeed, supported. In particular, it will be argued that the bacterium *Vibrio cholera* can 'infect' and/or cause 'disease' due to humours, miasma, contagion or all of the above. Understanding the complexities of cholera infection/disease, thus offers better insight into the various treatments and efforts seen in the various publications and thought processes of the times and how these affected Edinburgh's fight against cholera.

Early Concepts of Disease

But what is a 'disease' and what is 'infection' and how is it different from 'contagion/ous'? A 'disease' is a collection of distinct symptoms, signs or bodily changes. 'Infection' is just one potential cause of a disease, albeit a necessary one for an 'infectious disease.' 'Contagious' just refers to someone or something carrying the cause of infective disease. Simply stated, cholera is a disease caused by the infection by *Vibrio cholera* that can occur after contact with a contagious something or someone carrying the bacteria. In the 1800s, physicians only had a few major diseases with classic and reproducible symptoms, not causes, which could be diagnosed and 'treated'. Tuberculosis was known by several names depending on its location and manifestations: 'pulmonary consumption' or 'long sickness' for the overall disease, 'phthisis' mainly for the lung, 'King's evil' or 'scrofula' for the lymph nodes of the neck or 'white swelling" for the bone.[102] Other diagnosable diseases included convulsions, 'heart disease', erysipelas (inflammation), pyaemia (septic clots in veins which could, in turn, form abscesses), septicaemia (an infection throughout the entire bloodstream/body) and gangrene (the death of tissue) although these are now considered symptoms or signs and not true diseases.[103] The large collection of diseases causing just fever, such as most infections, were more difficult to diagnose accurately partly because 'fever' was considered a disease itself and not a sign of one. In fact, the diagnoses of 'fevers' and of 'typhus' were often only separated by skin rashes which occurred in the latter. Modern infective diseases like measles, scarlet fever, smallpox, typhus, plague, and certain venereal diseases were not yet considered 'infections' in the 19th century. Apart from inoculation for smallpox, none had any real scientifically grounded basis.[104]

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[102] W. F. Bynum, *Science and the Practice of Medicine in the Nineteenth Century*, Cambridge History of Science (Cambridge: CUP, 1994), 21-23; D.E. Wright, "Old Names for Diseases," http://www.rootsweb.ancestry.com/~armissis/diseases.htmlAccessed 28 Jul, 2015.

[103] Bynum, *Science and the Practice of Medicine in the Nineteenth Century*, 20-21; Youngson, *The Scientific Revolution in Victorian Medicine*, 33.

[104] Bynum, *Science and the Practice of Medicine in the Nineteenth Century*, 4 & 20-24.

So, instead of truly diagnosing a disease, including looking for a causative organism, several, varying theories about the cause of disease prevailed in the late 1700s and through the 1800s until Germ Theory, the concept of infective agents like bacteria, viruses and fungi, was proven.[105] Most prominent amongst these earlier theories are 'humours', 'miasma' and 'contagion'. Some believed in a combination of one or more of the above. All had their proponents and all had their time at the forefront of the debate in the late 1700s through the 1800s. All, too, had their evidence that readily proved their theories (albeit based on usually weak observations). Unfortunately, that theory would be disproven by the next theorist with their own weak observations as proof.[106] Each one's merits and failings will be explored below.

Humouralist Theory

Prominent in the thought processes of doctors (and the general public) in the 1700s and early 1800s was the idea of the 'four humours' of the body: blood, phlegm, choler (yellow bile) and melancholy (black bile). Importantly, these could be touched, measured and manipulated. The balance or imbalance in the body was believed to impact directly on a person's health in terms of vomit, diarrhoea (faeces) and urine and these, too, could be felt and seen … and smelled. These were palpable parts of the human body and, in a world with only minimal understandings of physiology and pathology, they most certainly provided some tangible explanation of disease. This theory, although possibly incredible now, still held a great deal of sway in the 18th and early 19th centuries and any newer interpretations of disease needed to follow this basic tenet of medicine.[107]

Protecting the humours from becoming unbalanced was a prime humouralist ideal. Renbourn explains the example of wearing flannel and flannel belts, writing about beliefs in the effects of 'perspiration' and 'the fear of chilling' on the humours. While originally felt to be the whole body, by the end of the 1700s, this was just focused on the abdomen, where two of the four humours (yellow and black bile) presided; thus, a 'changing emphasis from long flannel shirts and waistcoats to abdominal bandages, binders and belts.' Renbourn further explains the theory that 'disease was occasioned by "a redundancy and putrid acrimony of the bile, cold, and food that easily turns rancid

[105] Rosen, *A History of Public Health*, 4-25, including the fact that Leeuwenhoek had published his pictures of 'little animals in the 1600s but no one seemed to know what to make of them; Youngson, *The Scientific Revolution in Victorian Medicine*, 127-128; E. Tognotti, "The Dawn of Medical Microbiology: Germ Hunters and the Discovery of the Cause of Cholera," *Journ. of Medical Microbiol.* 60, no. 4 (2011).

[106] Rosen, *A History of Public Health*, 4-5, 79-85, 159-166; Youngson, *The Scientific Revolution in Victorian Medicine*, 34-35.

[107] Tognotti, "The Dawn of Medical Microbiology: Germ Hunters and the Discovery of the Cause of Cholera", 1-4; J. Lane, *A Social History of Medicine: Health, Healing and Disease in England, 1750-1950* (London: Routledge, 2001), 2-3; D. Tulodziecki, "How (Not) to Think About Theory-Change in Epidemiology," *Synthese (Dordrecht)* 198 (2021), S2572.

or sour in the stomach .... They ought likewise to beware of cold, moisture or whatever else obstructs the perspiration and should wear flannel next the skin." Most standard books wrote similarly on diarrhoea, dysentery or cholera.' So prominent was this belief that 'British soldiers, in 1831, were ordered to wear (and pay for) a flannel belt.' In 1848, official instructions to Army Medical Officers note that 'each soldier is to be provided with two cholera belts, as part of his Necessaries.' Flannel waistcoats could be had 'if thought necessary … at their own expense.'[108] Advertisements also started in the 1830s (and persisted through the 1850s) for flannel cholera belts.[109] Beyond their ability to balance and stabilise the four humours, they also held important miasmatic properties. Renbourn reports on a 1785 suggestion regarding flannel being 'a filter, as it were, to separate the impurities of the air before it comes in contact with the surface of the body ….'[110] The idea of flannel's filtering effect against miasmatic diseases persisted in 1862s, *A Manual of Diseases of India* which lauded its infective disease prophylaxis and protection against 'inflammation of the liver or kidneys'; a [flannel] cummerbund also protected against sunstroke.[111]

By the late 1860s support for humoural theories began to vary as other theories emerged. In an Army order of 1867, flannel belts were only to be issued 'during a cholera outbreak at the discretion of the officer in command (two belts per soldier and a payment of one shilling required if they were lost or damaged).' As late as 1888 (Koch announced his discovery of *Vibrio cholera* in January 1884), flannel's effect against any infective disease was seriously questioned by some military doctors (partly due to the overheating effects of soldiers wearing them in hot areas) but still vehemently supported by others[112] As mentioned above, blood, the first humour, was also important in both the early theories of cholera but also in its treatment. Most prominent was the early, somewhat wide-spread belief in and use of blood-letting in treating not only cholera patients but, often, any patient presenting with a disease (Chapter 3). With regards to the four humours, this treatment was based on the belief "that the heart should be 'freed from an oppression which impeded its functions' and become 'equal to the task of propelling the mass of blood.'"[113] With a cold, blue cholera patient in front of them, who could blame the doctors for trying – particularly when it sometimes seemed to work.

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[108] E. T. Renbourn, "The History of the Flannel Binder and Cholera Belt," *Medical History* 1, no. 3 (1957), 214-217.

[109] "Advert for Ladies Anti-Cholera Belt," *Scotsman*, Mar 10 1832, 1.

[110] Blane, Gilbert, "Observations on the Diseases Incident in Seamen. (London: 1785) as quoted in Renbourn, "The History of the Flannel Binder and Cholera Belt", 213.

[111] Moore, W.J. "A Manual of Diseases of India" (London: 1862) as referenced in ibid, 218.

[112] Ibid, 219.

[113] Howard-Jones, "Cholera Therapy in the Nineteenth Century", 375.

To the modern reader, the four humours theory may seem dangerous for patient care. But this must be considered in the context of the several factors that influence how infections occur (see Figure 2-2). In the 1700s and most of the 1800s, the idea of an infective agent was impossible to prove and highly suspect to many. Microscopes had begun to be used but would not show anything like a cholera organism until 1854 (Pacini) or definitively in 1884 (Koch).[114] As such, the entire left side of Figure 2-2 was not even considered by learned people of the 19th century.

But directly or indirectly, the four humours illustrated the 'disease' and 'defences' of the individuals (see Figure 2-2, right side). Did they have an adequate diet/nutritional status to receive enough iron, vitamins and nutrients to not be anaemic or readily prone to disease (blood humour)? Did they suffer from chronic inflammation from their lungs (phlegm humour) from exposure to pollution either at their home or their work environment (or from someone who did because of overcrowding)? Did they have any acute or chronic disease that would affect the state of their liver and gall bladder health to the point of 'yellow' bilious vomit (choler humour) or of the breakdown of their natural barriers/responses leading to chronic, severe intestinal disease (melancholy humour)?

The humours could also be 'treated' in cholera patients (see Chapter 3). In a cholera patient whose blood was thick enough to congeal, blood-letting could restore localised circulation and be seen as efficacious. Similar blood problems and treatments occur in modern medicine with conditions where the body produces too much iron/red blood cells (e.g. haemachromatosis); one treatment continues to be regular bleeding. Leeches, a miniature version of bleeding and of anti-clotting, are part of contemporary treatments to prevent/treat blood disorders not too dissimilar from that of the cholera patient. Fluids by mouth or vein or even by rectum would 'adjust' the blood humour (and possibly others), albeit either in a good way or a bad; thus, the controversy over giving fluids (discussed in Chapter 3). Inflammation seen in cholera produced excess phlegm as the lungs attempted to clear themselves. Precursors to modern-day anti-inflammatories and opiate derivates used by 19th century doctors would have often helped the 'misbalance' in the phlegm humour; similar medications continue to be used today for 'breathlessness'.[115] Various other treatments for imbalances of the two biles may also have been considered given the copious diarrhoea and frequent vomiting of many cholera sufferers. Perhaps treating the four humours was not such a bad idea when little else was available in the doctor's bag.

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[114] Bynum, *Science and the Practice of Medicine in the Nineteenth Century*, 123-127.

[115] NHSS Scotland, "Scottish Palliative Care Guidelines - Breathlessness," https://www.palliativecareguidelines.scot.nhs.uk/guidelines/symptom-control/breathlessness.aspx, Accessed 23 Jan, 2023.

Miasmatic Theory

Miasmatic theory was one of the more prominent theories of diseases like cholera in the 1800s. Ryan notes that 'miasma' (literally meaning pollution or defilement in Greek) ascribed disease to unhealthy smells and emanations from decaying matter.[116] The sanitary state of most 19th century towns and cities (e.g., Edinburgh) and abundance of decaying matter gave credence to this theory. Like touching humours, environmental miasma also included natural things like weather which were easily (and accurately) felt, measured, studied and reported. Victorian science was also starting to be able to detect and characterise electricity and various other physical 'waves.' One very important atmospheric miasma risk factor for cholera was the cholera 'mist' or 'cloud' and Mukharji provides an excellent review of this phenomenon. He notes the many sightings of such clouds or mists 'as often by the elites as by the poor' and the many forms seen from yellow, white, grey, black, blue or red (Europeans reported blue, Chinese reported red), sometimes 'with electricity' or 'followed by locusts.' These events, no matter what colour, were often accompanied by death and disease of sometimes incredulous (but still believed) descriptions (Figure 2-3).[117] These clouds/mists were also the subject of intense scientific study (including 'capturing' samples of the clouds for microscopic examination) that made their way into several medical/scientific texts.[118] One, John Snow-like researcher mapped these clouds in an epidemiological attempt to understand the 1849 cholera epidemic.[119]

In Germany, Maxwell von Pettenkofer, a prominent medical professor, was so convinced in 'diseases due to bad air' and not contagious elements that he drank a glass of known, cholera-contaminated water. Fortunately, the amount of *Vibrio* was low and he only suffered mild diarrhoea. He later theorised that bad (sulphur-containing?), swamp air was the cause and mapped out this miasma for one cholera epidemic. In 1854, a year before Snow published his version of a cholera map, Pettenkofer showed via mapping that victims of cholera lived in low-lying areas of the marshes where the impure air would collect. Von Pettenkofer came to the obvious conclusion that the foul air seeped into the damp soil and 'initiated a chemical reaction' that led directly to the disease of cholera. 'Proof positive' that the miasma theory was correct.[120] Was there ever any doubt?

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[116] Ryan, "Eyes on the Prize: Lessons from the Cholera Wars for Modern Scientists, Physicians, and Public Health Officials", 610.

[117] P.B. Mukharji, "The "Cholera Cloud" in the Nineteenth-Century "British World": History of an Object-without-an-Essence," *Bulletin of the History of Medicine* 86, no. 3 (2012), 303-332.

[118] Ibid, , 303-332.

[119] R. D. Grainger, Report of the General Board of Health on the Epidemic Cholera of 1848 and 1849 (London: Clowes, 1850), Appendix B as referenced in ibid, 330.

[120] Mehlhorn, "Cholera (Blue Skin Disease) and Its History", 146; Sherman, "Cholera", 34 & 47.

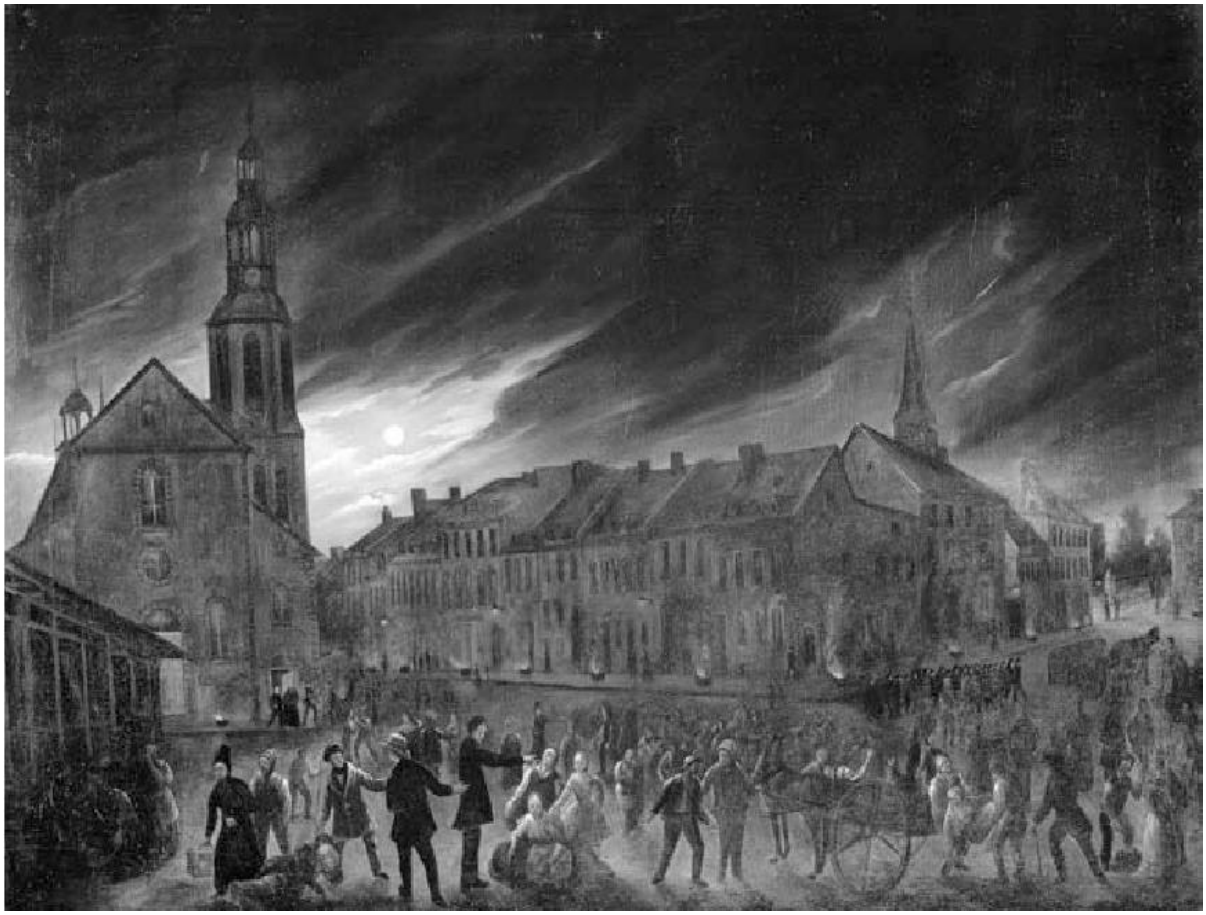

Figure 2-3. Depiction of a Cholera Cloud in Quebec, ca. 1832.[121]

So, why the focus on 'poisons' in the atmosphere, either detectable or not? In the context of these references to atmospheric conditions and even strange clouds/mists and their relationship to cholera, one must again consider the factors that lead to infection and why miasmatists would tout the ideas above. As previously noted, many substances readily 'aerosolise;' that is to say that small amounts of the substance leave the main mass and enter the air. If of an appropriate size and able to reach the olfactory (smell) nerves in the nose, that 'smell' is detected.[122] We are familiar with smells of smoke, sewage and rotting organic material to include rotting food, carcasses and von Pettenkofer's (sulphur-containing?) swamp gases. So were the people in Edinburgh in the 1800s and, perhaps, even more so.

[121] Joseph Légaré, "Cholera Plague, Quebec," ca. 1832. Photo © National Gallery of Canada. Image provided courtesy of the National Gallery of Canada, Ottawa. Taken from Mukharji, "The "Cholera Cloud" in the Nineteenth-Century "British World": History of an Object-without-an-Essence", 329.

[122] Brookes J.C., "Science Is Perception: What Can Our Sense of Smell Tell Us About Ourselves and the World around Us? ," *Phil. Trans. R. Soc. A.* 385 (2010), 3491-3502.

Does this imply that people could catch cholera just by inhaling it? As noted above, one study indicates that one-hundred million *Vibrio* bacteria (depending on the strain) are needed to produce true, symptomatic disease; it is difficult, although not impossible, to imagine that amount of *Vibrio* to be inhaled, make its way through the natural barriers of the nasal passages and other parts of the body and into the digestive tract to cause disease. We refer now to the right side of Figure 2-2 and the 'Environment' part. There are various descriptions of the city of Edinburgh in the 1800s, focused mainly on the Old Town and specifically its unseemly lanes and many closes (e.g., see Johnston's comprehensive review of the Closes of the Old Town in 1856).[123] That miasmatic 'pollution or defilement' and those 'unhealthy smells and emanations from decaying matter' were the primary focus for the miasmatists. And where there was smell, there was potential cause for disease.

While the idea of inhaling enough *Vibrio* to cause disease is suspect, the person offended by the stench could have picked up contaminated faeces or water or any other *Vibrio*-laden substance on bare feet, shoes, capes or other clothes, hands or even their carts or personal items they carried with them. As discussed in Chapter 1, *Vibrio* not only could be found on these items but could be fully capable of causing disease. So, air (possibly), water, dirt, the propensity of cold temperatures and damp (rain) that drove people indoors in small, poorly maintained dwellings or the local pub (over crowdedness/intemperance) could readily contribute to cholera infections and the epidemics. And while with one breath the miasmatists would point out the unhealthy odours with the next breath they would talk about what would become public health reform (Chapter 4). To them, these things that could be observed (e.g., smelled) were the only possible cause of the terrible diseases and treatment plans could be established to fight them.

Contagionist Theory

Tulodziecki summarises contagionist theory as a belief that '"the material of contagion" was a living organism,' a major tenet in today's, well-accepted, Germ Theory.[124] But why could contagionism theory still not take hold? As noted, it was difficult for persons thinking of four, humoural elements and who could see and smell 'miasmatic decay' to believe in creatures they could not see. One other big problem faced the contagionists – why could doctors and nurses treat cholera patients and mainly not get the disease? Many people in the New Town died from cholera – despite their spacious and well-aired streets and (often) indoor plumbing and lavatory facilities – is

[123] H. Johnston, *Letter to the Lord Provost, Magistrates, and Council of the City of Edinburgh on the State of the Closes in the Lawnmarket, High Street, Canongate and Cowgate* (Printed by the Boys at the Deaf and Dumb Institution, 1856).

[124] Tulodziecki, "How (Not) to Think About Theory-Change in Epidemiology", S2572.

that to say that these victims did not attend the right church or pray enough or, perhaps, drank too much to cause their own deaths? Why did isolating or 'quarantining' potentially infected people or things not work? These observations provided potent fodder for miasmatists and 'anti-contagionists' whose numbers grew from the 1830s through to the middle of the century; unfortunately, the contagionists had little response.[125]

To understand this better, we must return to the question of 'infectivity' discussed above. Importantly, the bacteria *Vibrio cholera* causes the disease. Not people with cholera, not water itself, not uninfected faeces, not properly-handled infected faeces. The thing that needed to be isolated or quarantined was the bacterium whether it be in or on infected diarrhoea, clothes, bedsheets, personal items and anything else. Anyone could interact with a cholera patient as long as they did not come into contact with and/or ingest the bacteria. One would assume that the doctors and nurses taking care of these patients were practising some type of sterile technique and/or at least washing their hands as well as the bed linen and instruments on a regular basis – a practice that may have not been occurring outside the cholera hospitals. Similar factors could have impacted the Edinburgh, middle- and upper-class victims of cholera. No poor sanitation, bad morality or lack of religion is needed – just *Vibrio cholera* on their shoes, clothes or simply randomly on a friendly hand extended to one who was already carrying the bacteria.

As noted above, one huge problem plagued the contagionists beyond the absence of a bacterium – the issue of quarantine. Paramount to the argument of a 'contagious' element was the idea of separating a sick person from the well. If contagion was correct, that would stop the spread, right? Unfortunately, as discussed previously, cholera is a complex bacterium and simple quarantining may not be enough to stop all of its myriad of ways to infect. And, in fact, the idea of something being contagious versus infective was the problem. David Barnes elaborates on this difference between contagion and 'infection' – 'an elusive but fundamental concept in nineteenth century public health.' He notes that quarantine during the 1800s was mainly 'based on a loosely articulated but firmly held conviction that foul or contaminated air could be imported from overseas vessels and goods.' In fact, the quarantine officials were more interested in the cargo on board as anything '(1) subject to decay, (2) permeable, or (3) of animal origin 'were suspect' (e.g., rags, horns, cotton, etc). The idea that something on or in the people on the ship could cause an infection was just not considered.[126]

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[125] D.S. Barnes, "Cargo, "Infection," and the Logic of Quarantine in the Nineteenth Century," *Bulletin of the History of Medicine* 88, no. 1 (2014), 75-101; K. Maglen, "'The First Line of Defence': British Quarantine and the Port Sanitary Authorities in the Nineteenth Century," *The Journal of the Society for the Social History of Medicine* 15, no. 3 (2002), 413-428.

[126] Barnes, "Cargo, "Infection," and the Logic of Quarantine in the Nineteenth Century", 75-76 & 82-89.

There was also a very big, political and economic argument to be had. Quarantine directly impacted maritime trade and, in the 19th century, that was extremely important to the island-based, British Empire. Maglen notes, 'The policy of isolation and exclusion which quarantine demanded was costly and declared to be in conflict with British liberal principles.' As alluded to above, quarantine also was being done wrongly simply due to ignorance of 'infection' and 'contagion' that persisted. Maglen further writes, 'Because the essential act of maritime quarantine was to detain and isolate ships with little discrimination between the sick and healthy or between the presence or suspicion of disease, it was both feared and resented.' Instead of being preventative, quarantine kept healthy passengers on board with the sick ones and held up cargo for up to thirty or more days.[127]

Indeed, the very idea of quarantine was a contentious one both in Great Britain and in Scotland but also around the world. In an 1831 Letter to the Editor, Dr. John Scott, experienced in India but now residing and practising in Edinburgh, questioned the Edinburgh Board of Health's 'opinion, that this disease is of a highly contagious nature' but was actually more concerned about 'the great loss and individual inconvenience' [that] 'will aggravate the threatened calamity.'[128] Still, a quarantine was started for the Firth of Forth, particularly for vessels from Russia where cholera had been raging for a time.[129] In 1837, a somewhat irate ship's captain emphatically noted that cholera was definitely not contagious and quarantines laws were 'evil'. He named names and specifically attacked the UK Board of Health for their perceived ignorance and insolence. The *Scotsman* seemed to support his calls despite his 'somewhat hasty temper.'[130] As the 1848/49 cholera epidemic appeared, Edinburgh and towns along the Forth once again considered quarantines. Although finally enacted throughout Great Britain, it was ended within a fortnight.[131] Great Britain would invoke another quarantine as cholera again struck in the 1850s but only because the other nations of the world still subscribed to it. The general public and several doctors continued to argue against the idea based both on their beliefs of infectivity but also due to the detrimental effect of an indiscriminate quarantine policy.[132] Despite this, Britain continued quarantine, although with revisions due to its relative, previous ineffectiveness. In 1861, a new report published by the Social Science Quarantine Committee recommended an inspection of ships by a Quarantine Medical Officer and 'any cases of illness should

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[127] Maglen, "'The First Line of Defence': British Quarantine and the Port Sanitary Authorities in the Nineteenth Century", 413 & 415-416.

[128] J. Scott, "Cholera Morbus by John Scott," *Scotsman*, Nov 5 1831, 3.

[129] "Warning to Pilots and Masters of Ships (Cholera)," ibid, Jul 23, 3; "The Trade with Russia - the Cholera Morbus," *Scotsman*, Jun 4 1831, 4.

[130] "The Evils of Quarantine Law," *Scotsman*, Dec 2 1837, 3.

[131] "Possible Quarantine of Ships," *Scotsman*, Jul 29 1848, 3; "The Cholera - Inspection of Ships," *Scotsman*, Oct 11 1848, 2; "The Cholera - Stoppage of Quarantine," *Scotsman*, Oct 21 1848, 2.

[132] "The Edinburgh Review on Cholera and Quarantine," *Scotsman*, Oct 9 1852, 1.

be removed to hospital but "the healthy should not be detained."'[133] At the start of the last cholera epidemic in 1866, a ship presented at Leith with a sailor sick with cholera. The patient was removed and his 'bedding, bed-clothes, &c.' destroyed. After confirming the health of the others, the vessel was cleaned and fumigated and the cargo was unloaded onto another ship kept moored just off the East Pier in Leith Harbour for further inspection. The 1872 Public Health Act further codified and strengthened this new method. A kinder and gentler version of 'quarantine' had been found.[134]

The controversial idea of quarantining or isolating people was also very prevalent in the 1800s. In the same 1831 Edinburgh Board of Health Report in which miasmatic and contagious cholera shared the same page, the Board felt it necessary to 'exhort the labouring classes to convey their sick friends with all speed to the hospitals, rather than try to cure them at home.' The city even provided 'carriages … for the instant removal of patients at all hours of the day and night.' While framed from a perspective of the proper, timely treatment patients needed, the Board went on to say 'that in certain circumstances the disease may be communicated by personal intercourse with infected persons or goods.' They quickly noted that this 'internal quarantine' or 'absolute seclusion of the sick' was not a blanket order but rather only to try to 'prevent its [cholera's] diffusion in the city.'[135] Despite the careful wording, the recommendation was not received well. When a 'quarantine house' was established at Fountainbridge by the Board, concerned 'proprietors and inhabitants' met at Scott's chapel on Bread Street to attempt to have it removed. These citizens were mainly concerned about the Board bringing cholera-laden patients into their midst.[136] Drummond residents were outraged with the name 'Drummond Street Hospital' for a cholera hospital, 'thereby misleading the public as to its real situation, and bringing suspicion upon the street.'[137] Similarly, one writer complained to the *Scotsman* about the need to use for 'distinct cars … for those who have only premonitory symptoms, and those in whom the disease is confirmed [with] a complete fumigation immediately after …,' noting 'if the disease is really contagious, may not be that an effectual means of communicating it in its worst form to the unhappy victim, whose fate it is to be placed in such a situation.' [138] At least the idea of contagion was being taken seriously by some.

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[133] Maglen, "'The First Line of Defence': British Quarantine and the Port Sanitary Authorities in the Nineteenth Century"m 418-419, 421-422.

[134] "Leith - the Supposed Case of (Vistula) Cholera," *Scotsman*, Jul 4 1866, 2; "The Supposed Case of Cholera at Leith (Vistula)," *Scotsman*, Jul 5 1866, 2; "Leith - Another Steamer (Buda) with Supposed Case of Cholera on Board," *Scotsman*, Jul 9 1866, 2.

[135] W. Chambers, "Report of the Edinburgh Board of Health," ibid, Nov 23 1831, 4.

[136] "Mr. Scott's Chapel Meeting," ibid, Mar 24 1832, 3.

[137] "Complaint by Residents - Drummond Cholera Hospital Names 'Drummond Street Hospital'," *Scotsman*, Feb 22 1832, 3.

[138] "Cholera - Suggestion for Isolation If Considered Contagious," *Scotsman*, Jul 28 1832, 2.

Others, though, felt something more sinister was going on as the Board had to deny 'any intention of forcible interference with Persons ill of Cholera.'[139] To put this fear into context, this was just after the 1827-1828 time period of Burke and Hare and the public had not forgotten.[140] They were convinced that more body snatching was happening with 'cholera' being a convenient excuse by the medical men. On 28 March, 1832, while the casket of a cholera victim was being transported from Crawford's Close, Grassmarket to Greyfriars' churchyard, a full-scale riot erupted. The coffin bearers had 'stones and other missiles' thrown at them and the coffin was ultimately seized by the crowd and broken open to ensure that there was, indeed, a body (and not stones as one 'old bedame' asserted) being interred. The mob refused to leave until the coffin had actually been buried.[141] The crowd could not necessarily be blamed. Early in February, two resurrectionists had mistakenly exhumed the body of one man's recently-departed mother (she had just died of cholera). Although they reburied the body, both were dead from cholera within thirty-six hours. The *Scotsman* article did not seem to express much remorse. Only a month before the riot, 'resurrectionists' had started exhuming an unknown number of cholera bodies in Musselburgh as well as the body of a young boy buried in Duddingston church-yard. An iron hook left by one of them proved the foul play.[142] Although a better-informed public gradually began to trust both the doctors and the city officials (see below), even as late as 1849, a doctor accused of putting a young boy in the morgue while still alive had to report 'He never was even seriously ill, but improved from the moment of his admission' and, in fact, been discharged in good health 'to seek employment.'[143]

So, why did quarantine <u>not</u> work? It depends on what is being isolated – the person/thing or the bacteria. Ships were kept at bay (sometimes for weeks) but sailors with potentially contaminated clothes/faeces were released into the general public. Cholera patients were taken to cholera hospitals and their families were sometimes moved to specialised, isolation homes while their homes were whitewashed and everything destroyed or discarded. But this did not happen often or consistently despite the best efforts of the local authorities mainly because the people still did not believe in invisible elements of disease. Doctors and scientists including those in or from Edinburgh, who had looked for these creatures had found nothing except food particles (perhaps tail-less *Vibrio*?). Even the Royal College of Physicians in London had concluded that 'Cholera bodies' simply

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[139] "Board of Health Groundless Report of Forced Hospitalisation," *Scotsman*, Mar 3 1832, 3.

[140] Ben Johnson, "Burkers and Noddies – Town Tinkers and the Body Snatchers in Scotland.," Historic UK Ltd. Company, https://www.historic-uk.com/HistoryUK/HistoryofScotland/Burkers-Noddies/, Accessed 25 May, 2022.

[141] "Cholera Riot," *Scotsman*, Mar 28 1832, 2.

[142] "Dangerous Trade - Digging up Bodies (Cholera)," *Scotsman*, Feb 1 1832, 3; "Resurrectionists Digging up Bodies," *Scotsman*, Feb 29 1832, 3.

[143] W. Robertson, "Royal Infirmary - Pendrith Case," ibid, Aug 15 1849, 3.

did not exist.[144] And while that belief persisted, the *Vibrio* bacteria travelled freely via infected faeces thrown into the streets, lanes and closes, bedclothes and furniture and the dirt that typified many of the towns, cities and dwellings of the day. The problem was not the ship or its crew, it was the bacteria in/on whatever water, solid or air it had found.

So, until a bacteria could be isolated in the 1880s, the contagionist theory was never fully accepted. To understand this, we again examine Figure 2-2, this time on the left side. In a world that was still waiting for Koch's *Vibrio cholera*, contagionism had none of the 'proofs' that humourism and miasmatic theories held. There seemed to be no provable link with the dirt and filth, the overcrowding and the poor housing that early sanitation efforts had seemed to address. It was one thing for the contagionists to talk about an infective body; it was another thing to show conclusive experimental proof of an actual agent. Until that was done, all contagionist arguments were based simply on theory and 'imagined' creatures.

Edinburgh's View of Cholera Theories

Even the intellectual wealth of arguably one of the best medical communities in the world could not pierce the mystery of cholera infections and disease. It was this very same medical community that was initially heavily advocating humours and miasma as the cause of the epidemic infections and treatments based on these ideas. As discussed above, one of the four humours ideas is the flannel belt or just flannel in general. In 1848, a *Scotsman* advertisement provided several quotes from a *Lancet* article on the preventative aspects of flannel against cholera. In this publication, a prominent surgeon, Mr Nisbet, who served in the East India Company, noted 'that people accustomed to flannels are not subject to cholera, and certainly they are less liable.' The reason …'direct warmth and support to the organs of digestion.' This claim formed the basis for an enterprising Hosier and Shirt Maker at 179 High Street, Edinburgh '… at the request of several of the Most Eminent of the Medical Faculty' (none were ever mentioned by name) to provide such flannel belts 'of various sizes and qualities, and at prices within the reach of all.' An early 1855, *Scotsman* story is also seen about a concerned sister sending her brother in the Crimean War '20 flannel cholera belts … 3 flannel jackets … [and] 4 yards of flannel.'; who could blame her given the experts' opinions?[145]

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[144] "The Fungoid Theory of Cholera," ibid, Oct 27, 2; Royal College of Physicians of London Royal College of Physicians of London, *Report on the Nature and Import of Certain Microscopic Bodies Found in the Intestinal Discharges of Cholera* (London: London, 1849), iii-iv.

[145] "From the Lancet, Flannel as Preventative for Cholera," *Scotsman*, Nov 15 1848, 1; "Advert - Nisbet, the Best Preventative of Cholera (Flannel)," *Scotsman*, Oct 13 1849, 1;"A Young Lady's Christmas Box for Her Brother at Sebastopol - Flannel Belts," *Scotsman*, Jan 13 1855, 4.

And where better than in the foul-smelling, filth and faeces-ridden closes and lanes of the Edinburgh Old Town could an argument for miasma be made (e.g., see again Johnston's review).[146] Several Edinburgh doctors were, in fact, outspoken champions of this theory. Edmund Tatham, one of the earliest (1827) Edinburgh scientific/medical writers on the disease of cholera, reported, 'Numerous conjectures have been thrown out regarding its origin and formation. Nearly all are in favour, however, of the influence of the atmosphere in its production, when assisted by certain conditions of the constitution and peculiar circumstances.'[147]

The *Scotsman* agreed noting the 'Ridiculous Report' that 'the waters of the Firth of Forth have become impregnated with "something" which has a tendency to produce cholera morbus.' These reports had led to people refusing to eat fish from the Forth and for families of sea-bathers to 'have fled from the sea-side into the interior.' The *Scotsman* directly implicated 'the fleshers' [butchers] in this rumour, noting, 'One thing is certain, that moderate eating – especially of butcher meat – in warm weather – moderate exercises, fresh air, and a liberal doze [sic] of sea-bathing, are the best preventatives in the case of infectious diseases of every description.'[148] With a decrease in cholera cases, fish consumption rose again, but a later *Scotsman* article noted the effect of 'unfounded alarms' for the consumption of fruits and vegetables due to a fear they may cause cholera. The *Scotsman* tried to reassure its readers that 'it is absurd to suppose, that wholesome food of any description, taken temperately, will bring on cholera, or any other disease.' The cholera risks of 'flatulent and crude vegetables' was also noted in the *Edinburgh Medical and Surgical Journal*.[149]

An 1849 letter from the Edinburgh Vegetarian Society noted that none of its members had contracted cholera.[150] At a large meeting of the Society in 1851, its President proudly reported only a single, vegetarian death has occurred from the cholera epidemics; clear proof that vegetarianism was a protective choice. The official story changed at that Society's 1855 meeting when the same President reported '… instances of vegetarians being seized with cholera, but there was not an instance of a vegetarian dying of cholera.'.[151] No wonder Kaye's Worsdsell's Vegetable Pills were advertised in the *Scotsman* as protection but also to cure oneself from cholera (Chapter 3).

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[146] Johnston, *Letter to the Lord Provost, Magistrates, and Council of the City of Edinburgh on the State of the Closes in the Lawnmarket, High Street, Canongate and Cowgate*.

[147] E. Tatham, "On the Duration of Fatal Cholera," *Edinburgh Medical and Surgical Journal* 29, no. 94 (1827), 74.

[148] "Ridiculous Report Firth of Forth with Cholera," *Scotsman*, Jun 29 1831, 3.

[149] "Comment on Wholesome, Garden Food Not Causing Cholera," *Scotsman*, Mar 7 1832, 3; "Safety of Fruit and Veg Letter to the Editor," *Scotsman*, Aug 8 1832, 4; Gibbs, "Observations on Cholera", 395.

[150] "Vegetarian Society - No Cholera," *Scotsman*, Nov 21 1849, 2.

[151] "One Vegetarian Society Member Dies of Cholera," *Scotsman*, Aug 6 1851, 4; "Effect of Vegetarianism on Cholera Infections & Deaths," *Scotsman*, Oct 13 1855, 3.

In the 1840s as the second cholera epidemic struck, several Edinburgh-based publications again touted miasma as the obvious source of cholera infections. Dr. James Stark, a physician and first Superintendent of Statistics for Scotland was a prominent figure during these times. His multiple tables of data showing increasing mortality (mainly for cholera and influenza) were interpreted as suggesting that 'Some unascertained and perhaps unascertainable atmospheric influence … [was] the cause of this unprecedented amount of mortality.'[152] These miasmatic, atmospheric influences could include cold and/or heat and even phosphorescence in storms in and around Edinburgh.[153]

It is, therefore, not surprising that as late as 1866, a submission to the *Edinburgh Medical Journal* described both the 1853/54 and 1866 cholera epidemics and their association with 'the epidemic conditions of the atmosphere … the general and particular atmospheric conditions which prevailed during the visitation …. [and] a certain blue mist present night and day, which I connected upon the meteorology of London in relation to the cholera epidemic.'[154] An 1865 *Edinburgh Medical Journal* article provides some additional background into why miasmatists would advance the ideas above. In this article, the author describes the deaths of 100,000 pilgrims in Egypt following the sacrifice of 'perhaps 2,000,000 sheep [which] added to these miasma'. Even in the 1860s and in a prominent medical journal, the idea of a contagious element, being passed between the people was never considered.[155] Only the smells from rotting rubbish and carcasses would be considered as a cause for disease. Indeed, Leith Town Council suggested a similar cause of deaths, especially in infants in 1862, reporting 'It is a fact well-known to all medical men that wherever either animal or vegetable matter exists in a state of decomposition, human life invariably suffers in exact proportion to the amount of noxious exhalation emanating therefrom, and the degree of proximity to the operating cause.' Usually, the miasmatists pointed towards smells but the Leith report continued to explain 'For the history of contagious epidemics, which, no doubt spread their devastating effects through an atmospheric medium … a deadly and subtle poison may surround the population of different localities … without palpable evidence of its immediate presence.' The Leith Town Council specifically pointed to their harbour – the same Firth of Forth so adamantly defended thirty years earlier – as the source of this 'miasmatic' poison.[156] Even as late as 1869, the *Scotsman* wrote an entire article on the 'Gasophane', a somewhat complicated instrument that could 'give a timely

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[152] "Public Health of Edinburgh," *Scotsman*, Dec 15 1847, 3.

[153] "Suggestion of Cold, Spring Winds Being Cause of Cholera", 3; "Cholera Brought on by Unfavorably Hot Weather", 2; "Weather Effects on Cholera (Dr Stark)", 3; "Cholera Deaths - Effects of Low and High Temperatures (Registrar General)", 2; "Phosphorescence in Connection with Storms and Disease," *Scotsman*, Sep 9 1865, 7.

[154] "The Cholera Mist Again," *Edinburgh Medical Journal* 12, no. 3 (1866), 285.

[155] "Egyptian Theory as to the Origin of Cholera," *Edinburgh Medical Journal* 11, no. 4 (1865), 394.

[156] "Leith Town Council: Causes of High Rate of Infant Mortality," *Scotsman*, Mar 5 1862, 2.

indication of the approach or presence of that poisonous state of the atmosphere which is generally believed to precede cholera or other epidemic diseases.'[157] But, there was a reason why thinking about the miasmatic smells was somewhat correct. 1800s Edinburgh was known for its offensive odours of sewage and, importantly, these were the actual substances in aerated form. In particular, the smell was molecules of faeces – potentially laden with *Vibrio cholera*.

For contagionists, Edinburgh doctors and scientists had looked for infective creatures but found nothing except 'food particles.' As noted above, the prominent Royal College of Physicians in London had completely agreed with this fact.[158] So, many early contagionists took a very cautionary approach. For example, a both miasma and contagion approach was seen in the first, 1831, cholera report of the Edinburgh Board of Health where the *Scotsman* reviewer stated,

> The Board are satisfied, that the disease may arise spontaneously from hidden causes; and that is may also become contagious in circumstances not yet ascertained. But they are fully warranted in declaring, that, when it does become contagious, the risk of its spreading in that manner is very much diminished if due attention is paid to cleanliness and sobriety.

And while 'hidden causes' do not necessarily mean 'miasma', the next lines expressed the Board's caution to fully committing to a 'contagious' source when they suggested that the inhabitants of Edinburgh 'not to be misled by exaggerated notions of its contagious nature ….'[159] A January 1832 'Cholera Update' did little to help as the writer produced both miasmatic, temperature-related arguments and 'the remarkable tendency of the disease to travel in a north-west direction' but also more contagionist suggestions of quick and aggressive mortality striking large parts of entire towns.[160] As cholera proceeded to strike Edinburgh, the *Scotsman's* tone changed slightly as they noted 'Speaking generally, there must be something either in the air, the water, or the condition of the inhabitants.' Despite not mentioning some 'organism,' the mentions of weather and atmospheric causes were no longer seen.[161] No wonder everyone was confused.

These ambiguities can also be seen affecting local politics in the post-1832 epidemic writing of David Craigie, who had served as the Physician at the Castle-Hill Cholera Hospital and was under the direction of the Edinburgh Board of Health and their policies. Their cholera policy was one of the

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[157] "The 'Gasophanes' (Cholera)," *Scotsman*, Aug 12 1869, 3.
[158] "The Fungoid Theory of Cholera", 2; Royal College of Physicians of London, *Report on the Nature and Import of Certain Microscopic Bodies Found in the Intestinal Discharges of Cholera*, iii-iv.
[159] Chambers, "Report of the Edinburgh Board of Health", 4.
[160] "Cholera Update," ibid, Nov 11 1832, 2.
[161] "Re-Emergence of Cholera, Possible Reasons," *Scotsman*, Mar 28 1832, 2.

'cautious contagionism' noted above. Dr. Craigie, who seemed to support full contagion theories, wrote about the possibility of censure if he spoke up and the fact that 'no good could result from any individual stating his own opinions, persuasions, and convictions.'[162] So, the relative quiet from the contagionists may have been due to local politics. Humoural and miasmatic theories certainly had an 'appeal' in the 1830s that invisible little creatures did not.

But there were some exceptions to these ambiguous contagionists. Definite, contagionist steps were taken as Edinburgh prepared for the 1832 epidemic. One writer to the *Scotsman* suggested an idea of contagion and cleanliness to his benefit – namely that 'to promote cleanliness among the lower orders of people … [was] it not imperative on Government to grant an immediate suspension of the duty on soap?'[163] More official publications specific to Edinburgh followed from the City Magistrates of Edinburgh, Commission on Police, Committee of Justices of the Peace for the county of Edinburgh, and, finally, the Head of the Cleaning Department. Each of these publications focused on the prophylactic cleaning of physical locations – 'the Cowgate and confined streets,' 'to memorialize the Town Council and the Water Company, for a supply of water to wash the closes,' 'securing cleanliness and free ventilation in their residences' and 'from garrets, cellars, occupied and unoccupied houses.' Like the miasmatists, these publications showed direct efforts towards cleanliness and sanitation; but differently, there was no discussion of air or smells or atmospheric qualities and only a direct or indirect inference to the 'infectivity' of cholera.[164] In December, 1831, a painter from St James' Square even offered 'the services of his workmen to assist in whitewashing the dwellings of the poor.'[165]

But some Edinburgh doctors directly proposed a contagionist idea of cholera disease. An 1827 review of Dr. Kennedy's imminent publication quoted him as saying, 'To the best of my judgment, I know no character belonging to any contagious disease which cholera does not appear to me to possess; and if it not be contagious, I know no other disease which I should be inclined to consider so.'[166] As cholera was striking the city in 1832, a *Scotsman* reader from Kirkcudbright asserted that the idea that 'cholera is caused by a peculiar state of the atmosphere … seems erroneous, for it often moves in direct opposition to the wind or current of the atmosphere, and breaks out at a great

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[162] D. Craigie, "Remarks on the History and Etiology of Cholera," *Edinburgh Medical and Surgical Journal* 39, no. 115 (1833), 333.

[163] Correspondent, "Request to End Duty on Soap Due to Cholera," *Scotsman*, Jul 27 1831, 2.

[164] "Precautions against Cholera," ibid, Nov 2, 1831, 3; "Commission on Police for Water to Wash Closes," *Scotsman*, Nov 9 1831, 3; "County of Edinburgh Regarding Cleanliness Throughout County," *Scotsman*, Nov 23 1831, 3; "City Purification," *Scotsman*, Nov 30 1831, 2.

[165] "Nicholson St Apothacary and St James Square Whitewasher," *Scotsman*, Dec 10 1831, 3.

[166] R.H. Kennedy, "Notes on the Epidemic Cholera," *Edinburgh Medical and Surgical Journal* 28, no. 93 (1827), 426.

distance from its former situation.' Rather, the author suggested 'effluvia, or invisible particles of matter arising from the cholera patient' which, when they make it to the stomach, 'act as a strong poison.' The author specifically mentioned both incidences of contact between infected and non-infected persons and finished the letter by suggesting to 'intercept, repel, or absorb the poisonous particles' to prevent added cholera infections.[167] Dr. Muir from Musselburgh was noted by the *Scotsman* as 'a zealous contagionist, and we must own that his arguments seem very weighty.'[168] In 1834, a physician from the Stockport area of Edinburgh wrote in no uncertain terms about an organism that caused cholera and even the effects of dose on the severity. He also addressed the 'absence' of an organism by noting, 'Believing, then, that the choleric virus [sic] is discoverable by no tests, and that its deleterious effects are to be subdued by no specific, but that there resides in the actions of the system a power of combating and subduing its influence, our object in the treatment is to support these vital actions.'[169] In other words, whether you can see the creatures or not … just treat the patients for them. Other contagionists in Edinburgh remained relatively quiet for the remainder of the 1830s and 1840s while 'anti-' or 'non-contagionist' arguments flourished.[170] In 1850 (perhaps prompted by the 1848/49 Edinburgh epidemic), a sole article about a fungal infection theory did appear in the *Edinburgh Medical & Surgical Journal*[171]

Then, as cholera again struck Edinburgh briefly in 1853 and again in 1854, a change was about to happen, and contagion theory was about to become a major player in cholera disease. One Letter to the Editor of the *Scotsman* touted the sensibility of 'making use of water for drinking after it has been boiled.'[172] Active sanitation efforts that seemed more focused on a 'contagious element' included drainage of suspected, infected water sources and active cleaning of the closes and streets by the Police Commission, recognition and public support of the efforts of the Lord Provost and Town Council during the epidemic and Houses of Refuge for the poor/homeless that allowed 'strict

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[167] "Kirkcudbright Letter to the Editor," *Scotsman*, Jan 25 1832, 2.

[168] "Review of 'Practical Observations on Malignant Cholera' by Dr. M Muir, Musselburgh," *Scotsman*, Feb 22 1832, 3.

[169] S. Gaskell, "An Attempt to Account for the Various Methods Adopted in the Treatment of Malignant Cholera," *Edinburgh Medical and Surgical Journal* 42, no. 120 (1834), 78.

[170] Medical Correspondent, "The Cholera," *Scotsman*, Nov 16 1831, 2; Editors, "Letter to Sir Henry Halford on the Tendency of the Proposed Regulations for Cholera, with Observations as to the Nature of the Disease, and the Course to Be Followed Immediately on Its Appearance in a Family," *Athenaeum*, no. 217 (1831), 832-833; A.T. Christie, "A Treatise on the Epidemic Cholera; Containing Its History, Symptoms, Autopsy, Etiology, Causes, and Treatment," *London Medical and Physical Journal* Vol.14 (83) (1833), 365; "Cholera Not Contagious," *Scotsman*, Nov 18 1848, 3; "Summary - Geographical Progress of Cholera," *Scotsman*, Dec 23 1848, 2.

[171] "Edinburgh Medical & Surgical Journal - Hypothesis Which Ascribes Cholera to Fungi," *Scotsman*, Jan 9 1850, 1.

[172] "Cholera - Preventative Means," *Scotsman*, Oct 21 1854, 3.

surveillance and precautionary measures for anyone showing early symptoms of cholera.[173] Another important feature of the 1850s response to cholera was the establishment of a Sanitary Conference for the city of Edinburgh starting in February 1853, during and even after the epidemic.[174] This was a notable change from 1832 when a multitude of cholera pamphlets from a variety of sources with seemingly endless and differing opinions and recommendations was the norm. In 1866 when the final, Edinburgh cholera epidemic occurred, the predominant recommendation for Edinburgh was that of the Royal College of Physicians, in essence mimicked by Dr. Littlejohn.[175]

Following the epidemic, several more contagion theory articles appeared. In 1855, the *Edinburgh New Philosophical Journal* reviewed a new book by Dr. Daubney noting his beliefs regarding all epidemic diseases, including cholera. Daubney still discussed threads of miasmic theory including a 'deterioration in the atmosphere' and 'dependence on extraneous conditions, such as soil, climate, and humidity, being limited to particular districts, streets, houses, or even to one side of an apartment.' But with that miasmatic 'footnote' stated, he wrote further about a 'poison [that] is of organic nature; from its capricious and uncertain operation lying dormant for a time, and then suddenly starting into activity; from its power of indefinite reproduction, transmitting itself from person to person and place to place without exhausting or diminishing its energy.' We again see words like 'fungus' used in direct relation to cholera disease as well as other infective diseases.[176]

When cholera appeared yet again in 1853/54, more contagionists began to be heard. In late 1855, William P. Alison published a paper with exhaustive observations not only by himself but also by a Dr. Budd. This eleven-page essay specifically implicated the infectivity of the 'rice-water dejections' and directly recommended separate toilets for use by cholera patients but also consideration of the 'handling' of these 'dejections.' Importantly, Alison also noted the ability for the disease to travel on clothes and other solids.[177] The review by the *Scotsman* puts this work into context when they reported on the theory of Budd and Alison 'which, supported by the strongest

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[173] "Police Commission - Water of Leith," *Scotsman*, Oct 25 1854, 3; "Drainage of Edinburgh," *Scotsman*, May 24 1854, 3; "Lord Provost Efforts Against Cholera." *Scotsman*, Nov 8 1854, 4; "House of Refuge - No Cholera Cases," *Scotsman*, Nov 22 1854, 3.

[174] "St Cuthbert's Parochial Board - Adoption of Sanitary Measures (Cholera)," *Scotsman*, Feb 23 1853, 3; "Warnings of the Approach & Sanitary Measures," *Scotsman*, Mar 18 1854, 2; "Sanitary Conference - Justices' Ruling," *Scotsman*, Apr 01 1854, 3; "City Parochial Board - Remuneration of Sanitary Board Officials," *Scotsman*, Jan 6 1855, 2.

[175] "The Cholera - Suggestions by the Royal College of Physicians for Preparation against an Outbreak of Cholera in Edinburgh", *Scotsman*, 20 Aug 1866, 2; "Precautions against Cholera (Littlejohn)," *Scotsman*, Aug 23 1866, 2.

[176] "Dr Daubney - Causes of the Production of Epidemic Diseases," *Scotsman*, Dec 12 1855, 5.

[177] W. P. Alison, "On the Communicability of Cholera by Dejections," *Edinburgh Medical Journal* 1, no. 6 (1855), 481-492.

evidence, destroys the mystery which has shrouded the progress of the fell destroyer, and unveils the manner of its diffusion. It is this -- A specific poison exists in the dejections of the patients.'[178] And while both the doctors and the *Scotsman* are a bit off as far as the particulars, a truly infective element is suggested and, unlike the previous two decades, done so openly.

In the next few years, the idea of that 'specific poison' was explored much further in Edinburgh. A Dr. Huxley gave an entire lecture on the topic of a 'fungus' and cholera to the Edinburgh Philosophical Institute in 1856.[179] Books were written not only discussing this 'poison' but also how overcrowding can lead to its passage from one person to another.[180] The Edinburgh Archaeological Institute even looked back to the Romans and how they handled sewage and asked why Britain (and Edinburgh) could not do the same as protection against cholera disease.[181] The term 'Sanitary Science' began to be seen more frequently and its methods explained to the general public; even life-long advocates against contagion were convinced of its credibility.[182] Doctors and scientists started asking questions about diseases in other animals including grouse, cattle and hogs, sparking an interest in sanitation efforts with regards to animals and livestock. These discussions continued into the 1860s and even included Professor Dick of the Edinburgh Veterinary College.[183]

Others Edinburgh medical emissaries were also prominent in the debate, albeit in a confusing way. Pelling recounts the influence of Dr. Southwood Smith (a graduate of Edinburgh Medical School who never practised medicine but who rather pursued the basis of mental 'phenomenon'). Southwood Smith mainly relied on William Cullen's 'nosology' of diseases to define the world where fever, inflammation and the direct roles of the bodily fluids and organs as part of an explanation of (infective) disease. Fevers were felt to be 'pre-eminently dependent upon, or associated with, conditions such as putrefaction, overcrowding, famine and uncleanliness, and the group also included, often without distinction, such diseases as diarrhoea, scurvy, dysentery, and relapsing fever which was peculiarly associated with famine.' Other diseases such as yellow fever, plague and typhus were often combined. He gradually admitted to some diseases 'caused by a 'peculiar and

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[178] "Edinburgh Medical Journal - Communicability of Cholera," *Scotsman*, Dec 12 1855, 5.
[179] "Query Fungal Connection to Cholera," *Scotsman*, Jan 9 1856, 2.
[180] "Epidemics Considered with Relation to Their Common Nature, and to Climate and Civilisation," *Scotsman*, Jul 16 1856, 3; "Dr Russell - Contagion Theory Conversion," *Scotsman*, Oct 14 1863, 6.
[181] "Ancient Methods Used against Cholera," *Scotsman*, Jul 23 1856, 3.
[182] G. Bell, "Privy Council - Sanitary Science," *Daily Scotsman*, Apr 1 1859, 2.
[183] "Disease of Grouse - Association with Cholera Type Infections," *Scotsman*, May 19 1858, 3; "The Cattle Plagues and Diseased Meat, in Their Relation with the Public Health and with the Interests of Agriculture," *Scotsman*, Apr 25 1857, 1; "Hog Cholera," *Scotsman*, Jan 2 1863, 2; "Refute of 'Hog Cholera'", 4; "Edinburgh County Meetings - Professor Dick (Cholera)," *Scotsman*, Aug 29 1865, 2; "Meeting of the Chamber of Agriculture (Disease Prevention)," *Scotsman*, Aug 17 1865, 3.

specific' poison … and 'another form of animal matter, secreted only in the body, and capable of producing a series of specific symptoms.' He still strongly considered that temperature, moisture, etc were the primary cause even coining the phrase 'epidemic atmosphere.' He also suggested that 'the term 'contagious' were restricted to diseases which arose from specific contagion, and if 'infectious' were used to describe those diseases which arose from every other poison.' Southwood Smith specifically felt that pain/suffering was best treated by 'spiritual and physical amelioration.'[184]

Unfortunately, some prominent Edinburgh Medical School-trained physicians of the time like Neil Arnott and James Kay-Shuttleworth supported Smith's position. The older and more 'experienced' Dr. Charles Maclean, an avid opponent of contagion, backed that view 'that the 'doctrine of contagion' was a pious fraud ….' William Farr, who had helped with Snow's research, joined the group, providing impressive 'Life Tables' and formulae of diseases that reinforced the group's cause. Smith's articles in *The Lancet* and other prominent journals affected public view although his and his colleagues' views still did not fall into favour with most of the medical profession.[185]

Summary

In 1884, Koch and colleagues would ultimately prove that the disease cholera resulted from the infection by a particular bacterium, *Vibrio cholera* (although the British government would refute Koch's discovery for several more years).[186] Despite this discovery now being almost 140 years old, cholera epidemics still ravage the world, mainly in poor and undeveloped areas (perhaps reminiscent of the Edinburgh Old Town). Even with the bacteria identified, 323,369 cases with 857 deaths in twenty-four countries were still recorded in 2020 alone.[187] Cholera has never been defeated, just kept at bay, and determining what 'specifically causes' cholera infections is not enough. Perhaps the operable question is what theory can actually say about what causes cholera disease – four humours? Fumes from decaying organic matter and atmospheric anomalies? An 'invisible' bacterium? One theory? None? All?

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[184] M. Pelling, *Cholera, Fever and English Medicine, 1825-1865*, Oxford Historical Monographs (Oxford: Oxford University Press, 1978), 7-8, 10-11, 14, 18-19, 22, 24.

[185] Ibid, , 12, 27-19, 107; Strangely in later life, Farr started suggesting the concept that 'Zymotic particles floated in the air, 'forming a morbid atmosphere, the density of which will be in proportion to the proximity of the bodies by which is it given off, and the greater or less facility to escape' (Pelling, p 107). Despite what sounds very much like a bacteria or virus, he continued to be a proponent, like Chadwick and Southwood Smith, of Miasma. (Pelling, pp 80-112).

[186] Koch, "An Address on Cholera and Its Bacillus", 403-407; E Klein, "The Bacteria of Asiatic Cholera," *Edinburgh Medical Journal* 36, no. 3 (1890), 252-254; M. Ogawa, "Uneasy Bedfellows: Science and Politics in the Refutation of Koch's Bacterial Theory of Cholera," *Bulletin of the History of Medicine* 74, no. 4 (2000), 671-707.

[187] "Cholera Annual Report 2020", 445-460.

The complex and confusing presentations of cholera would result in the varying theories that created proponents and opponents of humours, miasma, contagion and the myriad of other theories that persisted in the 1800s. Basic components, or in 18th/19th century-speak, humours of the body were being attacked and their health or lack thereof changed resistance to the infection. Smells and rotting objects (and their aeration) were potential places where *Vibrio* was hiding, such as the gardyloo-filled passages and houses of the Old Town. Contagion and resulting quarantine were targeting the wrong thing and while Alison would be a strong proponent, invisible creatures that cause disease were going to have a hard time being believed in light of blood, phlegm, biles or stinking and rotting refuse that could also be easily removed. Perhaps all these theories can be seen as partly 'correct' in light of the still limited scientific and medical knowledge of cholera throughout the 19th century. Only the advancement of microscopy later in the century would provide true answers.

What causes the disease of cholera? The infection by *Vibrio cholera*. Full stop. What prompts that infection to take place and potentially cause disease? That important step is dependent on a myriad of physical and socioeconomic factors, each affected by their own history of progress and development (see Figure 2-2). Together, *Vibrio cholera* and these factors helped to generate the varied theories that were developed and supported by various individuals who were completely convinced they were correct while all of them were, perhaps, just a little bit wrong.

Chapter 3. Medical Treatments in the 1800s

Introduction

Howard-Jones quotes a doctor from Berlin, who declared in 1833: 'we know of absolutely no other disease in which the utter powerlessness of the healing art is manifested as cholera.'"[188] Sherman writes similarly about 'nostrums and quack remedies' used by physicians in the 1800s as they sought to find a treatment for cholera.[189] But, perhaps, these treatments were not quite as lacking or bizarre as they may at first seem. While advances were being made regarding theories of infection (Chapter 2), we must realise that options for treatment were still very limited. With only some exceptions, the practice of medicine was not necessarily curative but rather providing mainly symptomatic care and relief. Knowledge of the relative situation physicians had to face is, therefore, an important part of understanding the state of medicine in the 1800s. More importantly, it provides a context for the methods they were trying – and often with good reason and effect. Opiates, in various forms, were one of the few actual 'medicines' available for doctors to give to patients but their proper use was still being determined. James Young Simpson's uses of gases for medical uses were only starting to emerge. Oxygen was available but only in equipped hospitals.[190] The remainder of the doctor's bag contained what looked more like the kitchen pantry with a variety of plant- and animal-based mixtures. Clinical medicine was still in its infancy.

Despite the above concerns, Edinburgh doctors did have options available to them for treating the infection that could have helped kill or weaken the *Vibrio* bacteria. Other treatments also could and would have relieved the major symptoms of (1) pain both general from intestinal and muscular spasms but also from the inflammation of both the gastrointestinal tract and, potentially the blood vessels; (2) loss of fluids and salts and the resulting deadly acidosis as well as thickening and decreased circulation of the blood resulting in the cold and blue appearance and (3) the general malaise and lethargy that all the above caused. This chapter will look at the overall theoretical effect of the multiple methods of physicians followed by an examination of individual medical treatments used by Edinburgh physicians during the four cholera epidemics. Most important is the point that a majority of these treatments were doing something, at least symptomatically, for the patients.

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[188] Howard-Jones, "Cholera Therapy in the Nineteenth Century", 374.

[189] Sherman, "Cholera", 47.

[190] John Abercrombie, Suggestions Submitted to the Medical Practioners …, 1832, 10; D. Craigie, "Observations, Pathological and Therapeutic, on the Epidemic Cholera, as It Has Prevailed in Edinburgh and Its Vicinity," *Edinburgh Medical and Surgical Journal* 39, no. 114 (1833), 62-63; W.H. Lizars, "Cholera Asphyxia as It Appeared in 1832 and in 1848," *Scotsman*, Oct 16 1852, 63 & 67.

Curing the Infection?

As noted in Chapter 1, the bacterium first enters the stomach where it encounters the highly acidic environment and utilises its ability to swap in and out DNA factors that help it survive. Depending on the time it takes to enter into the intestines, *Vibrio* would remain in the stomach for up to four hours before proceeding to the small intestine where the main infection effect occurs.[191] Studies in mice show the vast majority of the cholera infection occurs in the first portion of the small intestine just beyond the stomach although *Vibrio* is found in lesser amounts in other sections as well.[192] Thus, anything taken orally and early could have a real chance to interact with the bacteria before or during the release and activity of the CT molecule and the start of the active disease.

Alcohol

Alcohol was often seen in the recommendations of several physicians both as a curative and a prophylactic measure for all age groups. But how could alcohol have helped fight the actual infection of *Vibrio*?

A rather novel, recent investigation has shed potential light on the relationship between alcohol consumption and cholera infection. The authors report, 'We found *V. cholerae* did not survive in 20% gin at 1 hour, 18.75% gin at 6 hours and 15% gin at 26 hours …. The results were much more dramatic with red wine, *V. cholerae* did not survive in 6.25% wine at 30 min.'[193] In addition, heavy alcohol use reduced the acidity of the stomach and made a lower dose of cholera more effective in heavy drinkers. However, moderate drinkers have a slightly higher level of stomach acid which would serve to kill cholera and be somewhat protective against cholera infection (i.e., the effective dose in the moderate drinker would need to be higher). This suggestion is supported by an 1890s microbiologist who noted that cholera grows best in an alkaline environment (i.e., pH 8.0).[194] Therefore, the effect of alcohol on the acidic environment of the stomach could also impact cholera infectivity and serious disease and, perhaps, even eliminate the infection altogether. Perhaps a drink of brandy by everyone in the family could have been a protective factor (see Figure 3-1).

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[191] "Gastric Emptying," ed. Paige Bennett, et al., *Diagnostic Imaging: Nuclear Medicine (Second Edition)* (Philadelphia: Elsevier, 2016), https://www.sciencedirect.com/science/article/pii/B9780323377539500311, Accessed 5 Mar, 2023.

[192] Yves A. Millet et al., "Insights into Vibrio Cholerae Intestinal Colonization from Monitoring Fluorescently Labeled Bacteria: E1004405," *PLoS pathogens* 10, no. 10 (2014); Ramamurthy and Bhattacharya, "Chapter 1. General Introduction".

[193] J.S. Guthrie & D.O. Ho-Yen, "Alcohol and Cholera," *Journal of the Royal Society of Medicine* 104, no. 3 (2011), 98.

[194] Kitasato, 1889 as referenced in B. Altonen, "Commentary: John Lea's Cholera with Reference to Geological Theory, April 1850," *International Journal of Epidemiology* 42, no. 1 (2013) 60.

Figure 3-1. Fortifying Against the Cholera Image from an 1831 London Publication. Brandy was recommended for adults but also children to defend them against cholera disease.[195]

[195]National Library of Medicine Digital Collections, "Fortifying against the Cholera," https://collections.nlm.nih.gov/catalog/nlm:nlmuid-101393384-img, Accessed 1 Sep, 2022.

Rhubarb

Rhubarb is mentioned as an additive in several Edinburgh doctors' orders.[196] Rhubarb has been shown to inhibit the ability for infective agents to cross the barrier from the intestine into the cell and also increases the movement of foodstuffs and faeces through the intestines.[197] Recent research has also shown that rhubarb action works the same as modern-day senna (as well as aloe) used to treat constipation.[198] As such, rhubarb could have decreased the ability of *Vibrio*'s CT factor to enter the small intestine's cells and, paradoxically, helped the patient by increasing the diarrhoea but in a way that would specifically eliminate the still active, *Vibrio* bacteria.

A number of other substances that were used in the 19th century for specifically killing the cholera bacteria are today considered to be poisonous or, at the least, extremely toxic to the human body. Despite this obvious concern, the potential good effects against cholera will be discussed in turn.

Calomel

Calomel appears to have been an extremely popular medication for physicians during the 19th century – a fact made even more interesting since calomel is simply a mercury compound. Even today, mercury is still recognised for its excellent induction of vomiting and ability to kill bacteria and it is sometimes still found in modern-day insecticides and fungicides.[199] In 1930, the Merck Manual, a classic, medical book still published today by the drug company Merck & Co., listed mercury's use to treat cholera amongst a variety of other infective and non-infective maladies.[200] Thus, both the vomiting/purging effects and potential anti-bacterial effects of calomel seen in the 1800s could have,

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[196] J. Abercrombie, "Suggestions Submitted to the Medical Practitioners of Edinburgh on the Characters and Treatment of the Malignant Cholera " (Edinburgh 1832), 7; A.T. Christie, "Observations on the Nature and Treatment of Cholera, and on the Pathology of Mucous Membranes (1828)," *Edinburgh Medical and Surgical Journal* 32, no. 101 (1829), 50-51 & 61; Ainsie, "Observations on the Cholera Morbus of India", 160.

[197] X. Zhang, Wang, L. & and Chen, D.C., "Effect of Rhubarb on Gastrointestinal Dysfunction in Critically Ill Patients: A Retrospective Study Based on Propensity Score Matching," *Chin Med J (Engl)* 131, no. 10 (2018), 1142.

[198] "Senna," https://bnf.nice.org.uk/drugs/senna, Accessed 22 Aug, 2022; Aloe juice is available in many countries and was sold over the counter in the United States as a powerful laxative until 2002 when it was banned by the US Food and Drug Agency since safety and related efficacy had not been well established. See "Aloe Vera Risks', WebMD, , https://www.webmd.com/diet/supplement-guide-aloe-vera#:~:text=Oral%20aloe%2C%20which%20has%20a,the%20colon%20during%20a%20colonoscopy, Accessed 22 Aug, 2022.

[199] "Calomel", Encyclopedia Britannica, https://www.britannica.com/science/calomel, Accessed 22 Aug, 2022.

[200] Merck's Index: Fourth Edition (1930) as per https://reginajeffers.blog/2015/04/06/calomel-a-poison-once-the-standard-for-medical-treatment/, Accessed 22 Aug, 2022.

indeed, ‘cured’ cholera patients. The idea of trying to get that poison out by either forcing vomiting or flushing of the bowels is seen in many of the other Edinburgh treatments for cholera.

However, continued exposure to mercury can cause serious neurological problems and even death. This fact has led to a ban of all mercury-containing thermometers in the past few decades.[201] But if ingested during the early phase of a *Vibrio* infection, its use would have potentially killed *Vibrio* bacteria either in the stomach or in the intestine and led to a perceived curative effect (Figure 3-2).[202]

Figure 3-2. Calomel. Note the listing of ‘Mercurous Chloride’ just under the product name.[203]

Ammonia

The use of ammonia is also seen in several instances in Edinburgh treatment of cholera and would have potentially killed the *Vibrio* bacteria if they were still in the patient’s stomach. Ammonia, usually in liquid form, is widely used today for cleaning and sterilising homes by killing bacteria (household, cleaning ammonia usually is a 5-10% solution in water). It is also considered as toxic to humans being directly damaging to the eyes, nose, throat, lungs and pulmonary tract. Repeated exposure to or ingestion of ammonia has led to serious injuries and/or death.[204] The same potentially lethal effect on humans could also have affected cholera. In essence, a cure.

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[201] “Mercury thermometers face final phase out”, Phys Org, 24 Feb 2011, https://phys.org/news/2011-02-mercury-thermometers-phase.html, Accessed 22 Aug, 2022.

[202] R. Jeffers, "Calomel: A Poison Once the Standard for Medical Treatment," https://reginajeffers.blog/2015/04/06/calomel-a-poison-once-the-standard-for-medical-treatment/, Accessed 7 Apr, 2020.

[203] Park Davis & Co Calomel, Wintergreen Flavor, PinInterest, https://www.pinterest.com/pin/604678687462201439/, Accessed 22 Aug, 2022.

[204] Prudent Reviews, "What Cleaning Products Contain Ammonia (19 Examples)," https://prudentreviews.com/cleaning-products-ammoniaAccessed 22 Aug, 2022; See also Ann Arbor District Library, "Suicide by Ammonia," https://aadl.org/node/103782, Accessed 22 Aug, 2022.

Colocynth

Calomel often was combined with colocynth in Edinburgh in the 1800s.[205] Colocynth, also *known as 'bitter cucumber', 'vine of Sodom' or 'bitter apple',* contains the chemicals cucurbitacins which can serve as an anti-inflammatory for the stomach and intestines as well as a purgative and laxative. But modern-day evaluation suggests that ingestion of even small amounts can lead to severe irritation of the lining of the stomach and intestines, bloody diarrhoea, kidney damage, bloody urine, an inability to urinate, convulsions, paralysis, and even death.[206] It was banned in the US in 1991 but is still readily available today in a variety of forms as an unregulated, herbal medicine in parts of the world, including non-allopathic clinical sources in the UK – often as Hoffman's drops (Figure 3-3).[207]

Figure 3-3. Hoffman's Drops (no longer available) and Colocynth (available online and at Herbal Stores).[208]

But could colocynth have actually helped cholera patients? The same, potentially lethal irritation could have disrupted the intestinal cells enough that *Vibrio cholera* and its own toxin could not establish the channels needed to produce the watery discharge. Colocynth may also have been a direct toxin to the bacteria when they were in the stomach and intestines. As such, colocynth's use could have, indeed, been effective for cholera patients – if it did not kill them first.

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[205] As noted in Lizars, 1832, 62; Gibbs, "Observations on Cholera", 396; Craigie, "Observations, Pathological and Therapeutic, on the Epidemic Cholera, as It Has Prevailed in Edinburgh and Its Vicinity", 49-50.

[206] "Colocynth", RXList, 11 June 2011, https://www.rxlist.com/colocynth/supplements.htm, Accessed 22 Aug, 2022.

[207] "Colocynth – Bitter Cucumber, Helios Hemeopathy", https://www.helios.co.uk/en/shop/colocynth, Accessed 22 Aug, 2022; "Citrullus colocynthis – Bitter Apple", RHS, https://www.rhs.org.uk/plants/157826/citrullus-colocynthis/details, Accessed 22 Aug, 2022.

[208] "Hoffmans Drops", Des Moines County Historical Society, https://sw-ke.facebook.com/DMCHistSoc/posts/as-a-collections-managermuseum-professional-i-have-been-asked-by-more-than-one-p/10158194331923284/, Accessed 22 Aug, 2022; Ebay, "Sbc Colocynth," https://www.ebay.co.uk/itm/392813869079, Accessed 22 Aug, 2022.

The Rest of the Kitchen Cupboard, Part 1

As discussed in Chapter 1, the acidity of the stomach does seem to have an effect on *Vibrio*, potentially in changes to protect itself from the stomach's acidic environment. Magnesia, bismuth, turpentine, cinnamon, antimony with mustard and castor oil were all used in Edinburgh for this purpose. The use of magnesia in water is exactly the same as modern 'Milk of Magnesia' or similar thick, white mixtures that coat but also reduce the acid level of the stomach; whether this would have inhibited *Vibrio* while in the stomach is uncertain (Figure 3-4). While a potentially counterintuitive argument, the coating and buffering of magnesia (as well as 'purgative properties') could lessen the cholera infection by limiting attachment of the bacteria and eliminating it from the stomach by vomiting. Its coating effect would also provide symptomatic relief to the cholera sufferers. In a similar way, 'the oxide of bismuth,' today found in the thick, pink liquid of Pepto-Bismol, coats and relieves an upset stomach/digestive tract, but may also specifically help to kill any infective organisms.[209] Much like today, magnesia and bismuth solutions could provide some fluids, reduce the lost ions and help allay both the infection by inducing vomiting and/or diarrhoea and comforting the stomach. Turpentine, used mainly topically but sometimes orally, may have some anti-bacterial qualities which could help reduce the *Vibrio cholera* infection (Figure 3-4).[210] Although the evidence is somewhat limited, cinnamon may also have some antibacterial and antifungal qualities; cinnamon and its relative camphor will be discussed in further detail below.[211] The active ingredient found in poisonous mustard gas also has quite well-known antibacterial qualities. Antimony salt combined with mustard for an enema would also have an antimicrobial action although with toxicity to the patient.[212] Castor oil, is obtained from the *Ricinus communis* plant, the seeds from which the lethal toxin ricin is also derived. Large amounts of castor oil can be poisonous, but, if used in smaller doses, it could have had some bactericidal effects in cholera patients if taken early enough.[213] As such, all of these agents could have been helpful to the suffering cholera patients in the 1800s.

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[209] Medical News Today, "Milk of Magnesia: What You Need to Know," https://www.medicalnewstoday.com/articles/323763, Accessed 22 Sep, 2023; "Facts About Bismuth", LiveScience, 21 Nov 2017, https://www.livescience.com/39451-bismuth.html, Accessed 22 Aug, 2022.

[210] Drugs.com, "Turpentine," https://www.drugs.com/npp/turpentine.html, Accessed 22 Aug, 2022.

[211] Joe Leech, "10 Evidence-Based Health Benefits of Cinnamon," *Healthline*, https://www.healthline.com/nutrition/10-proven-benefits-of-cinnamon#TOC_TITLE_HDR_13, Accessed 7 Aug, 2022.

[212] "Antimony: a metallic cleanse of the Middle Ages", McGill University, Office for Science and Society: Separating Sense from Nonsense, 15 Feb, 2017, https://www.mcgill.ca/oss/article/antimony-metallic-cleanse-middle-ages, Accessed 7 Aug, 2022.

[213] Castor Oil Overdose", MedLine Plus, https://medlineplus.gov/ency/article/002768.htm, Accessed 7 Aug, 2022.

Figure 3-4. Bismuth/Milk of Magnesia Preparations and Turpentine Medicinal Bottle.

Although Bismuth preparations were readily available throughout the 1800s, Charles Phillips of New York formulated his own 'Phillips Milk of Magnesia' and successfully marketed it in 1873. Bayer Healthcare purchased the company in 1995 but the product still thrives today.[214]

Pain and Inflammation Control

The pain experienced by cholera patients has been described in previous chapters, resulting mainly from spasms of the intestines and the muscles of the body. Inflammation focused in the gastrointestinal tract but also the blood vessels (Chapter 1) is also a major part of any infective process and is prominent part of cholera disease. Importantly, inflammation actually releases various molecules into the human body that are responsible for pain. As such, treating inflammation also treats pain and decreases the effects of the *Vibrio* infection. Several examples of such anti-inflammatory treatments are seen in 19th century cholera treatments.

[214] Trademarks and Manufacturers, "Genuine Philip's Milk of Magnesia," http://productmanufacturers.blogspot.com/2012/10/genuine-phillips-milk-of-magnesia.html. Accessed 24 Oct, 2012; "Antique Spirits of Turpentine- vintage labelled quack medicine bottle", Etsy, https://www.etsy.com/ie/listing/1219471562/antique-spirits-of-turpentine-vintage, Accessed 18 Sep, 2022.

Opiates

The exact point of the first discovery by man of the various properties of opium is not known but there is ample evidence that it has been known and in use since the 6th century BC.[215] Friedrich Sertürner first isolated the opiate 'morphine' in 1804 and, by the mid-1800s, his method was optimised so that morphine could be produced on an industrial scale with opium soap, pills, lozenges, plasters, enemas, liniments, and other products such as vinegar of opium found in most British chemists. Laudanum, a tincture of 10% opium and alcohol, was the most readily available version of opiates available in the 1800s and was available to clinician and non-clinician alike.[216] Opium and its derivatives act on the human brain, spinal cord and nervous cells to create the classic pain control along with an hallucination and addiction potential. Side effects can include constipation (due to a slowing of the movement of the intestines), calming and fatigue.[217] Opiates are used for the terminally ill patient in modern, palliative care medicine not just for pain control but also for anxiety (including from breathlessness). As such, opiates used in the treatment of cholera would provide much needed pain relief, potentially slow the diarrhoea, decrease anxiety and the feeling of 'air hunger' and would also be something of a sedative.

Mustard

Mustard has been used as far back as the ancient Egyptians and mustard plasters were first suggested by Hippocrates, the 'father' of modern medicine.[218] The medical effects of mustard and mustard oils, oral and topical, are still not well proven but there are past and present indications for its beneficial effects for lung problems (e.g., cough and congestion) and an increase in circulation and potentially for pain (e.g., muscle aches, cramping, headache, back pain and arthritis) via both its anti-inflammatory and warming effect. The anti-inflammatory effect and the warming provided by topical to a painful stomach and abdomen presents another possible reason why mustard plasters could have provided some 'relief' to patients suffering from pain during a cholera infection (Figure 3-5).[219]

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[215] K. Brook, J. Bennett, and S.P. Desai, "The Chemical History of Morphine: An 8000-Year Journey, from Resin to De-Novo Synthesis," *Journal of Anesthesia History* 3, no. 2 (2017), 50-51; G.W. Pasternak and Y.K. Pan, "Mu Opioids and Their Receptors: Evolution of a Concept," *Pharmacol Rev.* 65, no. 4 (2013), 1259.

[216] "Laudanum", Encyclopedia Britannica, https://www.britannica.com/science/laudanum, Accessed 2 Sep, 2022; "Morphinomania in the 19th Century", National Trust for Scotland, https://www.nts.org.uk/stories/morphinomania-in-the-19th-century, Accessed 2 Sep, 2022.

[217] Pasternak and Pan, "Mu Opioids and Their Receptors: Evolution of a Concept", 1276-1277.

[218] "Brief History of Mustard Plasters", World History US, 15 Aug, 2017, https://worldhistory.us/american-history/brief-history-of-mustard-plasters.php, Accessed 7 Oct, 2022.

[219] "Does a Mustard Plaster Work", Healthline, 30 Sept, 2020, https://www.healthline.com/health/does-mustard-plaster-work-for-coughs-and-colds#does-it-work, Accessed 7 Oct, 2022.

Figure 3-5. Victorian-Era Mustard Plaster.[220]

Camphor

Camphor is a well-known anti-inflammatory made in Victorian times by distilling the wood of the *Cinnamomum camphora* tree.[221] It is still used in modern, topical creams (e.g., Vicks VapoRub, Tiger Balm, Biofreeze gel and, combined with turpentine, Bengay). In its oil forms its anti-inflammatory effect is still used today for atopic dermatitis, muscle and joint pain, headaches, coughs and congestion, superficial burns treatment and, although its efficacy is still being studied, possibly in chronic diseases like cancers, Alzheimer's dementia and others.[222] Thus, oral ingestion of camphor could have delivered doses of an anti-inflammatory medication directly to the gastrointestinal tract where the inflammation was present (Figure 3-6). If delivered by enema, the camphor would still be absorbed by the colon and into the blood stream. Although the sluggish circulation of a severely-affected cholera patient may have limited its distribution, at least the medication had the chance of reaching all inflamed parts of the body, including the blood vessels themselves.

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[220] "Pharmacy, Mustard Plaster, 20th Century," (Victorian Collections), https://victoriancollections.net.au/items/52a99fc42162ef1a74d6f4c4, Accessed 7 Aug, 2022.

[221] N.-J. Kang et al., "Cinnamomum Camphora Leaves Alleviate Allergic Skin Inflammatory Responses in Vitro and in Vivo," *Toxicol Res.* 35, no. 3 (2019).

[222] "Camphor Oil: Types, Uses and Products", Medical News Today, 22 May, 2020, https://www.medicalnewstoday.com/articles/camphor-oil#_noHeaderPrefixedContent, Accessed 7 Aug, 2022.

Figure 3-6. Camphor Medicinal Bottle.[223]

The Rest of the Kitchen Cupboard, Part 2

The observant reader may have noted the tree from which camphor was originally obtained, *Cinnamomum camphora*. The spice cinnamon is obtained from a close relative in the *Cinnamomum* tree genus. Not surprisingly, cinnamon also has anti-inflammatory qualities and is sometimes used today for gastrointestinal upset, diarrhoea and intestinal gas as well as for inflammatory arthritis and other inflammatory conditions.[224] In a similar vein, 'the oxide of bismuth' already mentioned above and found in today's Pepto-Bismol can specifically work as an anti-inflammatory in the small intestine.[225] Turpentine, mentioned several times before and found in modern-day Bengay, has an additional, potentially anti-inflammatory effect (e.g., for muscles when rubbed on as noted previously).[226] Castor oil is also metabolised to its active form specifically in the small intestine where it has anti-inflammatory properties. It is still sometimes used today for gastrointestinal complaints. Thus, cinnamon, bismuth, mustard, turpentine and castor oil could all have had real anti-inflammatory effects for cholera patients. Since mustard was rarely given orally, it would have only had a smaller, topical effect but often focused on the inflamed stomach.

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[223] "Camphor Bottle", Etsy, https://www.etsy.com/market/camphor_bottle, Accessed 18 Sep, 2022.
[224] Leech, "10 Evidence-Based Health Benefits of Cinnamon".
[225] Abercrombie, "Suggestions Submitted to the Medical Practitioners of Edinburgh on the Characters and Treatment of the Malignant Cholera ", 12; "Facts About Bismuth", LiveScience, 21 Nov, 2017, https://www.livescience.com/39451-bismuth.html, Accessed 22 Aug, 2022.
[226] WebMD, "Turpentine Oil – Uses, Side Effects and More," https://www.webmd.com/vitamins/ai/ingredientmono-508/turpentine-oil, Accessed 22 Aug, 2022; "The Cholera - Suggestions by the Royal College of Physicians for Preparation Against an Outbreak of Cholera in Edinburgh", 2.

Alcohol

Apart from potentially killing the *Vibrio* bacteria, alcohol could have also decreased the inflammation of the stomach, intestines and blood vessels. The preventative use of alcohol (e.g., a glass of red wine a day) against heart attacks and strokes was first proposed in the 1990s although more recent research has shown benefits mainly just in women over fifty-five years of age.[227] Besides acting as an anti-inflammatory, alcohol's 'sedative' and 'calming' effect could have also been at play. Many people still take a 'nip' of whisky or brandy every night to help them sleep and or at other times to 'calm' one's nerves; a few whiskies or brandies could have, in essence, made the cholera patient inebriated enough (considering their relative dehydration due to fluid loss) to soothe their pain and suffering. Perhaps alcohol was just what the doctor ordered.

Losing Fluids

One of the main and sometimes deadly effects of cholera is the marked loss of both water and ions. Even today when cholera infections often occur in areas where the availability of modern medication is extremely limited, the mainstay is still supportive care including sterile fluids, either by vein or orally (although antibiotics do sometimes play a role, their availability in remote areas and the ready resistance of *Vibrio* often makes their use futile).[228] The marked loss of fluids from cholera would lead to thick, congealed blood that did not flow. The resulting increase of deoxygenated blood would lead to the classic blue colour of cholera patients as well as the shortness of breath (blood not moving through the lungs), the aforementioned acidosis (blood not moving through the kidneys) and the often-severe fatigue (blood not moving very much at all). Little to no blood flow would also result in cooling of the body as well as lack of delivery of nutrients and removal of wastes to/from the cells. Anything that would increase the circulation would, therefore, help the cholera patient. Despite this, a resistance in Edinburgh and other areas to give water to a patient suffering with cholera either by vein or by mouth can be understood because some physicians were starting to see one, possible connection between water and cholera. One can also understand why only hot water would be recommended by some doctors while others specifically forbade any cold-water use, particularly while water was starting to become suspect of causing the disease?[229]

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[227] "Effects of Alcohol on Your Heart", British Heart Foundation, Heart Matters, https://www.bhf.org.uk/informationsupport/heart-matters-magazine/medical/effects-of-alcohol-on-your-heart, Accessed 1 Sep, 2022.

[228] R. LaRocque and J.B. Harris, "Cholera: Clinical Features, Diagnosis, Treatment, and Prevention," UptoDate, https://www.uptodate.com/contents/cholera-clinical-features-diagnosis-treatment-and-prevention/print, Accessed 4 Aug, 2022.

[229] Gibbs, "Observations on Cholera", 396-397; Lizars, "Cholera Asphyxia as It Appeared in 1832 and in 1848", 63.

Slowing the Flow

With water becoming suspect, somewhat indirect methods to treat fluid loss are also seen in 19th century cholera treatments. Opiate's action of slowing the peristaltic movements of the intestines, would slow the 'rice water' diarrhoea and the resultant fluid losses.[230] Bismuth mentioned above and found in the Victorian equivalent of Pepto-bismol, slows the secretion of ions and of fluid in the colon and may have also helped allay both the vomiting and diarrhoea (and the fluid loss by them) often present in cholera infections.[231] Any other means to slow the loss of fluids would be beneficial to the cholera sufferer.[232]

Let it Bleed

Something that was practised rather consistently by a number of British doctors treating cholera patients was bleeding. This idea fed very much into a humouralist idea of correcting an imbalance in the body. Regardless of the specific theory, anything that would get the blood flowing again at all was certainly going to be of help. But why did many doctors think that bleeding helped and why did it seem to revive some patients? One possibility is that it was something that doctors could actually 'do' as opposed to symptomatic treatments. Doctors were able to access large veins, even in a dehydrated patient, so they had a decent chance of getting at least local circulation established. Probably more importantly, if the patient was revived enough that they could get up and walk (as was reported), then muscular action, particularly in the legs, could propel the thick, congealed blood and clear the circulatory system (like walking in an airplane to avoid deep vein thrombosis or clots in the legs).

If a doctor could not access a vein or found it difficult to produce blood from a cut, leeches were often employed for blood-letting. Additionally, leeches are now known to inject an anti-clotting molecule when attached so they would have also helped keep the blood from clotting by injecting the equivalent of modern-day 'blood thinners' like Warfarin while they are feeding.[233] The localised effect may have 'restarted' a stalled circulatory system when the thick blood was not adequately flowing, improving the patient, and seeming quite efficacious. But some doctors disagreed with the

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[230] P. Holzer, "Opioid Receptors in the Gastrointestinal Tract " *Regul Pept.* 155 (2009), 12-13.

[231] "Facts About Bismuth", LiveScience, 21 Nov 2017, https://www.livescience.com/39451-bismuth.html, Accessed 23 Nov, 2022.

[232] Encyclopedia Britannica, "Salt. Acid-Base Reactions, 31 Aug. 2022," https://www.britannica.com/science/salt-acid-base-reactions, Accessed 23 Nov, 2022.

[233] "What is Leech Therapy", Healthline, 21 Apr, 2017, https://www.healthline.com/health/what-is-leech-therapy#how-it-works; "Leeches in Modern Medicine", Australian National University, Research School of Biology, https://biology.anu.edu.au/research/research-stories/leeches-modern-medicine, Accessed 1 Sep, 2022.

idea of bleeding or leech application. Howard-Jones notes by the middle 1800s, 'bloodletting had fallen out of fashion and was only rarely used in the treatment of any disease.'[234]

Warming Things Up

Cholera patients were almost always cold due mainly to the marked decrease in the circulation of blood as well as the fatigued state that limited movement and any muscle action. Fortunately, there were some things for doctors to do that would help them such as a warm room and a decent blanket but also varying rubs, applications and drinks (Figure 3-7).

Figure 3-7. An 1831 Cholera Patient with a Blanket.[235]

Turpentine and Mustard

Turpentine is obtained from certain pine trees and its modern-day use is as more of a solvent used in painting and cleaning. When turpentine is put on the skin, it produces a warming effect. Today, it is still used in certain medications (e.g., Bengay) to provide warmth for the aching skin and muscles.[236] The prominent warming effect of mustard has already been mentioned. And its effects on a painful stomach, abdomen and remainder of the body could have provided some 'relief' to patients suffering from cholera.

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[234] C.R. Hall, "Prophylactic Medicine - the Cholera," *Association Medical Journal* s3-2, no. 95 (1854), 978; O. Boyd, "Hints Respecting Cholera: With Directions Which May Be Most Safely Followed When Medical Aid Cannot Be Immediately Obtained," (Edinburgh: Boyd, O., 1830), 70-74; E. Greenhow, "Observations on the Nature and Treatment of Cholera," *Edinburgh Medical and Surgical Journal* 43, no. 123 (1835); Howard-Jones, "Cholera Therapy in the Nineteenth Century", 379.

[235] Cholera Online: A Modern Pandemic in Text and Images, US National Library of Medicine, Cholera Woman with Blanket Reference, https://www.nlm.nih.gov/exhibition/cholera/images/a012673.jpg, Accessed 1 Sep, 2022.

[236] WebMD, "Turpentine Oil – Uses, Side Effects and More".

Alcohol

Although the physicians in the 1800s probably did not understand what the alcohol was doing to/for their patients, they almost certainly saw some improvement and continued its use.[237] But there was one more probable effect of alcohol on patient's infected by *Vibrio.* As discussed previously, the flow of blood in a cholera patient is often slowed by fluid loss and other factors. Clots can form leading to low or deficient areas of oxygenation. One potential way of getting the blood flowing again is to increase acutely both the heartrate and blood pressure – an established effect of alcohol.[238] The sudden increase in pulse and pressure after a treatment of brandy, whisky, fortified wine or whatever was available could have helped blood to flow again and that would have resulted in warming of the body and potentially reviving a patient. In 1823, one doctor suggested this very thing noting both the anti-inflammatory 'counter irritation' of alcohol but also its 'warming effects' for cold (and blue) cholera patients.

A Bite To Eat

Other treatments such as food were given with the idea of simply comforting or settling the stomach or to provide much needed calories and energy to the often exhausted and lethargic cholera patient. Intake of any foods by mouth would have produced the same acid buffering effects in the stomach that may have alleviated the cholera infection. In addition, the sheer provision of calories from any food would help any patient. Sherman also notes a modern type of oral therapy beyond just simple fluids, namely 'food-based Oral Replacement Therapy [ORT],' which substitutes starches and proteins from cereal grains and beans for the glucose normally added to the oral fluids. The 'raw soup' of the 1800s would be just as effective as the modern-day versions of a digestive biscuit or bread, a bowl of porridge or chicken noodle soup or the 'fluid with food' ORT. All would help to buffer the stomach, replace lost ions and nutrients and, if tolerated, reduce the nausea and vomiting as well as possibly helping the diarrhoea and, therefore, the mortality.

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[237] J. Forsyth, "Official Correspondence on Mr Henderson's Method of Treating the Indian Cholera," *Edinburgh Medical and Surgical Journal* 26, no. 88 (1826), 42; C.A. Douglas, "A Cheap and Effectual Medicine to Cure the Cholera, or Colick. The Gentleman's Magazine and Historical Chronicle," 15 (Feb 1745), p 91 as cited in Edinburgh Medical Essays, Vol 5. p 646; Tatham, "On the Duration of Fatal Cholera", 71; Gibbs, "Observations on Cholera", 397.

[238] Mayo Clinic, Alcohol: Does It Affect Blood Pressure?", 16 Jan, 2021, https://www.mayoclinic.org/diseases-conditions/high-blood-pressure/expert-answers/blood-pressure/faq-20058254#:~:text=Drinking%20too%20much%20alcohol%20can,lead%20to%20long%2Dterm%20increases, Accessed 23 May, 2020.

Commercial Products

As the 1800s cholera epidemics progressed and doctors across Edinburgh and the UK and the world struggled to find effective treatments, the commercial world saw an opportunity. These commercial efforts not only came from chemists looking to help their customers while also making some money but, apparently, also doctors. Doctors had originally published and sold pamphlets regarding their own particular expertise and recommendations regarding cholera, mainly in the 1830s. But as information became more publicly available and readily published in newspapers and city government productions (often free to the poor), this source of added income lessened. As a result of both factors, medications and treatments were offered for consumption by the general public by chemists and non-chemists (discussed further below). The contents of these treatments often were never revealed and may have never worked. Often these products would be promoted, either openly or discretely by many of the physicians of the day to add to their perceived legitimacy – a practice that seemed to paradoxically increase as doctors wrote fewer pamphlets and official, medical society sources began to prevail. Sometimes the chemists would simply invoke the idea of a local, unnamed 'faculty' member to sell their products. The emergence of this medical capitalism and doctor testimonials still continues today in the form of 'Infomercials' or 'spam-mails'.

A History of Edinburgh Medical Treatments

During the cholera epidemics of the 1800s, many Edinburgh physicians were prominent in publications regarding treatments. Many of these same physicians had served in India and had treated both British soldiers and local people and felt they each had the answer to cholera's deadly effects. With true equivalents of modern-day medications somewhat lacking, Edinburgh physicians had to use other options at their disposal and, even though sometimes questioned now, they truly felt they were being successful. But while these treatments would only have a small chance of cure, these techniques were usually only symptomatic; it was more of a matter of each individual patient's body to survive the *Vibrio* bacteria's effects. Still, many of these medications and methods should not be underestimated or dismissed.

Many Edinburgh commentators noted the sins of alcohol use and need for abstinence in times of cholera. Beyond the suggested religious and moral factors, the socio-cultural environment that existed in the Edinburgh pubs may have played a part as the increasingly inebriated, packed-in patrons could pass cholera onto their unsuspecting fellow drinkers. This could have been via fluids or solids or even the foods being served. But perhaps these commentators were not quite correct. The brandy or other alcohols that were a mainstay of 19th century treatments of cholera by several of their Edinburgh physician colleagues may have had benefits. Either so-called moderate or heavy

drinkers could have actually been, respectively, prophylactically or actively saving themselves from cholera infection. Specific suggestions by Edinburgh physicians for the use of alcohol are shown in Appendix 3-1 and include varying concoctions of wine, brandy and other spirits often mixed with water as well as many of the medications above such as laudanum, opium, cinnamon and ammonia.

Specific recommendations for alcohol lessened rather dramatically over the subsequent years as Edinburgh physicians became more experienced. Potentially better methods of treatment emerged and, along with an increasingly strong temperance movement and perceived 'direct' links to the use of alcohol and acquiring the cholera infection, its use was increasingly discounted. In 1849, the City Parochial Board suggested, 'to lessen the consumption of stimulants, and to substitute spirits for wine when it was possible.'[239] An Edinburgh cholera doctor used some 'Diffusible stimuli' such as brandy but concluded they 'produce no beneficial effect, [including increasing] the irritability of the stomach, and added to the oppression of the precordia [heart].'[240] By 1866, the Royal College of Physicians noted 'Give no whisky or brandy unless under medical direction, or in the absence of cordial mixture, when a dessert spoonful of either may be given every hour.'[241] Drs. Littlejohn and Smart, possibly understanding the Edinburgh audience better than the Royal College, suggested 'stimulants, such as a glass of whisky or brandy, should be given' and 'A little brandy or whisky without water may be given', respectively. Only a month later, Littlejohn's reported to the Council that 'in all the reported cases the system has been debilitated by destitution or intemperance' and Smart wrote a rather scathing note about how the excess use of alcohol leads to cholera.[242]

So, while alcohol could have some benefits for cholera patients, it was not the real answer. Since alcohol generally dehydrates the body, it was, in fact, maybe not an answer at all. As such, doctors became more experienced with other treatments and as social and temperance pressures rose, alcohol would only be suggested for use in the 1832 and 1849 epidemics.

Calomel use was also supported by several physicians practising in Edinburgh or who had trained at the medical school. Henderson noted 'Of all the medicines lately in use for the cure of the disease

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[239] "City Parochial Board - Closure of Cholera Hospital, Changes in Medications," *Scotsman*, 3 Nov 1849, 3.

[240] W.D. (Parochial Surgeon Adams, City Parish, Edinburgh), "Extra-Professional Services in Connexion with Cholera in the Third Medical District of the City Parish, Edinburgh, 28th August to 30th November 1854.," (Edinburgh: John Stark, 1854), 22.

[241] "The Cholera - Suggestions by the Royal College of Physicians for Preparation against an Outbreak of Cholera in Edinburgh", 2.

[242] "Precautions against Cholera (Littlejohn)", 2; Littlejohn; "Edinburgh Town Council, Old Town Improvement & Littlejohn," *Scotsman*, 1 Nov 1866, 8; "Dr. Smart, Recommendations for Guarding against Cholera," *Scotsman*, Oct 30 1866, 2.

… calomel has been the most successful. Its action is confined entirely to its purgative quality.'[243] In fact, many Edinburgh doctors did use calomel, in varying amounts for both its colonic, purgative properties but also to induce or to stop vomiting (see Appendix 3-2a for specific examples of used of calomel by Edinburgh physicians). Special note is also made of some Edinburgh doctors who felt that the liver and its product bile as well as the intestines (e.g., humours) were important in treating cholera patients and that calomel was a specific treatment for this problem (see Appendix 3-2b). But there were some astute, Edinburgh physicians who realised that cholera affected the intestines and they had their uses for calomel, too (see Appendix 3-2c). As with all the methods, there were dissenters. Forsyth, whose experience was mainly drawn from treating patients in India, writes

> The use of calomel is however objectionable, 1st, On account of the extreme uncertainty of its operation particularly by Continental Europeans; 2dly, On account of the length of time it takes in a disorder rapid in the extreme; 3dly, On account of the extreme irritation and spasmodic action it excites in the stomach.[244]

It was probably a good idea that Forsyth was suspicious of this medication; as noted above, calomel is simply a mercury compound that could lead to mercury poisoning if regularly used.[245]

An even more aggressive method of eliminating the disease from the gastrointestinal tract is suggested by one *Scotsman* contributor who has very definite ideas that 'The effluvia, or invisible particles of matter arising from a cholera patient' suggests an equivalent of stomach pumping to '… draw off the whole of the poisoned substance ….'[246] Much like modern-day stomach pumping performed in Emergency Departments in cases of ingestions of poisons, this physician understood that the physical removal of the offending 'effluvia' could have a marked effect on a cholera patient.

Bleeding also held a prominent place in Edinburgh treatments with some doctors getting very little thick and clotted blood while others did get active bleeding. Dr. Abercrombie, a proponent, seemed to have great success with the technique, reporting 'It seems to relieve an oppression of the circulating system … and the patient expressing himself as delivered from an insufferable load which he felt in the region of the heart.'[247] Dr. Christie, an Edinburgh-based physician, considering a

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[243] J. Browne, "Official Correspondence on Mr Henderson's Method of Treating the Indian Cholera," *Edinburgh Medical and Surgical Journal* 26, no. 88 (1826), 45; Gibbs, "Observations on Cholera", 396.
[244] Forsyth, "Official Correspondence on Mr Henderson's Method of Treating the Indian Cholera", 42.
[245] Jeffers, "Calomel: A Poison Once the Standard for Medical Treatment", https://reginajeffers.blog/2015/04/06/calomel-a-poison-once-the-standard-for-medical-treatment/, Accessed 7 Apr, 2020.
[246] "Kirkcudbright Letter to the Editor", 2.
[247] Abercrombie, "Suggestions Submitted to the Medical Practitioners of Edinburgh on the Characters and Treatment of the Malignant Cholera ", 11 & 14.

pathology beyond the humours, wrote, 'The pathological cause of the disease being an inflammation of the gastroenteric mucous membrane, the bleeding will remove this inflammation … and the cause being removed, of course all the symptoms will disappear.[248] Other prominent, Edinburgh physicians of the time, mainly those with experience in India, echoed his sentiments.[249] Dr. J.S. wrote 'Early bleeding before the stage of collapse takes place, seems in most cases to arrest the progress of the disease, or at any rate to mitigate the intensity of the cold stage, at the same time it never fails to relieve the cramp in the extremities, and diminishes the irritability of the stomach.'[250] One Edinburgh doctor felt it so important that it should start even before a doctor arrived (although specifics about how the family should do this are lacking) and that 'the danger is, that too small rather too large a quantity of blood is removed.'[251] In 1831, the Edinburgh Board of Health also suggested that 'blood-letting, when resorted to within the first, second, or third hour from the commencement of the attack, has been very generally found useful.'[252] Lizars 'found that arterial blood relieves congestion of the venous system better than venous blood.'[253] This makes medical sense, as arterial blood is naturally under more pressure and less subject so it clots than venous blood. Restarting circulation via either the arteries or veins could allow a heart with small clots or no blood at all to start moving at least some blood again.

Leeches were also commonly used by Edinburgh physicians for cholera patients and formed part of the suggestions by government agencies for its treatment.[254,] Dr. Mackintosh writes, '… about one-half of those who recovered after this operation were bled, or had leeches applied … and on looking back at the cases, I believe that several were lost from want of bleeding….'[255] Indeed,

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[248] A. T. Christie, "Observations on the Nature and Treatment of Cholera: And on the Pathology of the Mucous Membranes," (Edinburgh,1828), 102.

[249] Howard-Jones, "Cholera Therapy in the Nineteenth Century", 374-379; Browne, "Official Correspondence on Mr Henderson's Method of Treating the Indian Cholera", 42; A. Miller, *Cholera Morbus. Observations on Cholera*, ed. Archibald Miller (Edinburgh: Edinburgh: Bell & Bradfute, 1831); Gibbs, "Observations on Cholera", 396; Editors, "Letter to Sir Henry Halford on the Tendency of the Proposed Regulations for Cholera, with Observations as to the Nature of the Disease, and the Course to Be Followed Immediately on Its Appearance in a Family", 832-833; Lizars, "Cholera Asphyxia as It Appeared in 1832 and in 1848", 65; Abercrombie, "Suggestions Submitted to the Medical Practitioners of Edinburgh on the Characters and Treatment of the Malignant Cholera ", 7; Craigie, "Observations, Pathological and Therapeutic, on the Epidemic Cholera, as It Has Prevailed in Edinburgh and Its Vicinity", 31.

[250] J.S., "Dr. J S Recommendations for Cholera Treatment," *Scotsman*, 22 Feb 1832, 3.

[251] Editors, "Letter to Sir Henry Halford on the Tendency of the Proposed Regulations for Cholera, with Observations as to the Nature of the Disease, and the Course to Be Followed Immediately on Its Appearance in a Family", 832-833.

[252] Chambers, "Report of the Edinburgh Board of Health", 4.

[253] Lizars, "Cholera Asphyxia as It Appeared in 1832 and in 1848", 3-5 & 66.

[254] "Singular Mode of Treatment of Cholera," *Chambers's Edinburgh Journal, Feb. 1832- Dec. 1853*, no. 207 (1836), 407; Abercrombie, "Suggestions Submitted to the Medical Practitioners of Edinburgh on the Characters and Treatment of the Malignant Cholera ", 14.

[255] "Singular Mode of Treatment of Cholera", 407.

Edinburgh doctors during the 1832 epidemic recommended locations including 'a copious stock of leeches be applied to the abdomen … where pain and tenderness exist', the head, the 'region of the kidneys', 'the arm' and 'the legs' and 'the loins'.[256] These recommended locations would have specifically targeted the blood vessels of the stomach and intestines and kidneys and/or some of the larger bloods vessels of the human body. As such, the bleeding and anti-coagulating effects of leeches could have had an impact. If a doctor was not available for this task, one pharmacist on George Street was happy to help the public with 'leeches (not diseased)' and 'will when requested by families or their medical advisors, send a proper person to apply them.' (Figure 3-8).[257]

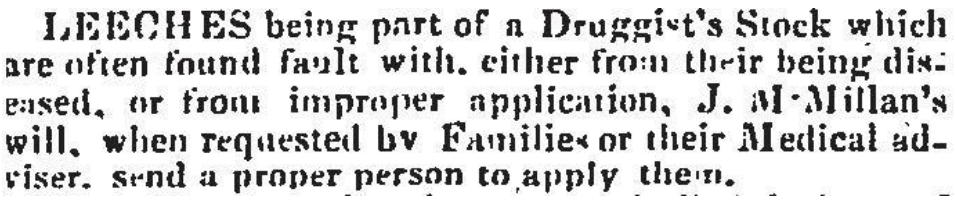
LEECHES being part of a Druggist's Stock which are often found fault with, either from their being diseased, or from improper application, J. M'Millan's will, when requested by Families or their Medical adviser, send a proper person to apply them.

Figure 3-8. Leeches (not diseased) Advertisement with 'a proper person to apply them'

There, thus, appeared to be an understanding by many Edinburgh doctors of the importance of blood circulating and the localised effect may have 'restarted' a stalled circulatory system which then improved the patient. As noted earlier, though, blood-letting declined and was only seen rarely by the 1840s and 1850s. No advocates of blood-letting could be found past Macintosh's 1836 essay in the sources researched for this work. Additionally, no mention of blood-letting or leeches is seen in The Royal College of Physicians' official Cholera Advice publications in 1853 and 1866.[258]

Edinburgh doctors actually could do something about another prominent symptom of cholera – cold.[259] Besides the use of opiates (see below), references to warming techniques are the most abundant treatment method mentioned in Edinburgh writings. Methods in the early 1830s included rubbing the patient, warm water bottles or hot sand or hot bricks 'applied to hands, feet, sides and every surface of the body', footbaths or 'hot vessels to the feet, and warm applications to the legs [and] heat applied along the course of the spine', warm blankets, and even 'whatever can be

[256] Tatham, "On the Duration of Fatal Cholera", 73; Craigie, "Observations, Pathological and Therapeutic, on the Epidemic Cholera, as It Has Prevailed in Edinburgh and Its Vicinity", 59-60, 62-64.

[257] "Advert for Dr Gregory's Stomacich [Sic] Mixture, Leeches and Camphorated Paper," *Scotsman*, Dec 17 1831, 1.

[258] "The Royal College of Physicians - Cholera Advice," *Scotsman*, Oct 22 1853, 4; "The Cholera - Suggestions by the Royal College of Physicians for Preparation against an Outbreak of Cholera in Edinburgh", 2.

[259] Abercrombie, "Suggestions Submitted to the Medical Practitioners of Edinburgh on the Characters and Treatment of the Malignant Cholera ", 10.

administered' to try to warm the cholera patient. One *Scotsman* writer treating cholera patients at sea used 'a ... tin case, ... filled in with hot water to the feet ... while the body was wrapped up in hot blankets, and bottles of hot water were applied to different parts of the body, and the room heated with a good fire.' Specific mention was made … for restoring the extremities their wonted [sic] warmth and power' and 'till the circulation is restored.'[260] The Edinburgh Board of Health officially recommended placing the patient in a hot-air bath.[261] In 1831 they even recommended that eager customers could purchase such a bath, orders placed at either the Insane Asylum or a certain 'Misses Dodd'' on North Frederick Street or Scot and Orr chemists with locations both on South Bridge and Princes Street. The Scot and Orr version was specifically '…much approved by the Medical Faculty' and 'upon a new and improved construction, capable of being packed in the boot, or under the seat of a carriage.' Neither prices nor the involved 'Faculty' were published in these articles.[262]

The Health Board also had a sample hot-air bath 'of simple construction, which may be seen at the Blind Asylum, and made by any carpenter, price about ten shillings.' along with 'several hospitals … opened over the city … [with] the heating apparatus.' They even had 'carriages, to serve at the same time as dry-heat baths,' … always ready at the Hospitals and stations.'[263] In cases where a hot-air bath could not be obtained, the Health Board repeated many of the other recommendations for heating noted above. One *Scotsman* correspondent even suggested a 'Cholera Stove Room … heated to the highest bearable degree … [which] might answer the purpose much better than partial external applications of heat…. The patient in a stove-room could be gradually heated to any temperature ….'[264] After the 1832 epidemic, hot air baths and stove rooms were not seen again.

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[260] Browne, "Official Correspondence on Mr Henderson's Method of Treating the Indian Cholera" 45; Tatham, "On the Duration of Fatal Cholera", 71-72; Gibbs, "Observations on Cholera", 396; Christie, "Observations on the Nature and Treatment of Cholera, and on the Pathology of Mucous Membranes (1828)", 421; Boyd, "Hints Respecting Cholera: With Directions Which May Be Most Safely Followed When Medical Aid Cannot Be Immediately Obtained"; 833; Lizars, "Cholera Asphyxia as It Appeared in 1832 and in 1848", 3-5, 63; Editors, "Letter to Sir Henry Halford on the Tendency of the Proposed Regulations for Cholera, with Observations as to the Nature of the Disease, and the Course to Be Followed Immediately on Its Appearance in a Family", 832-833; Abercrombie, "Suggestions Submitted to the Medical Practitioners of Edinburgh on the Characters and Treatment of the Malignant Cholera ", 8; J.S., "Dr. J S Recommendations for Cholera Treatment", 3; "Cholera Morbus Treatment from Gentleman in London," ibid, Aug 11, 4; "Plague, Cholera," *Chambers's Edinburgh Journal, Feb. 1832- Dec. 1853*, no. 1 (1832), 8; "Remedy for Cholera," *Chambers's Edinburgh Journal*, no. 251 (1848), 272; "Symptoms of Cholera in Edinburgh (Case Report)," *Scotsman*, Nov 12 1831 3.

[261] Chambers, "Report of the Edinburgh Board of Health", 4.

[262] Ibid, , 4; "Advert for Hot Air Bath," ibid, Nov 26, 1; "Scott & Orr Chemist Advert (Chlorides of Soda and Lime, Hot Air Bath)," *Scotsman*, Jan 11 1832, 1.

[263] Chambers, "Report of the Edinburgh Board of Health", 4.

[264] From a Correspondent, "Cholera Stove Room," ibid, Feb 22 1832, 3.

There were, however, conflicting ideas about keeping cholera patients warm. In 1837, one dissenting doctor asked for 'the room to be kept cool, and the quantity of bed-clothes to be regulated by the feelings of the patient.'[265] Suggestions for warming, though, are still seen through the 1850s and 1860s epidemics to include 'frictions with powdered mustard and ginger', '(if necessary) hot bottles should be applied to the feet, and that the legs and spine should be well rubbed with turpentine.'[266] Just before the 1866 epidemic, a Dr. Chapman combined cooling and heating with '…an India-rubber bag full of ice "next to the skin … kept close to the back, and … renewed as long as sickness, cramps, coldness of the skin, and other symptoms of cholera, or any sign of collapse continues.' If any signs of fever were seen, he recommended '…water bags, with the water at 110^{o} to 120^{o}, to the back….'[267] In 1855, the Royal College of Physicians and Drs. Littlejohn and Smart recommended that 'The patient should at once go to be in a well-aired apartment and keep himself moderately warm.'[268] The Royal College did provide detailed instructions in 1866 beyond earlier hot bricks, sand, flannel or hot friction rubs seen in the 1832 epidemic as follows:

> Place five or six blankets in an unoccupied bed. Then wring a small sheet out of hot water, spread it over the blankets, and lay the patient naked in centre, wrap the sheet quickly over the whole person so as to cover all closely but the head. Then fold the blankets in the same way and in succession over the person.

Mustard packs, also known as 'poultices' or 'sinapisms' were also frequently suggested for their warming effects by Edinburgh medics from the 1830s through the 1866 cholera epidemic. They consisted either solely of ground mustard seed or were occasionally mixed with such secondary ingredients as porridge and linseed meal.[269] The poultices were usually applied 'over the belly and on the soles and calves' while other physicians just used this treatment mainly over the stomach. They could get so warm (to the point of burning the skin) that instructions were left to only leave them on 'till the patient complaints of smarting' or to be removed 'in forty minutes or sooner, if they cause much pain'.[270] Turpentine, another warming agent when rubbed on the skin was specifically used by

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[265] Greenhow, "Observations on the Nature and Treatment of Cholera", 359.

[266] Adams, "Extra-Professional Services in Connexion with Cholera in the Third Medical District of the City Parish, Edinburgh, 28th August to 30th November 1854.", 2.

[267] "A New Remedy for Cholera," *Scotsman*, 5 Sep 1865, 4.

[268] "The Cholera - Suggestions by the Royal College of Physicians for Preparation against an Outbreak of Cholera in Edinburgh," *Scotsman* (1866), 2.; "Precautions against Cholera (Littlejohn)", 2; "Dr. Smart, Recommendations for Guarding against Cholera", 2.

[269] Chambers, "Report of the Edinburgh Board of Health", 4; "Cholera Morbus Treatment from Gentleman in London", 4.

[270] Ibid, , 4; "Successful Treatment of Cholera ...", ibid, May 2 1832, 3; "The Cholera - Suggestions by the Royal College of Physicians for Preparation against an Outbreak of Cholera in Edinburgh", 2; "Precautions against Cholera (Littlejohn)", 2.

Edinburgh physicians either sprinkled on clothes or in some of the warming, friction rubs noted above.[271] For the vast majority of fatigued, cold and blue, cholera patients, simple warming measures would have been important. Perhaps the 1866, Edinburgh recommendations are not that far away from a simple, hot water bottle or a nice, warm, woollen blanket that is used even today.

Several other items were given by Edinburgh doctors which would have provided an anti-inflammatory effect. Cinnamon is mentioned several times in Edinburgh doctors' treatments, including the Board of Health in 1831 which suggested a mixture of 'sulfuric ether and aromatic spirit of hartshorn, of each half an ounce, compound tincture of cinnamon, one ounce. Mix and cork up carefully.'[272] In 1853, the Royal College of Physicians simply suggests 'the compound of cinnamon powders'[273] although the same is not seen in their recommendations for 1866.[274]

Camphor was also a mainstay of British/Edinburgh clinicians, including homeopathic ones, through all four, cholera epidemics. In 1831, the Edinburgh Board of Health printed specific instructions in the *Scotsman* to include how to make a particular pill 'No 3', made of camphor, opium, wine and rose to be kept as a stock in the home for the approaching cholera. Instructions for the proper use of these pills by the general public were also provided.[275] The founder of Homeopathy, Samuel Hahnemann, also suggested the use of camphor for cholera treatments in 1831.[276] Camphor is noted in many of the mixtures noted below and in the Appendices.

Castor oil is also frequently seen in the recommendations of 19th century, Edinburgh physicians. Two Edinburgh doctors specifically praised a colleague's almost exclusive use of castor oil although they write about having to keep the patient in a recumbent position by force to keep them taking the castor oil and to stop them from vomiting it back up. Despite this rather aggressive treatment,

> as soon as the medication had reached the *seat* of the disease, some alleviation of the symptoms ensured …. 'The first perceptible change for the better, was the return of the circulation to the larger vessels of the extremities … evinced by the pulsation becoming distinct, and gradually increasing in strength, followed by warmth and sensation ….[277]

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[271] "The Cholera - Suggestions by the Royal College of Physicians for Preparation against an Outbreak of Cholera in Edinburgh", 2.
[272] Chambers, "Report of the Edinburgh Board of Health", 4.
[273] "The Royal College of Physicians - Cholera Advice", 4.
[274] "The Cholera - Suggestions by the Royal College of Physicians for Preparation against an Outbreak of Cholera in Edinburgh", 2.
[275] Chambers, "Report of the Edinburgh Board of Health", 4.
[276] S. Hahnemann, "An/Ruf an Denkende Menschenfreunde Über Die Ansteckungsart Der Asiatischen Cholera (Leipzig, 1831) as Referenced in Norman Howard-Jones, 'Cholera Therapy in the Nineteenth Century'," *Journal of the History of Medicine and Allied Sciences* 27, no. 4 (1972), 382.
[277] Forsyth, "Official Correspondence on Mr Henderson's Method of Treating the Indian Cholera", 43; Browne, "Official Correspondence on Mr Henderson's Method of Treating the Indian Cholera", 45.

Most Edinburgh doctors through the 1800s seemed to choose other methods besides castor oil to treat their cholera patients.[278] It is notable that none of the recommendations from the Edinburgh Board of Health or Royal College of Physicians from 1831 through 1866 included its use.[279] Still, the direct effect of this anti-inflammatory medication on both the digestive and the cardiovascular systems can be seen in the above report and, along with other anti-inflammatory agents, could certainly have provided relief to cholera sufferers. In 1823, one doctor suggested alcohol works 'like blisters in inflammation, by counter irritation' giving another use for alcohol.[280]

Finally, the provision of oral fluids to try to replace the large volumes lost in diarrhoea and vomiting are now considered almost lifesaving. As noted above, water was beginning to be suspect although some Edinburgh-based physicians still suggested it. A doctor writing earlier in 1745 notes, 'If the patients are not too much exhausted before he is called, he makes them drink heartily of warm water; three or four times, which they always throw up: this dilutes, and by this means blunts the acrimony of the humours and at the ſame [sic] time evacuates them.'[281] In 1827 and 1828, one Edinburgh physician suggests 'thin gruel or tea might be given him for drink in case of thirst' (although the patient had not complained of thirst) and that attendants should give 'saline draughts with an excess of alkali' which may 'assist in allaying the irritation of the stomach and bowels, unless the inflammation of their internal membrane be considerable.' However, this water was more for treating nausea and not thirst or the loss of fluids.[282] In 1831, a doctor working in St Peterburg but writing in the *Edinburgh Medical and Surgical Journal* notes, 'Warm water given early affords relief' and 'likewise warm drinks of mint and elder-flower tea -- have been liberally resorted to' although the warm drinks were suggested mainly 'to restore the heat of the body and excite perspiration', a topic to be further explored below.[283] Given the concerns about water as a source of cholera, others shied away from giving water and instead suggested 'To abate as much as possible the unquenchable thirst … to keep constantly in [the patient's] mouth a slice of lime, to be renewed from time to time.' but also, to avoid any unwanted ingestion of water, 'A careful person should be

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[278] J.S., "Dr. J S Recommendations for Cholera Treatment", 3; Craigie, "Observations, Pathological and Therapeutic, on the Epidemic Cholera, as It Has Prevailed in Edinburgh and Its Vicinity", 49-53; Greenhow, "Observations on the Nature and Treatment of Cholera", 358; "Remedy for Cholera", *Chambers Edinburgh Journal*, 272; A.B.C., "Cholera - Is There a Cure for It!," *Scotsman*, 8 Aug 1866, 6.

[279] Chambers, "Report of the Edinburgh Board of Health", 4; "The Royal College of Physicians - Cholera Advice", 4; "The Cholera - Suggestions by the Royal College of Physicians for Preparation against an Outbreak of Cholera in Edinburgh", 2.

[280] Forsyth, "Official Correspondence on Mr Henderson's Method of Treating the Indian Cholera", 42.

[281] Douglas, "A Cheap and Effectual Medicine to Cure the Cholera, or Colick. The Gentleman's Magazine and Historical Chronicle", 91.

[282] Tatham, "On the Duration of Fatal Cholera", 71 & 73.

[283] Gibbs, "Observations on Cholera", 396.

placed near the sick, to prevent them from swallowing any liquid. The thirst in this disease being of the most urgent and desperate description, no words are of any avail in preventing the sick from swallowing any liquid within their reach.'[284] One doctor felt that treating the other problems would be the prudent way of treating 'The urgent thirst which usually attends the complaint' but giving water was not part of that treatment.[285] Another did allow water as below,

> I had opportunities of trying in several cases in which the patients were importunate for drink; but it never was attended with the effect of restoration …. I must, nevertheless, add, that I never saw any advantage from forbidding patients to quench their thirst freely; and I think the practice of refusing them drink where thirst is so urgent, is only adding most unnecessarily to their sufferings.[286]

In 1848, the resistance to giving fluids was still present; *Chamber's Edinburgh Journal* writes, 'Much liquid must not be given; but to relieve the thirst, which is great, brandy and water by spoonfuls occasionally is the best mode.'[287] So, the idea of giving fluids orally was present in the 19th century treatments but varied at best.

Other Edinburgh doctors provided fluids via a somewhat different way. One wrote, 'Large injections of hot water [per rectum], of the quantity of two or three pounds, have been found extremely useful – to be repeated every hour or two, or as often as they are discharged.'[288] Another doctor preferred to 'throw three to four pints of some fluid, as hot as the patient can bear, into the rectum.'[289] Again, this was more to keep the patient warm and not for fluid resuscitation. Others were happy with hot-saline enemas but to 'counter-irritation over the kidneys' as well as to attempt to 'restore heat and circulation'[290] The idea of fluid enemas actually is not without effect. Because the colon can readily absorb fluids/water, the same, general technique is used in modern-day Emergency Rooms when vascular access is not possible and fluids need to be urgently given. Warm/hot enemas are also still used for emergency warming of victims of cold exposure and/or ice water drowning. So, even though these physicians were doing things for different reasons, they most certainly were seeing some positive results – and believing in their medical treatments.

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[284] Miller, *Cholera Morbus. Observations on Cholera*.
[285] Browne, "Official Correspondence on Mr Henderson's Method of Treating the Indian Cholera", 45-46.
[286] Craigie, "Observations, Pathological and Therapeutic, on the Epidemic Cholera, as It Has Prevailed in Edinburgh and Its Vicinity", 58.
[287] "Remedy for Cholera", 272.
[288] Abercrombie, "Suggestions Submitted to the Medical Practitioners of Edinburgh on the Characters and Treatment of the Malignant Cholera ", 8.
[289] J.S., "Dr. J S Recommendations for Cholera Treatment", 3.
[290] Hall, "Prophylactic Medicine - the Cholera", 978.

Most British physicians who had treated troops in India and had seen the effects of (polluted) water had long decided that giving water was the wrong thing to do. One such doctor wrote in 1817 that 'the frequent & lamentable calls for cold water should never be satisfied, for I observed many unfortunate camp followers who had died in the act of drinking.'[291] The same doctor had military sentries posted to make sure that no patient had access to water. As late as 1853, the Royal College of Physicians noted that 'No saline aperients … should be taken without the advice of a medical man.'[292] Even in 1866, the official advice from the Royal College of Physicians, Dr. Littlejohn and a Dr. Smart had no mention of giving fluids amongst a long list of treatment suggestions.[293] There were still a few, isolated voices of dissent including Dr. William Adams, who, during the 1853/54 epidemic, wrote about 'Effervescing salines [and] free use of water – gratefully received by all … patients, seemed to afford them considerable relief from thirst and sickness'.[294] Another British physician wrote, 'are we to disregard the state of the body, robbed as it evidently is, in most instances, of all its serous and aqueous parts?'.[295]

Both the idea of losing water plus ions and of excess acid in the body were sometimes specifically present in the minds of some physicians, including those in Edinburgh as these doctors were not only giving water but many of the salts that were being lost.[296] In fact, 'Chlorides of soda and lime' were offered for sale to the general public as part of a recommended, self-cholera treatment plan.[297] In fact, an 1827 and a separate 1854 pamphlet counteract 'an excess of alkali' acknowledging that controlling the excess acidity of the blood in cholera patients was important in cholera treatment. Though the reasoning may have been only partly understood, these efforts would be somewhat efficacious, prompting their continued use. A list of the varying, oral and rectal fluids provided by Edinburgh doctors is shown in Table 3-3.

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[291] Howard-Jones, "Cholera Therapy in the Nineteenth Century", 385.
[292] "The Royal College of Physicians - Cholera Advice", 4.
[293] "The Cholera - Suggestions by the Royal College of Physicians for Preparation against an Outbreak of Cholera in Edinburgh", 2; "Precautions against Cholera in Edinburgh," *Scotsman*, Aug 9 1866, 2; "Dr. Smart, Recommendations for Guarding against Cholera", 2.
[294] Adams, "Extra-Professional Services in Connexion with Cholera in the Third Medical District of the City Parish, Edinburgh, 28th August to 30th November 1854.", 22.
[295] Howard-Jones, "Cholera Therapy in the Nineteenth Century", 385.
[296] Christie, "Observations on the Nature and Treatment of Cholera, and on the Pathology of Mucous Membranes (1828)", 358-359; "Successful Treatment of Cholera ..., 3; "Singular Mode of Treatment of Cholera", 407; J.W. Begbie, "Observations on the Urine in Cholera," *Monthly Journal of Medical Science* 3, no. 41 (1849), 1207-1213; "Prophylaxis and Arrest of Asiatic Cholera, Dr Mccormac, Belfast, 14 Oct 1861," *Edinburgh Medical Journal* 7, no. 5 (1861), 502.
[297] "Scott & Orr Chemist Advert (Chlorides of Soda and Lime, Hot Air Bath)", 1.

Table 3-3. Varying Oral Salts Used in Edinburgh for the Treatment of Cholera[298]

Date	Salt/Ions	Notes
1827 & 1854	Saline (Sodium Chloride and Water) plus 'an excess of alkali' (a base to counteract acidity)	Replaces Na^+ and Cl^-, provides water and would slightly buffer acidic changes
1832, 1866	Soda Water/Carbonate of Soda (Sodium Bicarbonate (sometimes with other salts added))	Replaces Na+, provides water, buffer in the form of bicarbonate and other added ions
1832	'Large quantities of chalk' (Calcium carbonate)	Replaces calcium which could also be affected by the loss of the other ions
1832	Oxymuriate of Potash (Potassium Chloride mixed with Ferric Oxyhydroxide ('rust'), Muriate of Soda (old name for Sodium Chloride), Carbonate of Soda, (Na_2CO_3)	'As soon as the stomach is quieted, and will retain it, give every half-hour, or hour.' Replaces sodium, potassium and chloride as well as a precursor to bicarbonate [CO_3^-] to help the acidosis

There was one, very bright spot that occurred only in the Edinburgh area in the 1830s – that is the idea of giving fluids by vein, a cornerstone of modern-day, cholera treatments. Irishman W.B. O'Shaughnessy, educated at the University of Edinburgh Medical School and, for a time, practising in England, helped to establish the idea of giving intravenous fluids to replace bleeding as a treatment option.[299] His 1831-32 article noted fluid made of potassium citrate plus water should be used 'First. To restore the blood to its natural specific gravity. Second. To restore its deficient saline matters.'[300]

Thomas Latta, a physician in Leith (now an integral part of Edinburgh) was impressed enough by O'Shaughnessy's ideas, including the use of not just simply water but rather potassium in water – an important part of the proper treatment of cholera patients – that he used it, possibly for the first time in a true clinic setting (O'Shaughnessy's had experimented on dogs). Latta felt that 'by injection

[298] Adams, "Extra-Professional Services in Connexion with Cholera in the Third Medical District of the City Parish, Edinburgh, 28th August to 30th November 1854.", 22; Tatham, "On the Duration of Fatal Cholera", 73; "Cholera Morbus Treatment from Gentleman in London", 4; Abercrombie, "Suggestions Submitted to the Medical Practitioners of Edinburgh on the Characters and Treatment of the Malignant Cholera ", 7 & 12; "The Cholera - Suggestions by the Royal College of Physicians for Preparation against an Outbreak of Cholera in Edinburgh", 2; Vinepair, "'What's the Difference between Club Soda, Seltzer, and Sparkling Water? (and Tonic, Too)", Https://Vinepair.Com/Articles/Difference-Club-Soda-Vs-Seltzer-Sparkling-Tonic/ " , Accessed 15 Mar, 2021.

[299] W.B. O'Shaughnessy, "Proposal of a New Method of Treating the Blue Epidemic Cholera by the Injection of Highly-Oxygenised Salts into the Venous System " *Lancet* 17 (1831), 366-371; Howard-Jones, "Cholera Therapy in the Nineteenth Century", 388-389.; Sherman, "Cholera", 47-48.

[300] Of note, Drs. Herman and Jaehnichen in Russia, Stevens in London, Sandras in Warsaw and Dieffenbach in Germany had tried intravenous fluid injection in varied forms although this was never met with any major, public success nor did it seem to transfer successfully to the UK/Edinburgh (see Howard-Jones, "Cholera Therapy in the Nineteenth Century.", pp 385-387 and Ryan, "Eyes on the Prize: Lessons from the Cholera Wars for Modern Scientists, Physicians, and Public Health Officials", 612 for excellent reviews).

of water and salts . . . we may restore the efficient fluids of the body and bring back the blood to its normal state.'[301] He reported in *The Lancet*, June 2, 1832 edition that he 'dissolved from two to three drachms of muriate of soda and two scruples of the subcarbonate of soda in six pints of water, and injected it at temperature 120 Fah[renheit]', thereby providing sufficient sodium, chloride and bicarbonate to his patients. *The Lancet* praised Latta for his efforts, prompting Latta and some others to optimise the technique for cholera and other patients for both intravenous and oral treatment.[302] Many of Latta's patients did, in fact, die after receiving these fluids although probably because he mainly tried it on severely ill patients who may have been beyond saving; however, about a third survived and recovered quite amazingly.[303] An 1836 book by Dr. Mackintosh detailing the technique was the topic of an entire review in *Chambers's Edinburgh Journal*.[304] This article discussed a 'deficiency of serum in the blood in cholera patients' along with 'the bold idea of restoring the loss at once, by injecting a large quantity of saline solution into the venous system.' Like Latta, Dr. Mackintosh's fluid contained 'Muriate of soda' [a.k.a. Sodium chloride] and 'bicarbonate of soda' [a.k.a. Sodium Bicarbonate].' Thus, sodium, chloride and bicarbonate (but not potassium) plus free water was being provided to replace the losses. He reported rather amazing effects for the pulse, body temperature, respirations, voice, expression, countenance, mentation, 'restlessness and uneasy feelings,' despondency, vertigo, tinnitus, thirst, urination and 'praecordial [heart] oppression.' In fact, he noted that the blue and shrunken appearance would 'generally disappear' and **'**I have not unfrequently seen patients sit up in bed immediately after the operation, in perfect possession of themselves, and speak with joy on th**e s**udden transition from agony and death to happiness and life.**'**

The procedure was not without perceived dangers, including large bubbles of air in the vasculature, nerve damage/dropsy and bleeding and inflammation and infection from placement of the large needle and the sometimes unsanitary conditions.[305] After earlier touting the procedure, the

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[301] Thomas Latta, "Letter from Dr. Latta to the Secretary of the Central Board of Health, London, Affording a View of the Rationale and Results of His Practice in the Treatment of Cholera by Aqueous and Saline Injections. 1832," *International Journal of epidemiology* 42, no. 2 (2013), 2; B. A. Foex, "How the Cholera Epidemic of 1831 Resulted in a New Technique for Fluid Resuscitation," *Emergency Medicine Journal* 20, no. 4 (2003), 316-318.

[302] Howard-Jones, "Cholera Therapy in the Nineteenth Century", 389.

[303] "Cholera - Saline Injections by Vein (20 June, 1832)," *Scotsman*, 2; Sherman, "Cholera", 47-48; Ryan, "Eyes on the Prize: Lessons from the Cholera Wars for Modern Scientists, Physicians, and Public Health Officials", 612; T.F. Baskett, "William O'shaughnessy, Thomas Latta and the Origins of Intravenous Saline," *Resuscitation* 55, no. 3 (2002), 231-34.

[304] "Singular Mode of Treatment of Cholera", 407.

[305] Howard-Jones, "Cholera Therapy in the Nineteenth Century", 390-392; "Cholera - Saline Injections by Vein", 2; "Singular Mode of Treatment of Cholera", 407; Dutta, Sur, and Bhattacharya, "Chapter 19. Management of Cholera", 347.

Scotsman published a somewhat dire warning about the technique as follows: **'**we admit that enough has been proved to warrant a cautious trial of the plan, we fear that the average mortality of cholera will be little affected by it. We do not certainly attach much importance to the result of the few cases in which it has yet been tried, but these are by no means encouraging.'[306]

Latta unfortunately died in 1833 and, in the same year, O'Shaughnessy left for southeast Asia. With the two UK champions of the technique lost and continued questions about its safety, its use mainly faded away although a few staunch supporters did continue to use it in the UK. The technique would only be fully revived and optimised further (mainly avoiding the large and sometime fatal, air bubbles) 160 years later in the early 20th century.[307] Thus, the mainstay of cholera treatment in modern times was in use in the early 1830s albeit very briefly.[308]

Several Edinburgh physicians also gave cholera patients ammonia. In 1828, Tatham prescribed 'a mixture of laudanum, liquor ammoniae acetate, and camphor mixture, together with warm brandy and water.' and noted that it 'generally affords agreeable warmth and comfort to the stomach.'[309] In 1830, Boyd suggested patients 'drink hot brandy and water, or hot water with a teaspoonful of sal volatile' [ammonium carbonate in alcohol].[310] As noted above, oral ammonia is a potentially harmful substance to the lining of oesophagus and stomach but, in a diluted form, it may have been effective.

Other oral agents given by Edinburgh physicians could have buffered and coated the stomach. In 1825, Dr. Ainsie recommended magnesia 'in large doses' to neutralise the stomach acid, noting this method can fail if given with milk (milk is a natural buffer of acids and so would have markedly reduced the anti-acid effect of magnesia).[311] Forsyth wrote 'The act of magnesia throws some light on the nature of the poison, by evincing it's possessing an acid principle, and that its [magnesia']

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[306] "Cholera - Saline Injections by Vein", 2.

[307] Howard-Jones, "Cholera Therapy in the Nineteenth Century", 392; A. M. Rivera, Strauss, K. W., van Zundert, A. & Mortier, E., "The History of Peripheral Intravenous Catheters: How Little Plastic Tubes Revolutionized Medicine," *Acta Anaesthesiol Belg* 56, no. 3 (2005), 271-282.; Sherman, "Cholera", 47-48.

[308] Interestingly, Christison's rather complete discussion of Board of Health recommendations for the 1832 epidemic (see Chapter 4) does not mention Latta's method. MacGillivray suggests a possible professional conflict between the two as a potential cause for this omission. Neil MacGillivray, "Dr Thomas Latta: The Father of Intravenous Infusion Therapy," *Journal of Infection Prevention* 10, no. 1_suppl (2009).

[309] Tatham, "On the Duration of Fatal Cholera", 71-72; Gibbs, "Observations on Cholera", 397; Abercrombie, "Suggestions Submitted to the Medical Practitioners of Edinburgh on the Characters and Treatment of the Malignant Cholera ", 10; "Remedy for Cholera", 272; "Plague, Cholera", *Chambers's Edinburgh Journal*, 8.

[310] Boyd, "Hints Respecting Cholera: With Directions Which May Be Most Safely Followed When Medical Aid Cannot Be Immediately Obtained"; CollinsDictionary, "Sal Volatile," https://www.collinsdictionary.com/dictionary/english/sal-volatile, Accessed 1 Sep, 2022.

[311] Ainsie, "Observations on the Cholera Morbus of India", 160; F. Salaün, Mietton, B. & Gaucheron, F., "Buffering Capacity of Dairy Products," *International Dairy Journal* 15, no. 2 (2005), 95-109.

success has been owing to its ant-acid [sic], as well as purgative qualities.'[312] Abercrombie also suggested 'large and repeated doses of magnesia.'[313] By 1843, 'two teaspoons full of magnesia in peppermint water' made its way into the *Chambers's Edinburgh Journal's* recommendations.[314] In 1839, a chemist in Edinburgh capitalised on the magnesia effects by selling 'Moxon's Effervescent Magnesian Aperient' noting, 'This unique preparation unites all the active powers of the most approved saline purgatives, with the palatable qualities of a glass of soda water. '… a safe, speedy, and effective remedy' for cholera morbus.[315] As noted above, this treatment is much like modern 'Milk of Magnesia' that coated and reduced the acid level of the stomach. The coating and buffering of magnesia (as well as 'purgative properties') could have lessened the cholera infection by limiting attachment of the bacteria and eliminating it from the stomach by vomiting. Abercrombie also recommended 'the oxide of bismuth,' i.e., Pepto-bismol.[316] All would have had an effect of comforting the stomach and, if given early enough and in sufficient quantities, would have possibly changed the acidity of the stomach and reduced the infectivity of the *Vibrio* bacteria.

Food was sometimes also used by Edinburgh physicians to help coat and calm the stomach. In 1745, Dr. Douglas suggested that 'care muſt be taken not to over-load the ſtomach, or to eat anything but what is of light nouriſhment, and grateful to the appetite.'[317] He also had his patients 'drink plentifully of a decoction of oat bread, baked without any leven or yeſt, …. If oat-bread … cannot be had, wheat-bread without yeſt or meal or wheat, as barley fry'd or toaſted brown, and ground to a powder will do very well.' [sic] Tatham treated nausea in his patients with 'Diluents, as barley-water, weak wine-whey, arrow-root boiled in water, with or without milk, in moderate quantities, serve both to refresh the sick person and dilute the irritating contents of the *primae viae*.'[318] Another physician suggested, 'Two-spoonfuls to a pint of gruel, made of equal parts of milk and water, is the general prescription; and our informant avers that every individual thus treated recovered in the end.'[319] In 1881, an entire article was written by a British physician serving in India strongly suggesting the attributes of 'raw soup' for cholera patients.[320] For others, the varying

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[312] Forsyth, "Official Correspondence on Mr Henderson's Method of Treating the Indian Cholera", 42.
[313] Abercrombie, "Suggestions Submitted to the Medical Practitioners of Edinburgh on the Characters and Treatment of the Malignant Cholera ", 13.
[314] "Plague, Cholera", 8.
[315] "Moxon's Effervescent Magnesian Aperient," *Scotsman*, 27 Aug 1839, 1.
[316] Abercrombie, "Suggestions Submitted to the Medical Practitioners of Edinburgh on the Characters and Treatment of the Malignant Cholera ", 12.
[317] Douglas, "A Cheap and Effectual Medicine to Cure the Cholera, or Colick. The Gentleman's Magazine and Historical Chronicle", 91.
[318] Tatham, "On the Duration of Fatal Cholera", 74.
[319] "Magnesia as Cure for Cholera," *Scotsman*, 16 Oct 1833, 3.
[320] T. M. Lownds, "Notes on Feeding Cholera Patients," *Edinburgh Medical Journal* 27, no. 5 (1881), 445-450.

derivates of opium were a mainstay of cholera treatment in Edinburgh. But like many treatments in the 1800s there was variation. Gibbs wrote, 'The acetate of morphia has been thought useful but no regular plan has yet been laid down, owing to the difference of opinion …. So much depends on the means and opinion of each medical practitioner, and there is such a variety of practice, that it is impossible to lay down any precise rules for acting.'[321] Other practitioners preferred to use only non-opioid treatments and the use of opiates slowly diminished over the time.[322] By 1866, the Royal College recommendations stated, 'Give no laudanum or other preparation of opium or astringents in this stage, unless ordered by a medical man.' Both Dr. Littlejohn and Dr. Smart agreed.[323]

A summary of the many suggested uses of opioids in Edinburgh is given in Appendix 3-4 (Parts 1-3). These uses were mainly focused on pain control but also for the marked coldness seen in cholera sufferers as well as the vomiting, diarrhoea and intestinal cramping. Opiate's pain control properties were known to Edinburgh physicians in the 1800s but, despite not always understanding how their side effects on intestinal motility, the feeling of 'air hunger' and anxiety, they certainly noticed these effects in their patients. And while the use of these opiate mixtures was very prominent in the 1832 epidemic treatments and gradually lessened particularly in the 1853/54 and 1866 epidemics, their utility in treating cholera patients cannot be dismissed. The doctors in Edinburgh as well as elsewhere in the world were seeing a response – and often a good one.

Many other, commercial products that were not given by doctors were available in Edinburgh during the period of 1820 to 1870 (see Appendix 3-5). As discussed previously, these varying products were often simply mixtures of many of the above discussed treatments or were carefully kept secret. As the general public's trust in both governmental and medical authorities increased, the advertisements for commercial products seems to have increased, potentially as an income source for chemists and for doctors who could no longer publish and sell individual pamphlets.

Summary

If the Edinburgh doctors were lucky enough to diagnose cholera and, in particular, Asiatic cholera, their treatment options were limited and mainly symptomatic. However, almost all had a real and potentially effective purpose in the treatment of the infection, loss of fluids and salts with resulting

[321] Gibbs, "Observations on Cholera", 396-397.

[322] Ainsie, "Observations on the Cholera Morbus of India", 160-161; "Cholera Morbus Treatment from Gentleman in London", 4; "Magnesia as Cure for Cholera", 3; "Publication - Dr Ayre 'on the Malignant Cholera'," *Scotsman*, Jun 10 1835, 1; "Chloroform in Cholera," *Scotsman*, 4 Nov 1848, 3; A.B.C., "Cholera - Is There a Cure for It!", 6.

[323] "The Cholera - Suggestions by the Royal College of Physicians for Preparation against an Outbreak of Cholera in Edinburgh", 2; "Precautions against Cholera (Littlejohn)", 2; "Dr. Smart, Recommendations for Guarding against Cholera", 2.

acidosis, cramping pain in the intestines and muscles and inflammation in both as well as in the blood vessels, the decreased flow of blood and resultant poor-oxygenation (blue colour) and coldness of patients and finally the sheer need for food for both calories and to potentially buffer the stomach and intestines. As a result, none of the treatments should be readily discounted.

But beyond symptomatic treatment, alcohol could potentially kill the bacteria and moderate drinking may have offered increased protection against the infection. Alcohol could also have had an anti-inflammatory effect in the blood vessels and would have also provided a calming, sedative-like as well as a warming effect. Rhubarb, calomel, ammonia, colocynth, magnesia (e.g., Milk of Magnesia), oxide of bismuth (e.g., Pepto-Bismol), oral turpentine, cinnamon, antimony and mustard enemas and castor oil (e.g., ricin) could all have killed or at least inhibited the mechanism of *Vibrio* infection in the varying ways.

In addition, calomel and oxide of bismuth would have helped reduce vomiting and diarrhoea to help stem the loss of fluids (a substantiative relief to a cholera patient) while magnesia would increase both vomiting and diarrhoea helping to eliminate the bacteria. Colocynth, magnesia and oxide of bismuth all decreased/disrupted the movement of water and/or ions out of the intestinal cells thereby reducing the loss of these ions but also the potentially fatal acidosis. Anti-inflammatory effects would have been possible via use of oxide of bismuth (small intestine), topical turpentine (muscles), cinnamon (entire digestive tract), mustard poultices (stomach and muscles), castor oil (small intestine) and camphor, a.k.a. Bengay, Vicks VapoRub, Tiger Balm (muscles and, when used as an enema, large intestine). Opiates would have reduced pain, slowed the diarrhoea, partly inhibited the spasms of the intestines, decreased anxiety and reduced the sensation of breathlessness exactly like it is used today in both acute and palliative care. Fluids would be offered, albeit with great variation, to help counter the loss of fluids and ions (Table 3-3). Dr. Latta of Leith would provide what is considered the first, human intravenous fluid therapy for the treatment of cholera – a technique which is a mainstay of modern medicine and the primary treatment mode for cholera today. Bleeding or the use of leeches could potentially restore the flow of blood by both direct action and thinning of the blood providing relief of the blueness and cold and countering the acidosis as well as increasing removal of waste and provision of nutrients. Blankets, turpentine (topical), mustard poultices and camphor would offer warming effects, magnesia could coat and sooth the stomach and simple, bland foods would provide nutrition and coat the stomach similar to the food-based, oral replacement therapies used in modern cholera treatments. Commercial products sold in Edinburgh also would mimic the above effects in a variety of different ways.

As one cholera epidemic turned into another, these treatments were evaluated for risks and benefits, many were stopped and, gradually, something of a simplified and accepted treatment strategy was adopted. And if these medical treatments did have any dire consequences, the doctors certainly did not realise them; in the end, they still adhered to the idea of *primum non nocere*, whether they knew the *nocere* or not.

Chapter 4. Public Health in Scotland

Introduction

Rees states that for public health to actually emerge, develop and flourish, 'There has to be appropriate skill and knowledge of sanitary engineering; there has to be the appropriate medical knowledge about the cause and prevention of disease; and there has to be the willingness of the public, local authorities and Parliament to legislate and carry through and uphold that legislation.'[324] In fact, public health efforts, including sanitation ones, have been present for over four millennia (e.g., Egyptian, Hebrew, Mesopotamian) often in fairly advanced states with foci on clean water sources, proper handling of sewage and a common theme that 'cleanliness is next to godliness.'[325] The question arises of 'What about Great Britain and, in particular, Scotland?' 'Why was there not a robust, Public Health system already in place in the 1800s?' 'Why in Scotland with its strong Presbyterian model could people be so unsanitary in the eyes of their god?' This chapter will examine those questions with a focus on the progression of the individual and combined factors that slowly but surely created that 'skill and knowledge' but also the 'willingness' for Scotland and, specific to this thesis, Edinburgh.

Overcrowding: A Nidus for Disease

Rees suggests that in pre-18th century Britain there was little or no need for public health due to its mostly sparse population density but also no driving force 'from local authorities and, in greater measure, from scientists, doctors, administrators and philanthropists [responsible for] various aspects of health problems in society.'[326] What did drive the problem of public health that then begged a solution was the emerging British Industrial Revolution, prompting a population shift towards the fast-appearing industries in cities and larger towns. Migration from the Highlands to the Lowlands, immigration from Ireland starting in the 1830s and increasing in the mid-1800s due to the potato famine (mainly to Glasgow and western Scotland) and troops returning in the 1820s from the Napoleonic Wars (military pensioners numbered slightly under 100,000 by the 1830s and still 70,000 by 1850) contributed to a much larger, urban Scottish workforce as demand for workers markedly increased, particularly in the Lowlands but also in particular rural areas.[327]

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[324] R. Rees, *Poverty and Public Health, 1815-1948* (Pearson Education, 2001), 109.
[325] Rosen, *A History of Public Health*, 1-3.
[326] Rees, *Poverty and Public Health, 1815-1948*, 109-111.
[327] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 156-157; T.M. Devine, *The Scottish Nation, 1700-2007* (Penguin, 2006), 155-156, 158-159, 162, 284, 460 & 463-464; J. E. Cookson, "Early Nineteenth-Century Scottish Military Pensioners as Homecoming Soldiers," *Historical Journal* 52, no. 2 (2009), 320.

The movement of people was especially predominant in Scotland where 'By the 1750s, Scotland was seventh in the league table of 'urbanized societies' in all Europe, fourth in 1800 and second only to England and Wales by 1850.'[328] Dingwall reports that 'by 1850 over 25% of all Scots lived in Glasgow, Edinburgh, Dundee or Aberdeen.'[329] Stable businesses such as the weaving industry in the Scottish Borders towns added to the need for more Lowland workers. Beyond sheer relative numbers was the speed by which urbanisation occurred in Scotland; unlike England, Scotland's urbanisation took place in just a few decades. Rodger notes that the number of people moving to urban areas in Britain between 1800 and 1830 was more that the total population in 1801. For Scotland, in particular, the percentage of inhabitants of Scottish towns of over 10,000 people grew in just fifty years from 9.2% in 1800 to 32% in 1850 with the masses of new people 'more likely to inflict greater pressure on urban relationships, amenity and sanitation.' Separate to the movements of people was the simple Scottish population growth (~0.6% from 1755-1801 to 1.2% from 1801-1811 and 1.6% from 1811-1821) that just added to the problem.[330]

There was also a unique demand in Scotland for rural work, particularly in the 1830s, as a great number of urban populations from around Britain were fed by agricultural products from Scottish farms; supplying troops during the Napoleonic Wars also provided a huge boom for Scottish farmers. This led to production changes on Scottish farms that more effectively used labour and led to higher yields of products. Additionally, protectionism legislation in England (e.g., Corn Laws) that may have affected worker movement were not applicable for Scots. Instead, Scotland viewed 'the high levels of technical efficiency in Scottish farming as an effective substitute for protection.'[331] As a result, agricultural hubs developed in smaller urban centres like Perth, Ayr, Haddington, Dumfries, Stirling and Inverness to handle the distribution of the farm products leading to increased need for workers in these locations. These regional centres offered jobs and, although sanitary problems were universal throughout Scotland, these centres also provided overall better sanitary conditions than the larger urban areas.[332] Thus, by the start of the 19th century, 'the population was ever more mobile to take advantage of new employment opportunities' despite their potential impact on their health.

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[328] Devine, *The Scottish Nation, 1700-2007*, 153.

[329] Rees, *Poverty and Public Health, 1815-1948*, 111; Dingwall, *A History of Scottish Medicine: Themes and Influences*, 156.

[330] R. Rodger, *Housing in Urban Britain 1780-1914: Class, Capitalism and Construction*, Studies in Economic and Social History (Basingstoke: Macmillan, 1989), 9.; J. de Vries, *European Urbanisation, 1500-1850* (London, 1984), pp 39-48 as modified for Table 8.1 in Devine, *The Scottish Nation, 1700-2007*, 152-154, 165 & 463.

[331] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 155; Rodger, *Housing in Urban Britain 1780-1914: Class, Capitalism and Construction*, 11-12.

[332] Devine, Devine, *The Scottish Nation, 1700-2007*, 154-156, 159, 163 & 462.

Rodger, again describing Britain as a whole, further notes, 'The cumulative pressure of numbers prompted a material breakdown of urban society as reflected in the state of public health and in the contamination of food and water supplies.'[333] Rees describes how throughout Britain 'The impact of thousands and thousands of people into smaller towns and cathedral cities that had had the fortune, or misfortune, to have one or more industries located there had a catastrophic effect on the existing housing and sanitation provision.'[334] Like in the rest of Briain, this mass shift of a Scottish population towards the fast-appearing industries in cities and larger, rural towns created ever-worsening public health problems.[335] Another, very Scottish factor also prompted a very mobile workforce beyond simple availability of jobs. Specifically for the poor, 'the incentive for Scots to remain in their parishes of birth or settlement was weaker than elsewhere in the United Kingdom' as only 230 out of 870 parishes (~26.4%) made assessments to help their 'assigned' poor.[336] With little prospect for poor relief by the local parish and work plus expenses being offered to them elsewhere, it is no wonder that the Scottish workforce was an extremely mobile one. This mobility meant a lot of people moving in mass and often at speed to where the work was offered despite the ability of the rural town or urban city to absorb their housing, public health needs, including improved sanitation.

In Scotland, this effect was worsened even further by the 'tradition of accommodating people in high-built tenements, courts and wynds.' As a result, housing problems would come well before sanitation solutions as workers coming to the large cities were forced to stay in 'the overcrowded, small, poorly sanitized areas of Edinburgh (Old Town) and Glasgow (Wynds) … because many had no alternative but to accept them.'[337] Rees notes 'Urban communities responded first, by using up and adapting existing 'vacant' living space and, second, by building new. Cellars and attics were filled with working people and their families, and were used as workplaces as well.' As empty spaces were soon filled, aging mansions were 'divided up into as many tiny living spaces as possible for poor families to rent at as much as the landlord dared to ask' and new housing was quickly erected with little or no standards for building or rules regarding how many people could be housed within them.'[338]

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[333] Rodger, *Housing in Urban Britain 1780-1914: Class, Capitalism and Construction*, 1 & 9.
[334] Rees, *Poverty and Public Health, 1815-1948*, 112.
[335] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 165-166; Bynum, *Science and the Practice of Medicine in the Nineteenth Century*, 62-64 & 66.
[336] Paul Laxton and Richard Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, First edition. ed. (Lancaster: Carnegie Publishing Ltd, 2013), 17; S. Blackden, "The Board of Supervision and the Scottish Parochial Medical Service 1845-90," *Medical History* 30, no. 2 (1986), 144 & 147.
[337] Devine, *The Scottish Nation, 1700-2007*, 168 & 267.
[338] Rees, *Poverty and Public Health, 1815-1948*, 113-114; Rodger, *Housing in Urban Britain 1780-1914: Class, Capitalism and Construction*, 3-4.

These housing conditions, including the resultant overcrowding and the related sanitation problems, were directly linked to increased morbidity amongst the inhabitants and soon mortality rates rose in the larger towns (e.g., Edinburgh: 1810-19, death rate 25/1000, 1820-29, 26.2/1000 and 1830-39, 29/1000.).[339] Great Britain and Scotland were no longer the predominately rural areas where public health did not matter greatly. In fact, Chadwick's *Report on the Sanitary Condition of the Labouring Population of Great Britain* directly stated 'that conditions were much worse in Scotland than in England.'[340] Rodger specifically addresses the issue of housing as a direct cause of sanitation problems with food and water and the unequivocal 'correlation between mortality and disease on the one hand, and housing and sanitary conditions on the other.' As a result, the middle class abandoned the town centres to the 'artisans and the petit bourgeoise while others were subdivided for multiple working-class dwellings …. It became easier to overlook the squalor of central slums from the comfortable distance of the suburban villa than occupying an older town house in the core of the city.' But Rodger also comments that the idea of segregation of classes

> has variously been interpreted as an abandonment by the middle and upper classes of a traditional responsibility for workers' welfare, as a dereliction of duty in setting social norms and imposing control mechanism on the working class, and as a liberalising of the working class from repressive traditions and behaviour.[341]

Regardless of any malevolent or benevolent intentions, the middle class and business owners left the city centres and the poor and working classes continued to pour in. Perhaps most importantly, this internal migration allowed these wealthier classes to temporarily sidestep any need for reform. Instead, funds were readily provided for building impressive buildings in urban centres to the glory of the Empire while investment in the poor and working-class areas was lacking. Nothing 'meaningful' beyond 'temporary palliatives' were considered up to the 1840s and it would not be until the latter half of the 19th century that real progress in housing and sanitation would start to be achieved. The poor were still being seen per the Presbyterian values of 'thrift, independence, sobriety, the work ethic and education' were still 'the very foundation of the middle- and "respectable" working-class culture.'[342]

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[339] Devine, *The Scottish Nation, 1700-2007*, 167.

[340] E. Chadwick, *Report on the Sanitary Condition of the Labouring Population of Great Britain* (Edinburgh: Edinburgh University Press, 1965); Rosen, *A History of Public Health*, 184-196.; Rees, *Poverty and Public Health, 1815-1948*, 135-138; Dingwall, *A History of Scottish Medicine: Themes and Influences*, 165.

[341] Rodger, *Housing in Urban Britain 1780-1914: Class, Capitalism and Construction*, 1-4.

[342] Ibid, 66-67; Dingwall, *A History of Scottish Medicine: Themes and Influences*, 168; Devine, *The Scottish Nation, 1700-2007*, 167 & 291.

Disease and Societal Change as a Driver of Public Health

The history of the development of public health rests, not in small part, on the diseases of plague, small pox, typhus, yellow fever and, in regards to this work, cholera (Figure 4-1). In fact, Ryan suggests that 'Cholera has played major roles in many advances of modern science and public health, perhaps noting more firsts than any other pathogen.' He lists a full twenty 'firsts' for cholera, including first modern global pandemic, driver of evidence-based epidemiology, described water-borne (non-airborne/contact) illness, pathogen identified by microscopy, use of laboratory-based public health intervention, use of therapeutic intravenous fluid and driver of development of oral rehydration solution (ORS). Rosen and Rees similarly outline the impact of cholera on public health.[343] And while there may be some debate about the extent, the four 1800s cholera epidemics can be seen as triggering important worldwide as well as British/Scottish legislative and sanitation efforts. Amongst its other contagious brothers, cholera holds a prominent place in the development of public health from the 1800s even through to today.[344]

The urbanisation and industrialisation already discussed 'created the circumstances which produced condition-induced or environmentally-induced diseases and injuries. This was the time of the major epidemics of cholera, typhus, measles and other potentially deadly diseases.' At least in the beginning, local and national governments only thought about 'reactive' measures against these maladies, since 'preventative' ones like 'Improving housing, providing clean water supplies, initiating vaccination programmes and other public health measures was expensive….' For cholera, the unknown aspect of this complex bacteria, the varying ways in which it could present, the variability of (effective) treatments and the multitude of theories meant that no one actually knew what they had to fight and, most importantly, how to fight it.[345] But there was more to the lack of impetus for improvements. Society had still not grown beyond seeing housing and disease problems as anything beyond a simple 'moral problem' of the poor and working classes and 'it was easier – and cheaper too – to target pigs, beggars and the Irish than to deal with sewers and drains where nuisance powers were weak.'[346] Society would have to change.

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[343] Ryan, "Eyes on the Prize: Lessons from the Cholera Wars for Modern Scientists, Physicians, and Public Health Officials", 612; Rees, *Poverty and Public Health, 1815-1948*, 49-61; Rosen, *A History of Public Health* See especially Chapters I, V & VI.

[344] R. E. McGrew, "The First Cholera Epidemic and Social History," *Bulletin of the History of Medicine* 34, no. 1 (1960), 65-71; ML Jackson & M Hanlen, "Cholera," (Singapore: Springer Singapore, 2020), 62; Ryan, "Eyes on the Prize: Lessons from the Cholera Wars for Modern Scientists, Physicians, and Public Health Officials", 612-614; Dingwall, *A History of Scottish Medicine: Themes and Influences*, 168.

[345] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 165-166.

[346] Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 30-31; Devine, *The Scottish Nation, 1700-2007*, 335.

Figure 4-1. Wood Engraving Showing a Public Health 'Angel' with her Shield of 'Cleanliness' and a Gate of 'Quarantine.' The three figures cowering in the foreground include the prominently-placed cholera with yellow fever and smallpox behind.[347]

[347] S.G. Ingrid, "Fig. 13: "At the Gates." Harper's Weekly 5 Sept. 1885. Images from the History of Medicine (Nlm)," *Epidemic Iconographies: Toward a Disease Aesthetics of the Destructive Sublime* (2013), Available from: https://www.researchgate.net/figure/At-the-Gates-Harpers-Weekly-5-Sept-1885-Images-from-the-History-of-Medicine-NLM_fig11_292833598 , Accessed 22 Sep, 2022.

As noted above, simply because these problems existed did not mean that efforts were being made to solve them. But there was slow progress of the upper and middle classes understanding the importance of public health not only for the poor but also for themselves. As noted, the changes would not start to take hold until the 1850s – after two, cholera epidemics had struck both rich and poor. Rosen points out two important factors in the immediate post-Chadwick period. First, the efforts of the 1830's and 1840's, albeit meek and mild, had, in fact, made a difference. The idea of society helping its less fortunate, which had started in the Enlightenment, had a much firmer ground and this help was now seen, at least partly, to need to involve regulation for public health by a central government. Secondly, he points out that public/ health reform was never really about medicine. Medicine did not know what it was doing at that point in history particularly in regards to sanitation and communicable diseases. Rosen suggests that, 'Significant instances … are the supervision of local health authority, and the position of the medical officer of health.' What was important, then, were new ideas about the poor as well as institutions that could actually act. But, while the UK (and Scotland) was becoming an industrial and intellectual power, there were still problems. Dingwall notes that the Enlightenment was probably 'limited to certain people and classes' and that, to a certain extent, these people and classes set the rules and reaped a number of the benefits.'[348] But why was this the case?

Prominent amongst British thinking as the 18th century was turning into the 19th was the economic power of the Industrial Revolution. The middle class was becoming wealthy and wanted it and not some governmental agency to determine the country's pathway and the way that society (and their businesses) would develop. As Colquhoun wrote in his work on education of the 'Labouring People,' 'Without poverty there would be no labour, and without labour there would be no riches.'[349] So, while caring and compassion was on the surface, the efforts of the middle class, along with any social regard afforded to them by the Enlightenment, were more practical to assist the poor. With factories running at capacity, having a numerous, healthy and happy workforce was a businessman's dream. The worker who was not home sick was making widgets to be sold. The child who did not die was the worker of tomorrow (or today). A work injury or illness could be more quickly remedied at a hospital or dispensary and the person returned to work versus potentially lengthy self-care. While many British factory owners did offer their heart-felt help and assistance to the poor and working class, it was, in the end, a sound, 'business' investment.[350]

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[348] Rosen, *A History of Public Health*, 200-201; Dingwall, *A History of Scottish Medicine: Themes and Influences*, 110 & 146.
[349] Colquhoun, P., 1806 as cited in Rees, *Poverty and Public Health, 1815-1948*, 6.
[350] Bynum, *Science and the Practice of Medicine in the Nineteenth Century*, 73.

So, the businessmen and middle class were taking care of the important workforce and the poor in exactly the way they wanted and feeling very, very good about it all. Although potentially seen as very self-centred and greedy, there were prominent reasons for the unique, British pathway. Unlike in Europe, 'Government,' especially local, was seen by the general public to only be serving a select few elected officials (for which elections were rare), the clergy, owners of water companies and even the 'night-soil' men who were reaping huge profits from waste removal (see below). If the local governments could not be trusted, why would anyone want a national government in charge?[351] And if government was not to be thanked, the benevolent and giving owner of the factory should.

But 'benevolent,' individuals could not provide the larger, mainly sanitary improvements needed by a large, ever-growing, predominately urban-based, British society. Rosen notes, 'Accumulation of sewage, pollution of water supplies, overcrowded and inadequate housing: in short, all the things that agitated the reformers of the Victorian period' were worsening. Efforts were made to provide basic cleaning of streets, lanes and closes, to improve the construction of old, dilapidated housing and light its streets and to establish some kind of functional clean and sufficient water source as well as a sewage system. But these improvements increasingly helped the rich while the poor were stacked upon each other in ever increasingly inadequate housing. As discussed above, the death rate, which had been falling for over half a century due to an increasing birth as well as survival rate (infant through adult), began to rise. Something more had to be done and the old system was no longer sufficiently providing for the poor and working classes. Unlike their European cousins, there was no central government to oversee public health improvements, particularly for the lower-class citizens. The efforts of the middle class had met its limits.

Beyond the factory owners, all classes of the general public were also starting to call for societal improvements even within the non-centralised model. With the government not to be (fully) trusted, the social classes were, necessarily, starting to see each other as commensalist and both the middle and upper classes had an increasing interest in as well as an effort to improve the state of the poor and working classes.[352] Scotland and Edinburgh still needed to change and adapt in order to truly provide a proper sanitary environment for all their citizens. Cholera had left them no choice; public health and sanitation improvements was now a matter of life and death for all from the poorest to the richest.

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[351] Rees, *Poverty and Public Health, 1815-1948*, 118-119; Dingwall, *A History of Scottish Medicine: Themes and Influences*, 173-174; Ian H. Adams, "Urban Reform," *Routledge Revivals: The Making of Urban Scotland* (1978), http://ebookcentral.proquest.com/lib/stir/detail.action?docID=5259918, 1-2.

[352] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 173-174; Adams, "Urban Reform", 10.

The Beginnings of Public Health in Scotland

Rees further points out that 'Bad housing was nothing new and it certainly was not a product uniquely of the industrial revolution …. What was unique about the industrial revolution was that it resulted in widespread, dense overcrowding.' Some direct effects of this overcrowding were 'what Victorians called "filth diseases" such as typhoid, diphtheria, tuberculosis, scarlet fever and, most dreaded of all, cholera. Other nineteenth-century killers, like measles and whooping cough, became endemic.'[353] The first, deadly cholera epidemic struck Britain in 1831-1832 with three more to follow. This disease hit the less sanitary areas inhabited by the poor and working classes as always but this new threat was different; suddenly, the upper classes were also infected and dying from cholera despite their newly acquired wide streets, clean water, improving sewage system and financial status.[354] Whatever else it did, cholera most certainly 'concentrated the minds of those who wished to promote urban health as well as individual health.'[355] Helping the poor, mainly by improving the terribly unsanitary environment that most lived in, was now a matter of life and death and for the middle and upper classes as well.[356]

Progress had been made at least in the thought process behind the Scottish model of public health. The 'public sphere of government, legislation and social control' became more interested in the effects of the Industrial Revolution and how they affected the poor and working classes. More importantly, they started to be given the tools and the power to affect change including the Burgh Police Act of 1861 and the Improvement Acts of the 1860s (e.g., Edinburgh 1867, Glasgow 1866) 'to promote large-scale demolition of some of the worst slums.'.[357] In 1854, Scotland finally enacted civil registration of births, deaths and marriages after eight failed, legislative attempts and almost twenty years after England and Wales.[358] This is the also when Medical Officers of Health began to be appointed (albeit still with limited powers) in the larger Scottish towns and cities with the specific duty 'to oversee measures introduced to improve the sanitary condition of the population and to deal with epidemics as they arose.'[359]

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[353] Rees, *Poverty and Public Health, 1815-1948*, 112; Devine, *The Scottish Nation, 1700-2007*, 168 & 267.
[354] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 156, 164 & 168, 195; Rees, *Poverty and Public Health, 1815-1948*, 49-61.
[355] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 156, 164 & 168; Devine, *The Scottish Nation, 1700-2007*, 333 & 336.
[356] Rosen, *A History of Public Health*, 126-184.
[357] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 173; Devine, *The Scottish Nation, 1700-2007*, 345.
[358] A. Cameron, "The Establishment of Civil Registration in Scotland," *Historical Journal* 50, no. 2 (2007), 377-384; Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 35.
[359] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 168.

Implicit in the changes to these changes in society and their views about the poor are the prevailing theories that would have directly influenced thought and, therefore, action. For Scotland and Edinburgh, the two major players in the question about how to 'handle' the poor were Thomas Chalmers and William Pulteney Alison. The two famously debated (for four days) at the September, 1840, annual meeting of the British Association for the Advancement of Science in Glasgow.

Chalmers, the better and more charismatic speaker of the two, espoused his theory of 'pauperism,' defined as 'a permanent legal dependence upon the labour or property of others,' a state considered by Chalmers to be 'essentially a moral disease [whose] cure would be found in the ideal of the covenanted community, in which both industry and benevolence would be encouraged by missionary ideal which transcended individual interests.'[360] This community would be his carefully planned, rather ambitious, multiple-parish, voluntarily-funded only system promoting necessary 'emphasis on self-reliance, character, [and] Christian morality.' His pursuit for a 'godly commonwealth' in a class-structured society struck a chord the urban upper, propertied and middle classes. It is not surprising then that these classes initially filled his Free Churches.[361]

Chalmers trialled his methods in the St John's parish in Glasgow and then the West Port area of Edinburgh (which just happened to also be where Burke and Hare had operated). He reported 'successes' in both locations, noting 'diminished poverty and crime, and elevated parish inhabitants with Christian and moral education. If the results had not been overwhelmingly convincing, it was because he had not received the necessary co-operation from the civil authorities.' Unfortunately for Chalmers, 'The actual solution for the West Port problem, then, was not the organisation of the existing population into a stable community, through visitations, church, and schools. Rather, it was the radical depopulation of the overcrowded district, perhaps the only solution possible.'[362] Public health was still not being addressed (or acknowledged). Alison, less of a speaker and more of a scientist-physician, quoted numbers and statistics that contradict Chalmer's 'successes.' Instead, he strongly supported contagionism and felt that the extreme poverty or 'destitution,' not 'pauperism,'

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[360] S. J. Brown, *Thomas Chalmers and the Godly Commonwealth in Scotland* (Oxford: Oxford University Press, 1983), 68-69; B. Harris, "Parsimony and Pauperism: Poor Relief in England, Scotland and Wales in the Nineteenth and Early Twentieth Centuries," *Journal of Scottish Historical Studies* 39, no. 1 (2019), 45.

[361] J.J. Smyth, "Thomas Chalmers, the 'Godly Commonwealth', and Contemporary Welfare Reform in Britain and the USA," *The Historical Journal* 57, no. 3 (2014), 846 & 849-851; Brown, *Thomas Chalmers and the Godly Commonwealth in Scotland*, 37-38, 41, 65-69, 75-80, 351-353 & 372-376.

[362] S.J. Brown, "The Disruption and Urban Poverty: Chalmers and the West Port Operation, Edinburgh, 1844-47," *Records of the Scottish Church History Society* xx, no. 1 (1978), 88-89; For a review of Chalmers' St John's, West Port or Scottish plans, the reader is directed to S. J. Brown, "Reform, Reconstruction, Reaction: The Social Vision of Scottish Presbyterianism C. 1830-C. 1930," *Scottish Journal of Theology* 44, no. 4 (1991); "Thomas Chalmers and the Communal Ideal in Victorian Scotland," in *Victorian Values* (1992).

being faced by the poor in Edinburgh and elsewhere was 'that great and general disease of the body politic.'[363] Alison promoted direct care to the poor, including sufficient and good food, employment and essential needs (e.g., clean surroundings). Although mainly overshadowed by the politically powerful Chadwick throughout his career, Alison's well-considered, contagionist voice, backed by copious and well-attained data, helped to define Scotland's and Edinburgh's early response to public health and provided notable connections between the effects of destitution and disease.[364]

Depending on the particular view of each onlooker, either side won the debate. Brown summarises the 'crux of the argument' as follows: 'Reform the social environment, Alison maintained, and individual moral reform would follow. But Chalmers believed the opposite. The first step was to reform individual moral character through Christian instruction, and then improvement in social conditions would "necessarily follow."'[365] Regardless of any outcome, these two leaders helped to reveal the 'atrocious conditions of mass destitution and ignorance in Scotland' but more importantly that care for the poor needed to change. [366] The solely church-run, parish-based system had failed 'in large part because the Churches failed to adapt their social vision, developed to meet the needs of small, agrarian parish communities, to the social structures of mature industrial society.'[367] The Disruption had also created different foci of how the poor should be treated amongst the Church of Scotland, Free Church and United Presbyterian churches. The Catholic church had also started to emerge in Scotland with its own vision of helping the poor, even involving educating girls and women. Indeed, the varying roles of the voluntary hospitals, societies, charities and churches all

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[363] C. Hamlin, "William Pulteney Alison, the Scottish Philosophy, and the Making of a Political Medicine," *Journal of the History of Medicine and Allied Sciences* 61, no. 2 (2006), 159-160 & 164-167; Alison WP, "Observations on the Epidemic Fever Now Prevalent among the Lower Orders in Edinburgh," *Edinb Med Surg J* 28(93) (1827), 233-263; Alison, "On the Communicability of Cholera by Dejections", 481-492; Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 36 & 38.

[364] *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 23, 27-36, 58 & 100; Adams, "Urban Reform", 14-15. These works, heavily augmented with numerical observations and statistical proofs, potentially formed a template for Henry Littlejohn's, later *Report on the Sanitary Conditions of the City of Edinburgh*. Notably, Alison was one of Littlejohn's Medical School instructors and certainly influenced both his student's approach(es) to public health and sanitary efforts and to his own report.

[365] Brown, *Thomas Chalmers and the Godly Commonwealth in Scotland*, 292-294.

[366] Brown, "The Disruption and Urban Poverty: Chalmers and the West Port Operation, Edinburgh, 1844-47", 66; D. E. Gladstone, "The New Poor Law Scotland: The Administrative Reorganisation of the First Quinquennium," *Social Policy & Administration* 9, no. 2 (1975), 117; Hamlin, "William Pulteney Alison, the Scottish Philosophy, and the Making of a Political Medicine"; O. Checkland, *Chalmers and William Pulteney Alison : A Conflict of Views on Scottish Social Policy* , 133 & 135-136; D. Doyle, "William Pulteney Alison," *The Journal of the Royal College of Physicians of Edinburgh* 39, no. 4 (2009), 378; I. Milne, "William Pulteney Alison (1790–1859) a Scottish Social Reformer," *Journal of Epidemiology and Community Health* 58, no. 11 (2004), 887.

[367] Brown, "Reform, Reconstruction, Reaction: The Social Vision of Scottish Presbyterianism C. 1830-C. 1930", 490; Brown, "The Disruption and Urban Poverty: Chalmers and the West Port Operation, Edinburgh, 1844-47", 69-70.

provided an important role in the emerging care of the poor.[368] Still, there was still a definite role for religion as public health continued to develop and flourish in Scotland. Although there were some dissenters and the public was still reluctant to provide taxes for any projects, there was a growing realisation that 'A true partnership between civil and religious authorities would ensure that Christianity could rise to the challenge of an industrial society and the "godly commonwealth" would indeed by brought about.' Cleaning the physical as well as the moral world became increasingly acceptable and even the 1840s British and Foreign Medico-Chirurgical Review agreed that 'one broad principle may be safely enunciated in respect to sanitary economics – that it costs more money to create disease than to prevent …'[369] So, the church maintained a palpable influence on Scottish society and poor relief. The church with a new 'religious vision' which equated social improvement with moral improvement, promoted 'free access to parks in Edinburgh and Glasgow, improved sanitation legislation, public house licensing, work schemes for unemployed and hungry in the cities as well as elsewhere.'[370] Despite the argument of who won the Chalmers-Alison debate, Scottish society coupled with religion had come to something of an emerging agreement regarding the role of government in the provision of public health.

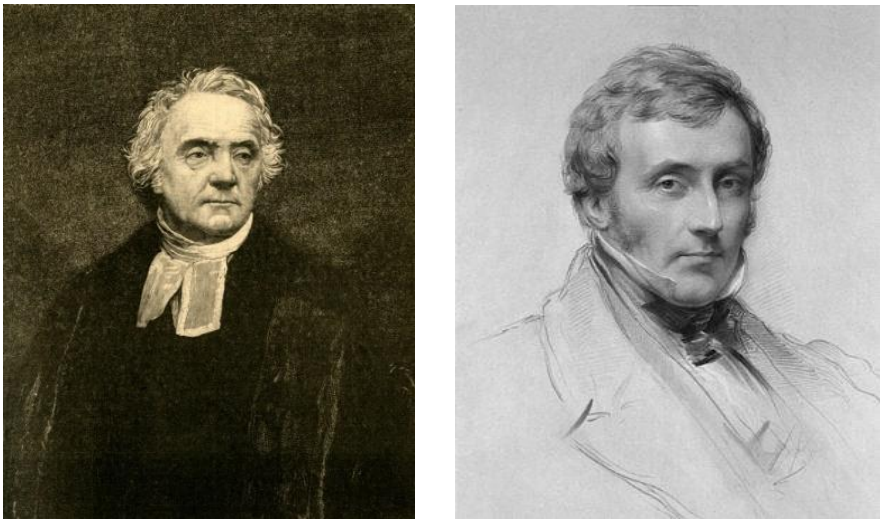

Figure 4-2. Thomas Chalmers and William Pulteney Alison[371]

[368] Brown, "Thomas Chalmers and the Communal Ideal in Victorian Scotland", 67-69; S.K. Kehoe, "Unionism, Nationalism and the Scottish Catholic Periphery, 1850-1930," *Britain and the World* 4, no. 1 (2011), 65 & 73-76; Dingwall, *A History of Scottish Medicine: Themes and Influences*, 173-174.

[369] Devine, *The Scottish Nation, 1700-2007*, 336-337 & 371; Brown, "Thomas Chalmers and the Communal Ideal in Victorian Scotland", 62-64.

[370] Devine, *The Scottish Nation, 1700-2007*, 363-367.

[371] Chalmers Image from Getty Images (Print Collector), "Thomas Chalmers," https://www.gettyimages.co.uk/detail/news-photo/thomas-chalmers-scottish-clergyman-theologian-and-political-news-photo/1155878474?adppopup=true, Accessed 22 Jul, 2023; Allison Image from Pulteney Alison image from "William Pulteney Alison," Royal College of Physicians of Edinburgh, https://www.rcpe.ac.uk/heritage/college-history/william-pulteney-alison, Accessed 22 Jul, 2023.

A New, Scottish Poor Law

The Scottish Poor Law, mainly a copy of the English/Welsh version, had started in the late 1570s and had remained mostly unchanged. Unlike in England/Wales, though, compulsory levies for the support of the poor were non-existent in Scotland. In addition, due to long-standing and firmly established lines of demarcation, co-operation between the Scottish parishes was not readily possible as per Chadwick's 'union of parishes' concept. In fact, many of the Scottish poor simply did not attend church in their 'assigned parish' due to many factors including the highly mobile, Scottish workforce. But the biggest difference was the Scottish system did not allow unemployed, able-bodied persons to receive aid (although 'extenuating circumstances were often considered as part of relief provided'), an attribute roundly praised by Scots and even by the English.[372]

However, an 1844 Royal Commission issued a scathing review of the Scottish system writing 'nothing could be more disgraceful than the present state of the poor in Scotland.'[373] But with powerful people and institutions involved, the report is an example of classic, political writing with care used to praise but also, somewhat indiscernibly, critique all sides of the argument (e.g., Alison and Chalmers had both written reports for the Commission). It recommended strict limits on central powers (insuring an active and important part for religious and local political bodies) but offered a parting note that 'by gradual and successive substitutions of itself throughout the various localities, shall at length displace the compulsory provision altogether.'[374] The result was the 1845 Poor Law Amendment (Scotland) Act which directly stipulated that 'care of the poor was, at least in terms of central control and legislation, secularised, although the "parish" remained the focus of organisation.'[375] Its limits were carefully laid out in the 30 August, 1845 *Examiner* to insure that all was done correctly.[376] Parishes were still at the forefront of relief but Parochial Boards and an

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[372] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 174-175; R. Mitchison, "The Making of the Old Scottish Poor Law," *Past & Present*, no. 63 (1974), 58-67 & 70-73; Gladstone, "The New Poor Law Scotland: The Administrative Reorganisation of the First Quinquennium", 115-125; Blackden, "The Board of Supervision and the Scottish Parochial Medical Service 1845-90", 147.

[373] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 176; Blackden, "The Board of Supervision and the Scottish Parochial Medical Service 1845-90", 151; Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 40.

[374] "Art. Vii.-Report from Her Majesty's Commissioners for Inquiring into the Administration and Practical Operation of the Poor Laws in Scotland," (Edinburgh: Open Court Publishing Co, 1845), 471-514.

[375] Blackden, "The Board of Supervision and the Scottish Parochial Medical Service 1845-90", 147-152; Gladstone, "The New Poor Law Scotland: The Administrative Reorganisation of the First Quinquennium", 115-127; David Englander, "The Poor Law in Scotland," in *Poverty and Poor Law Reform in 19th Century Britain, 1834-1914 : From Chadwick to Booth* (London: Routledge, 2013), 47-55; Harris, "Parsimony and Pauperism: Poor Relief in England, Scotland and Wales in the Nineteenth and Early Twentieth Centuries", 40-74'; Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 41-42.

[376] "Scottish Poor Law," *Examiner*, no. 1961 (1845), 546; G. Troup, "Relief of the Poor in Scotland," *Tait's Edinburgh Magazine* 14, no. 162 (1847), 472-477.

overarching Board of Supervision, located in Edinburgh, were established to oversee their efforts with increased powers during epidemics and the ability to implement

> … measures to provide emergency medical help, by the appointment of suitable medical practioners; that rules for medical relief should be observed; that poor houses should provide medical treatment; that there should be trained nurses in poor houses; and that lodgings should be provided for those who were both sick and homeless ….[377]

Still, there were deficiencies in this new, Scottish Poor Law. The '"able-bodied" unemployed in Scotland still had no legal right to relief, even if some support was often given in practice' although Alison would argue, 'Where is the difference – for in truth we cannot perceive it – on the ground either of equity or of human feelings, between the applicant for charity who is not able to work, and the applicant who is not able to obtain work?'[378] The Board of Supervision had no medical member, infuriating many, but this was later rectified and later even Littlejohn served as the Medical Advisor for the Board in 1859.[379] The Board became overseers of the poor law hospitals as well as the proper training of nurses and medical staff beyond doctors (the later Medical Act of 1858 would further codify this). Medical care for the poor still had inequities but steadily improved.[380]

Part of this was due to the emerging idea of the compulsory provision of public health from the central government (as had been practised for many years on Continental Europe) via a still empowered local government but also because the various Boards and players in this process were starting to rethink 'the causes of poverty, the causes of disease, the extent to which self-help was possible, and the role and responsibilities of central government as opposed to the individual or the locality.'[381] In 1866, the UK Parliament passed a new Sanitary Act, although it would not be in effect until November 1867.[382] Along with new requirements on the local boards, powers were importantly increased and universally given to all local boards instead of a select number. Further changes would lead to the 1875 Public Health Act which consolidated all the acts and their powers before.[383] There was just one more step for Scotland – getting a new Public Health Act.

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[377] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 176-177.
[378] "Art. Vii.-Report from Her Majesty's Commissioners for Inquiring into the Administration and Practical Operation of the Poor Laws in Scotland", 506; Devine, *The Scottish Nation, 1700-2007*, 343.
[379] Inquirer, "Medical Men and the Board of Poor Supervision," *Scotsman*, Oct 9 1865, 5; Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 3, 10 & 43. In his role, Littlejohn 'travelled to several larger cities and all twenty-one, Scottish ports to do inspections and discuss sanitary changes.'
[380] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 177-178; Blackden, "The Board of Supervision and the Scottish Parochial Medical Service 1845-90", 158-169.
[381] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 177.
[382] "Circular for the Public Health (Scotland) Act 1867," *Scotsman*, 14 Sep 1867, 3.
[383] Rees, *Poverty and Public Health, 1815-1948*, 147-149.

The Public Health (Scotland) Act (1867)

Dingwall reviews the 1867 Public Health (Scotland), noting that 'After many delays … this placed on legal footing many of the *ad hoc*, piecemeal trends which had characterised the first half of the nineteenth century. After this point the Medical Officers of Health and their departments were able to wield some considerable power over actions and methods.' As described, this Act was more of a conglomeration and codification of other Police Acts/legislation that were already in place but its effects were real. But as a result of the gradual evolution that had occurred in Great Britain and in Scotland, this was not a dictatorial, central controlling body. Rather, Dingwall notes that 'there was a broad framework of increasingly active central government, but one which enabled the localities to act independently and the voluntary sector to continue to operate – described as 'firmly governing an unequal but stable society through a process of negotiation among the major social factions.' Indeed, people saw 'the role of the central government as enabling rather than enforcing, and claims that many of the legislative measures came about as a result of change, rather than being the cause of it.' [384]

Real changes in urban centres started to be seen. Previously, the responsibility for the removal of these so-called nuisances (to include 'domestic refuse including excrement … rubbish from trades, manufacturing and food production, including slaughtering of animals') in private areas were the responsibility of private citizens like householders, landlords and business owners while public streets and market areas were the responsibility of the local council. In reality, the actual clean-up was often sporadic, especially in poor areas. But, society in general became 'increasingly unwilling to tolerate filth and the concomitant assault on the senses prompted ever more intense feelings of disgust.' 'Burgh Police Acts' put the onus on the council by the establishment of police commissions (employed 'scavengers were used in some instances) responsible for as lighting, paving and drainage, and services such as water supply and cleaning which was funded by local rates and 'was subjected to close scrutiny by residents of all classes.'[385] Specific for Edinburgh (who had 'borrowed' the idea of a police commission from Glasgow's 1800 Act) an official Parliamentary Act was passed in 1832 allowing increased powers of washing, cleaning and lighting adding to prior and later local Acts for 'drainage (1809), street improvements (1816, 1827, 1831, 1833), lighting (1818), garden and green spaces (1809, 1822), slaughterhouses (1850), and slum clearances (1853).'[386]

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[384] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 169 & 173.
[385] Deborah Brunton, "Regulating Filth: Cleansing in Scottish Towns and Cities, 1840–1880," *Urban History* 42, no. 3 (2015), 425-428.
[386] Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 26, 31 & 45-46.

Brunton specifically notes that these Police Acts provided 'Clean, well-ordered public space served the community in a number of ways' to include real or perceived avoidance of epidemics, improved and freer movement of people and their goods through the streets, lanes and closes but also 'social effects.' Specifically, contentment and high morals were increased because 'if the public authorities showed an interest in the sanitary condition of the town, then the inhabitants were more likely to keep their homes and neighbourhood clean.' The practice was extended to regular refuse collections with curb-side or even permanent dustboxes and ashbins provided in public areas and available around the clock. Edinburgh's police commissioners made the unfortunate error of changing the time of collection from the morning to the evening resulting in a rash of complaints about the refuse lying about all day and 'the necessity of sending respectable female servants into the streets at a late hour, where they mixed with lower-class inhabitants.'[387] 'Refuse' collection even extended to the collection of human and animal waste but with a twist. Changing farming techniques began to demand more fertilizer to maintain the soil fertility and the manure of humans, horses, cows and other animals along with 'household refuse, fish and animal offal, rags, bones and leather scraps all found their way onto fields.' The collected manure/refuse was sold at an often-handsome price thereby providing the city finances a much-needed infusion of cash.[388]

The increased empowerment of the MOH, a step strongly supported by the Royal College of Physicians of Edinburgh, also helped. This was the time of MOH's like Littlejohn in Edinburgh, William Tennant Gairdner (part-time) and then James Burn Russell (full-time) in Glasgow, Matthew Hay in Aberdeen and John McVail in Stirling. Examples of the new powers of the MOH and Town Council from the new Public Health Act included Littlejohn forcing practitioners to start reporting disease to a central authority, allowing 'mapping of the patterns of infectious diseases, particularly during times of epidemics.' and Glasgow starting a 'ticketing system' which 'gave sweeping powers to the MOH to set limits on the numbers of inhabitants in any house or room.'[389]

And the results of all these efforts were soon seen in Edinburgh where the death rate fell from 26.3 per 1000 people from 1865 to 1875 to 9.9 per 1000 from 1875 to 1885, a drop in deaths that was greater than almost all other UK cities (St Giles' Ward still had a death rate double that of the New Town). The pieces and the power for real public health reform in Scotland were finally in place, creating that long-awaited, more proactive instead of reactive process.[390]

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[387] Brunton, "Regulating Filth: Cleansing in Scottish Towns and Cities, 1840–1880", 427-429 & 431; Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 48-50 & 57-58.
[388] Brunton, "Regulating Filth: Cleansing in Scottish Towns and Cities, 1840–1880", 433-434.
[389] Adams, "Urban Reform", 12; Dingwall, *A History of Scottish Medicine: Themes and Influences*, 169-171.
[390] Adams, "Urban Reform", 12.

A summary of the evolution of public health milestones for Great Britain, provided by Adams, is shown in Figure 4-3. Specific roles of Scottish Police Burghs (1833 on), Alison's (1840) and Chadwick's (1842) publications, the Royal Commission on the Health of Towns (1844), the founding of the Board of Supervision (1845), Scottish Civil Registration and the General Registrar Office (1854) and the Public Health (Scotland) Acts (1867 & 1897) along with the timing of the four cholera epidemics are illustrated.

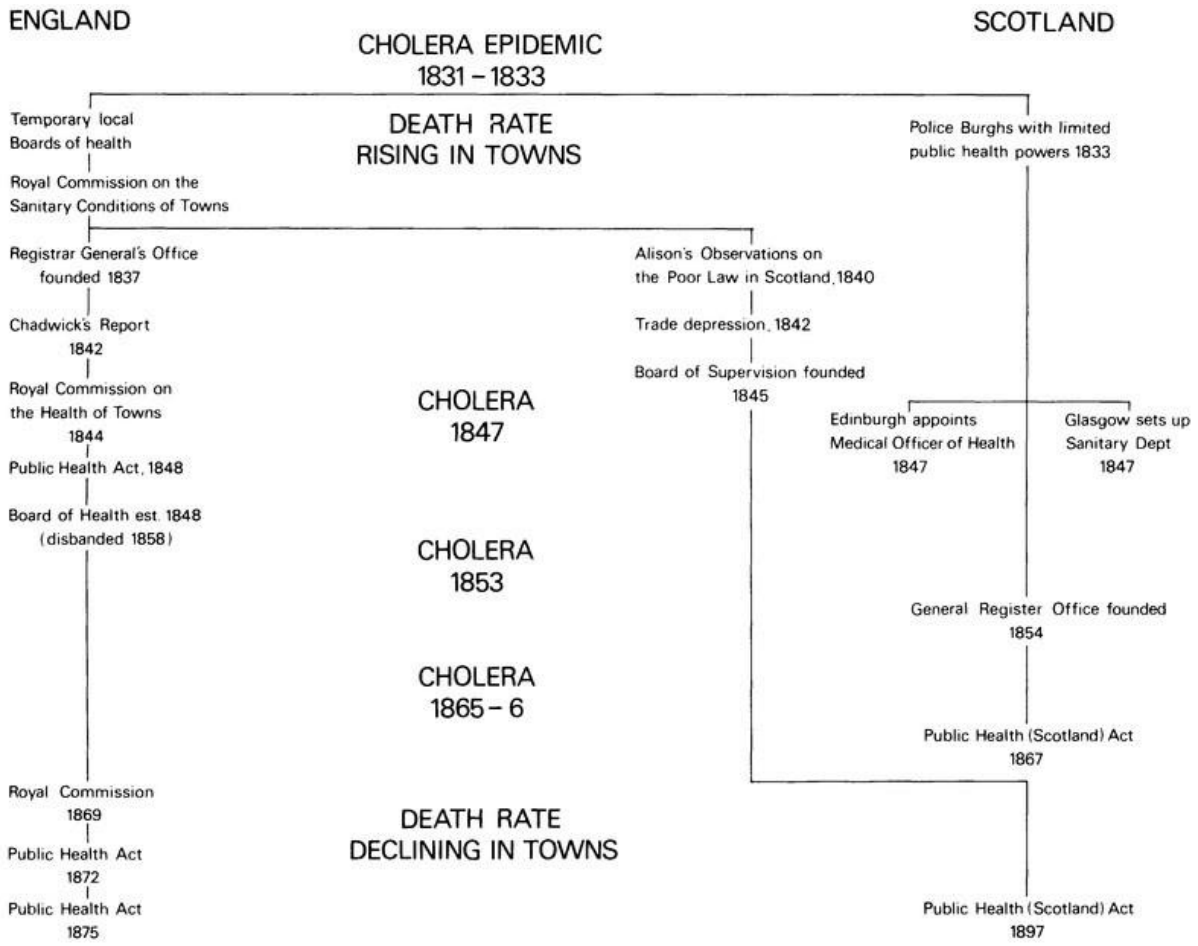

Figure 4-3. Summary of Public Health, 19th-Century Milestones in Great Britain.[391]

[391] Ibid, 11; Despite the suggestion by this figure, while Liverpool appointed the first MOH in 1847 via English Public Health Act, Scotland relied on the 1850 and 1862 General Police (Scotland) Acts, the latter of which allowed an effective MOH position, e.g., Littlejohn (Edinburgh).

Public Health in Edinburgh in the 19th Century

Edinburgh's public health developed in several novel ways. As early as 1681, three doctors were appointed to teach medicine at the newly forming Medical School, specifically by and on behalf of the Council. The idea was copied in other parts of Scotland and started a movement of 'eventual consolidation' of medical training in several cities of Scotland. The 18th century Scottish Enlightenment, prominent in Edinburgh, also prompted 'the desire and ability for the effects of the new thought to be disseminated downwards throughout the whole of Scottish society.'[392]

These pre-19th century events effected the way the Edinburgh medical school taught its students and saw its role in the provision of medicine both in the cities and the rural areas of the country. Sutton notes how charity work by medical students became a very important part of an Edinburgh doctor's education with public education and charity dispensary work becoming 'part of the normal curriculum of the medical student.' By 1858, students ''were required to attend at either charity dispensaries or outpatient departments in order to satisfy requirements across four separate statutory strands of the medical curriculum.' This 'Scottish approach' was strongly supported by the professors and administration of the school and '… came to be admired. Indeed, by the end of the 1880s, it was held up for emulation elsewhere in Britain.'[393] Although direct effects from these approaches to medical care may have taken time, they did eventually have a slow and steady impact later in the city's history.[394] In more practical terms, the poor in Edinburgh received decent medical care (although hospitals were still prejudiced towards the middle/upper classes) while other areas of Scotland (especially rural) would still see markedly varying medical and other assistance.[395]

But not all in Edinburgh was to be lauded, at least yet. In the 1830s and early 1840s, Scottish and Edinburgh public health management was still 'fragmented,' poor relief was ''defective' (mainly due to uneven and unreliable funding between parishes) and pubic and social health policies were 'in turmoil' and/or 'paralyzed.' For Edinburgh, Laxton and Rodger note non-interacting city committees; uncoordinated parochial boards overseeing epidemic disease response; continued lack of civil registration in Scotland until 1855 (see above); erroneous beliefs about poverty and disease and the continued difficulties for local council spending on public health issues.[396]

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[392] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 108-110.
[393] D. Sutton, "Charity Dispensaries, Medical Education and Domiciliary Medical Care for the Poor in Edinburgh and Glasgow, C.1870–1914," (Edinburgh University Press, 2014), 27-29 & 34-36.
[394] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 108 & 110.
[395] Dingwall, A History of Scottish Medicine: Themes and Influences, 176-177; Blackden, "The Board of Supervision and the Scottish Parochial Medical Service 1845-90", 145-146 & 150-151.
[396] Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 22, 58-59, 61-63 & 68.

Edinburgh also had to deal with its own influx of immigrants from the Leitrim, Monaghan and Cavan areas of Ireland from the 1810s through the 1830s as well as a large number of agricultural workers from the eastern and southern Scottish Highlands. These unskilled Irish and Highland workers moved mainly to the Old Town. As the Old Town filled up, 'The upper classes of Edinburgh moved to the New Town or to cheaper land on the outskirts away from the filth and overcrowding of the High Street and its dark and unsanitary Closes and Wynds.'[397] In Edinburgh, one only had to look across the now-drained Nor Loch between the Old and New Towns to see the effect.

In 1831/early 1832, news of a terrible cholera epidemic trickled in from Europe. Multiple publications about the disease and how to combat it started to appear from doctors (see references in Chapter 3) as well as the Edinburgh Board of Health although overall ignorance of cholera, the myriad of 'professional' suggestions along with a general distrust of any governmental authorities and doctors (partly due to the recent exploits of Burke and Hare reinforced by continued 'Resurrectionist' activities) probably did not help their impact.[398] Further methods were made to organise communities, keep the citizens updated on developments and to establish and keep open soup kitchens and shelters for the poor, both before and after the epidemic.[399] Despite these 'good' efforts, there were troubles – and not just a few. Several 'Commissioners of Police expressed great reluctance to undertake the duties of visiting the houses of the lower orders in their wards' to assess their social as well as sanitation needs. It took 'repeated remonstrations on the part of the Board, as well as their own colleagues' before they reluctantly agreed.[400] Medical personnel, including doctors, nurses and ambulance attendants were attacked.[401] The idea of paying them via a 'Cholera Tax' was

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[397] Ibid, , 16-17; Devine, *The Scottish Nation, 1700-2007*, 347; Rodger, *Housing in Urban Britain 1780-1914: Class, Capitalism and Construction*, 3-4, 28, 38 & 40-41.

[398] Robert Christison, "Account of the Arrangements Made by the Edinburgh Board of Health, Preparatory to the Arrival of Cholera in That City," *Edinburgh Medical and Surgical Journal* 37, no. Suppl to Vol 37 Iss 111 (1832); "Kill the Doctors, Nae Board of Health ...", *Scotsman*, Mar 28 1832, 2; Johnson, "Burkers and Noddies – Town Tinkers and the Body Snatchers in Scotland."; "Criticism of Board of Health Letter to the Editor," *Scotsman*, Apr 4 1832, Accessed 22 Aug, 2022, 3; "Dangerous Trade - Digging up Bodies (Cholera)", 3; "Resurrectionists Digging up Bodies", 3.

[399] "30th Ward Meeting with Police Advert," *Scotsman*, Feb 8 1832, 1; "Cholera, Various Suggestions to Prevent Epidemic," *Scotsman*, Feb 8 1832, 3; "The Cholera: Edinburgh (Comment on Who Is Getting Disease)," *Scotsman*, Feb 18 1832, 3; "Bill for Preventing the Spread of Cholera," *Scotsman*, Feb 22 1832, 3; "Board of Health (Ramsay) Reports on Purification of the City," *Scotsman*, Mar 14 1832, 2; "Cholera Victim in Damp House," *Scotsman*, Mar 21 1832, 3; "Cholera - Continued Fumigation," *Scotsman*, Oct 24 1832, 2; "Decreasing Cases but Still to Keep up Fumigation," *Scotsman*, Nov 14 1832, 3; "Call for Reinstatement of Soup Kitchens and Re-Inspection of the City," *Scotsman*, Jul 7 1832, 2; "Soup Kitchen Appeal," *Scotsman*, Jan 30 1833, 2; "House of Refuge (from Cholera Soup Kitchens)," *Scotsman*, Feb 6 1833, 3.

[400] "Review of Edi Med & Surg J Report Publication," *Scotsman*, Mar 17 1832, 2.

[401] "Medico-Phobia," *Scotsman*, Mar 14 1832, 2; "Opposition to Police Bill (Cholera)," *Scotsman*, Mar 28 1832, 2; "Water of Leith and Canonmills Cholera - Attacks on Officials," *Scotsman*, Mar 14 1832, 2; "Sanitary Conference - Attack of Nurse," *Scotsman*, Oct 19 1853,3; "Riot at One of the Hospitals/Rebuttal of Doctors Taking Patients to Experiment," *Scotsman*, Mar 17 1832, 3; "Cholera Riot", 2; "Multiple Pamphlets & Riots,"

supported by some but not by all.[402] Doctors were even fighting amongst themselves and one was fined for refusing to report deaths of cholera patients under his care.[403] A plea by the *Scotsman* for private doctors to publish their separate recommendations for cholera prophylaxis and treatment marks the level of distrust of the official channels of information.[404]

Between the 1832 and 1848/49 epidemics, a period of reflection commenced. Unripe fruit and new potatoes received criticism for their potential role in the cholera infection, albeit 'English cholera, and other alarming effects in the stomach and bowels.'[405] The Edinburgh Health Board managed to keep the soup kitchens open and even established a 'House or Refuge for destitute wanderers' at Morrison Close on the High Street – all to be prepared if cholera reappeared.[406] Bills from the prior cholera visitation were paid partly by a continued Cholera Tax although one citizen was not happy about it, writing a lengthy letter to the *Scotsman* that nevertheless did not seem to change minds.[407] The relative benefits of permanently established, community dispensaries were confirmed.[408] Any appearance of fever was promptly reported and, although a continuation of the sanitary efforts in 1832 was not seen, some observed the conditions of areas such as the West Port as a potential cause of disease[409] In the early 1840s, Edinburgh Town Council tried to combine committee responsibilities and powers under the office of a 'Medical Officer' although still requiring 'no undue expence [sic] be imposed on the public.' Ramsay and, in a series of fifteen lectures, even James Young Simpson continued calls for real powers of public health under the auspices of an official Medical Officer of Health [MOH]. Unfortunately, real progress towards such an official office (with actual powers) would falter again.[410]

Scotsman, Apr 4 1832, 2; "Threats About Removal of Patient to Hospital," *Scotsman*, Apr 4 1832, 3; "Complaint About Transport of Cholera Patients on Streets," *Scotsman*, Oct 20 1832, 3.

[402] "Philico-Justica - Call for Better Pay for Doctors," *Scotsman*, Jul 28 1832, 4; "Cholera Doctors - Complaint About Parliament Funding of Doctor Payments," *Scotsman*, Sept 1 1832, 2; "The Cholera Doctors," *Scotsman*, Jan 16 1833, 2; "Cholera Assessment," *Scotsman*, Apr 20 1833, 3; "Scots Cholera Amended Bill," *Scotsman*, 24 Mar 1832, 2; "Cholera Tax," *Scotsman*, May 1 1833, 3; "Edinburgh Cholera Debt," *Scotsman*, Jul 29 1837, 3.

[403] "Meeting of Edinburgh Medico-Churchigal Society," *Scotsman*, Mar 10 1832, 3; "A Refractory Surgeon and £5 Fine," *Scotsman*, Mar 5 1832, 2.

[404] "Cholera - Request for Physician Publications," *Scotsman*, Jul 11 1832, 2.

[405] "Unripe Fruit and Potatoes Cause Cholera," *Scotsman*, Aug 1 1838, 2.

[406] "Health Board Efforts," *Scotsman*, Mar 28 1832, 2.

[407] "Police Commission - Cholera Payments to Cleansing Committee & Surgeon," *Scotsman*, Mar 14 1849, 4; "Expense of Funerals 'Out of House'," *Scotsman*, Sep 7, 1833, 3; RIE Short £187 from Cholera," *Scotsman* 21 Dec 1833, 4; "Lament over Cholera Tax," *Scotsman*, Jul 26 1834, 2.

[408] "Role of Edinburgh New Town Dispensary," *Scotsman*, Feb 5 1834, 2.

[409] "Fever in West Port," *Scotsman*, Nov 4 1843, 3; Civis, "Fever in Edinburgh," ibid, Apr 17 1844, 3.

[410] Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 63-65.

In 1846 cholera again appeared in Europe and, although it would not reach Edinburgh until 1848, sanitation efforts increased. The state of the Water of Leith, specifically around Stockbridge became a topic of concern (see also Chapter 5).[411] Dr. Stark published a detailed pamphlet reviewing the sanitary state of Edinburgh with drains and sewers being directly implicated in the disease of cholera. And he was not alone. Unlike in 1832, the Edinburgh citizens were just now starting to understand the role of sanitation in disease prevention. Dr. Allison's cries for sanitation efforts in the city were heard by the City Parochial Board.[412] The *Scotsman*, a former critic of the 1832 Edinburgh Board of Health's recommendations, now fully backed 'Sanitary Reform' noting 'The hasty precautions of 1831, inspired more by panic fear than sober sustained purpose …' and called for 'an intelligent system, with compulsory powers and adequate supervision.' The *Scotsman's* tone regarding the Board's advice had changed to full support and presentation of the emerging scientific and medical reasons for those efforts, including, again, a prominent mention of sewers and drainage.[413] But like in 1832, sanitary efforts were employed, albeit just not all the right ones.[414]

Homeopathic Dispensaries were established with the blessing of the Lord Provost, the Town Council suggested the Commissioners of Police and the Superintendent of Cleaning should clean up 'filth' in the city but 'hoped that no unnecessary alarm would be created' and the City Parochial Board lamented the 'dirt' in all the places it had been before.[415] The Royal College of Physicians provided Edinburgh citizens with preventative instructions, but little had changed from 1832 beyond suggestions about diet and alcohol abstinence and further details on 'attend[ing] to the proper regulation of the bowels.' Edinburgh's General Board of Health provided no additions but, instead, seemed mainly focused on cleaning and the provision of dispensaries, medical aid and isolation for cholera patients and their families.[416] Ships were quarantined and inspected (although that was soon revoked), refuse containers for discarded shells were provided in Newhaven (although the clams, oysters and mussels that may have contained cholera were already ingested), the Parochial Boards

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411 "Letter to Editor, Water of Leith (1846)," *Scotsman*, Jun 20 1846, 3.

412 "Review of the Sanatory [Sic] State of Edinburgh, Dr Stark," *Scotsman*, Mar 17 1847, 3; "City Parochial Board, Dr. Allison," *Scotsman*, May 26 1847, 2.

413 "The Cholera and Sanitary Reform," *Scotsman*, Oct 20 1847, 3; "Avoidance of Cholera Advice," *Scotsman*, Nov 10 1847, 2; "Sanitary Reform in Edinburgh," *Scotsman*, Dec 8 1847, 3.

414 "The Cholera in Edinburgh (Editorial)," *Scotsman*, Oct 11 1848, 2; "Sanitary Improvements at Newhaven," *Scotsman*, Oct 18 1848, 3; "Editorial - Filth of the City," *Scotsman*, Nov 1 1848, 2.

415 "Edinburgh Homeopathic Dispensary Districts & Lord Provost Meeting," *Scotsman*, Jan 19 1848, 2; "Town Council Proceedings - Preparation for Cholera," *Scotsman*, Oct 4 1848, 3; "City Parochial Board Special Meeting," *Scotsman*, Oct 7 1848, 3; "Police Commission (Special Meeting)," *Scotsman*, Oct 11 1848, 3.

416 "The Royal College of Physicians on the Prevention of Cholera," *Scotsman*, Oct 18 1848, 3; "General Board of Health Cholera Regulations," *Scotsman*, Oct 25 1848, 3; "Board of Health Additional Cholera Instructions," *Scotsman*, Nov 4 1848, 4.

met and planned and administered (although their powers were still minimal), Musselburgh relocated a manure depot and pigs were removed, mainly from the Irish who were directly blamed for bringing cholera back to the city (although neither man nor beast had done anything wrong).[417]

So, Edinburgh continued to battle cholera somewhat inappropriately and ineffectively but, after the epidemic, there was progress. Real plans to provide better and more sanitary housing for the poor and even some removal of buildings in the Old Town were a major focus of the Lord Provost and Town Council. William Chambers, still pre-Lord Provost, provided an ambitious plan to open Don and Warriston Closes and allow 'a convenient and ready communication between the High Street and the various railway termini at Waverley Bridge' – a plan that would 'remove all the overhanging buildings, and all the irregularities of projections' and also 'a thoroughfare … to consist of three or four handsom [sic] flights of broad steps (now the Warriston Close Stairs (Figure 4-4).[418]

Figure 4-4. Warriston Close Stairs (photo by the author)

[417] "The Cholera - Inspection of Ships", 2; "Sanitary Improvements at Newhaven", 3; "Directions to the Parochial Boards," *Scotsman*, Oct 18 1848, 3; "Conference of Parochial Boards in Regard to the Cholera," *Scotsman*, Oct 25 1848, 3; "City Parochial Board Meeting," *Scotsman*, Nov 4 1848, 2; "Progress of Purification," *Scotsman*, Oct 25 1848, 2; "Sanitary Operations," *Scotsman*, Nov 4 1848, 2; "City Parochial Board, Dr. Allison", 2; "Musselburgh - Removal of Manure Pile," *Scotsman*, Nov 11 1848, 2.

[418] "Police Commission - Cholera Payments to Cleansing Committee & Surgeon", 4; "Chambers - Warriston Close Proposal," *Scotsman*, Aug 22 1849, 3; "Proposed City Improvements," *Scotsman*, Feb 14 1866, 8.

But in 1849, as before, mistakes were also made. In Stockbridge, a 'choked up or burst soil-pipe convey[ed] the contents of its privies and all its filth and waste … disseminating a stench that is quite intolerable.' Multiple attempts by the locals to get the Police Inspectors and Commissioners to address the problem had gone unheeded.[419] The Town Council continued to fumigate houses where cholera victims had died but instances of a new family moving in before cleaning were reported.[420] To add insult to injury, Dr. Stark, who had so correctly pointed his concerns to sewers prior to the second epidemic, now published pamphlets suggesting that the weather was the prominent modifier of not only cholera but other infective diseases. The *Scotsman* rightfully commented 'With regard to the nature of the disease, or its treatment, it does not appear that we have advanced one step beyond the knowledge we acquired in 1832.'[421]

In the aftermath of the 1848/49 epidemic, another reflective period followed in Edinburgh and this time with a bit better focus on what actually worked and did not work for *Vibrio* infections. In November 1849, Edinburgh passed specific bye-laws for the Cleaning Committee 'That every drain and sewer within 200 yards of any street, court, or dwelling-house, causing nuisance or annoyance to any inhabitant, shall be covered up, to the satisfaction of the Superintendent of Streets ….' Additional bye-laws required a 'sufficient back door … with proper fastenings' on every common stair as well as new rules for windows and stair railings in that common stair. Perhaps even more importantly, fines of from five to forty shillings were put in place. Similar bye-laws with fines were also imposed on the keepers of Lodging Houses which had proved to be a focus of cholera infections during the recent epidemic.[422] The city had finally started to learn about potential harm of the same overcrowded housing that had created such problems earlier and started to do something about it. And while cleaning efforts had been stopped between the 1832 and 1848/49 epidemics, this time they continued as the theme of general cleanliness and sanitation took further hold as both a superficial appearance but also a health matter for the city. As a *Scotsman* review from a *Globe* article commiserated, for 'the Athens of modern times … nowhere is the contrast more striking between external grandeur and hideous misery …. It is painful to learn that Edinburgh has hitherto achieved the most insignificant results in the direction of sanitary reform.' Fortunately, that was beginning to change and for the better.[423]

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[419] "Dangerous Nuisance - Bedford Street, Stockbridge," *Scotsman*, Sep 15 1849, 3.
[420] "Town Council Proceedings - Receiving House for Fumigation Families," *Scotsman*, Oct 10 1849, 3.
[421] "Mortality of Edinburgh and Leith Cholera (Dr. Stark)," *Scotsman*, Jan 3 1849, 4; "Mortality of Edinburgh and Leith in 1848 Full Abtract (Dr. Stark)," *Scotsman*, Mar 31 1849, 4.
[422] "Bye Laws for Cleaning Committee/Lodging Houses," *Scotsman*, Nov 11 1849, 3; "Lodging House Association (Cholera)," *Scotsman*, Apr 30 1853, 4; "Housing Association - Cholera Deaths," *Scotsman*, Dec 29 1849, 4.
[423] "From the Globe (Edinburgh Sanitation)," *Scotsman*, Nov 9 1853, 4.

As cholera again approached the city in the early 1850s, the 1832 and 1848/49 efforts that were actually effective were again employed. With time to spare, the city established how medical care would be provided to all, continued 'sanitary precautions with good effect' (unlike the last intervening period) and 'all the lodging-houses [had] been inspected, and other steps … to prevent the outbreak of the epidemic …', and perhaps, most important, powers were willingly conceded to the Board and City Government.[424] A summary of the efforts between 1849 and the early part of the 1853/54 cholera epidemic are provided in the Appendix 4-1 (Parts 1 & 2).

There were, as always, criticisms. In the Council, there were notable poor communication and infighting throughout (and even after) the epidemic. [425] Condemnations were pointed at the perceived heartless owners of the buildings that were either being demolished or cleaned, the political and monetary influence on the sanitation efforts and, for one disgruntled *Scotsman* writer 'X.Y.Z,' a need for documentation of any remaining filth of the Old Town. As always, the pigs and the Irish also needed to be blamed, not only for the filth but also for the diseases.[426] To add insult to injury with regards to all the proper sanitation efforts, a Dr. Balbirnie published *The Philosophy of Epidemic Cholera* in which he extolled the sole benefits of friction and rubbing with either snow or cold water to treat cholera; fortunately, the *Scotsman* was critical, noting that the doctor's ideas were wrongly going 'to lead captive the minds of the multitude' and ending with 'Heaven help his patients.'[427] Despite these 'drawbacks', the general idea of sanitation was beginning to take hold in Edinburgh. Authors wrote about disease prevention by sanitation rather than medical cures and began to stop blaming the morality and social actions of people, mainly the poor, for the disease of cholera. Focus was, again on sewerage and drainage as one wrote,

> As long as in such a town as Edinburgh scores of closes and dozens of streets are unsupplied with any other than surface drainage, while many of the underground drains are of a nature calculated to propagate rather than remove the chances of disease, it is not unreasonably that its inhabitants tremble at the cry of the coming cholera.[428]

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[424] "The Cholera - Appearance in the City," *Scotsman*, Sep 17 1853, 3; "The Cholera - Question About Appearance in City," *Scotsman*, Sep 21 1853, 2; "Editorial Review," *Scotsman*, Sep 21 1853, 2; "Cleaning of Edinburgh," *Scotsman*, Nov 9 1853, 2.

[425] Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 67.

[426] "Edinburgh Sanitary Measures - to the Editor of the Scotsman," *Scotsman*, Nov 12 1853, 3; X.Y.Z., "How Edinburgh Is Prepared for the Approach of Cholera," ibid, Sep 21, 3; "Sanitary Reform in Leith and Edinburgh," ibid, Nov 16, 5.

[427] "The Philosophy of Epidemic Cholera (Review)," *Scotsman*, Dec 3 1853, 3.

[428] "Cholera - Benefits of Preventative over Curative Measures," *Scotsman*, Sep 17 1853, 2; "Cholera," *Scotsman*, Oct 26 1853, 2

As cholera appeared for a third time in Edinburgh in 1853/54, a marked change was seen in the approach taken by the city. The Parochial Board, Hospitals and Town Council continuously prepared as cholera slowly crept towards the city.[429] One 'Letter to the Editor' of the *Scotsman* touted the sensibility of 'making use of water for drinking after it has been boiled.'[430] Active sanitation efforts included drainage of suspected, infected water sources and active cleaning of the closes and streets by the Police Commission, recognition and public support of the efforts of the Lord Provost and Town Council during the epidemic and Houses of Refuge for the poor/homeless that allowed 'strict surveillance and precautionary measures for anyone showing early symptoms of cholera.'[431]

In the latter half of the 19th century, housing in all Britain also started to improve as the impact of places like the Edinburgh Old Town was realised. Rodger discusses how 'Philanthropic and charitable institutions, employer's housing and working men's building cooperatives illustrated individual and collective pragmatism in addressing housing needs.' And, though old attitudes were hard to change, the mid- to late-Victorian age provided 'a more enthusiastic embrace of council-building, utopian planning and garden city ideals.' These efforts were aided by 'a growing discontentment after 1850 by the population for unsanitary conditions' but also a slowing of migration to and even a relative decrease of people in the city centres due to increasing public transportation, reduced family sizes and improving laws and regulations regarding housing that led to increased and better housing development by councils and private builders alike. Although, these efforts did not come to full fruition until the last quarter of the nineteenth century, the changes in attitudes towards the poor were well on their way to becoming established by the 1853/54 and 1866 cholera epidemics. This changed attitude towards the poor would be part of the answer to control this dreaded disease.[432]

With still no universal support for taxes to pay for true urban reform prior to the 1850s/1860s, a notable increase in charitable societies was seen throughout Britain.[433] In Edinburgh, efforts by the middle-class, in particular, changed from 'reactionary' efforts establishing (usually temporary) soup kitchens and housing for the poor to 'preventative' inquiries and real actions, including a series of

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[429] "City Parochial Board - Preparations for Cholera," *Scotsman*, Oct 8 1853, 2; "Correspondence - Leith Hospital," *Scotsman*, Oct 15 1853, 3; "City Parochial Board - Preparations for the Cholera," *Scotsman*, Nov 5 1853, 2.

[430] "Cholera - Preventative Means", 3.

[431] "Police Commission - Water of Leith", 3; "Drainage of Edinburgh", 3; "Lord Provost Efforts Against Cholera," 4; "House of Refuge - No Cholera Cases", 3.

[432] Rodger, *Housing in Urban Britain 1780-1914: Class, Capitalism and Construction*, 4, 9, 38, 66-67.

[433] Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 28 & 34-35; Devine, *The Scottish Nation, 1700-2007*, 336. Only in 1872 was an overarching Public Health Committee finally formed to oversee a variety of public health services from burial grounds to lodging houses to inspection of livestock, food and meat (see Laxton and Rodger, 195).

Scotsman-published articles discussing several and varied aspects of the problem.[434] The (now) deserving, poor were starting to be seen as not tainted beggars but people who needed help and who, with that help, could actually help the country, the economy and the society. And that society had now started to ask the questions and look for the answers of what caused and cured poverty.

The MOH position would finally be locally defined in Edinburgh from 1858 and the 1862 General Police (Scotland) Act would finally provide real Scottish-wide, powers.[435] An Edinburgh Sanitary Conference was established in February 1853, offering a unified voice to the public for advice regarding avoidance and treatment of cholera both during and after the epidemic; this was a notable change from 1832 when a multitude of cholera pamphlets from a variety of sources with seemingly endless and differing opinions and recommendations was the norm.[436] By January 1854, the scattering of 1853 cholera cases had apparently disappeared.[437] A *Scottish Review* article suggested that, just maybe, cholera was 'preventable'?[438] Had the public health and sanitation efforts actually worked? The answer was a qualified maybe.

In March 1854, Edinburgh was still clear but the infection was re-approaching. A now pessimistic *Scotsman* reported the reapproach of cholera terms and that 'to look for prolonged immunity would be to indulge a preposterous delusion' due to the 'superficial and temporary measures of prevention which are themselves a humbling confession and disclosure of continued neglect of real remedies.'[439] A few days later, the newspaper reviewed a December 1853 Health Board Report suggested again 'the unpreparedness of Edinburgh for the threatened visitation of the cholera' and the 'superficial and makeshift system on which [the] Police Commission have acted.' But amidst the rather marked and directed criticism, there was an important message … 'We have yet no general system of drainage in Edinburgh – the primary and essential element in all sanitary reform.'[440]

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[434] "Soup Kitchen Appeal", 2; "House of Refuge (from Cholera Soup Kitchens)", 3; "Condition of the Poor of Edinburgh (Editorial)," *Scotsman*, 27 Jan 1849, 2; "Causes and Cure of Pauperism," *Scotsman*, 20 Jun 1849, 3; "Dwellings of the Working Classes," *Scotsman*, 3 Oct 1849, 3; Our Special Commissioner, "Inquiry into Destitution and Vice in Edinburgh, Letter Iv," ibid, Feb 13 1850, 3; "Relief of the Destitute Poor," ibid, 14 Nov 1866, 2; "Poorhouses, Their Function, Conditions, and Administration," *Scotsman*, 26 Nov 1866, 3; "Inquiry into Charities and Relief of the Deserving Poor," *Scotsman*, 2 Aug 1867, 2.

[435] Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 87-90 & 98.

[436] "St Cuthbert's Parochial Board - Adoption of Sanitary Measures (Cholera)", 3; "Warnings of the Approach & Sanitary Measures", 2; "Sanitary Conference - Justices' Ruling", 3; "City Parochial Board - Remuneration of Sanitary Board Officials", 2.

[437] Campbell, "Cholera in Nineteenth Century Edinburgh", Histogram No. 3.

[438] "The Scottish Review - Cholera Preventable," *Scotsman*, Jan 4 1854, 1.

[439] "Warnings of the Approach & Sanitary Measures", 2.

[440] "Sanitary Condition of Edinburgh - Government Inspector's Report," *Scotsman*, Mar 25 1854, 3; "Unpreparedness of Edinburgh," *Scotsman*, Mar 25 1854, 2.

Part of the problem was the relatively powerless Public Health Acts still in place. The city's Sanitary Commission Conference on 1 April, 1854 reported that per a decision on a 'complaint from Portobello', all that could be done to the city's drains was 'to order obstructions in the drain to be cleared away, but [the Justices] had refused, on the ground of want of power, to order it to be covered.' And even though the Lord Provost disliked the result, he could only ask the Inspectors to work on any obstructions.[441] Approximately a month later, an article questioned the entire idea of a comprehensive drainage system in Edinburgh, not because of the idea but rather because Edinburgh simply did not have enough water supply to adequately fill and clear the new drains. But another water concern (re)emerged – that of the Water of Leith which had been discussed in 1848. As above, all the Police Commission could do for this and any other troublesome drains was to clear obstructions.[442] A small number of cholera cases had appeared in October through December, 1853 and a moderate number in July through November, 1854, but by December, cholera had again left Edinburgh.[443] At that time, though, the city was not quite ready for the final step against cholera.

With cholera again gone until 1866, another period of self-reflection began in Edinburgh. The Board of Health warned about the return of cholera but also noted 'general laws against nuisances and the modes of their enforcement' that they had at hand.[444] Things happened behind the scenes, too. Fillipo Pacini first saw *Vibrio cholera* in late 1854. Although Koch's more widely disseminated confirmation would take another thirty years, some Edinburgh physicians may have taken note.[445] Henry Littlejohn became Edinburgh's first, fully-empowered Medical Officer of Health in September 1862 and an official Department of Public Health, with Littlejohn as Secretary, was established in the same year. Finally, William Chambers was elected Lord Provost of Edinburgh in 1865.[446] This is not to say that all was being figured out about the bacteria *Vibrio* and cholera. While Germ Theory still waited for a confirmed bacterium, alternative causes of cholera were promoted.

So, with miasmatic theories still prominent, the dutiful sister wrapped her flannel Christmas gift for her military brother (1855), the vegetarians tried to convince everyone of their insights (1855), Southwood Smith gave miasmatic talks to the Edinburgh Philosophical Institution (1855), Dr. Stark continued to extoll weather as a cause of cholera (1855) and was joined by the Registrar General

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441 "Sanitary Conference - Justices' Ruling", 3.
442 "Drainage of Edinburgh", 3; Police Commission - Water of Leith", 3.
443 Campbell, "Cholera in Nineteenth Century Edinburgh", Histogram No. 3.
444 "Board of Health Circular - Warning About Cholera Return," *Scotsman*, May 16 1855, 2.
445 Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 164-165.
446 D. Lippi and E. Gotuzzo, "The Greatest Steps Towards the Discovery of Vibrio Cholerae," *Clinical microbiology and infection* 20, no. 3 (2014), 191-195; Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 172-173; "Fourth Department - Public Health," *Scotsman*, Oct 9 1863, 6.

(1859). Cattle (1857), grouse (1858), hogs (1863) and finally animals in general (1866) were blamed for human cholera, fear and melancholy were touted as the actual cause of cholera (1858) and phosphorescence (1865) and then ozone (1866) were both blamed for the disease. Then, just when the idea of improved sanitation as a preventer of illness was possibly getting a small foothold in Edinburgh, a rather scathing article by the editors of the *Scotsman* suggested 'the fallacy of the opinion urged by sanitary reformers, that improved sanitary arrangements would extinguish the epidemic class of diseases.' The paper instead demanded these actions only for 'ordinary [endemic] diseases.'[447] Sanitary efforts for disease prevention were fine to pursue for several infective diseases … just not for cholera.

But with a bacterium now somewhat known, Littlejohn and an official Public Health Department in place and William Chambers pursuing his program to renovate and purify the Old Town even prior to becoming Lord Provost, the derogatory writings and fairly useless efforts that had been seen in preparation for the first three cholera epidemics soon became only shadows in the background of more robust, pro-sanitary efforts. Hidden in the same 1859 Registrar-General report that promoted weather as a cause of cholera was a curious sentence … 'Cold and poverty are by no means so amenable to the influence of the Registrar-General's teaching as deficient water supply and epidemic disease.'[448] Water and sewerage and contagious elements were still on the minds of some … if not many. Unfortunately, the city and the various health officials were still waiting for the power to make the necessary changes.

In 1864, a more congenial *Scotsman* published a rather detailed article on the ongoing town improvements noting, this time, the 'statistical' advantages of a town with sanitary efforts versus 'the country, other things being equal.' The article further suggested that 'A well-drained, well-lighted, well-built town … secures to its inhabitants at all seasons …that all but the very lowest class of townspeople are at least as well off in point of health ….' The paper, in particular, lauded 'The improvement of the Mound, and the opening of Waverly Bridge and Cockburn Street' as well as the

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[447] "A Young Lady's Christmas Box for Her Brother at Sebastopol - Flannel Belts", 4; "Effect of Vegetarianism on Cholera Infections & Deaths", 3; "Epidemics Considered with Relation to Their Common Nature, and to Climate and Civilisation", 3; "Weather Effects on Cholera (Dr Stark)", 3; "Cholera Deaths - Effects of Low and High Temperatures (Registrar General)", 2; "The Cattle Plagues and Diseased Meat, in Their Relation with the Public Health and with the Interests of Agriculture", 1; "Disease of Grouse - Association with Cholera Type Infections", 3; "Hog Cholera", 2; "Refute of 'Hog Cholera'", 4; "Human Cholera from Animal Carcasses," *Scotsman*, Jan 23 1866, 3; "The Human Mind in Its Relation with the Brain and Nervous System," *Scotsman*, May 22 1858, 3; "Phosphorescence in Connection with Storms and Disease", "Phosphorescence in Connection with Storms and Disease", 7; "Effect of Ozone in Telegraph Offices on Cholera," *Scotsman*, Jun 25 1866, 7; "Improved Sanitary Arrangements Ineffectual against Epidemics," *Scotsman*, Feb 12 1866, 8.

[448] "Argument for Sanitary Efforts (Cholera)," *Daily Scotsman*, Feb 22 1859, 2.

(never-completed) 'new street between George IV. Bridge and the South Bridge,' efforts near George Square and the Meadows and several others. Specific issues of overcrowding and the provision of open spaces, fresh air and ventilation are mentioned and a call for public health measures followed with calls for further efforts of the city's Improvement Commission and arguments for added tax assessments due to the benefits of these public health efforts. All in order to 'bring the present "cribbed, cabined, and confined" Old Town into something like equality with the airy and open New Town.'[449] In late July, 1865, a report appeared regarding sanitation efforts in Leith and Edinburgh in which the authors called out those who promoted simple white-washing as a '"damnable iteration," instead of … activity in reform' and (indirectly) accused the *status quo* sanitationists (in)actions as a 'culpable and fatal apathy.' Only a handful of days later in early August, Littlejohn's famous *Report of the Sanitary Condition of the City of Edinburgh* would be published. Armed with this report, then candidate William Chambers would be elected Lord Provost in November 1865.[450] The final pieces of the puzzle were now complete. Unfortunately, the impending 1866 cholera epidemic postponed the celebrations.

As the fourth 1866 cholera epidemic got nearer, attention was turned to the necessary steps that had helped in the 1853/54 epidemic. Areas of the city were inspected, cleaned in a much more uniform way than prior epidemics, instructions for the public were requested (and provided by the Royal College of Physicians, Drs. Smart and Littlejohn), money was raised to pay for it all, nuisances were removed when possible and, albeit a bit late, public burials were coordinated with the city cemetery companies.[451] Amongst the calls about nuisances were complaints about sewers – this time not just by doctors, Registrar-Generals or *Scotsman* editorialists but from the citizens of Edinburgh.[452] The average citizen had a fuller understanding that these sewers could be the cause of disease, including the dreaded and fast-approaching cholera. While the Police and Sanitation and Drains Committees were certainly doing their best with recently-gained powers over sewerage and drainage, there just had not been enough time or, perhaps, focused effort. As the *Scotsman* had

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[449] "Town Improvement," *Scotsman*, Feb 29 1864, 3; "Leith Port & Edinburgh Unsanitary Conditions (Cholera)," *Scotsman*, Jul 29 1865, 2.

[450] Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 159-163, 224-226.

[451] "Editorial - Public Health Improvements," *Scotsman*, 30 Jul 1866, 2; "Precautions against Cholera in Edinburgh", 3; Cosmopolitan, "The Cholera - Request for Plain Instructions for Cholera," ibid, Aug 4, 7; "The Cholera - Suggestions by the Royal College of Physicians for Preparation against an Outbreak of Cholera in Edinburgh", 2; "Precautions against Cholera (Littlejohn)", 2; "Dr. Smart, Recommendations for Guarding against Cholera", 2; "Canongate Parochial Board - Funds in Case of Cholera," ibid, Aug 8, 2; A Constant Reader, "Cholera - Newington and the Grange, Call to Remove Manure Depot," ibid, Aug 11, 7; Another Citizen, "Nuisances at Old Dalkeith Road," ibid, Aug 22, 6; "Town Council Meeting Including Discussion of the Cemetery Companies and the Visitation of Cholera," ibid, Oct 3, 6.

[452] A Voice From The East-End, "Cholera, All Hail!," ibid, Aug 16, 4; Citizen, "Nuisances at Old Dalkeith Road", 6.

lamented just over a year ago, the old sanitation ways (like white-washing) still prevailed in the minds of the sanitationists. This was not helped by continued publications promoting miasma, atmospheric changes, homeopathic treatments and a continued focus on alcohol (although unlike the Royal College and Drs. Smart and Littlejohn made no such warning in their summary publications).[453]

There was, indeed, little time to effect real changes for the new Lord Provost and Littlejohn but, unlike past cholera epidemics, both ploughed ahead with their sanitary efforts.[454] Fortunately, a permanent cholera hospital had already been established in October 1865. Also in October, the *Scotsman* reported on an 'Edinburgh Commission' on cholera, organised well before the UK's one, 'to investigate the disease, with a view chiefly of discovering the best method of care.' Members of the Commission included Dr. Littlejohn and Professor Dick.[455] Starting in early 1866 with approval in late August and with cholera still in Edinburgh, a city Improvement plan was published by Chambers.[456] This plan lessened the grade of and opened up several old and new Old Town passages and streets, provided sewers and drains and demolished old, dilapidated buildings but with an emphasis on the housing of displaced citizens. In early October, the powerful Merchant Company gave its full support to the proposal with its Master citing several, strong public health and sanitation reasons and regarding the 'well-timed sanitary reform … Our place should be at the front, and not at the rear, of such a movement.'[457]

As December 1866 ended, the city would see its last, cholera epidemic. Importantly, these changes born from preparation for and as a result of the fourth Edinburgh cholera epidemic seem to have finally taught the people, the doctors, the city officials and the press what it took to control infections from cholera. As Laxton and Rodger summarise, public health now relied on 'meticulous research and pain-staking, even forensic, analysis upon which to construct public policy.' This progression of science, medicine, social understanding, appropriate government power, both local and national, and a willingness of the citizens of Edinburgh to not resist these efforts but to instead embrace and promote them will be further discussed in Chapter 5.[458]

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[453] "On Malignant Cholera," ibid, Nov 22, 6; "Howe, Reflections on Cholera," *Scotsman*, Nov 12 1866, 6; "Advert - Homeopathic Statistics of Cholera. Cases Treated by Camphor Alone,," *Scotsman*, Oct 23 1866, 1.

[454] "Littlejohn Report - Management of the Poor," *Scotsman*, Sep 12 1865, 2; Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 3-5.

[455] "The Poorhouse Site at the Forrest Road - Erection of Permanent Cholera Hospital," *Scotsman*, Oct 2 1865, 3; "Knowledge and Remedy - Defence of the Medical Profession (Cholera)," *Scotsman*, Oct 6 1865, 4.

[456] "Proposed City Improvements", *Scotsman*, Feb 14, 1866, 8.

[457] "The Merchant Company and the City Improvements," *Scotsman*, Oct 5 1866, 3.

[458] Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 5 & 225.

John Snow – Hero?

Any discussion of public health, particularly as it pertains to cholera, without the story of John Snow and the Broad Street Pump would be considered a notable exclusion. Snow is credited by many as the one who canvassed the area around the pump, came up with the idea of mapping all the cholera deaths and proved that cholera-contaminated water in the pump was the direct cause of human infections and deaths.[459] With proof in hand, he convinced Westminster Council to remove the pump handle after which the disease and number of deaths plummeted. Besides saving the local population, Snow's actions are often credited as the very beginning of modern epidemiology.

But contemporary and modern numerical and statistical analysis has led to concerns about Snow's work and his claims and the above story is now questioned.[460] As discussed previously, the bacteria can infect humans often by several means. There is also now a question if the Broad Street Pump handle was ever removed or, if it was, did it make any difference.[461] Snow's mapping was also certainly not the first. Epidemiological mapping has a long history and was already been done in Exeter by Shapter and by a city engineer looking at the Broad Street pump only a few months earlier.[462] In fact, Snow did not publish a map in his 1849 treatise and one only appeared later in his 1855 and 1856 publications.[463] This is not to say that John Snow should not be rightfully credited with popularising already-existing, epidemiological techniques, including making maps of disease and death incidence. His conclusions that there was something in the water and his suggestions,

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[459] J. Snow, *On the Mode of Communication of Cholera, 1849* (London: Churchill, 1849); *On the Mode of Communication of Cholera, 1855* (London: Churchill, 1855); "On the Mode of Communication of Cholera, 1856".

[460] H. Brody, Rip, M.R., Vinten-Johansen, P., Paneth, N. & Rachman, S., "Map-Making and Myth-Making in Broad Street: The London Cholera Epidemic, 1854," *Lancet (British edition)* 356, no. 9223 (2000), 64-68; K. S. McLeod, "Our Sense of Snow: The Myth of John Snow in Medical Geography," *Social Science & Medicine (1982)* 50, no. 7-8 (2000), 923-935; J.M. Eyler, "The Changing Assessments of John Snow's and William Farr's Cholera Studies," *Sozial- und Präventivmedizin* 46, no. 4 (2001), 225-232; T. & Denike Koch, K., "Rethinking John Snow's South London Study: A Bayesian Evaluation and Recalculation," *Social Science & Medicine (1982)* 63, no. 1 (2006); Hamlin, *Cholera: The Biography*, 180-191; I. & Upton Cawood, C., "Divine Providence: Birmingham and the Cholera Pandemic of 1832," *Journal of Urban History* 39, no. 6 (2013), 1108.

[461] L.W. Janson, Unpublished data; P. Bingham, Verlander, N. Q. & Cheal, M. J., "John Snow, William Farr and the 1849 Outbreak of Cholera That Affected London: A Reworking of the Data Highlights the Importance of the Water Supply," *Public Health (London)* 118, no. 6 (2004); McLeod, "Our Sense of Snow: The Myth of John Snow in Medical Geography", 923-935..

[462] Shapter, *The History of the Cholera in Exeter in 1832* Front piece; Brody, "Map-Making and Myth-Making in Broad Street: The London Cholera Epidemic, 1854", 66-67; D.M. Morens, "Snow and the Broad Street Pump: A Rediscovery," ibid, no. 9242; 1688-1689; Tom Koch, *Cartographies of Disease: Maps, Mapping, and Medicine* (Aylesbury, United Kingdom: Esri Press, 2016).

[463] *Cartographies of Disease: Maps, Mapping, and Medicine*; Shapter, *The History of the Cholera in Exeter in 1832*; Brody, "Map-Making and Myth-Making in Broad Street: The London Cholera Epidemic, 1854". The maps Snow published may, in fact have been provided by his colleagues.

often forgotten, that water was not the only means of infection, are certainly true. However, his techniques and the actual historical role he played in ending cholera epidemics (per the above, 'stylised' story) are, as noted above, now in doubt. A review and thorough critique of Snow's work is far too involved and divergent from the focus of this thesis and will not be discussed further. The potential role of water as well as other potential vehicles (air and solids) for infection by *Vibrio cholera* will be examined for the 1866 Edinburgh, cholera epidemic in Chapter 5.

Summary

One very important factor that helped Edinburgh stop the devastating effects of cholera was the progression of an often wrongly focused and intentionally inactive central government but also a 'separated' society. Westminster and Edinburgh City Council (and its varying committees and personnel) were slowly but surely learning about the importance of public health and related sanitation efforts, acquiring increasing powers and then putting in actual measures that would be preventative rather than reactive. For Scotland, these would come via the various Burgh Police Acts, start of Registration, establishment of Medical Officers of Health (initially relatively powerless), passage of the Scottish Poor Law (1845) with provision of increasing secular care, a Board of Supervision and real powers for MOHs and passage of the Public Health Act (Scotland) 1867. The writings of Chalmers, Alison, Littlejohn and other 1800s Edinburgh writers added to this understanding. From the 1850s, Old Town over-crowding and squalor in the Old Town homes and lodging houses would begin to be addressed. Chambers, Littlejohn and Ramsay would start to open up (e.g., Cocksburn, Warriston Close, the planned South Bridge to George IV Bridge route) and effectively clean the streets and public spaces. Water would be provided not only as pure but also as sufficient and available for public, council and business uses. Finally, sewerage and water closets would be established (and connected) in a practical way that met the needs and the abilities of the public. Along with all of these factors, Edinburgh society was gradually changing from blaming to helping the poor, considering the idea that all are a part of an 'Enlightened' society and that public health actually mattered as it saved lives and, in the end, money. Religious outlooks on poverty also evolved as secular oversight increased but the city's organised religion still maintained a role and an influence, no matter what denomination.

In Edinburgh, the 'spine' of the Royal Mile, Calton Hill and Leith Walk had probable physical impacts on cholera's infective path. The Cowgate's unique position created a basin where excrement and refuse ran down from the High Street with little chance of escape. The varying bodies of water around Edinburgh also played their role in cholera epidemics. The authority of Edinburgh's prominent medical school and its instructors' and graduates' writings would both help but also

hinder progress towards controlling cholera. Edinburgh's Burke and Hare and other resurrectionists would also continue to instil a fear and deep mistrust in Edinburgh citizens regarding the doctors and city administrators who were simply trying to help them in the best way they could.

But, probably the more important test in these epidemics 'was a test of administrative skills [needing] 'a rapid and convincing response' [with] 'inadequate evidence.'[464] And this is, indeed, the crux of the situation. In Sunderland, these efforts failed. In Birmingham, they succeeded. And in every other cholera-stricken hamlet, town and city with their own nuances, the citizens came together in these varying ways and combatted the disease with varying successes. Edinburgh would follow the same overall path as all these other areas in its own way and with its own successes and failures in public health and sanitation efforts. Along with a progression of knowledge and beliefs of the scientists and clinicians in understanding the bacteria and ways to treat the infection, these growing and changing efforts by city officials and all the citizens for the whole of Edinburgh would finally end the seemingly undefeatable cholera attacks.

[464] Morris, *Cholera, 1832: The Social Response to an Epidemic*, 17-19.

Chapter 5. Cholera in Edinburgh, 1866

The preceding chapters have shown that cholera is a very complex and complicated bacterium that can live (and hide) in various mediums, change readily and infect with varying ways and disease severities. Some specifics of how Edinburgh dealt with the complexities and complications have been provided in previous chapters. Here a much more detailed view of the 1866 Cholera Epidemic will be undertaken to better understand Edinburgh's response and why this would be the last.

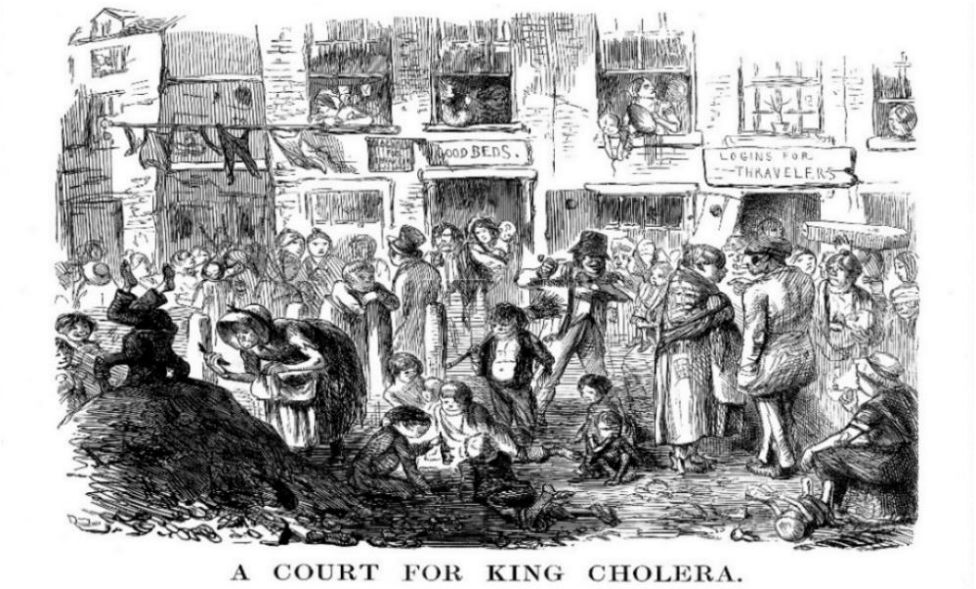
Edinburgh Cholera – Poisonous Air?

That sufficient quantities of *Vibrio* could be present in the air to cause disease has been discussed in Chapter 2. Indeed, the varying descriptions by people like Chadwick, Stark, Johnston, Alison, Chambers and Engels of the amount of faeces and refuse (all of which would be aerating into the atmosphere to some extent), the overcrowded, poorly-ventilated and squalid conditions of the varying tenements and cellars ('a shocking stench and swarms of vermin') of that area, and the state of the streets and closes of Old Town Edinburgh (described as 'chambers of death' and as some of the worst sanitary conditions in the UK), could make unlikely air-borne cholera infections, likely.[465]

The issue of sufficient air and of its quality was certainly on the minds of people in Edinburgh. Following cholera and typhus attacks in the 1830s, the Edinburgh Police Commission was tasked 'to reduce unpleasant smells [due to the] widely held beliefs about polluted air as the cause of infection.'[466] In 1849, Chambers's *Edinburgh Journal* wrote, 'The victims of cholera are those who are confined to dirty, ill-ventilated dwellings … and who are not taught to dilute them by ventilation.'[467] An 1850 Report of the General Board of Health noted that it 'originates and maintains its virulence chiefly from want of ventilation [providing] one of the most persuasive invitations which can be offered to the disease.'[468] In 1852, the *Scotsman* published a critical article on 'Defective Ventilation in Staircases', describing a standardised 'Edinburgh staircase' (named due to its prevalence in the city), only aerated by 'a close or passage leading to the street … [and] a small ventilating pipe placed in the centre of the skylight.' As the 'water-closet windows look into the staircase and, from the contracted nature of the whole … any gases which may escape from the water-closets find their way

[465] Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 19-23; Johnston, *Letter to the Lord Provost, Magistrates, and Council of the City of Edinburgh on the State of the Closes in the Lawnmarket, High Street, Canongate and Cowgate*, 18 & 23-37; W. P. Alison, Observations on the Management of the Poor in Scotland, and Its Effects on the Health of the Great Towns, (Edinburgh: William Blackwood and Sons, 1840), https://wellcomecollection.org/works/vpa3xxeb. Accessed 4 Jul, 2023, 9-14.
[466] Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 58.
[467] "Pure Air Versus Cholera," *Chambers's Edinburgh Journal, Feb. 1832- Dec. 1853*, no. 299 (1849), 190.
[468] "Ventilation - the Cholera," *Chambers's Edinburgh Journal, Feb. 1832- Dec. 1853*, no. 351 (1850), 192.

into the houses [providing] a constant quantity of poisonous gas floating near the roof…' The article and the London Board of Health both argued for a change to this construction design but also admitted, 'The Board cannot but regret their want of power to apply any sufficient remedy to the evils complained of.'[469] In 1865, one irritated tenant wrote about his disappointment with the reception by the Edinburgh Town Council for simple measures like 'a ventilator to be placed in each cupola, and one also in the fan light over the door'.[470] This was particularly poignant as the General Police and Improvement (Scotland) Act of 1862 had actually extended powers to Scottish cities and towns to start enforcing such public health problems.[471] One suggested way was for 'notices to the proprietors of houses inhabited by the working classes, requiring them to introduce a water-closet to each flat of such house within a month from the date of the notice' although it never did happen. Indeed, Dr. Stark, who fully supported the concept of good sanitation, suggested 'all the individual water closets would just be used for rubbish and garbage' with 'choking and bursting of the pipes and drains, flooding of the premises with the common sewage, and vitiation of the air from the noxious emanations …'[472] Perhaps the Town Council chose to have the contents of the gardyloo buckets emptied in the streets where they could see (and smell) it instead of in stairwells.



A COURT FOR KING CHOLERA.

Figure 5-1. Engraving Illustrating the Condition of British Cities and Towns.[473]

[469] "Defective Ventilation of Staircases," *Scotsman*, Sep 25 1852, 3.
[470] J.H.C., "Foul Air in Common Stairs," ibid, 2 Oct 1865, 6.
[471] D.G. Barrie, "Anglicization and Autonomy: Scottish Policing, Governance and the State, 1833 to 1885," *Law and History Review*, no. 30 (2), 473-481.
[472] J. Stark, "Water Closets in the Houses of the Working Classes," *Scotsman*, Aug 7 1865, 4.
[473] J. Leech, "Court for King Cholera," The National Archives, https://www.nationalarchives.gov.uk/education/resources/victorian-industrial-towns/court-for-king-cholera/, Accessed 14 Aug, 2022.

Edinburgh Cholera – A Matter of Water?

But what was the role of water, if any, in Edinburgh? A history of Edinburgh's water supply is one of trying to provide a water supply and sewerage to an ever-growing population (Table 5-1).

Table 5-1. History of Edinburgh's Municipal Water Supply (Pre-1817-1860s)[474]

Time Period	Activity
Pre-1817	Inhabitants got water from springs, burns and private/public pumps and wells, including ones in the Cowgate, High Street and Lawnmarket. Town Council (1674-1681) brings water from Todswell Spring at Comiston via lead pipes running to the Castle Hill (supplying five cisterns in the city centre) and Heriot Green (supplying the south of the city) reservoir buildings. The supply proved to be unreliable due to insufficient volume of the pipes. leaks and decreased water in the springs in the summer. Additional springs were accessed at Comiston in 1684 and 1685 but still proved to be insufficient. Work was started (1674-1722) to replace the pipes with larger ones and iron pipes begin to replace lead ones.
1817-1822	Public outcry increased until a city 'Water Company' was created and then incorporated in 1819 by an Act of Parliament. A plan was formulated to add the Crawley Springs and a portion of the Glencourse Burns to the town's water supply. Although difficulties ensued, the new water supply plan was completed in 1822
1836-1842	Although initially a great success, the Glencourse source soon was exceeded due to increased population demand. Specific years of trouble with supply are noted in 1836, 1838 and during a drought in 1842.
1843-1846	Another Parliamentary-approved plan was obtained in 1843 to obtain more water from the Bavelaw and Listonshiels Estates and from the Black Springs (all from the northern parts of the Pentland Hills. Work was begun but it soon became evident that even this new source would be insufficient for the increasing demands of the Edinburgh population.
1847-1848	A second Parliamentary Act allowed for an increase in the capacity of the Glenclose Reservoir as well as additional capacity via the Loganlea, Bonaly, Clubbiedean and Torduff Reservoirs as well as another cistern in the Castlehill. Filters were also constructed at the Torduff and Glenclose Reservoirs. This work was completed in 1852.
1856-1859	Due to continuing need, a further Act of Parliament was obtained that allowed water to be obtained from the Colzium estate and a reservoir at Harperrig was constructed. More demand and more construction were assumed to be imminent.
1842-1863	A summary provided by Ramsay illustrates both the increase in water provision (249.56 ft^3/min in 1842 to 731.80 ft^3/min in 1863), population (166,878 in 1842 to 208,647 in 1863) and demand (13.14 gallons/person/day to 31.2 gallons/person/day in 1863). Regardless, demand still continued to outstrip supply until St Mary's Loch was added to the Edinburgh water system in the 1860s/70s (see also below).
1869	Transfer of water supply to 'Edinburgh and District Water Trust' on 24 July 1869 but this was politically contentious Eventually worked out but took about ten years. In the end, though, water was under public control.

[474] E. H. Winant and E. L. Kemp, "Edinburgh's First Water Supply: The Comiston Aqueduct, 1675-1721," *Proceedings of the Institution of Civil Engineers. Civil Engineering* 120, no. 3 (1997), 119-124; Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 54 & 205-207; "Edinburgh's Water Supply," Edinburgh City Libraries,https://www.ourtownstories.co.uk/story/2409, Accessed 1 Feb, 2022; WordPress.com, "The History of Edinburgh's Water Supply," https://historicaljourneysalongbritishrivers.files.wordpress.com/2019/06/a1.-the-history-of-edinburghs-water-supply-posting-2019-1.pdfAccessed 1 Feb, 2022; A. Ramsay, "On the Water Supply of Edinburgh" (paper presented at the Royal Scottish Society for the Arts, Edinburgh, 23 Nov 1863).

But the water pipes and the burgeoning sewerage system also needed connected; unfortunately, this was not always the case. In the early-1800s, polluted and smelly water and refuse just gathered in the holes and crevasses of the cobbled streets since they were not directly connected to any sewers. The city attempted to fix this problem by an 1822 Act authorising landlord to connect street drains to sewers but this was usually thwarted as the ground-floor tenants had to give permission. The sewage problem was further illustrated in the Grassmarket where only surface drains existed until the 1840s when private supporters had to build an almost 800-metre sewer to carry the waste away. The few drains for sewage that were connected were overwhelmed and turned into 'fetid channels,' e.g., the Water of Leith (see also below) reportedly received 'the sewage of 100,000 people.' The problem was exacerbated by the amounts of water used by the city both to clean the streets (by 1842, every day) but also to take 'the drainage of half of Edinburgh to the meadows where pumps were used to spread the slurry.' The effect on water supplies was evident by the fact that Edinburgh cisterns often only had water a few hours a day, only two or three times a week. In 1847, James Young Simpson commented that the poor in Edinburgh 'content themselves with a driblet of water … probably their little tea-kettle full. Anything like personal cleanliness in such a condition is rare, while domestic cleanliness is quite out of the question.' And while Ramsay had documented increasing supplies (Table 5-1), the fact was that the Edinburgh Water Company did not try to expand water supplies for its first twenty years and had not considered supplies needed for 'manufacturing processes, the fire service or watering the streets, nor for future sources of demand such as the introduction of water closets in the houses of the poorer classes.' Even as late as 1857, only 26% of houses in Edinburgh had a water connection and in 1861 the Edinburgh Town Council was informed that '30,000 people living in our closes in the Old Town were without the slightest sanitary conveniences.' The city tried again to require landlords to connect their buildings to the sewer system but this was deemed untenable due to both costs and the powerless 1848 Police Act. So, the water and sewer pipes dutifully added by the city ran by houses, especially those inhabited by the poor, with no connections and, as a result, no increase in sanitation. Finally in 1862, another General Police Act was passed that would force landlords to hook up water pipes, make water closets and install drains in these domestic properties although the Town Council was still reluctant to use its powers, partly because even in 1865, there seemed to be enough water but the water and waste pipeage and sewage disposal was still wholly inadequate. To make things worse, the cost of connecting the old buildings of the Old Town was known to be a monumental and expensive task.[475]

[475] Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 54-55, 87 & 133-143; Adams, "Urban Reform", 6-9.

Fortunately for Edinburgh, Henry Duncan Littlejohn was now MOH, his report had just been published and he was receiving support from both the public and the press. With the same astuteness that had allowed a whisky during cholera in 1866 (Chapter 4), Littlejohn suggested less expensive and more practical solutions like sewage ventilation, street urinals and public lavatory blocks, trap drains to isolate cesspools from dwellings as well as lighting in common stairs so they all could be seen and kept clean. Gently and intelligently 'armed' with the new Police Bill, Littlejohn oversaw over one-hundred constructions of water-closets and sewer connections (25% were in the New Town) between 1864 and 1869 without any public backlash and, when the water supply was sufficient and attached, the introduction of even more individual or shared water closets.[476]

But concerns about water went beyond the city officials. Review of writings from 1832 to 1869 shows that Edinburgh citizens also were concerned about both the potential link between cholera and water and then need for water purity. In 1832, 'Hydrophobus' discussed his observed link of 'brackish and unwholesome water' and cholera and even proposed an experiment with boiling the water to see if it eliminated the disease's risk.[477] With the exception of the Water of Leith (discussed later in this chapter), this direct question of something in the water causing cholera would not be seen prominently again until August of 1866 when a paper entitled 'The Effects of the Pollution of Rivers' was published. Unfortunately, an Edinburgh Professor named Bennett suggested that 'there had been a great deal of exaggeration as to the influence of bad smells in producing disease [and] ridiculed the fears of injury to public health from the pollution of rivers ….' A jury trial took place at about the same time in Edinburgh regarding pollution of the River Esk but, despite showing there were a multitude of particles in the river water, doctors who testified at the trial could not report any link to cholera.[478] As discussed above, though, purity was not always the issue but rather proper access to water. Two other writers noted the need for purity and cleanliness but asked how, when public sources of water are turned off in the early morning or 'kept on only for a short time twice a day! and people are forced to beg "for love or money" from those who have private cisterns.'[479] Once again, there was no apparent bacterium or direct connection of cholera to water.

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[476] Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 100-103, 144-145, 201-209 & 215. Unfortunately, even in 1874, one-third of Old Town homes (e.g., Canongate, Grassmarket, St Giles', Tron) were still without water closets or connections for their sanitary use.

[477] "Letter to the Editor - Hydrophobus Water Letter," *Scotsman*, 25 Jan 1832.

[478] Our Own Reporter, "The Pollution of Rivers," ibid, 28 Aug 1866, 3; "Jury Trial - North Esk Pollution Case (Cholera)," ibid, 8 Aug, 8; "The Pollution of the River Esk - Important Discovery," *Scotsman*, 22 Sep 1866, 2.

[479] "Water Supply Problems," *Scotsman*, 30 Jun 1832, 2; "Scarcity of Water at Public Wells," *Scotsman*, 14 Jul 1832, 2; "The Supply of Water to Edinburgh, No. Iv," *Scotsman*, 1 Jan 1851, 2; "Deficiency of Water Supply," *Scotsman*, 5 Oct 1864, 7; Ramsay, "On the Water Supply of Edinburgh", 1-20; "Edinburgh Town Council - Supply of Water," *Scotsman*, Apr 25 1866, 8; J. Kemp, "Musselburgh Water Supply," ibid, 4 Dec 8;

Although water can play a prominent role, cholera can also infect by other ways. To determine water's role in Edinburgh, death certificates/declarations from the four, cholera epidemics were examined using the 'Scotland's People' digitised database. As official recording of death certificates did not start in Scotland until 1 January, 1855, death records for the first, three epidemic periods use only church records.[480] The only surviving church parish records available were for the St Cuthbert's parish with less than 20-30% complete and, in many instances, not at all legible; these were deemed unreliable and only used for subjective analysis. Official death certificates for the 1866 epidemic were found to be well over 95% complete. For each of these deaths, full name and relevant occupation, date and location of death, gender, age, parental information, official cause of death and duration of disease and the certifying person when the death as well as the specific district of Edinburgh were recorded (see example, Figure 5-2).

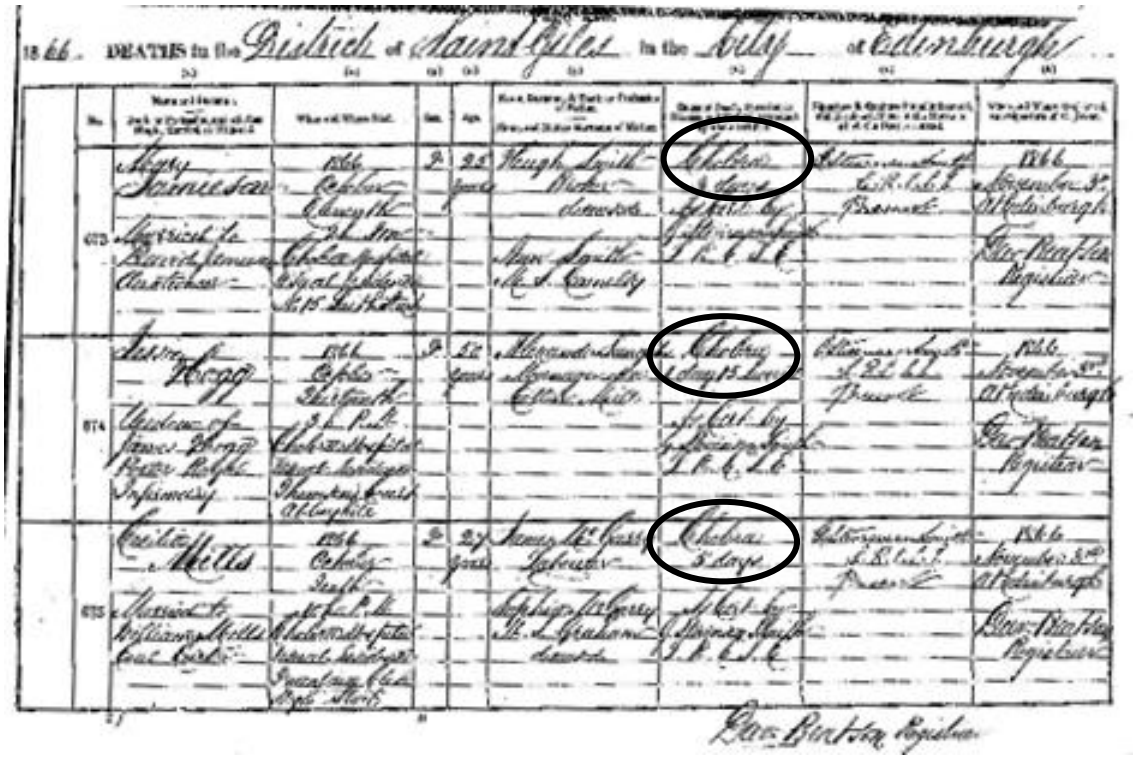

Figure 5-2. Sample Page from 1866 Death Certificates. Note the cause of death as 'Cholera' in black ovals[481]

"Edinburgh and District Water Bill (St Mary's Loch)," ibid, 2 Jul 1869, 7; "Edinburgh and District Water Bill (St Mary's Loch), Part 2," *Scotsman*, 3 Jul 1869, 3.

[480] Alice Reid et al., "'A Confession of Ignorance': Deaths from Old Age and Deciphering Cause-of-Death Statistics in Scotland, 1855-1949," *The History of the Family* 20, no. 3 (2015), 320-344.

[481] Scotland's People, https://www.scotlandspeople.gov.uk/, Accessed 4 Nov, 2014. Mary Jamieson (top listing) and her 'colleague' Margaret McLean (listed on a separate page) both died on 11 October, 1866 at 15 Leith Street. They were both known to work at a "House of Illfame in Leith Street. 'The Cholera'," 11 Oct 1866, 2.

Using this data, the location of each 1866 cholera death in Edinburgh was temporally and spatially mapped to look for Broad Street Pump-like foci (Figure 5-3). Four areas were identified and noted as 1) West Port, 2) Ponton Street, 3) Canongate and 4) Arthur Street Area.

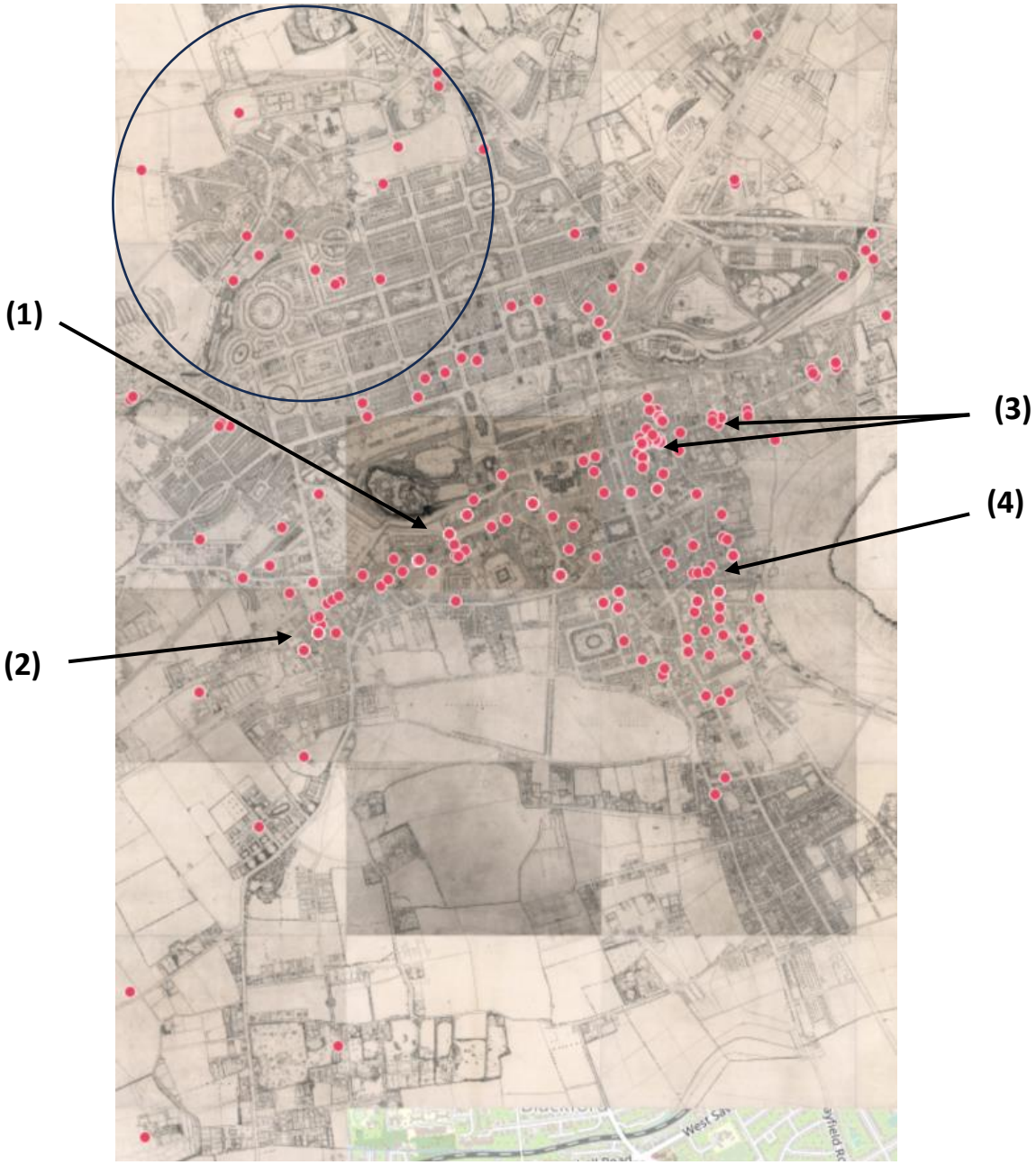

Figure 5-3. 1866 Edinburgh, Cholera Deaths. Each Death is Noted by a Red Dot. Deaths which occurred at the same location were skewed slightly off point for visualisation. Circle show the approximate location of Water of Leith and Canonmills (see below for further discussion)

Utilizing the 1857-1895, Edinburgh Ordinance Survey map, each focus was examined for water sources which could have been a source of cholera infection.[482] Each pertinent Ordinance map section that included a possible focus was used to locate any water sources to include wells, pumps, cisterns and troughs with each being marked by a yellow circle. An example for possible focus, #1, West Port is given in Figure 5-4.

View: OS town plan - Edinburgh, Sheet 35 - Ordnance Survey large scale Scottish town plans, 1847-1895
https://maps.nls.uk/view/74415483

Figure 5-4. Example of 'Water Sources' Mapping. Each water source is noted by a yellow dot. The centre of the West Port, possible focus is noted by a red dot.

Using the cholera deaths and the water sources maps, a potential contaminated water source was sought for each of the possible, four foci as noted below.

1) West Port Focus: The five, cholera deaths which make up this possible focus all occurred at 50 West Port. These five deaths specifically occurred in a building at this address called Crombie's Land (see Figure 5-5).[483] The deaths included
    a. William McLean, 47-year-old, labourer who died on 2 October.
    b. George Cunningham, 44-year-old, road labourer who died on 5 October.
    c. Mary Cunningham, 42-year-old wife of George on 8 October.
    d. John McClean, 2 ½-year-old son of William McLean on 12 October.
    e. Helen Johnstone, 20-year-old wife of a mason's labourer on 15 October.

[482] "Town Plan of Edinburgh," in *Ordnance Survey large scale Scottish town plans, 1847-1895* (National Library of Scotland, 1849-53), https://maps.nls.uk/townplans/edinburgh1056_1.html, Accessed 15 Nov, 2015.
[483] "Edinburgh Town Council - Unsanitary Crombie's Land," *Scotsman*, 8 May 1867, 6.

Helen Johnstone was taken to the Forrest Road Cholera Hospital but died despite medical assistance. The four other victims at Crombie's Lane died at home with no medical attendant. Reviewing the near-by water sources, a large and very prominent pump was located at the west end of the Grassmarket and was likely the primary source for residents of the area. The next nearest sources on the south and north sides of the Grassmarket are three pumps in Brown's Close and Dunlop's Court (north) and Ballantyne's Close (south). These were certainly accessible to the cholera victims but it seems unlikely they would have walked directly past the larger and more accessible pump to gain access to the north pumps or, for the single, south pump, up a fairly prominent hill (the area of the current Vennel) and to the back of a small close for their water. There are two other pumps also available at the south and east ends of the Grassmarket but these seem improbable given the larger, west end pump. Perhaps most telling is the relative paucity of other foci of deaths around the West Port and Grassmarket areas. As has been noted in previous chapters, this area was known for sanitation problems had been the focus of Chalmers and the first, Edinburgh Lodging House. If any of the water sources around West Port had been contaminated like the Broad Street Pump, there would have certainly been many more deaths around that water source.

Figure 5-5. Crombie's Land, 50 West Port Edinburgh, 1868 Painting.[484]

[484] Jane Stewart Smith, "Crombie's Land Exterior. West Port," in *http://canmore.org.uk/collection/1345337* (Edinburgh, Scotland: Canmore: National Records of the Historic Environment, 1868), Accessed 19 Jul, 2023.

2) Ponton Street Focus: Seven deaths occurred on Ponton Street, near Tollcross. These deaths included
    a. John Dingwall, 4-year-old, son of George and Isabella on 10 October.
    b. Janet Dingwall, 2 ½-year-old, daughter of George and Isabella on 10 October.
    c. Agnes Heron, 46-year-old wife of baker John Heron on 1 November.
    d. John Heron, 49-year-old baker on 6 November.
    e. James Bain, 50-year-old mason and a widower on 16 November.
    f. Peter Bryan, 25-year-old, house painter on 17 November.
    g. William Bryan, 2-year-old son of Peter on 17 November.

In the case of this possible focus, it is interesting to note that John and Janet Dingwall as well as James Bain and Peter and William Bryan all lived at 14 Ponton Street. Agnes and John Heron lived a few doors down at 23 Ponton Street. There was a rainwater cistern located down a small passage just behind both 14 and 23 Ponton Streets and, as such, could have served as a cholera-contaminated water source, although there is no indication of this from the available reports. Immediately behind this area was a large slaughterhouse with no identified water sources but also without direct access to the cistern. There were also two pumps a short distance northwest of the two locations although these were owned by and on the premises of a Coal Yard and are assumed not for use by the local residents. The only nearby water pump was on Thornybank Road (one road to the east); this pump was in a courtyard and, therefore, accessible for all residents. Robert Anderson, resident of Thornybank Road did die from cholera on 9 October and Henry Shaw of 9 Dunbar Street (two roads to the east of Ponton) on 17 October but there were no other fatalities from that area. Perhaps even more importantly, there does not seem to be a consistent, temporal relationship for the above deaths nor a spatial one. The Dingwall children died on 10 October and then no further deaths occurred in this area for about three weeks. Next, a baker and his wife at a different address died at the same home within about five days of each other. About a week and a half later, three more died back at 14 Ponton Street. There does not seem to be any temporal or spatial relationship regarding these cholera deaths except for close, house contacts. There are also not a large number of other deaths in the area that could be identified with either the cistern or the pump. So, no Broad Street Pump source of cholera deaths seems to be present for the Tollcross area.

3) Canongate Focus: Two possible foci were identified in what will be referred to as the Canongate area. These foci are located at a) the intersection of the Royal Mile and St Mary's Close (now Street) and b) the area of the intersection of the Royal Mile and St John's Street (to include Little John's Close, Big John's Close and St John's Close). Thirty-six deaths occurred in total in these areas (twenty-seven near St Mary's Close and nine near St John's Street). These deaths include

St Mary' Close Area

a. James Nairn, 16-month-old son of blacksmith journeyman on 25 August.
b. William Wright, 43-year-old dock labourer on 3 September.
c. James Bell, 7-month-old illegitimate boy on 9 September.
d. Margaret McLaren, 68-year-old wife of a 'Ispanner' [word not clear] on 29 September.
e. Peter Cheyne, 10-year-old on 6 October.
f. James Gow, 39-year-old mason journeyman on 8 October.
g. Frederick Lightbody, 22-month-old illegitimate boy on 10 October.
h. Cretia Mills, 27-year-old wife of coal carter on 10 October.
i. George Leith, 17-month-old son of James and Ann on 11 October.
j. Joanie Dodd, 3-month-two-week-old illegitimate girl on 12 October.
k. Maria Finney, 2 ½-year-old girl on 16 October.
l. Patrick Reynolds, 4-year-old son of Mary Ann & Patrick on 21 October.
m. Francis Reynolds, 5-month-old son of Mary Ann & Patrick on 23 October.
n. John Casey, 55-year-old nursery labourer on 23 October.
o. Mary Ann Reynolds, 33-year-old wife of nursery labourer on 24 October.
p. Isabella Mackay, 38-year-old, wife of mason labourer on 25 October.
q. Alexander Pearson, 5-year-old on 28 October.
r. Flora Frame, 34-year-old wife of coal carter on 28 October.
s. Andrew Frame, 44-year-old, coal carter on 29 October.
t. Sarah Hughes, 36-year-old, wife of a slater on 1 November.
u. Edward Lowark, 62-year-old, coal porter on 4 November.
v. Margaret Donaldson, 57-year-old wife of St Cuthbert's Poor House courier on 5 November.
w. Charles Winton, 6-year-old son of lithographic printer on 7 November.
x. John Lynch, 67-year-old mason on 10 November.
y. John Beattie, 23-year-old scavenger on 19 November.
z. George Paterson, 25-year-old typefounder on 25 November.
aa. James Stevenson, 14-month-old son of currier journeyman on 15 December.

and St John's Street area

a. Walter Turnbull, 58-year-old blacksmith on 12 September.
b. Alison Rutherford, 19-year-old seamstress on 3 October.
c. Mary Mason, 57-year-old widow of a shoemaker on 3 October.
d. Margaret Rutherford, 59-year-old widow of tailor journeyman (possible mother of Alison) on 5 October.
e. Ann Leith, 36-year-old wife of lithographic printer on 11 October.
f. James Leith, 38-year-old lithographic printer (husband of Ann) on 11 October.
g. Alexander Howden, 41-year-old, iron founder's labourer on 13 October.
h. Isabella McGraw, 40-year-old wife of bookbinder journeyman on 16 October.
i. Mary McLennan, 48-year-old wife of typefounder on 31 October.

This area has several, important features. Most of the Royal Mile, including the Canongate area, was served by a series of cisterns/pumps (not wells) whose water source originated from the Edinburgh Water Works' Castle Hill Reservoir, located adjacent to the Castle Esplanade. As such, all the cisterns/pumps running from the reservoir down to the Palace were sequentially connected (see Figure 5-6)[485] As per Table 5-1, the water in this reservoir was obtained from a series of lochs and reservoirs in the Pentland Hills and, later, from St Mary's Loch in the Borders. The various sources of water were constructed starting in 1821 under the auspices of the Edinburgh Water Works company, its temporary rival the Edinburgh and Leith Water Company and finally by an Edinburgh Trustee-run, public water company under the same name.[486] In general, the water was pure (a series of filtering beds were constructed below the Pentland Hills) and, although planners attempted to keep up with demand, the growing population of Edinburgh, Leith and surrounding towns caused often serious supply problems, including at least one instance in 1832 when all water sources in the Canongate were turned off from 7 o'clock in the morning for most of the day.[487] In Musselburgh, the Water Company had completely skipped providing water much to the dismay of local residents.[488]

For the St Mary's area there is an obvious, close contacts connection between the deaths of Patrick and Francis on 21 and 23 October, respectively, and their mother Mary Ann Reynolds on 24 October, as all lived at 27 Blackfriars Wynd. The much later death (5 November) of Margaret Donaldson, also an inhabitant of 27 Blackfriars Wynd, appears unrelated. A coal carter husband and his wife die one day apart at South Foulis Close but no further deaths at that address are seen. Edward Lowark and James Stevenson died at the same address of 39 Leith Wynd but almost forty days apart.

Obvious connections of deaths in the St John's Street area include the deaths of the married couple Ann and James Leith at 14 Shoemaker's Close. Their neighbour at the same address had died 8 days prior of cholera, most certainly too long a time for a direct, water-based, Asiatic cholera infection to have been transferred. Their neighbour Alexander Howden died just two days after

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[485] "Cisterns in the Old Town," (2103), https://forgottengalicia.com/cisterns-old-town-edinburgh/, Accessed 24 Jul, 2022, 1-3; "Castlehill Reservoir and Edinburgh's Water Supply," (2018), https://www.edinburghexpert.com/blog/castlehill-reservoir-and-edinburghs-water-supply, Accessed 24 Jul, 2022, 1-3.

[486] For a history of the water supply for Edinburgh and surrounding areas see Winant and Kemp, "Edinburgh's First Water Supply: The Comiston Aqueduct, 1675-1721", 119-124; "The Supply of Water to Edinburgh, No. Iv", "The Supply of Water to Edinburgh, No. Iv", 2.; Ramsay, "On the Water Supply of Edinburgh", 1-20 and A. Leslie, "The Edinburgh Waterworks" (paper presented at the Minutes of proceedings of the Institution of Civil Engineers, 1883), 91-127.

[487] "Scarcity of Water at Public Wells", 2; "Water Supply Problems", 2; "Deficiency of Water Supply", 7.

[488] Kemp, "Musselburgh Water Supply", 3.

them; his address is only listed as ‘Shoemaker’s Close’ so a direct spatial interaction cannot be established. At Whitehorse Close, Alison and Margaret Rutherford, presumed daughter (seamstress) and mother, given Alison’s and Margaret’s husband’s prior field of work (tailoring), died within two days of each other. Their neighbour, Isabella McGraw, also of Whitehouse Close, died eleven days after Margaret; thus, a direct, water-infection connection between the two sets of deaths does not seem apparent. The deaths of Walter Turnbull and Mary McLennan were separated by approximately a month and a half and so are also deemed unrelated despite both being residents of Big John’s Close. The remainder of the numerous deaths in this part of Edinburgh are scattered both temporally and spatially. A clustering of deaths within a particular time frame like appeared at Broad Street is simply not seen.

Figure 5-6. A Sample Cistern/Pump Potentially on the Edinburgh Royal Mile, 1890. Several Edinburgh cisterns/pumps still survive today.[489]

[489] Figure taken from “Edinburgh's Water Supply”; See also "Cisterns in the Old Town", 1-3.

4) Arthur Street Area. There is a small, but noticeable, possible focus of cholera deaths in the area of Arthur Street to include both the Arthur Street and Middle Arthur Close areas. Five deaths included

    a. John Kennedy, 15-month-old on 2 September.
    b. Archibald Russell, 35-year-old carter on 16 October.
    c. Thomas Laing, almost 2-year-old son of a joiner journeyman on 21 October.
    d. John Laing, 4-year-old son of the same joiner journeyman on 26 October.
    e. Margaret Geddy, 9-year-old daughter of Robert and Helen on 27 October.

The deaths of John Kennedy and the two Laing sons were at 16 and 13 Arthur Street, respectively. The death of Russel Archibald and Margaret Geddy were at 3 and 6 Middle Arthur Close, respectively. There were two, rainwater cisterns within close proximity of these addresses albeit both down small passages at the backs of houses. There was one tank located similarly down a small passage and behind a building although this appears to have been completely closed off. Prominent in this area are several, marked, water points thus indicating that there may have been some type of piped water available to all of the residences. Temporally, there also does not seem to be any relationship of the deaths with the exception of the two Laing sons who died about five days apart. In the context of a possibly, contaminated water source, the death of Margaret Geddy does not appear to be temporally related to her neighbour Archibald Russell, eleven days prior.

One further fact argues against a particular well or wells being a source for cholera infections in any of the four, Edinburgh cholera epidemics. Edinburgh, in fact, had a fairly extensive water supply network even as early as 1813. Using data provided in *Reports on the Means of Improving the Supply of Water for the City of Edinburgh,* a map was created showing the series of pipes (lead, wood and iron) that ran through multiple parts of the Old Town, New Town and even as far south as Marchmont and as far north as Canonmills (see Figure 5-7 and 5-8).[490] As noted above, examination of the same, Ordinance Survey map used above also confirms numerous 'Water Points' throughout Edinburgh.[491] Although the pipes are not as numerous in the Old Town, there was water available coming from the Castle Hill reservoir and running down to the cisterns noted above. If the source was contaminated, many more would have contracted cholera and potentially died. In Broad Street Pump terms, if one water source running from the Castle to the Palace got infected with cholera, all would likely follow. Compounding this argument is the previously discussed factor of whether or not connections existed from the water pipes to the houses (Chapter 5).

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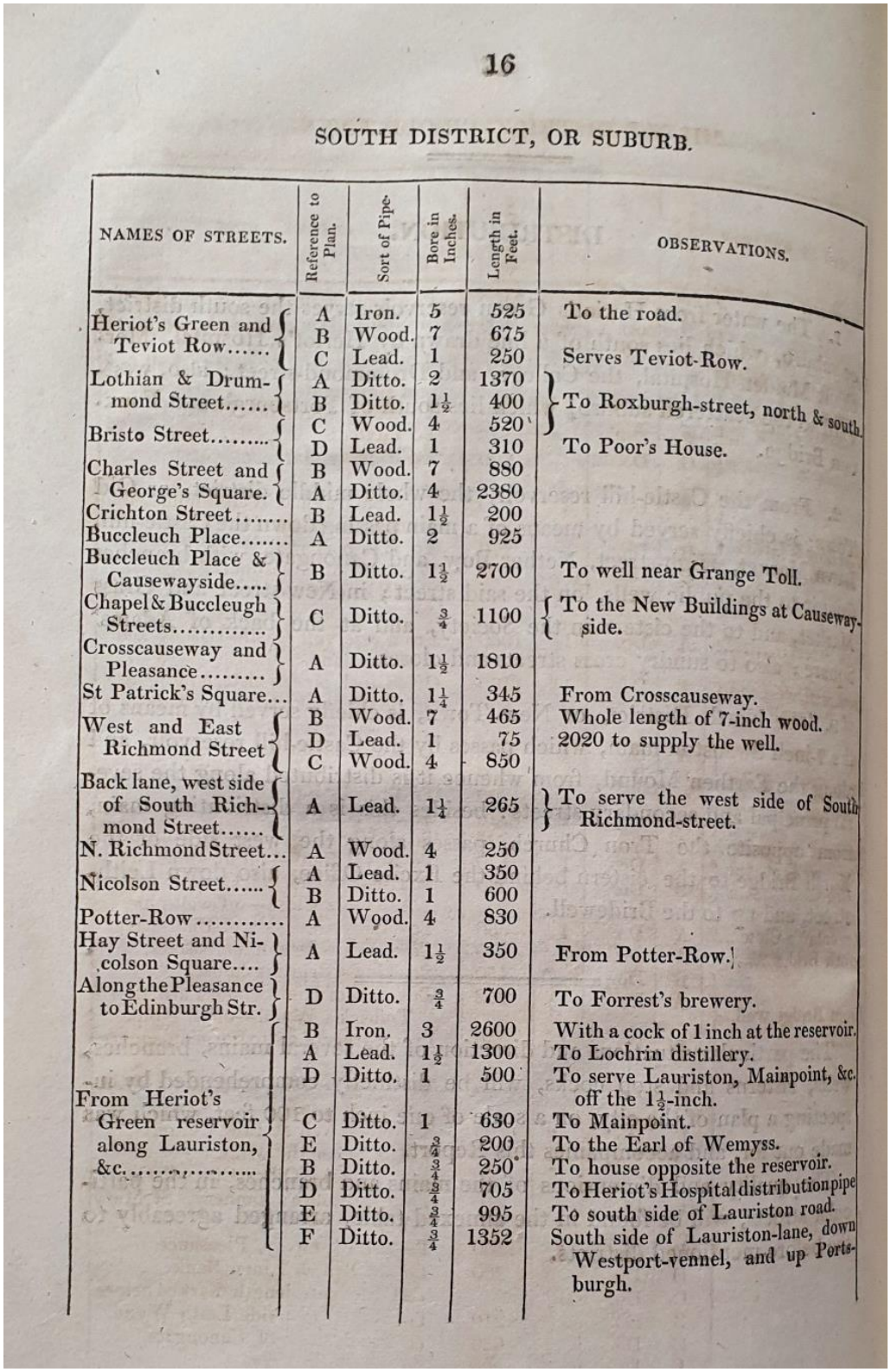
[490] "Reports on the Means of Improving the Supply of Water for the City of Edinburgh, and on the Quality of the Different Springs in the Neighbourhood," (Edinburgh: Archibald Constable, 1814), 15-20.

[491] L Janson, personal observations.



16

SOUTH DISTRICT, OR SUBURB.

NAMES OF STREETS.	Reference to Plan.	Sort of Pipe.	Bore in Inches.	Length in Feet.	OBSERVATIONS.
Heriot's Green and Teviot Row.....	A	Iron.	5	525	To the road.
	B	Wood.	7	675	
	C	Lead.	1	250	Serves Teviot-Row.
Lothian & Drummond Street.....	A	Ditto.	2	1370	To Roxburgh-street, north & south.
	B	Ditto.	1½	400	
Bristo Street.....	C	Wood.	4	520	
	D	Lead.	1	310	To Poor's House.
Charles Street and George's Square.	B	Wood.	7	880	
	A	Ditto.	4	2380	
Crichton Street.....	B	Lead.	1½	200	
Buccleuch Place.....	A	Ditto.	2	925	
Buccleuch Place & Causewayside.....	B	Ditto.	1½	2700	To well near Grange Toll.
Chapel & Buccleugh Streets.....	C	Ditto.	¾	1100	To the New Buildings at Causeway-side.
Crosscauseway and Pleasance.....	A	Ditto.	1½	1810	
St Patrick's Square...	A	Ditto.	1¼	345	From Crosscauseway.
West and East Richmond Street	B	Wood.	7	465	Whole length of 7-inch wood.
	D	Lead.	1	75	2020 to supply the well.
	C	Wood.	4	850	
Back lane, west side of South Richmond Street.....	A	Lead.	1¼	265	To serve the west side of South Richmond-street.
N. Richmond Street...	A	Wood.	4	250	
Nicolson Street.....	A	Lead.	1	350	
	B	Ditto.	1	600	
Potter-Row.....	A	Wood.	4	830	
Hay Street and Nicolson Square....	A	Lead.	1½	350	From Potter-Row.
Along the Pleasance to Edinburgh Str.	D	Ditto.	¾	700	To Forrest's brewery.
From Heriot's Green reservoir along Lauriston, &c.....	B	Iron.	3	2600	With a cock of 1 inch at the reservoir.
	A	Lead.	1½	1300	To Lochrin distillery.
	D	Ditto.	1	500	To serve Lauriston, Mainpoint, &c. off the 1½-inch.
	C	Ditto.	1	630	To Mainpoint.
	E	Ditto.	¾	200	To the Earl of Wemyss.
	B	Ditto.	¾	250	To house opposite the reservoir.
	D	Ditto.	¾	705	To Heriot's Hospital distribution pipe
	E	Ditto.	¾	995	To south side of Lauriston road.
	F	Ditto.	¾	1352	South side of Lauriston-lane, down Westport-vennel, and up Portsburgh.

Figure 5-7. Example of Listing of Water Pipes in Edinburgh.[492]

[492] "Reports on the Means of Improving the Supply of Water for the City of Edinburgh, and on the Quality of the Different Springs in the Neighbourhood", 16.

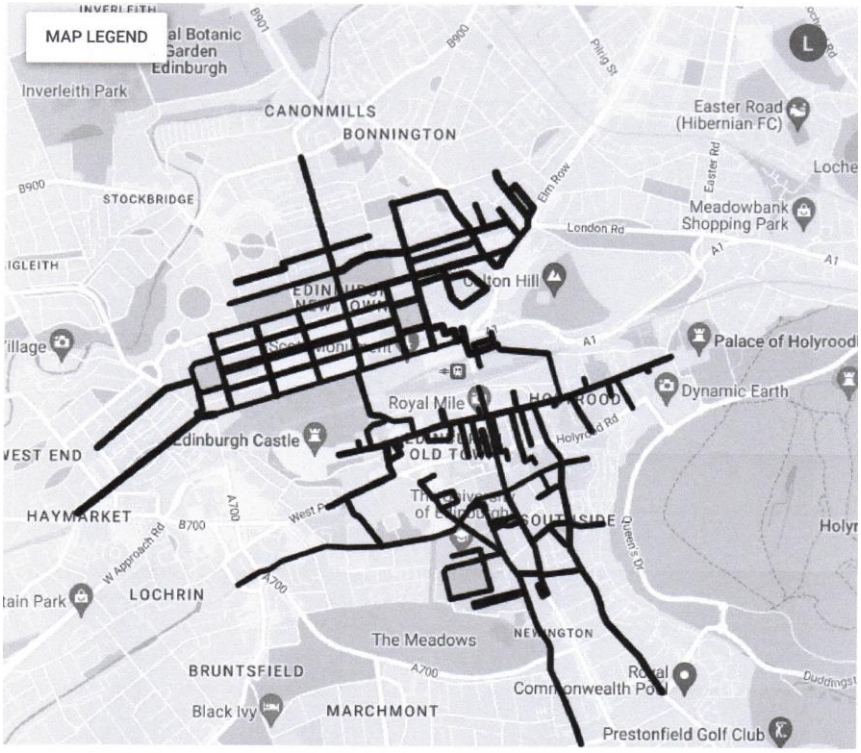


Figure 5-8. Map of Water Pipes in Edinburgh in 1813 (by the author).[493]

One water source that does need to be examined more carefully for Edinburgh is the Water of Leith. This waterway and its obvious pollution and smell were reported through all four Edinburgh cholera epidemics.[494] During the 1832 epidemic, there was, in fact, reports that 'At Canonmills and the Water of Leith … cholera seems to have obtained a footing'. However, the Water of Leith was known to frequently flood after heavy rainfall. Various reservoirs, e.g., Treipmuir (1843), Harlaw (1848), Harperrig (1860), along with agreements with mill owners regarding release of water helped to alleviate this flooding. One specific instance in 1866 is of particular note as a *Scotsman* contributor reports on Slateford (about 1000-1500 feet downstream from the part of Edinburgh called 'Water of Leith' and upstream from Canonmills) where 'a draw-well – the only one in the village ….[495] stands with a few yards of a mill-lade on the Water of Leith … and in bad weather the rain carries all sorts of filth into it.' Could the Water of Leith and not the well have been the source of infection?

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[493] Ibid, 15-20.

[494] Adams, "Urban Reform", 6.

[495] "Water of Leith and Canonmills Cholera - Attacks on Officials", 2; "Water of Leith and Canonmills Cholera Infections," *Scotsman*, 14 Apr 1832, 3; "Letter to Editor, Water of Leith (1846)", 3; "Letter to Editor, Water of Leith (1848)," *Scotsman*, Sep 16 1848, 3; "Police Commission - Water of Leith", 3; WordPress.com, "Water of Leith," https://historicaljourneysalongbritishrivers.files.wordpress.com/2019/06/4.-water-of-leith-posting-2019-1.pdf&tbm=ilp&biw=1517&bih=698&dpr=0.9 , Accessed, 29 Aug, 2023; Caution, "How Cholera Is Bred (Water of Leith Contamination)," *Scotsman*, 1 Nov 1866, 5.

Unfortunately, as only St Cuthbert's death records exist for the first three Edinburgh epidemics, a strict analysis of this question is not possible. There is also no available reference to a specific flood of the Water of Leith during March/April 1832. To see if a persistent focus could be seen with the caveat that this data is very much incomplete but is all that is available, these reported deaths were used to generate MESH maps of the Edinburgh cholera epidemics of 1832, 1848/49 and 1853/54.[496] Two potential foci can, indeed, be seen in 1832 in agreement with the Scotsman reports (Figure 5-9a). These do not persist into the 1848/49 or 1853/54 epidemics (Figures 5-9b, c) nor 1866 (see Figure 5-3 above). Whether via reservoirs established starting in 1843 or efforts to stop blockage of the Water of Leith and, in fact, establish better drainage of the entire city starting the 1850s, Edinburgh cholera never seemed to have a true Broad Street Pump.[497]

Figure 5-9a. 1832 Edinburgh, Cholera Deaths (St Cuthbert's Data). Each Death is Noted by a Red Dot.

[496] Mapping has been kindly provided by Prof. (Emeritus) Richard Rodgers using his Mapping Edinburgh's Social History (MESH) software.

[497] "Police Commission - Water of Leith", 3; "Mr Mcnab - Water of Leith," *Scotsman*, 7 Sep 1864, 7; "Drainage of the City," *Scotsman*, Sep 8 1852, 3; "Drainage Committee (Edinburgh and Leith Plans)," *Scotsman*, Nov 16 1853, 2; "Drainage of Edinburgh", 3;"Edinburgh and Leith Sewerage Bill," *Scotsman*, 11 Jun 1864, 7; "Edinburgh Town Council - the Water of Leith Sewerage Expenses," *Scotsman*, 10 Oct 1865, 2; "Water of Leith Drainage Scheme," *Scotsman*, 26 Oct 1865, 2.

Figures 5-9b, c. 1848/49 and 1853/54 Edinburgh, Cholera Deaths (St Cuthbert's Data). Each death is noted by a red dot (1848/49) or blue dot (1853/54). Circles show the approximate location of Water of Leith and Canonmills.

Given the influence of John Snow's work on the study of cholera infections, a potentially contaminated water source seems to be on many people's minds. However, as even Snow wrote in his latter two publications, water is not the only way to transmit cholera disease. In 1832, when flooding of the Water of Leith could have occurred, there was potentially some contaminated wells but in later Edinburgh epidemics no cholera-contaminated water sources are evident. The analyses of the above, potential, water foci show people in the same family or in the same home getting cholera at the same time but there seems to be no direct link to a particular well or other water source that would have been available to them. Throughout all of the Edinburgh reports both official (e.g., Littlejohn) and via residents, there were also no actual inferences of a specific, contaminated water source.[498] And while contaminated water appears to have not played a prominent role in Edinburgh's 1866 cholera epidemic, the lack of sufficient water may have, indeed, played a part. So, what did cause the spread of *Vibrio cholera* in Edinburgh? Air? Water? Or, perhaps something more?

[498] Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*, 145-146.

Edinburgh Cholera – A Matter of Occupation?

The 1866 Edinburgh Death Certificates also provide a listing of the deceased's occupation (or a prominent family member from the same home). Using this information, the number of deaths per Occupation was graphed (Figure 5-10)

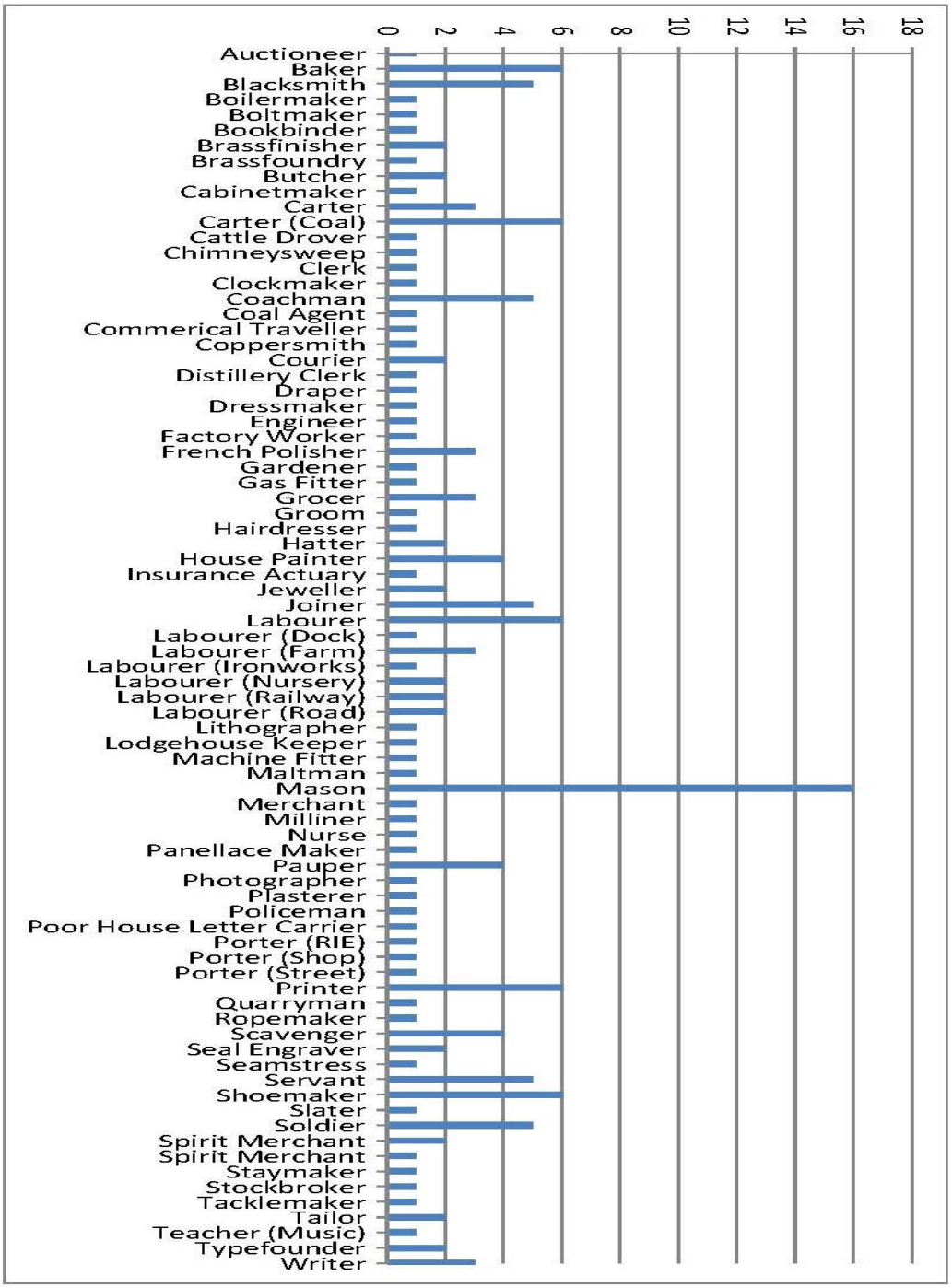

Figure 5-10. 1866, Edinburgh Cholera Epidemic Deaths by Occupation (Occupation, x-axis; Number of Deaths, y-axis)

Prominent amongst the occupations are Bakers, Blacksmiths, Coal Carters, Coachmen, Labourers (General), Joiners, Printers, Servants, Shoemakers, Soldiers and, especially, Masons. Were these high numbers of deaths just due to simple numbers of persons in each occupation? To determine this, the 1861 Scottish Census was examined for the stated occupations (Table 5-2). From this analysis, these eleven occupations were found to be responsible for over 40% of the total, 1866 Edinburgh cholera deaths and almost 8% of the total cholera deaths in Scotland. Additionally, a simple numerical relationship between the total number of people in a particular occupation and the number of deaths does not seem to be evident, e.g., Masons represent only 0.77% of the total, 1861 Scottish population but were responsible for over 9% of the total, 1866 Edinburgh cholera deaths.[499] The question then emerges whether there is a reason why these job types were more prone to cholera infection and/or death.

Table 5-2. Cholera Deaths by Occupation vs Number in Scottish Population[500]

Occupation	1866 Edinburgh Deaths	% of Total 1866 Edinburgh Deaths	Number in 1861 Scottish Population	% of Scottish Population
Baker	6	3.59%	10,894	0.36%
Blacksmith	5	2.99%	19,610	0.64%
Coal Carter	6	3.59%	2,054	0.07%
Coachmen	5	2.99%	3,240	0.10%
Joiner	5	2.99%	26,319	0.86%
Labourer (General)	6	3.59%	120,127	3.92%
Mason	16	9.%	243	0.77%
Printer	6	3.59%	12,723	0.42%
Servant	5	2.99%	4,470	0.15%
Shoemaker	6	3.59%	15,054	0.49%
Soldier	5	2.99%	4,498	0.15%
Total	**71**	**42.51%**	**219,232**	**7.93%**

[499] The numbers of deaths in each occupation are too small to make any conclusive statements about these cholera deaths. Using Lehr's rough calculation of necessary power, 77.76 cases would be needed for statistical power (α=0.05, β=0.2, Power = 0.8). Unfortunately, numbers of Masons or other occupations specific for Edinburgh could not be found during the course of this work. Further efforts are planned. Of note, John Snow also performed a similar analysis in his 1855, update-paper *On the Mode of Communication of Cholera* although the occupations he chose do not fit well with the Edinburgh and Scottish occupations listed in Death Certificates.

[500] Ditto Books, "Census of 1861 – Occupations – Scotland," https://www.dittobooks.co.uk/extras/census/census-of-1861-occupations-scotlandAccessed Aug 23, 2023.

To determine if these types of interactions were responsible, the occupations from Figure 5-9 were divided into those that may be considered to be involved with 'Public Interaction' or 'Group Occupation' activities or not. Examples of Public Interactions included Baker, Carter, Coachmen, Grocer, Merchant, Tailor, etc while those working in Group Occupations that would allow easy transfer of Vibrio included Auctioneer, Labourers not including 'Farm,' Masons, Soldiers (retired soldiers were not included for this analysis), etc. As shown in Figure 5-10, the occupations designated as 'Public Interactions' represented 47% of all deaths while those noted as 'Group Occupations' included an additional 24% of the deaths. In total 'Public' and 'Group' jobs represented 71% of all the deaths in the 1866, Edinburgh, cholera epidemic.

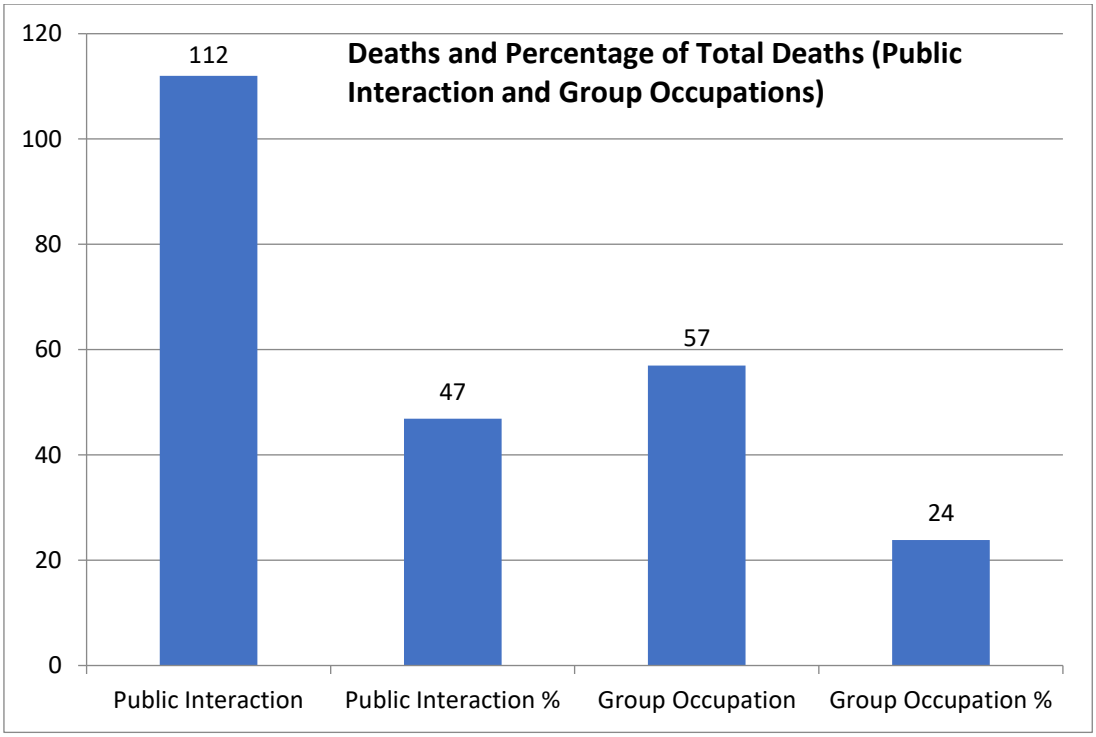

Figure 5-10. 1866, Edinburgh Cholera Epidemic 'Public Interaction' and 'Group Occupations' Deaths.

Edinburgh Cholera – Beware of Solids?

It is well established (see Chapters 1 and 2) that *Vibrio cholera* can be transmitted by solids. Thus, while *Vibrio cholera* is often a waterborne bacterium, it is the contaminated, human faeces in the water that is the actual source of infection. That same faeces can be carried on a dirty piece of clothing of a tradesman who is attending a middle-class home in New Town Edinburgh, be picked up by unsuspecting passers-by as a 'gardyloo' pail is pitched out of an Old Town Edinburgh tenement and continues running down a close to the Cowgate or Nor Loch. It can similarly be accidentally

given to a customer by a fruit and vegetable vendor in the Luckenbooths on the Edinburgh High Street who shared a contaminated loo and did not quite wash his hands after toileting, be given by a son or daughter bringing a cup of water to their elderly parents from a contaminated well or be eaten by a tired, Leith fisherman savouring a raw oyster at the end of a hard day at work. *Vibrio* can even travel in simple dirt on solids like clothes, blankets, boots or coats that have just travelled through a foul, Edinburgh Close (in one reported instance a 'dung hill' in a close could have filled it with 'deposits' eighteen inches deep, thirty feet long and two feet wide). Cholera can also be transferred by the touch of a hand of a friend in an Old Town Public, Poor, Work or Lodging House or even in just a house – rich or poor, Old Town or New.[501] It can even travel and infect via different animals like plankton, seaweed, shellfish, cuttlefish and nautilus, turtles, birds, water-associated midges, insects, domesticated animals, and as a co-infection with certain parasites. This concern was seen in various forms from the first, 1832, cholera epidemic up to the last in 1866.

It also was now generally accepted that the filth from gardyloo buckets, ash refuse and just general rubbish was a potential for disease, whether by humours, miasmatic or contagionist causes. Edinburgh looked at animals like pigs, including their bones, hoofs and horns as well as other solid items like fruits and vegetables and, although not popular, quarantining cargo on ships.[502] They also saw connections with drinking and intoxication instead of aspects of overcrowding and passing on cholera via glassware and direct contact. This sentiment was seen towards Lodging Houses where the same overcrowding and close contact persisted until legislation finally emerged in the late 1840s.[503] These same insights into overcrowding and the potential to contact filth that can cause disease was also seen in the emerging care of the poor. Charities and soup kitchens were established and critical commentaries regarding housing for the poor started in the 1830s and continued to establish an understanding of at least some of the maladies of poverty.[504] The wealthy had now seen a probable direct link to their health as well.

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[501] "Sanitary Condition of Edinburgh - Government Inspector's Report", 3.

[502] "Removal of Rubbish and Swine in Leith," *Scotsman*, Feb 1 1832, 3; "Banishment of Pigs," *Scotsman*, Nov 12 1831, 3; "Burnt Bone, Hoof or Horn Mitigatres Cholera," *Scotsman*, Dec 18 1831, 3; "Safety of Fruit and Veg Letter to the Editor", 4; "Unripe Fruit and Potatoes Cause Cholera", 2; Citizen, "Nuisances at Old Dalkeith Road", 6; "The Evils of Quarantine Law", 3; "Possible Quarantine of Ships", 3.

[503] "Complaint - Intemperance, Uncleanly Habits ...", ibid, 30 Jun 1832, 2; "Cholera Caused by Wretched Habit of Intoxication," *Scotsman*, 14 Jul 1832, 2; "Suggestion of Link between Cholera and Intoxication," *Scotsman*, 29 Aug 1832, 2; "The Evils of Licensed Public Houses in Edinburgh," *Scotsman*, 24 Mar 1868, 6; "Lodging House Association (Cholera)", 4; "Bye Laws for Cleaning Committee/Lodging Houses", 3.

[504] "Call for Reinstatement of Soup Kitchens and Re-Inspection of the City", 2; "Soup Kitchen Appeal", 2; "House of Refuge (from Cholera Soup Kitchens)", 3; "Health Board Efforts", 2; "Directors of House of Refuge - Soup Kitchen Considerations," *Scotsman*, 21 Dec 1853, 1; "Comparison of Edinburgh Dwellings to

Other efforts regarding 'solids' also developed. As early as 1831, the Police were required to wash the streets, lanes and closes and General and Resident Commissioners were tasked with local inspections to identify any potential sanitation problems.[505] Fumigation was performed both before, during and sometimes after the epidemics, mainly during 1832 when the city was ill-prepared and could often do little else. In 1866 a home fumigator was even sold by a local chemist.[506] By 1832, solids like fabric/clothes, furniture and personal items and even human teeth were suspect for the transmission of cholera and efforts instituted to combat those sources.[507] Whether by concern of miasmatic, airborne or contagious, direct contact, the residents near the Canongate Churchyard asked their 8th Ward General Commissioner to insure that all caskets of cholera victims were buried sufficiently deep and always covered with enough soil and rocks.[508] Detailed articles on specific disinfection of solids, again either from their miasmatic or contagionist threat, began to appear from the Pharmaceutical Society of Great Britain's Edinburgh division in 1852 and from the International Sanitary Conference in 1866 (prophylaxis for both preventing a miasmatic 'disengagement of emanations' as well as a contagionist 'germ of the disease' are seen in the latter). Both helped to refocus a failed 'quarantine' effort to what potentially would help. Disinfecting fluids from local chemists persisted from the Edinburgh epidemics from 1832 up to and including 1866 with specific methods to disinfect clothing, sheets, towels and even the diarrhoea from cholera patient treatments noted in the last epidemic's publications (see also Chapter 4).[509] Through the 1866 epidemic, Musselburgh focused on destroying (usually burning) clothes as a possible transmission vector (even paying for 'the articles consumed') and removed dung steads, (although this just resulted in even more filth piling up in the streets) and, as always, removal of usually, innocent pigs from the town limits.[510] At least the Irish were not also blamed this time.

Other Cities (Cholera)," *Scotsman*, 2 Sep 1840, 2; "Dwellings of the Working Classes", 3; "German Traveller's Opinion of Edinburgh," *Scotsman*, 11 May 1844, 2.

[505] "Commission on Police for Water to Wash Closes", 3.

[506] "Musselburgh Fumigation Success," *Scotsman*, 29 Feb 1832, 3; "Cholera - Continued Fumigation", 2; "Decreasing Cases but Still to Keep up Fumigation", 3; "The Chlorine Fumigator," *Scotsman*, 31 Aug 1866, 4.

[507] "Contagion," *Scotsman*, 1 Feb 1832, 3; "Cholera Brought to Edinburgh from Musselburgh on Clothes", 3; "Stop of Beggars Bringing Furniture, Etc into Edinburgh," *Scotsman*, 1 Feb 1832, 3; "Advert - Mineral Teeth Free from Cholera," *Scotsman*, 20 Jul 1833, 3.

[508] "The Canongate Churchyard (Cholera)," *Scotsman*, 27 Dec 1848, 3.

[509] "Pharmaceutical Society of Great Britain (Edinburgh) - Some of the More Important Disinfectants," *Scotsman*, 27 Oct 1852, 4; "Disinfection of Cholera," *Edinburgh Medical Journal* 12, no. 5 (1866), 477-479; "Advert by Beufoy's Chemist for Disinfectant," *Scotsman*, Dec 24 1831, 1; "Advert - Sir W Burnetts Disinfecting Fluid," *Scotsman*, 6 May 1854, 3;"The Cholera - Suggestions by the Royal College of Physicians for Preparation against an Outbreak of Cholera in Edinburgh", 2; "Musselburgh Police Commission - Removal of Pigs and Dungsteads," *Scotsman*, 18 Oct 1866, 2.

[510] "Musselburgh Police Commission - Removal of Pigs and Dungsteads", 2.

Beyond these particular items, system-wide policies and increasing governmental (both local and national) efforts also began to emerge. As noted above, earlier efforts seemed to be focused on the wrong 'solids' as a *Scotsman* article wonderfully points out reporting on the City Council's efforts in removal of 'spider webs, soot flakes, mouse nets and rat warrens' as well as the ever-threatening 'grumphies]' [pigs] although at least the dogs and the chickens were spared.[511] But by the 1840s, much improved sanitary efforts had joined emerging public health ones to include cleaning of filth (and manure) from closes, lanes, drains and sewers as well as a discussion of the need for enough water for citizens to continue their own cleaning efforts. Perhaps even more importantly, these efforts persisted at least in some form through each of the subsequent, cholera epidemics with formal evaluation of the city and regular reports on various Committee's efforts.[512] As societal views about the poor changed, focused efforts were also made for them as well.[513]

As reviewed in Chapter 4 and above, these efforts were not always actually effective against cholera, but the doctors, government officials and the general public were slowly learning (see Table 5-3, next page). During the 1832 and 1848/49 epidemics, official focus was on habits of people as if personal morals and lifestyle was the answer to cholera. At least in 1848/49, vegetables/fruits and attendance 'of the bowels' was mentioned. But in 1853/54, we start to see a change. Suddenly a call to help the poor (instead of blaming them) and thinking about basic needs and, in a very public health and sanitation way, considering 'impurities … whether in the air, water, or soil' are seen. By the 1866 epidemic, the suggestions were basically one-hundred percent public health and with the more correct and sustained effort, cholera could finally be controlled.

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[511] "Board of Health (Ramsay) Reports on Purification of the City", 2.

[512] "Sanitary Improvement of the City (1845)," *Scotsman*, 26 Mar 1845, 5; "Sanitary Reform in Edinburgh", 3; "Public Health of Edinburgh", 3; "Police Commission (Special Meeting)", 3; "Sanitary Conference - Attack of Nurse", 3; "City Parochial Board Special Meeting", 3; "Progress of Purification", 2; "Sanitary Improvement of Towns," *Scotsman*, Nov 21 1849, 2; "Sanitary Improvement of the City (1853)," *Scotsman*, Aug 27 1853, 3; "Police Commission - Sanitary Operations," *Scotsman*, Sep 28 1853, 4; "Police Commission - Drainage of the City," *Scotsman*, Oct 26 1853, 4; "Sanitary Conference," *Scotsman*, Nov 2 1853, 2; "Sanitary Conference with Inspectors," *Scotsman*, Nov 9 1853, 2; "The Police Commission - the Sanitary Condition of the City," *Scotsman*, Nov 16 1853, 4; "Warnings of the Approach & Sanitary Measures", 2; "Fourth Department - Public Health", 6; "Edinburgh Town Council - Sanitary Measures," *Scotsman*, 7 Nov 1865, 4; "Proposed City Improvements", 8; "Musselburgh - Formation of a Sanitary Reform Association," *Scotsman*, 19 Dec 1866, 2; "Editorial - Public Health Improvements", 2; "Precautions against Cholera in Edinburgh", 3.

[513] "Cholera Victim in Damp House", 3; W P Alison, "Observations on the Epidemic Fever of Mdcccxliii in Scotland, and It's Connection with the Destitute Condition of the Poor," (Edinburgh: William Blackwood and Sons, 1843); Troup, "Relief of the Poor in Scotland", 472-477; "Condition of the Poor of Edinburgh (Editorial)", 2; "Causes and Cure of Pauperism", 3; Commissioner, "Inquiry into Destitution and Vice in Edinburgh, Letter Iv", 3; "Relief of the Destitute Poor", 2; "Kirkcudbright Letter to the Editor", 2; "Poorhouses, Their Function, Conditions, and Administration", 3; "Inquiry into Charities and Relief of the Deserving Poor", 2.

Table 5-3. Evolution of Public Health Efforts in Edinburgh Cholera Epidemics[514]

Year	Source	Public Health Recommendations
1832	Edinburgh Board of Health	'… the most essential precaution for escaping the disease is sobriety,' 'in like manner, strict attention to personal cleanliness … and ventilation of dwelling houses, … warm clothing, … regularity of hours of sleep, … keeping as much as possible within doors at night, … and to taking food before going out in the morning.'
1848-49	The Royal College of Physicians	'To avoid excess in the use of spirits …. To observe more than ordinary care in avoiding cold from light clothing or wet; and when the body has been accidently chilled, to restore warmth by artificial means, especially by the warm footbath …. To use as substantial a kind of food as possible; avoiding free indulgence of liquids of all kinds, and the use of uncooked vegetables, unripe, sour, or stone fruit, the poor kinds of small beer, all tart sorts of malt liquor, ginger-beer, and acid drinks generally … To shun long fasts … To attend to the proper regulation of the bowels; and therefore … To check a tendency to looseness of the bowels.'
1854-55	The Cholera Committee of The Royal College of Physicians	'… such a plan of diet as each individual has found by experience to be most conducive to his health,' 'the rich the necessity of supplying those in need with food, fuel and clothing,' 'The extreme importance of removing or counteracting all impurities, whether in the air, water, or soil, as by ventilation, cleanliness, or zinc, cannot be too strongly insisted upon'
1866	Board of Supervision, The Royal College of Physicians	'Keep the person and clothes scrupulously clean. Woolen garments that cannot be washed should be carefully aired,' 'Avoid all tainted meat, fish, or game, and all uncooked vegetables. Ripe fruits and well -cooked vegetables … should be used in moderation,' 'Avoid over-indulgence in spiritous liquors,' 'Take care that the air you breathe in your house … is pure, and frequently renewed.,' 'Inside houses take care that waste-pipes communicating with sewers are properly trapped, and that there is no foul air draining from them into cisterns or water closets.' 'That your water used for domestic purposes is plentiful and good, and especially that it is free from all organic matters', 'The discharges should be mixed with chloride of lime, and removed', 'The soiled linen, clothes, &c., should be thrown into a tub of boiling water …', 'All food intended to be used should be removed from the room in which is a cholera patient', 'Wash the face and hands, and rinse the mouth frequently with water', 'Never eat in, or directly after coming from, the sick room; or without washing the hands and rinsing the mouth', 'Avoid as far as possible the exhalations from the body and discharges of the patient.'

[514] Chambers, "Report of the Edinburgh Board of Health", 4; "The Royal College of Physicians on the Prevention of Cholera", 3; "The Royal College of Physicians - Cholera Advice", 4; "The Cholera - Suggestions by the Royal College of Physicians for Preparation against an Outbreak of Cholera in Edinburgh", 2.

Summary

The 1866, Edinburgh Cholera Epidemic would prove to the city's last. Data available from the Death Certificates enables us to attempt to determine what was prominent in causing the infections and deaths. While *Vibrio cholera* can often be transmitted by infected water sources, mapping of the individual deaths and attempts to find potential cholera-infested, water sources illustrate that water was almost certainly not a major source of the disease.[515] But cholera can also notably be transmitted by air and/or solids. The descriptions of Edinburgh during the 1800s would lend credence to such transmission by contaminated articles and, possibly, by aerosolization of *Vibrio* bacteria, especially in the closed in and poorly ventilated buildings and passageways of the Old Town. Occupations that could offer such opportunities for cholera to travel by direct, solid-to-solid transfer represent over 70% of all the registered deaths. These findings can be interpreted in the context of how the *Vibrio* bacterium infects, how some of the medications employed may have offered some kind of effectiveness, how each of the major, infection theories had support and, finally, how public health and sanitation efforts finally helped stop another epidemic from striking.

So, the question remains … 'Why?' What had Edinburgh done wrong during the prior three epidemics and what did they finally do right in 1866? A possible answer for Edinburgh and, possibly, other towns and cities that were struck and may be struck in the future by *Vibrio cholera* will be provided in the concluding chapter.

[515] As additional evidence against the prominence of water in cholera infections, Taylor, et al. cite a recent study showing water quality efforts alone only reduced diarrhoeal disease by 17% and proper excreta disposal only 36%. When these two efforts were combined with simple hand washing, disease was reduced from 42-48%. Additionally, despite his connection to tainted water, Snow's 'conviction that hand washing with soap could dramatically slow down, or even stop the rapid outbreak of cholera epidemics is often forgotten.' Efforts towards sanitation and not solely water purity are also of prime importance in the battle against any infective disease, including cholera. Taylor et al., "The Impact of Water, Sanitation and Hygiene Interventions to Control Cholera: A Systematic Review", e0135676-e0135676.

Conclusions

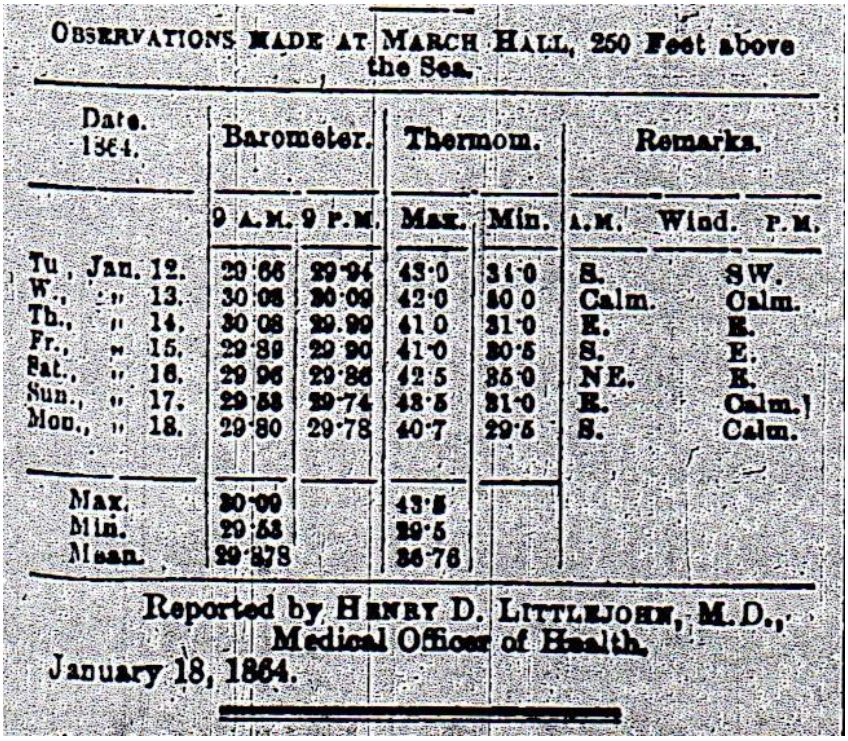
In 1832, the first of four epidemics of cholera (1832, 1848/49, 1853/54 and 1866) struck Edinburgh. After the fourth, no further, significant incidences occurred in the city. Edinburgh, like every other town in Scotland, Great Britain and the world would be faced with the task of trying to stop these deadly cholera attacks that would occur seemingly at random and with no regard to class or station. To examine the response(s) of Edinburgh (or any other location) and their effectiveness it is important to put oneself in the place of those 19th century people. Deaths from these epidemics, mainly of the poor, are often blamed on poor medical care or varying (incorrect?) theories of infection or inadequate public health and sanitation (including tainted water). On top of all of this is a bacterium whose incredible complexities are often unappreciated.

Several different forms of *Vibrio cholera* exist which can change (even becoming 'Non-Culturable' in a laboratory), swap genes and change both internally and internally, become infective or non-infective (to varying degrees) and, when conditions are not correct, can 'turn off' and hide away, form a protective film and keep track of its external environment to see when it needs to leave. Multiple molecules, not just CT, and structures on the bacterium help to decide when to do what and how to do these changes. The emerging understanding of non-O1/O-139 types also offers a tantalising possibility … 'Was "British cholera" the non-O1/O139 type and "Asiatic cholera" the true O1 type?' If so, British/Edinburgh physicians who had not served in India and were, instead, used to a milder 'British cholera' disease would have not appreciated the seriousness of the epidemics they were going to face and how to treat it effectively. Those who had served in India and seen 'Asiatic cholera,' including the many Edinburgh-based physicians who were writing about their cholera experiences, would have more insight but may not have understood that these infections were not the 'British cholera' type until too late.

The changes by *Vibrio* are often due to the bacterium's environment and help it decide where to be at a particular time, whether that be in the water or in a host such as man but also a collection of other animals and plants. Edinburgh was, in fact, perfectly set to suffer *Vibrio* infections from several, different water-borne sources. A number of water and non-water organisms potentially harbouring cholera could easily have been lurking in the fresh, brackish and salt water (and the varying salinity as seasons and tides changed) that are all around Edinburgh. Despite Snow's work, *Vibrio* probably did not come directly from a water source but, instead, could have been in the seafood that was ever present in the Edinburgh/Leith area. There is also growing evidence that *Vibrio* can survive outside of water making transfer from solids a real possibility, be that on the

shoes, clothes, blankets, carts, hands or wares for sale of anyone who walked the filthy back (and front) streets and closes of the Old Town and even the New Town.

The link between weather and season would also be important and was, in fact, considered by several people of that time.[516] Temperature changes, in particular, would have frozen or thawed water in the town. In fact, Littlejohn published temperature, air pressure and even elevation in his 1865 Sanitary Report, Tables II – VI (pp 8-55) and also published weekly values of air pressure, temperature, wind direction and general weather conditions in his Health of the City reports in the *Scotsman* (Figure C-1).[517] He just did not know why they may have been important as the marked temperature changes experienced over a year in Edinburgh may have also helped *Vibrio* 'hide' via its various mechanisms of adaption and survival, including when it is time to be virulent and when it is time to not.



OBSERVATIONS MADE AT MARCH HALL, 250 Feet above the Sea.

Date. 1864.	Barometer.		Thermom.		Remarks.		
	9 A.M.	9 P.M.	Max.	Min.	A.M.	Wind.	P.M.
Tu., Jan. 12.	29·66	29·96	43·0	31·0	S.		SW.
W., " 13.	30·08	30·09	42·0	30·0	Calm.		Calm.
Th., " 14.	30·08	29·99	41·0	31·0	E.		E.
Fr., " 15.	29·89	29·90	41·0	30·5	S.		E.
Sat., " 16.	29·96	29·86	42·5	35·0	NE.		E.
Sun., " 17.	29·58	29·74	43·5	31·0	E.		Calm.
Mon., " 18.	29·80	29·78	40·7	29·5	S.		Calm.
Max.	30·09		43·5				
Min.	29·58		29·5				
Mean.	29·878		36·78				

Reported by HENRY D. LITTLEJOHN, M.D., Medical Officer of Health.

January 18, 1864.

Figure C-1. Example of Standard Observations Reported Each Week by Littlejohn.[518]

[516] "Cholera Brought on by Unfavorably Hot Weather", 2; "Suggestion of Cold, Spring Winds Being Cause of Cholera", 3; "Weather Effects on Cholera (Dr Stark)", 3; "Cholera Deaths - Effects of Low and High Temperatures (Registrar General)", 2.

[517] "Cholera Deaths - Effects of Low and High Temperatures (Registrar General)", 2; Laxton and Rodger, *Insanitary City : Henry Littlejohn and the Condition of Edinburgh*.

[518] H.D. Littlejohn, "Health of the City, 18 Jan, 2864," *Scotsman*, 22 Jan 1864, 3.

Throughout the history of cholera in Edinburgh we see staunch supporters but also deniers of all the theories of infection. The humours still seemed important but gradually faded as science and medicine evolved. Chadwick's ideas, seemingly supported by direct observations and also by prominent medical authorities, seemed to show that 'Pauperism and disease were alike gratuitous and preventable.'[519] Indeed, Chadwick (and colleagues) felt that only large-scale sanitary improvement to improve miasma was the only way to care for the poor.[520] Miasmatic theory was still very much alive. Vying for opposing views were William Pulteney Alison and contagion colleagues who felt poverty was the root of disease and who had spent a career studying fevers, contagious disease and how to prevent them. They felt they had to stop the direct transmission by the isolation and quarantine of infected person(s) and items as well as cleaning of those infected areas, increasing wages to improve the poor's' standard of living and improving housing. But why did these not seem to work? Why could some be in direct contact with a 'contagious' patient and not become ill. Importantly, where were these contagious elements?

Perhaps more important is what was each group of theorists going to do about the problem? By the very definition of miasma, Chadwick also felt that any discussions of isolation or quarantine were fruitless versus improving water supplies, the general environment and sanitation. In direct contrast, Alison wrote, 'It is not asserted that destitution is a cause adequate to the production of fever … nor that it is the sole cause of its extension. What we are sure of is, that it is a cause of the rapid diffusion of contagious fever [and] that its existence may always be presumed, when we see fever prevailing in a large community to an unusual extent.'[521] The only thing that all camps could agree on was increasing nutrition and improving building regulations.[522]

So, which is correct? Actually, an isolated view of humours or miasma or contagion misses the point. Perhaps a modern name for keeping the humours in balance is simply 'staying healthy' and, just as today, that helped reduce infections and the potential of death from cholera disease. So, too, when we smell the undeniable odour of manure freshly spread on a field, we are not physically touching it, but we are being exposed to it. Aerosolisation, the conversion of a physical substance to small, airborne particles happens in some form to every solid as they erode or break down or, as the miasmatists would suggest, decay and/or decompose. There was, indeed, miasma and it correctly pointed towards places where *Vibrio* may await, and these smells and those surroundings weakened

[519] Pelling, *Cholera, Fever and English Medicine, 1825-1865*, 10-11.
[520] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 174.
[521] Alison, *Observations on the Management of the Poor in Scotland, and Its Effects on the Health of the Great Towns*, 19.
[522] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 167-168.

the individuals so their innate and their external defences were overcome. Finally, there was contagion as *Vibrio* could be passed by contaminations; in these possibly deadly contaminations lurked the bacteria *Vibrio cholera* but for most of the 1800s, no one could argue that point. With multiple theories being proposed and seemingly supported regarding cholera's infectivity and a bacterium that is not only difficult to characterise but that could change at any time and in a variety of ways, one can appreciate what Edinburgh physicians and scientists were dealing with and how their efforts could be seen to be in vain. More would have to be understood and done in order to stop the Edinburgh cholera epidemics. But, slowly, through each epidemic, lessons were being learned.

So, with complicated, multiple bacteria and complicated, multiple theories, 1800s doctors, nurses and other medical staff in the city were trying learn how to treat the patients. With a cursory look at these treatments, it is easy to criticise their 'quack' treatments unless one understands both the limitations they faced and the fact that there was some validity to their use. Although anyone could see that a cholera patient was losing fluid via the copious, watery diarrhoea, the exact means of treating that was still not apparent. Indeed, even in modern medicine, diarrhoea and vomiting still represent two major 'good' ways the body can rid itself of something it does not want inside. It is just when the loss of fluids/water becomes so great that these physiological processes become dangerous. For cholera patients, why would one want to give water when some evidence seemed to point to water as the possible culprit. And why would adding salts to the water make any difference to only a few when the understanding of ions in the human body was just in its beginning. As one, honest, Edinburgh physician wrote, 'We are staggered by the feeble influence of our remedies in cholera.'[523]

But throughout Edinburgh's four cholera epidemics, an overriding theme of cholera treatments does emerge. And as one cholera epidemic turned into another, these treatments were evaluated for risks and benefits, many stopped and something of a simplified and accepted treatment strategy was adopted. As the regular, sometimes potentially harmful, medicinal use of alcohol, calomel, ammonia, colocynth, turpentine and castor oil gradually faded, doctors in Edinburgh were not necessarily killing the bacteria. With a medical bag filled with some opium and a small collection of mainly plant derivates and the general public and city officials looking for any type of results, these doctors were usually only treating the symptoms and, reportedly, with some successes.

[523] Gaskell, "An Attempt to Account for the Various Methods Adopted in the Treatment of Malignant Cholera", 76.

There is also another reason why these varying medical efforts were important to at least try. Whether an academic or a small-town GP, experienced in India or simply Scotland or a contagion or miasma proponent, all physicians used the same basic treatments to help their patients. Why? Because they did not have anything else to offer. Despite progress in the 1800s, there was a limited selection of treatments and, since no one yet knew that *Vibrio cholera* existed and caused the disease, treatments were predominately symptomatic and intended to try to keep the patient alive while they, hopefully, got better. The only real bias seen amongst the varying publications is that most physicians/authors felt that their combination was the one that worked. Given the bacteria's multitude of ways to change, adapt (including to antibiotics), hide and emerge when it wanted, these means may have been the best that could ever be done against cholera. And, if we believe any of the copious reports of Edinburgh and other physicians, they absolutely saw patients responding positively to these treatments and, although they may have not understood quite why, they definitely wanted to and did continue them.

The use of 'laudanum' and/or opium mimics the 1% morphine given by modern-day physicians for pain; however, side effects of opiates to include constipation (by decreasing the intestines' motility) and reduction of breathlessness and anxiety that would have helped with the pain and their side effects also helped with the cramping, diarrhoea, breathlessness and anxiety experienced by many cholera sufferers. Strange concoctions of medications including mustard, camphor, cinnamon, turpentine, magnesia, bismuth, castor oil and even judicious use of alcohol could have reduced the inflammation that is such a part of the cholera disease and, along with it, some of the pain. The ideas behind the use of opium, the many anti-inflammatories actually did make sense, even though that sense was probably still not known to the treating doctors. 1800s suggestions to eat a small amount of 'a bit of unleavened oat bread (or wheat or meal or toasted barley)' is the modern-day equivalent of a bowl of porridge or a 'digestive biscuit' for an upset stomach. The 19th century offerings of cognac, wine or other 'stimulants' to cholera patients is nothing much more than the dram of whisky or a brandy that is still a common 'treatment' for ailments today due, in part, to its partial 'anaesthetic' qualities.[524] Some of these same solutions along with blood-letting and leeches actually could have helped to reduce fluid losses and could get blood flowing both by mechanical

[524] Christie, "Observations on the Nature and Treatment of Cholera, and on the Pathology of Mucous Membranes (1828)"; Douglas, "A Cheap and Effectual Medicine to Cure the Cholera, or Colick. The Gentleman's Magazine and Historical Chronicle"; Gibbs, "Observations on Cholera" In the time of Dr. James Young Simpson's experiments with chloroform as an anaesthetic in childbirth, some physicians were using gases such as diethyl ether, nitrous oxide as well as chloroform for cholera patients as early as 1831 in the UK and France. See E. H. Conner, "Anesthetics in the Treatment of Cholera," *Bulletin of the History of Medicine* 40, no. 1 (1966), 56-58. One instance of the use of chloroform for cholera was found in the Scotsman. See "Chloroform in Cholera", 3.

action but also by leeches thinning the blood.[525] In a century that started with a continued belief in four humours and miasmatic theories of something bad in the environment, why would a physician not want to get out whatever poison had found its way into a patient by blood-letting while simultaneously lessening the effects of fluid loss. Finally, anything that warmed a cold patient could have only done good, be it a simple covering, warm flannel, turpentine, mustard poultice, hot air, steam bath, massage or, again, alcohol is just like a modern hot water bottle or warm blanket. [526]

Perhaps most importantly, one needs to compare 19th century to modern-day, cholera efforts. The seventh cholera epidemic is still ongoing and has been since 1961, infecting 2.9 million people and killing about 95,000 of them a year.[527] Cholera still has not been defeated in the world. Supportive, not curative, care like fluids and symptomatic treatments are still the mainstay and, if available, antibiotics (although resistance is always a concern and logistical factors can be inhibitive). Should 1800s doctors and their treatments be referred to as 'benevolent homicide', 'quack remedies' or 'poisons' or the fact that those treatments were not actually curative? Perhaps only if the same criticisms are levelled at today's, very similar medical treatments.

Besides emerging scientific theories and medical treatments, other things were contributing to Edinburgh's fight against cholera. Starting in the late 1700s but increasing particularly in the 1850s and 60s, society realised that helping each other was good for all and that more centralized efforts, including governmental involvement, were needed. The idea that central oversight by a government was not only desired but essential emerged slowly but surely. Legislation leading the increasingly supportive British (and Scottish) public to this new (albeit old European) ideal passed in stages. Sometimes these stages were incomplete or needed to be reversed and/or altered, but progress was progress. These changes helped lead to better water, sewerage and drainage, reduced overcrowding, decent housing and the consistent cleaning of public (and private) areas. A specifically identified bacteria in the 1880s helped to cement those efforts. The result was less endemic and epidemic disease and improved health for all.

Dingwall writes specifically about the *status quo* of Scotland at the beginning of Queen Victoria's reign as,

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[525] Brian Krans, "What Is Leech Therapy?," https://www.healthline.com/health/what-is-leech-therapy, Accessed 15 Jul, 2022.

[526] "Advert for Hot Air Bath", 1; "Symptoms of Cholera in Edinburgh (Case Report)", 3; Chambers, "Report of the Edinburgh Board of Health", 4; Gibbs, "Observations on Cholera", 395-398; Christie, "Observations on the Nature and Treatment of Cholera, and on the Pathology of Mucous Membranes (1828)", 418-421.

[527] WHO, "Disease Outbreak News; Cholera - Global Situation (1 Feb, 2023)".

> … the full spectre of urban squalor was just beginning to be apparent; civic pride and civic government were solidly established but not yet entirely effective. Scotland was in the throes of empire-building but also of cholera and other devastating disease; hospitals were more numerous but no more able to cure than they had been for half a century; doctors and surgeons still trained. in a piecemeal and badly regulated fashion; operations were performed without anaesthetic and post-operative shock and infection claimed many lives; the Napoleonic wars were within living memory; and the economic situation was not propitious. [528]

In fact, the very idea of 'public' health – health policies designed for the masses and not for the individual and focusing on clean air, water as well as streets and houses was 'not even contemplated until the 1840s, and not before the second half of the nineteenth century were some of the worst aspects of the urban problems effectively tackled.'[529]

Be it the criticised Auld Reekie or the enlightened Athens of the North, Edinburgh would go forward and backward in its efforts to control cholera. As infection theories came and went, flannel would come into and out of fashion, cholera mists would be feared but also studied and quarantine of ships and also people would be tried and then halted. All would partly succeed but ultimately fail because the thing that needed to be separated was still not known and an understanding of what causes infection was still lacking (Figure 2-2). Despite the work of Snow, there would be no, true Broad Street pump in the city despite the smell and appearance of the Water of Leith, confounding the contagionists.[530] Instead, solids that could be passed from person to person, especially in particular occupations, would appear to be the primary means for the transmission of Edinburgh cholera infection. All the above would embroil the city in confusion, making cholera difficult to identify, track, treat and avoid. We can see the Edinburgh City Town Council and the Edinburgh public trying to interpret all of the varied information and make sense out of it. The Town Council and the private citizens would, in turn, respond, often in newspaper articles or pamphlets, with their take on the disease and the proper path forward. We see good things even in the early 1830s like cleaning of the city, comments on the poor state of the Old Town and charitable efforts by groups and individuals but also less useful efforts to banish the ever-culpable pigs from the city and burn 'bones, and hoofs, and any kinds of horn' to prevent the cholera infection, refusals to help set up cholera hospitals and much emphasis on alcohol as the one and only cause of cholera.[531]

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[528] Dingwall, *A History of Scottish Medicine: Themes and Influences*, 205.
[529] Devine, *The Scottish Nation, 1700-2007*, 166-167.
[530] Shapter, *The History of the Cholera in Exeter in 1832*, 75-76 & 90-99.
[531] "Precautions against Cholera", 3; Chambers, "Report of the Edinburgh Board of Health", 4; G. L. Roupwll, Field, H., Babington, B. G. & Ridout, "The Cholera - Preparation of the City," ibid, Nov 16, 3; "The Cholera - State of the Old Town and Call for All to Clean up City," ibid, Dec 14, 3; "Donations at Portobello Church for

Rosenberg writes, often 'Disease could not be cured: it must – and could - be prevented through cleanliness and sanitation.' Modern-day, infective disease such as HIV, flu, swine flu and, most recently, Covid-19 (and the other, very recent, coronavirus variants SARS and MERS) remind us of that grim fact. So, while cholera is almost certainly endemic to the world we live in, progress has been definitely made and the fact that this and other, modern, infective diseases cannot be conquered but only contained is now increasingly accepted. Like its younger cousins, cholera still ravages parts of the world today.[532] When it does strike, public health is applied, sanitation efforts are employed and oral or intravenous versions of O'Shaughnessy and Latta's fluids are still the mainstay of treatment … until the next outbreak occurs.

What stopped epidemic cholera in Edinburgh and every other place in Britain and the world? It was not just the discovery of *Vibrio cholera*; Koch would not prove the bacterium's existance until roughly twenty years after Edinburgh's final epidemic. It was not just an understanding of how this complicated bacterium actually infects; that effort is still ongoing today and parts of all the 19th century theories actually may be contributory. It was not just modern-day advancements in the treatment of the disease; the same treatments that eventually emerged during the 19th century are basically the same used today. It was not just the emergence of public health, now provided by a central governmental agency instead of local and/or religious ones, that provided clean and sufficient water to the homes or proper sewerage, improved housing, diet, general medical care or even a changed attitude of the upper and middle classes towards the poor and working classes. Each of these has their individual places in any fight against *Vibrio* infection be it in Edinburgh, Sutherland, Birmingham, Exeter or anywhere else in the world. Ultimately, though, it was the necessary, coordinated, multi-factorial combination of scientific knowledge and infective theory, medical treatments and public health efforts and governmental and societal responses all with public support progressing at different rates over thirty years and four, horrid visits by the *Vibrio* bacterium until success was finally found. It is this same combination that still forms the background that helps the modern world control but not conquer cholera but also many, many other epidemic and pandemic infections. Cholera's role in the ability to control these diseases should not be dismissed.

Poor of Village (Cholera)," *Scotsman*, Nov 30 1831, 3; "Nicholson St Apothacary and St James Square Whitewasher", 3; "Banishment of Pigs", 3; "Burnt Bone, Hoof or Horn Mitigatres Cholera", 3; "City Workhouse Charity and Lord Provost Meeting to Establish Cholera Hospital," *Scotsman*, Dec 24 1831, 3; "Ardent Spirits - Cholera," *Scotsman*, Dec 18 1831, 4.

[532] On 23 Sept, 2023, the following article was published in Lancet illustrating both the modernity and importance of continued cooperative efforts to fight infective diseases on a world-wide basis, Matthew M. Kavanagh et al., "Increasing Compliance with International Pandemic Law: International Relations and New Global Health Sgreements," *The Lancet (British edition)* 402 (2023), 1097-1106.

Appendices

Appendix 3-1. Varying Uses in Edinburgh of Alcohol for the Treatment of Cholera[533]

Source	Recommendation
A Cheap and Effectual Medicine to Cure the Cholera, or Colick. (1745)	'afterwards a draught of wine mix'd with an equal quantity of the decoction [laudanum, opium and cinnamon]'
On the Duration of Fatal Cholera (1827)	'warm brandy and water'
Hints Respectful of Cholera with Directions Which May be Most Safely Followed (1830)	'He should drink hot brandy and water, or hot water with a teaspoonful of *sal volatile'* [ammonium carbonate in alcohol][534]
Symptoms of Cholera in Edinburgh (1831)	'a common wine glass full of Cognac brandy, mixed with double the quantity of water'
Report of the Edinburgh Board of Health (1831)	'a table-spoonful occasionally of warm spirits and water, or strong spiced wine.'
Observations on Cholera (1831)	'malt liquor, in lieu of which I add two table spoonsful of Cognac to a proper quantity of boiled water, and take a little port wine'
Letter to Sir Henry Halford on the Tendency of the Proposed Regulations for Cholera, with Observations as to the Nature of the Disease, and the Course to be Followed Immediately on 3; its Appearance in a Family (1831)	'six tablespoonsfuls [sic] of brandy [mixed with laudanum]
Suggestions Submitted to the Medical Practitioners of Edinburgh on the Characters and Treatment of the Malignant Cholera (1832)	'warm wine and water, or warm spiced wine'
Plague. Cholera (1832)	'a wine glass full of brandy or whiskey [sic], mixed with hot water, will be useful'
Remedy for Cholera (1848)	'brandy and water by spoonfuls'

[533] Douglas, "A Cheap and Effectual Medicine to Cure the Cholera, or Colick. The Gentleman's Magazine and Historical Chronicle", 91; Tatham, "On the Duration of Fatal Cholera", 71; Boyd, "Hints Respecting Cholera: With Directions Which May Be Most Safely Followed When Medical Aid Cannot Be Immediately Obtained"; "Symptoms of Cholera in Edinburgh (Case Report)
", 3; Chambers, "Report of the Edinburgh Board of Health", 4; Gibbs, "Observations on Cholera", 397; Editors, "Letter to Sir Henry Halford on the Tendency of the Proposed Regulations for Cholera, with Observations as to the Nature of the Disease, and the Course to Be Followed Immediately on Its Appearance in a Family", 832; Abercrombie, "Suggestions Submitted to the Medical Practitioners of Edinburgh on the Characters and Treatment of the Malignant Cholera ", 10; "Plague, Cholera", 8; "Remedy for Cholera", 272.

[534] CollinsDictionary, "Sal Volatile", Accessed 1 Sep, 2022.

Appendix 3-2a. Varying Uses of Calomel by Edinburgh Physicians for Generic Uses[535]

Source	Recommendation	Notes
Dr. Steel from Craighill (a part of southwestern Edinburgh), 1832	'He confines himself to calomel and colocynth.'	'discovered the pernicious effects of camphor, opium, and other stimulants.'
Abercrombie, 1832	'one, or at most two grains of calomel, with from a quarter to a half grain of opium, sometimes combined with one or two grains of camphor In cases of extreme collapse, large doses of camphor have been recommended, as ten or fifteen grains, combined with ten grains of calomel, and ten drops of any of the essential oils; I know not with what success.'	… to be repeated every hour, or two hours … [and] small doses of calomel and opium may be repeated, at longer, intervals, as the circumstances may require.'
A reader from London but writing in the *Scotsman*, 1832	'small doses of calomel'	
Dr. JS Recommendations for Cholera Treatment	'large dozes [sic] of calomel'	'I have never seen ill effects to arise from the quantity of calomel taken'
Advert, Dr. Ayre on the Malignant Cholera	'given in minute and frequently repeated Doses'	'Researchers illustrative of the great efficacy of Calomel in the treatment of Malignant Cholera'

[535] Lizars, "Cholera Asphyxia as It Appeared in 1832 and in 1848" 62; Abercrombie, "Suggestions Submitted to the Medical Practitioners of Edinburgh on the Characters and Treatment of the Malignant Cholera ", 7, 12-13; "Successful Treatment of Cholera ...,1832, 3; Chambers, "Report of the Edinburgh Board of Health", 4; J.S., "Dr. J S Recommendations for Cholera Treatment", 3.; "Publication - Dr Ayre 'on the Malignant Cholera'", 1.

Appendix 3-2b. Varying Uses of Calomel by Edinburgh Physicians with Focus on the Liver[536]

Source	Recommendation	Notes
Dr. Miller, 1831	'Calomel and Laudanum should be given in large doses at the commencement' with the calomel specifically to be 'put on the tongue, mixed with a little sugar, and swallowed dry.'	'Calomel is the medicine which produces the desired change in the functions of the liver. That organ in this disease secretes no bile. When this medicine begins to act, and bile appears in the evacuations, the patient is then safe, but not till then.'
Gibbs, 1831	'Small dose of calomel, with compound extract of colocynth (and aloes by some) … Our formula for the exhibition of calomel is two grains of calomel with a quarter grain of opium every other hour.'	'given to induce a secretion of bile, and to rouse the chylopoietic organs when nausea has subsided.'
Lizars, 1832	'administering calomel in three or four grain doses, combined with five or ten grain doses of aloetic or colocynth pill mass, every three hours'	'until the alimentary canal is thoroughly cleansed of the undigested food and accumulated non-bilious feces [sic], and until the stool are perfectly bilious.'
Dr. JS, 1832	'large dozes [sic] of calomel'	and 'I have not in any instance seen ill effects to arise from the quantity of calomel taken, it has a direct tendency to allay vomiting, and to excite the suspended functions of the liver and kidneys, none of which effects are likely to be attained by castor oil or laudanum.'
Greenhow, 1834	'administering every two or three hours a pill, containing a grain of calomel and a minute dose of opium'	'The calomel will act upon the liver, and the first flow of bile will produce a [bowel] motion.'

[536] Miller, Cholera Morbus. Observations on Cholera; Gibbs, "Observations on Cholera", 396; Lizars, "Cholera Asphyxia as It Appeared in 1832 and in 1848", 62; J.S., "Dr. J S Recommendations for Cholera Treatment", 3; Greenhow, "Observations on the Nature and Treatment of Cholera", 358.

Appendix 3-2c. Varying Uses of Calomel by Edinburgh Physicians with Focus on the Intestines[537]

Source	Recommendation	Notes
Tatham, On the Duration of Fatal Cholera (Sept 1827)	'one of a few pills, each containing two grains of extract of opium, and four grains of calomel, might be taken.'	'improving the secretions, and dislodging the concrete mucus from the internal coat of the bowels.'
Lizars, 1832 (note that Dr. Lizarz also felt the liver was involved (see Table 3b above))	'administering calomel in three or four grain doses, combined with five or ten grain doses of aloetic or colocynth pill mass, every three hours'	'until the alimentary canal is thoroughly cleansed of the undigested food and accumulated non-bilious feces [sic], and until the stool are perfectly bilious.'
Craigie (intestinal disease), 1833	Varying doses of calomel depending on whether or not the cholera symptoms were mild, moderate or severe.	'In several instances, in which there was less of the epigastric weight, and chiefly frequent profuse alvine [i.e., intestinal] evacuations, the exhibition of castor-oil, the colocynth pill, and calomel, alternated with opiates, was adequate to remove the disease.

[537] Tatham, "On the Duration of Fatal Cholera", 71 & 73; Lizars, "Cholera Asphyxia as It Appeared in 1832 and in 1848", 62; Craigie, "Observations, Pathological and Therapeutic, on the Epidemic Cholera, as It Has Prevailed in Edinburgh and Its Vicinity", 50-54, 56.

Appendix 3-4 (Part 1). Varying Uses in Edinburgh of Opiates for the Treatment of Cholera[538]

Source	Recommendation
A Cheap and Effectual Medicine to Cure the Cholera, or Colick (1745)	'a pill of opium, to the quantity of two thirds of a grain to a grown perſon, increaſing or diminiſing the dose according to the age or ſtrength or the patient.' and 'if the patient is convulſed, and the extream [sic] parts cold, then it is proper to give a ſtrong doſe of liquid laudanum, becauſe it has its effect ſooner than opium' and 'To prevent a relapſe, which the patient is not able to bear, it will be proper to repeat the opiate, in a moderate quantity, for ſome days, morning and evening.' [sic]
On the Duration of Fatal Cholera (1827)	'He took from me a mixture of laudanum, liquor ammoniae acetate, and camphor' and 'In case vomiting should return … one of a few pills, each containing two grains of extract of opium, and four grains of calomel, might be taken.' and 'Opium, accompanied with camphor, ammonia, and similar cordials, generally affords agreeable warmth and comfort to the stomach. Indeed, the first is often most felicitous in checking the train of morbid action, and recovering the exhausted frame from tremor and agitation.'
Letter to Sir Henry Halford on the Tendency of the Proposed Regulations of Cholera (1831)	'and take a pill of two grains of calomel and one grain of opium, to be repeated every two or three hours' and 'In case of his complaining of pain, from twenty to forty drops of laudanum may be given; should, however, the pain be accompanied with spasms, the dose may be thirty to fifty drops.'
Hints Respecting Cholera: With Directions Which May Be Most Safely Followed When Medical Aid Cannot Be Immediately Obtained (1830)	'Laudanum is usually to be found in every house …. A tea-spoonful of laudanum, added to six table-spoonsfuls of brandy, may be prepared … and one table-spoonful of this mixture may be administered in half a wine glass of hot water every quarter hour'
Cholera Morbus: Observations on Cholera (1831)	'Calomel and Laudanum should be given in large doses at the commencement' and 'The tincture of opium should be given with a few drops of water, only to prevent it from being rejected by the stomach'
Report of the Edinburgh Board of Health (1831)	Preparation: 'Take of opium twenty-four grains' camphor one drachm; spirit of wine and conserve of roses …' Treatment: 'without delay, No 1 [opium pill as above', with 60 drops of laudanum, in half a wine glassful of cold water … Repeat two tea-spoonfuls of the Mixture, with 30 drops of laudanum, every half hour, if the first doze [sic] fails to relieve…. But after the vomiting and cramps ease, the Mixture or Pills must not be repeated without medical advice....
Letter to the Editor from Dr. JS (1832)	'small dozes [sic] of opium'

[538] Douglas, "A Cheap and Effectual Medicine to Cure the Cholera, or Colick. The Gentleman's Magazine and Historical Chronicle", 91; Tatham, "On the Duration of Fatal Cholera", 71-72; Editors, "Letter to Sir Henry Halford on the Tendency of the Proposed Regulations for Cholera, with Observations as to the Nature of the Disease, and the Course to Be Followed Immediately on Its Appearance in a Family", 832-833; Boyd, "Hints Respecting Cholera: With Directions Which May Be Most Safely Followed When Medical Aid Cannot Be Immediately Obtained"; Miller, *Cholera Morbus. Observations on Cholera*; Chambers, "Report of the Edinburgh Board of Health", 4; J.S., "Dr. J S Recommendations for Cholera Treatment", 3.

Appendix 3-4 (Part 2). Varying Uses in Edinburgh of Opiates for the Treatment of Cholera[539]

Source	Recommendation
Suggestions Submitted to the Medical Practitioners of Edinburgh on the Characters and Treatment of the Malignant Cholera (1832)	'pills containing one, or at most two grains of calomel, with from a quarter to a half grain of opium, sometimes combined with one or two grains of camphor – these are to be repeated every hour, or two hours' and 'The operation of this should probably be followed by another moderate opiate … after which the small doses of calomel and opium may be repeated, at longer, intervals, as the circumstances may require.' and 'a moderate teaspoonful of laudanum may be added, but the laudanum must be repeated with caution [in the later stages of the disease]'
Reading of paper on Cholera by Professor Lizars to Medico-Chirurgical Society (1832)	'Suggestions from his experience in the use of "large and repeated dozes of opium or laudanum."'
Successful Treatment of Cholera (1832)	'Small doses of calomel and opium'
Observations, Pathological and Therapeutic, on the Epidemic Cholera, as it has Prevailed in Edinburgh and its Vicinity (1833)	'ten grains of calomel, and half a grain of opium; and to repeat this dose at the end of two or three hours, according to circumstances' and 'where the vomiting and purging and cramps are violent or frequent, but not of long duration there is no difficulty; for a blood-letting of twenty or twenty-four ounces, followed by ten grains of calomel and half a grain of opium, repeated after six or eight hours, will infallibly remove the disease, if anything will.' and 'In milder cases, the usual practice which, after many trials, was found to be most successful, was to exhibit, either at once 20 grains of calomel, and one grain of opium, or 10 grains of calomel, and half a grain of the drug, at the interval of one, or two, or three hours, according to the state of the stomach.'
Plague. Cholera (1834)	'from 20 to 40 drops of laudanum may be administered' and 'Should the symptoms not abate in a hour, or an hour and a half, [the] laudanum, may be repeated.'
Observations on the Nature and Treatment of Cholera (1835)	'In the first stage of diarrhoea, little difficulty is generally experienced. The Mistura Cretae cum Tinct. Opii, a pill at bed- time, containing blue pill and opium' and 'When, however, the evacuations have become pale-coloured, and vomiting has set in … it is then necessary to keep the patient in bed, administering every two or three hours a pill, containing a grain of calomel and a minute dose of opium'
Remedy for Cholera (1848)	'The ingredients employed are, asafoetida, opium, and black pepper pulverised. The dose for an adult is from a grain and a-half to two grains of each; if pure, one and a-half grains will be sufficient. These ingredients are to be made into a pill. The dose should be repeated every half or three-quarters of an hour, according to the urgency of the symptoms, until they have been subdued. From three to five doses have generally been sufficient for this, although as many as eight have been given before health has been restored in bad cases.'

[539] Abercrombie, "Suggestions Submitted to the Medical Practitioners of Edinburgh on the Characters and Treatment of the Malignant Cholera ", 7; "Meeting of Edinburgh Medico-Churchigal Society", 2; "Successful Treatment of Cholera ...", 3; Craigie, "Observations, Pathological and Therapeutic, on the Epidemic Cholera, as It Has Prevailed in Edinburgh and Its Vicinity", 49-50 & 54; "Plague, Cholera", 8; Greenhow, "Observations on the Nature and Treatment of Cholera", 358; "Remedy for Cholera", 272.

Appendix 3-4 (Part 3). Varying Uses in Edinburgh of Opiates for the Treatment of Cholera[540]

Source	Recommendation
Extra-Professional Services in Connexion with Cholera … (1854)	'Catechu, tannin, gallic and sulphuric acids, haematxylon, and the acetate of lead, with, and without opium.'
The Royal College of Physicians – Cholera Advice (1853)	'Previous to the arrival of a medical attendant, some of the medicines at other times used for checking diarrhoea should be taken .... for example, the chalk mixture; the compound of cinnamon powers; or the compound chalk powder with opium, in doses of from twenty to forty grains for an adult.'
Traditional Medicine and Food Habits for Prevention of Cholera (1850s)	'During the fifth decade of the nineteenth century, Dr. J. Collins Browne, an army surgeon worked in British India, invented a patented medicine Chlorodyne, a compound of tincture of chloroform and morphine for the treatment of cholera patients'

[540] Adams, "Extra-Professional Services in Connexion with Cholera in the Third Medical District of the City Parish, Edinburgh, 28th August to 30th November 1854.", 22; "The Royal College of Physicians - Cholera Advice", 4; Mukhopadhyay and Ramamurthy, "Chapter 2. Asiatic Cholera: Mole Hills and Mountains", 18.

Appendix 3-5 (Part 1). Cholera-Related, *Scotsman* Advertisements (1831-1869)[541]

Date/Source	Item Being Sold	Description
17 Dec 1831/ Chemist and Druggist, John McMillan, 69 George's St	Dr. Gregory's in a fluid form	'Agreeable to take, and the dose more easily regulated, the Medicines recommended in Cholera by the Edinburgh Board of Health'
7 Jan 1832/Apothecaries' Hall, North Bridge	Extracts of Sarsaparilla and Ginger	'Amongst Other Preparations Recommended to the Public Attention'
11 Jan 1832/Scott & Orr Chemists, No 100 S Bridge St & 69 Princes St	The medicines recommended by the different Boards of Health. Have on hand, carefully put up in Sets, in a box for carriage, with full Printed Directions for use.	'Would particularly recommend Labarraque's Chlorides of Soda and Lime … on account of their cleansing, purifying, and disinfecting properties'
8 Feb 1832/Archibald Young, Surgical Instrument Maker and Cutler to his Majesty, 40 S Bridge St.	Read's Patent Domestic Machine … opens the Bowels instantly without inconvenience or uneasiness, and removes Indigestion, Flatulence, Spasms, Bilious Complaints, Piles, Fistula, and other Disorders arising from a confined habit of body,	'The visitation of Cholera increases the necessity for this Apparatus, which should be in the possession of every family, it being ascertained that the use of Purgative Medicines predisposes the Bowels equally with Costiveness, to the attacks of this dreadful disorder'
3 Aug 1833/Family Medicine Warehouse, South St and St Andrew's St, J Barker & Co, Surgeons, Chemists and Druggists	Antibilious Pills	'Which will be found extremely serviceable in all complaints, whether arising from a redundancy, or a vitiation of the biliary secretions, and an excellent preventative of, an antidote against, the Bilious Cholera, which always prevails at this season of the year'
27 Aug 1836/The Hygeian Agent, 31 S Bridge St	Morrison's Medicine	'Cures a number of illnesses, including cholera'
3 Sep 1836/Various Wholesale and Retail Chemists	Concentrated Essence of Jamaica Ginger	'A certain Cure and Preventative of all Nervous Complaints, Spasms, Gout, Rheumatism, &c. The essence proved, in numerous cases during the prevailing epidemic of 1832, to be decidedly successful in cases of Cholera, or spasms of the Stomach and Bowels.'
12 Aug 1837/SJ Peddie & Co, Edinburgh,	Improved Universal Vegetable Pills	'Cure for all curable diseases, even Consumption, Fever, Plague, Cholera, Dropsies, Inflammation, ….'

[541] "Advert for Dr Gregory's Stomacich [Sic] Mixture, Leeches and Camphorated Paper", 1; "Scott & Orr Chemist Advert (Chlorides of Soda and Lime, Hot Air Bath)", 1; "Read's Patent Domestic Machine Advert," *Scotsman*, 8 Feb 1832, 1; "Advert - Antibillious Pills," *Scotsman*, 3 Aug 1833, 1; "Morrison's Medicine," *Scotsman*, 27 Aug 1836, 1; "Concentrated Essence of Jamaica Ginger," *Scotsman*, 3 Sep 1836, 1; "Universal Vegetable Pills," *Scotsman*, 12 Aug 1837, 1.

Appendix 3-5 (Part 2). Cholera-Related, *Scotsman* Advertisements (1831-1869)[542]

Date/Source	Item Being Sold	Description
27 Mar 1839/J & R Raimes, Wholesale Chemist, Edinburgh	Moxon's Effervescent Magnesian Aperient	'This unique preparation unites all the active powers of the most approved saline purgatives, with the palatable qualities of a glass of soda water… a save, speedy, and effective remedy'
8 Apr 1846/ J & R Raimes, Wholesale Chemist, Edinburgh	Parr's Life Pills[543]	'Tens of thousands have testified that perseverance in the use of Parr's Life Pills will completely cure any [cholera].'
11 Oct 1848/John MacKay, Chemist, 121 George St	Important to Families and to Persons in the Country. Sets of the Medicines considered most efficacious' against cholera available for sale.[544]	'Price, will full directions, in Boxes, 6s, 6d each and in smaller Packets, 3s, 6d each.'
5 Oct 1853/Croom and Sons, Chemists and Druggists, 61 South Bridge Street	Anti-Cholera Mixture	'Mixture in bottles at 1s, 6d and in Family Bottles, 3s, 6 d. Anti-cholera lozenges, quite pleasant to the taste, Two or three taken occasionally, remove all sickness and pain in the bowels. Boxes at 6d, 1s, and 1s 6d each.'
9 Jul 1853/Dr Townsend's Infant's Carminative	Effective against infant maladies including cholera	'preserves and protects the health of children from one day up to the age of five years.'
19 Nov 1856/Sold by Wholesale Chemist	Kaye's Worsdell's Vegetable Pills (Cholera)	'Safe and salutary remedy for those Bowel complaints to which so many are subject ... Mrs W., of Ewelme, Wallingford, says: "I believe Kay's Pills saved my life when I was attacked by English Cholera."'
14 Aug 1858/Raines & Co, Wholesale Chemist, Edinburgh	Glanville's Hydrosulphate of Iron Mixture,	'A certain cure for diarrhoea, dysentery, and cholera, &c, recommended by Eminent Medical Men'
11 Dec 1858/J Sanger, Oxford St, London and all Chemists	Du Barry's Anti-Diarrhoeal Bon Bons	'Are a never failing remedy for English Cholera'
31 Aug 1866/Sang & Barker, Edinburgh	Hydrozone	'The only known and reliable remedy for Cholera and Choleraic Diarrhoea, and an infallible preventative when taken as directed.'
5 Apr 1869/All Chemists	Sir James Murray's Cordial Fluid Camphor (Cholera),	'Extensively prescribed as a reviving Tonic, and as the best restorative for … Cholera.'

[542] "Moxon's Effervescent Magnesian Aperient", 1; "Parr's Life Pills," *Scotsman*, 8 Apr 1846, 1; "Advert, John Mackay Chemist, Medications Available," *Scotsman*, 11 Oct 1848, 3; "Advert - Anti-Cholera Mixture," *Scotsman*, 5 Oct 1853, 3; "Dr Townsend's Infant's Carminative," *Scotsman*, 9 Jul 1853, 1; "Kaye's Worsdell's Vegetable Pills (Cholera)," *Scotsman*, Nov 19 1856, 1; "Glanville's Hydrosulphate of Iron Mixture," *Scotsman*, Aug 14 1858, 1; "Du Barry's Anti-Diarrhoeal Bon Bons," *Scotsman*, Dec11 1858, 1; "Advert - Hydrozone," *Scotsman*, 31 Aug 1866, 4.; "Advert -- Cordial Fluid Camphor (Cholera)," *Scotsman*, Apr 5 1869, 5.

[543] Advertised again in 1853 and 1863.

[544] Advertised again in 1853.

Appendix 4-1 (Part 1). Edinburgh Public Health Efforts (1849 and 1853).[545]

Date	Source	Action
21 Nov, 1849	Sanitary Improvement of Towns	Specific mention of need for continued cleaning of Edinburgh Closes and to demolish, old, dilapidated buildings.
8 Dec, 1849	City Parochial Board - Continued Cleaning per Public Health Committee	End of payment to Medics but long-term continuation of cleaning efforts.
29 Dec, 1849	Housing Association - Cholera Deaths	Focus on Lodging House cleanliness. No cholera infections except one that had entered the House with cholera.
19 Jan, 1850	The Edinburgh Review on Sanitary Reform	Article on 'Sanitary Reform' that 'sets out by defining the field and object of "the science which aims at preserving health by precautionary arrangements."'
13 Feb, 1850	Inquiry Into Destitution and Vice in Edinburgh, Letter IV	Part of a series. Rather scathing review of sanitary state of the Old Town, focusing on the Closes/Lanes and Lodging Houses. Criticism of the churches not providing substantiative relief for the poor vs simply prayer, general review of the destitution.
2 Mar, 1850	Edinburgh Slaughter Houses Bill	Preliminary inquiry into 'the erection of public slaughter-houses for the city' to consolidate 'about sixty different killing places scattered throughout the city' in order to provide better control of conditions especially in consideration of the close-by inhabitants. Hearing included testimony by Dr. Allison.
4 Sep, 1852	The Cholera – Nuisances in the City	Cholera seen in Continental Europe. City Medical Relief Committee to meet with the various parishes to establish a cleaning plan, mostly the Old Town and High Street. Discussion of limitations of Police Act which only allows admission into homes but no forced removal of nuisances.
8 Sep, 1852	Editorial – The Fearful Ravages of Cholera	Editorial noting the formidable problems with sanitation in the city as well as potential cures. Note of the limited ability of laws to force citizens to comply.
8 Sep, 1852	Drainage of the City	Specific discussion of drains in the city …' many of them constructed in such a way as to collect effluvia in one particular place [and] then allowed to escape into the air.'
25 Sep, 1852	Defective Ventilation of Staircases	Discussion of the 'prevalent practice of constructing staircases defective in ventilation … (known by the name of the Edinburgh staircase)' with minimal ventilation especially as 'The water-closet windows look into the staircase, and … it is impossible that a free and pure ventilation can take place.' 'The Board cannot but regret their want of power to apply and sufficient remedy …'
30 Apr, 1853	Lodging House Association (Cholera)	Annual Meeting Report with fairly congenial agreements to work on improvement of sanitary conditions
27 Aug, 1853	Sanitary Improvement of the City	Report on continued cleaning of Closes and Wynds but new offer to clean inside the houses if occupants allowed to combat any risk of cholera/infection.

[545] "Sanitary Improvement of Towns", 2; "City Parochial Board - Continued Cleaning Per Public Health Committee," *Scotsman*, Dec 8 1849, 3; "The Edinburgh Review on Sanitary Reform," *Scotsman*, Jan 19 1850, 2; "Inquiry into Charities and Relief of the Deserving Poor", 2; "Edinburgh Slaughter Houses Bill," *Scotsman*, Mar 2 1850, 3; "The Cholera - Nuisances in the City," *Scotsman*, Sep 4 1852, 3; "Editorial - the Fearful Ravages of Cholera," *Scotsman*, Sep 8 1852, 2; "Drainage of the City", 3; "Defective Ventilation of Staircases", 3; "Lodging House Association (Cholera)", 4; "Sanitary Improvement of the City (1853)", 3.

Appendix 4-1 (Part 2). Edinburgh Public Health Efforts (1849 and 1853).[546]

Date	Source	Action
25 Sep, 1852	Defective Ventilation of Staircases	Discussion of the 'prevalent practice of constructing staircases defective in ventilation … (known by the name of the Edinburgh staircase)' with minimal ventilation especially as 'The water-closet windows look into the staircase, and … it is impossible that a free and pure ventilation can take place.' 'The Board cannot but regret their want of power to apply and sufficient remedy …'
30 Apr, 1853	Lodging House Association (Cholera)	Annual Meeting Report with fairly congenial agreements to work on improvement of sanitary conditions
27 Aug, 1853	Sanitary Improvement of the City	Report on continued cleaning of Closes and Wynds but new offer to clean inside the houses if occupants allowed to combat any risk of cholera/infection.
24 Sep, 1853	Sanitary Precautions	Report of cleaning 72 of the city's Closes but dire reports of remaining including one with 'long-standing impurities … at least eighteen inches deep, and will have to be carried off through the windows from which it has been thrown … The space in which this putrid mass is contained is about thirty feet long and two broad.' Note that 'it is evident that till it is causewayed, the nuisance cannot be put a stop to.'
28 Sep, 1853 – 21 Dec, 1853	Meetings of the Joint Cleansing and Sanitary Committees	Regular meetings and publications giving updates on cleaning as well as public criticisms and one report of a nurse being attacked
28 Sep, 1853 – 9 Nov, 1853	Meetings of the Police and Drainage Committees	Regular meetings and publications giving updates on activities of the Police Commission as well the initial consideration, revision of engineering plans and final planning by both Edinburgh and Leith.

[546] "Sanitary Precautions," *Scotsman*, Sep 24 1853, 2; "Precaution Measures against Cholera," *Scotsman*, Sep 21 1853, 4; "Sanitary Condition of the City (Sep 1853)," *Scotsman*, Sep 28 1853, 4; "Sanitary Condition of the City (Oct 1853)," *Scotsman*, Oct 5 1853, 5; "Sanitary Conference - Attack of Nurse", 3; "Sanitary Conference", 2; "Sanitary Committee - the Cholera (Nov 1853)," *Scotsman*, Nov 16 1853, 2; "Sanitary Condition of the City (Nov 1853)," *Scotsman*, Nov 19 1853, 2; "Sanitary Committee - the Cholera (Dec 1853)," *Scotsman*, Dec 14 1853; "Sanitary Committee (the Cholera)," *Scotsman*, Dec 21 1853, 2; "Police Commission - Sanitary Operations", 4; "Police Commission - Drainage of the City", 4; "The Police Commission - the Sanitary Condition of the City", 6; "Drainage Committee (Edinburgh and Leith Plans)", 2.

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