# The Perfect Food and the Filth Disease: Milk-borne Typhoid and Epidemiological Practice in Late Victorian Britain

JACOB STEERE-WILLIAMS

Program in the History of Medicine and Allied Sciences, University of Minnesota, MMC #506 Mayo Building, 420 Delaware Street, Minneapolis, Minnesota 55455. Email: will2019@umn.edu

***Abstract.*** This article explores the initial set of epidemiological investigations in Victorian Britain that linked typhoid fever to milk from dairy cattle. Because Victorian epidemiologists first recognized the milk-borne route in outbreaks of typhoid fever, these investigations served as a model for later studies of milk-borne scarlet fever, diphtheria, and perhaps tuberculosis. By focusing on epidemiological practices conducted by Medical Inspectors at the Medical Department of the Local Government Board and Medical Officers of Health, I show that Victorian epidemiology was committed to field-based, observational methods that defined the professional nature of the discipline and its theories and practices. Epidemiological investigations of milk-borne typhoid heated up several important public health debates in the second half of the nineteenth century, and demonstrate how Victorian epidemiology was not solely wedded to examining population studies using statistical methods, as historians have typically argued, but also relied on observational case-tracing in individuals, animals, and even environments. ***Keywords:*** Britain, Victorian, epidemiology, public health, milk, typhoid fever.

In 1872, Alfred Haviland stated that "typhoid fever is now a national disgrace; we ought not to rest until we reduce it to one simply local or personal; its existence will then become

JOURNAL OF THE HISTORY OF MEDICINE AND ALLIED SCIENCES

doi:10.1093/jhmas/jrq010

punishable."[1] Typhoid, or enteric fever, was at the center of epidemiological and etiological debates in late Victorian Britain. Much has been written about the diagnostic, clinical, and pathological problems that typhoid presented to Victorian physicians and medical scientists. Indeed, the classification of the "continued fevers" was still a matter of controversy into the 1860s, and questions of the etiology of typhoid fever persist into the 1880s.[2] Because of its insidious endemic nature, by the 1870s, typhoid was considered by most public health authorities the pre-eminent filth disease, that is, bred and propagated by fecal pollution of air and water.[3] Typhoid held somewhat of a privileged status both scientifically and socially throughout the second half of the nineteenth century; continued outbreaks that struck both the houses of the rich and the poor created a unique class dimension, and continued sanitary improvements and scientific evidence appeared to show that it was eminently preventable. Typhoid was, as historian Lloyd Stevenson has noted, the "exemplary disease" of the nineteenth century, both in its biological nature and relation to public health reform.[4]

From 1860 to 1880, the period when interest in typhoid was most intense, the two main etiological views on the disease were represented by William Budd and Charles Murchison.[5] Budd, a physician in Bristol, saw typhoid as a contagious, self-propagating disorder, with by far the most virulent part of the specific poison contained in the diarrheal discharges. The drain, he argued, was a continuation of

1. Alfred Haviland, "Abstract of Two Lectures on the Geographical Distribution of Typhoid Fever in England and Wales," *Br. Med. J.*, 1872, *580*, 148–49, 148.

2. Margaret Pelling, *Cholera, Fever, and English Medicine, 1825–1865* (Oxford: Oxford University Press, 1978), 281.

3. John Simon, "Filth Diseases and Their Prevention" in "Medical Officer of the Privy Council and the Local Government Board," *Annual Report to the Local Government Board*, n.s., 1, Parliamentary Papers, 1874.

4. Lloyd G. Stevenson, "Exemplary Disease: The Typhoid Pattern," *J. Hist. Med. Allied Sci.*, 1982, *37*, 159–81, 159.

5. There was, of course, much etiological confusion before the 1870s. See Leonard G. Wilson, "Fevers and Science in Early Nineteenth Century Medicine," *J. Hist. Med. Allied Sci.*, 1978, *33*, 386–407; and Dale C. Smith, "Gerhard's Distinction between Typhoid and Typhus and Its Reception in America, 1833–1860," *Bull. Hist. Med.*, 1980, *54*, 368–85. In 1869, typhoid was separated from typhus and simple continued fever in the annual statistics of the registrar-general. Typhoid incidence peaked somewhere between 1860 and 1870, and thereafter (unsteadily) declined. See Anne Hardy, *The Epidemic Streets: Infectious Disease and the Rise of Preventive Medicine, 1856–1900* (Oxford: Oxford University Press, 1993), 151–90.

the intestine.[6] Murchison, assistant physician to the London Fever Hospital, agreed with Budd that typhoid was a specific disease, but thought of it as non-contagious, originating spontaneously from decomposing organic filth. Murchison believed typhoid fever (he preferred to call it "pythogenic fever") to be a product of the fermentation of excreta, which was often, although not exclusively, transmitted from a previous case of the disease.[7] The key difference between the two rested on how infection occurred, and what essentially separated the two views was Murchison's focus on decomposition. However, etiological camps were ill defined, and there was a continuum of etiological beliefs with most British medical practitioners occupying a centrist, multifactoral, or contingent–contagionist approach.[8] Because of the multiplicity of germ theories, as Michael Worboys has shown, one could argue that typhoid was spread via water, but not specify how that water came to be infected. Most argued that air and water spread typhoid, and that filth, indiscriminately (in the older Chadwickian sense), was the main culprit.[9] There was even debate among those who argued more exclusively that typhoid could be spread solely by the intestinal discharges of the sick. Here, the pendulum swung from Budd's belief that typhoid discharges were infective immediately after leaving the body, and German physician Max von Pettenkoffer's theory that they needed to undergo a fermentation-like process in the soil.[10]

By the 1860s, most public health authorities agreed that typhoid, like cholera, was at times, if not primarily, spread via infected water supplies. Budd's 1847 investigation in Richmond Terrace, Clifton (outside of Bristol), first led him to suspect that typhoid could

6. Budd held a multifactoral view for most of his life, believing that air and water could disseminate typhoid and cholera. See Pelling, *Cholera, Fever, and English Medicine*, 275–77.

7. Charles Murchison, *Treatise on Continued Fevers of Great Britain* (London: Longmans, Green, & Co., 1862). See also, Pelling, *Cholera, Fever, and English Medicine*, 288–89. Murchison clung to the belief that typhoid could originate spontaneously well into the 1870s, as did many British medical practitioners. The question of whether typhoid ever spontaneously generated was fiercely debated at the Annual Meeting of the British Medical Association in Edinburgh, August 1875. See Cornelius B. Fox, "Is Enteric Fever ever Spontaneously Generated?" *Br. Med. J.*, 1876, 795, 374–77.

8. Pelling, *Cholera, Fever, and English Medicine*, 284–85.

9. On Chadwick's etiological beliefs, see Christopher Hamlin, *Public Health and Social Justice in the Age of Chadwick* (Cambridge: Cambridge University Press, 1998).

10. Pelling, *Cholera, Fever, and English Medicine*, 284.

be communicated through infected water.[11] He continued with articles such as "On Intestinal Fever: Its Mode of Propagation," which was published in 1856 in the *Lancet* and based on an outbreak of typhoid in the Clergy Orphan School in London.[12] Budd's epidemiological ideas on typhoid culminated in his 1873 *Typhoid Fever: Its Nature, Mode of Spreading, and Prevention*, which laid out his extensive theory that typhoid was a specific disease spread via the intestinal discharges of sick patients, and his prescription for preventing typhoid through the specific disinfection of excreta.

Budd's water-borne theory was confirmed at the Medical Department of the Privy Council (and later the Local Government Board) by investigations conducted by John Netten Radcliffe, George Buchanan, and Richard Thorne-Thorne which relied theoretically and methodologically on investigations of water-borne cholera.[13] Connecting typhoid to cholera was important both methodologically and theoretically; arguing that typhoid was a specific disease propagated by the intestinal discharges of previous sufferers added weight to the cause of public health reforms such as clean water supplies, effective drainage, and improved sanitation. However, even non-contagionists could concede that water played a part in disseminating cholera or typhoid without agreeing that the intestinal discharges played the vital role per Budd's theory. Although analytical chemists such as Edward Frankland and James Alfred Wanklyn were frequently brought in to settle public health debates about water (and milk) and epidemic disease, their conclusions were often too imprecise or inconsistent to unequivocally resolve such cases.[14]

The importance of connecting water to epidemic disease was that it provided a methodological grounding for further research, and, under certain pretexts, a theoretical way out of confusing etiological

11. William Budd, *On the Causes of Fevers (1839)*, ed. Dale C. Smith, The Henry E. Sigerist Supplements to the *Bull. Hist. Med.*, n.s., no. 9 (Baltimore: Johns Hopkins University Press, 1984), 137–38.

12. William Budd, "On the Fever at the Clergy Orphan Asylum," *Lancet*, 1856, *2*, 617–19.

13. These reports can be found in the *Annual Report of the Medical Officer of the Local Government Board*, 1865 to 1875.

14. On water analysis, see Christopher Hamlin, *A Science of Impurity: Water Analysis in Nineteenth Century Britain* (Berkeley: University of California Press, 1990).

debates.[15] What it provided was a model, an epidemiological analogy. Margaret Pelling has argued that early epidemiologists such as Budd used a smallpox analogy to argue that cholera was a specific disease that could be spread via certain vehicles.[16] By the 1870s, the generation of British epidemiologists after Snow and Budd used the waterborne theory to test the hypothesis that other mediums could spread epidemic disease. From the 1870s, the most important vehicle implicated in outbreaks of typhoid, and later scarlet fever, diphtheria, and tuberculosis, was milk.[17] Establishing the milk-borne route of disease transmission, which occurred in the 1870s, was not only a vital testing ground for etiological hypotheses, but also a way in which epidemiologists could claim scientific authority in public health. This, unsurprisingly, was not always successful, as milk played a variety of social roles in Victorian society. It was a nutritive staple to children, invalids, and the wealthy; an economic product to dairy producers; and a symbol of purity, agriculture, and fleeting pastoralism in an increasingly urbanized world.

Through a detailed examination of the initial set of epidemiological investigations in the 1870s that linked typhoid to milk, this paper argues that epidemiological claims that milk could spread disease disrupted several fundamental Victorian tensions—urban versus rural, local versus state, and purity versus pollution—making the construction of epidemiological evidence uneven and contested, and the organization of a coherent public health response controversial throughout the nineteenth century. Examining these epidemiological practices demonstrates the ways in which epidemiologists were dependent upon local knowledge about communities and environments where they were put into contact with local physicians,

15. On the relationship between water and epidemic disease in the Victorian period, see Bill Luckin, *Pollution and Control: A Social History of the Thames in the Nineteenth Century* (Bristol: Adam Hilger, 1986); and Hamlin, *A Science of Impurity*.

16. Pelling, *Cholera, Fever, and English Medicine*, 250–51 and 275–76.

17. Although it was traced later than typhoid, milk-borne scarlet fever has been given the most historical attention. See Leonard G. Wilson, "The Historical Riddle of Milk-borne Scarlet Fever," *Bull. Hist. Med.*, 1986, *60*, 321–42; and John Eyler, "The Epidemiology of Milk-borne Scarlet Fever: The Case of Edwardian Brighton," *Am. J. Public Health*, 1986, *76*, 573–84. The link to tuberculosis spread via milk was clearly a separate problem in the nineteenth century. Milk could act as a vehicle in spreading typhoid, scarlet fever, and diphtheria, but in cases of tuberculosis, milk was intrinsically feared. See Keir Waddington, *The Bovine Scourge: Meat, Tuberculosis, and Public Health, 1850–1914* (Woodbridge: Boydell Press, 2006), 153–74.

chemists, veterinarians, farmers, politicians, and business owners, not to mention bad drains, privies, and cowsheds. I remind historians that British epidemiologists in the second half of the nineteenth century used opportunities such as the milk-borne typhoid problem to bolster their scientific authority, and be at the forefront of codifying public health knowledge in order to discipline public health practice.

## MEDIUMS OF TRANSMISSION: FROM WATER TO MILK

In 1888, Richard Thorne-Thorne noted,

> But even in places where works aiming at the safe disposal of the solid and liquid refuse of populations, and at the provision of wholesome water-services, had been carried out, periodic, and at times large, outbreaks of enteric fever still occurred, and it remained for those engaged in epidemiological research to discover those more obscure channels through which the infection of this fever was at times conveyed to man.[18]

The most important of those obscure channels was milk.

From the 1870s, British epidemiologists used the etiological framework of water-borne typhoid to explore how other foodstuffs, most importantly milk, spread disease. Analogous reasoning suggested that milk could spread disease, but milk posed a number of different theoretical and methodological questions compared with water. The milk-borne hypothesis was first suggested in the British medical press in 1858 by an article published in the *Edinburgh Medical Journal* by Michael Taylor, a local physician of Penrith. Titled, "On the Communication of the Infection of Fever by Ingesta," the article described an outbreak of typhoid in Penrith and the surrounding countryside which peaked in the autumn of 1857, causing several deaths from typhoid. Taylor traced the cases, which primarily affected children, to a single source, namely the use of one common milk supply. Investigating the dairy, Taylor found several members of the family sick with typhoid and the sanitary conditions ripe for the contamination of milk with filth. Taylor's etiological views were multifactoral. He concluded, "what I have more especially inferred is that the poisonous effluvia and

18. Richard Thorne-Thorne, *On the Progress of Preventive Medicine during the Victorian Era* (London: Shaw and Sons, 1888), 26.

cutaneous exhalations of fever may be absorbed by fluids (such as milk), which, when used as ingesta, may constitute one means of spreading the disease. If this be a fact, I conceive it to be a new one in the etiology of fever."[19] Taylor's article went largely unnoticed in the British medical press, perhaps not least because his methods were vague and his conclusions weak. Looking back, Thorne-Thorne noted, "this report received but little publicity."[20] Although several notable epidemiologists in the 1870s and 1880s referred back to Taylor's study, it is unclear whether they accepted Taylor's milk-borne hypothesis early on, or anachronistically used it to bolster their own epidemiological claims.

It is probable that British epidemiologists did not pursue the milk-typhoid connection until the early 1870s because they were instead focused on exploring and debating the water-borne hypothesis, which was, as Christopher Hamlin has shown, uneven and problematic.[21] Moreover, the milk-borne hypothesis could be contained within the water-borne hypothesis, in that milk adulterated with polluted water was typically suspected as the method of milk contamination. Most importantly, however, was the context in which milk stood in relation to public health before 1870.[22] Edward Ballard noted in 1870 that "the practice of watering milk is all but universal."[23] Early anti-adulteration treatises such as Frederick Accum's 1820 *A Treatise on Adulterations of Food, and Culinary Poisons* did begin to call attention to the widespread practice of adulteration.[24] However, it was not until the analytical

19. Michael W. Taylor, "On the Communication of the Infection of Fever by Ingesta," *Edinb. Med. J.*, 1858, *3*, 993–1004.

20. Thorne-Thorne, *On the Progress of Preventive Medicine during the Victorian Era*, 26. In 1867, Taylor argued that scarlet fever could be spread via infected milk as well. See Michael W. Taylor, "On the Transmission of the Infection of Fevers by Means of Fluids," *Br. Med. J.*, 1870, *519*, 623–25. See also Wilson, "The Historical Riddle of Milk-borne Scarlet Fever," 321.

21. Hamlin, *A Science of Impurity.*

22. Peter J. Atkins's rich analysis on how milk practices, both production and consumption, varied greatly over the Victorian period, contains useful information on this topic. See, Peter J. Atkins, "Sophistication Detected: Or, the Adulteration of the Milk Supply, 1850–1914," *Soc. Hist.*, 1991, *16*, 317–39; and P. J. Atkins, "White Poison? The Social Consequences of Milk Consumption, 1850–1930," *Soc. Hist. Med.*, 1992, *5*, 207–27.

23. Edward Ballard, *Annual Reports of the Medical Officer of Health for Islington* (London: J. & I. Tirebuck, 1870), 10.

24. Frederick Accum, *A Treatise on Adulterations of Food, and Culinary Poisons* (London: J. Mallett, 1820).

studies by microscopist Arthur Hill Hassall on food adulteration in the 1850s connected with the work of Thomas Wakley's Analytical Sanitary Commission of the *Lancet*, that it became clear that the adulteration of milk was a widespread practice. Early anti-adulteration reformers such as Hassall and Henry Letheby did consider milk adulteration a serious problem. It deprived milk, nature's most perfect food, of its beneficial nutritional qualities. The problem, before the 1870s, and this was crucial, was that milk adulterators were both morally dishonest and economically fraudulent. Milk adulteration, in other words, was a moral and economic problem, one that perhaps needed administrative reform, but not necessarily a public health issue. It was only through epidemiological inquiries conducted in the early 1870s by Edward Ballard and John Netten Radcliffe that milk began to be seen as a major public health threat.

## THE MEDICAL OFFICER OF HEALTH FOR ISLINGTON

In a correspondence to the *British Medical Journal (BMJ)* on 24 September 1870, well-known gynecological surgeon Lawson Tait suggested that "milk is an extremely dangerous agent for the spread of contagion." He continued by predicting that,

> If we bethink ourselves of any instances of diseases which might in certain instances be communicated by milk, typhoid fever stands out with fearful probability. Enteric fever is nowhere more common nor more fatal than in country farm-houses, where means for the removal of the dejections are not sufficiently well adapted for security, and much too convenient for safety.[25]

Tait's timely calculation was most probably predicated on his knowledge of an ongoing investigation of milk-borne typhoid conducted by Edward Ballard, Medical Officer of Health (MOH) for Islington.

In his Annual Report to the Vestry of St. Mary, Islington, in 1870, Edward Ballard noted,

> At no time during the year was Typhoid Fever unusually prevalent among our population *generally*, but between 3 July and 10 September

25. Lawson Tait, "The Influence of Milk in the Propagation of Contagious Disease," *Br. Med. J.*, 1870, *508*, 344.

> in one circumscribed locality no fewer than 168 individuals of different ages, and the inhabitants of 67 different houses were attacked with this form of Fever, and of them 26 died.[26]

For an industrious, active MOH such as Ballard, the sudden increase in cases of typhoid confined to one-quarter of a mile radius (essentially one neighborhood) warranted his full attention.[27] His inquiry lasted several months, in which he visited the houses of suspected victims and traced the incidence of typhoid from case to case, hoping to identify a common cause. In examining the epidemic profile of the isolated outbreak, Ballard was surprised to find that the disease distribution followed unexpected class lines. He reported, "the persons who suffered were not of the class among whom fevers are most commonly observed, but were persons in very comfortable positions in society, attended by private medical men, and residing in some of the best houses in the parish," a fact he considered a "remarkable feature."[28]

Although Ballard would have been familiar with the famous attack of typhoid that killed Prince Albert in 1861, little epidemiological evidence had previously tied typhoid to wealthy Britons. By linking an outbreak of typhoid fever, considered the pre-eminent filth disease, to the consumption practices of wealthy Londoners, Ballard was challenging the Victorian association between disease and poverty. If, after all, the wealthy inhabitants of Islington had properly drained houses and privately hired physicians, why had they succumbed to a disease born of filth? William Luckin has suggested that by the 1860s and 1870s, Victorians feared that typhoid was the most serious epidemic threat to middle and upper class inhabitants.[29] The death of the Prince Consort and his son Prince Edmund from typhoid sparked a popular fear of the disease, but epidemiological evidence (starting with Ballard's classic study) that linked typhoid to milk consumption must also be considered. Since heavy

26. Ballard, *Annual Reports of the Medical Officer of Health for Islington*, 7. In his final report, published separately, Ballard tabulated that the outbreak struck 70 families, caused 175 cases, and led to 30 deaths. Edward Ballard, "On a Localised Outbreak of Typhoid Fever in Islington," *Med. Times Gaz.*, 1870, *2*, 611–17.

27. In his final report, Ballard noted that the outbreak left him "somewhat staggered." See ibid.

28. Ballard, *Annual Reports of the Medical Officer of Health for Islington*, 8.

29. Bill Luckin, *Pollution and Control*, 135.

consumption of fresh milk was largely confined to middle and upper class houses, milk-borne outbreaks struck the upper classes of Victorian society with equal if not greater ferocity than the poor.

After talking with local physicians, Ballard considered four hypotheses: (1) an alteration of the local railway had cut into several old sewers and drains and produced typhoid miasmas, (2) a local dung-shoot (or dung heap) induced the epidemic, (3) local sanitary and domestic drainage was at fault, or (4) a single source of milk had been polluted.[30] While the first three suggestions, either alone or in combination, would have been acceptable and logical conclusions for most Victorian observers (and would have fit into Murchison's etiological framework), Ballard started the investigation with a broader understanding of typhoid causation. He was unconvinced of the first three hypotheses, because they were unable to explain why on some streets typhoid picked out certain houses and within certain houses it picked out only certain members of the family, and with the evidence he found for each theory. Certainly the randomness of distribution in cases of typhoid, under the multifactoral causation theory common among British medical practitioners, was not sufficient proof for dismissing its assumptions. However, Ballard became convinced of the milk-borne route as a result of what he considered overwhelming statistical and descriptive evidence. For instance, he found that in no cases where two families occupied the same house did typhoid occur except where both families used the same milk. Attacks within families followed consumption practices, even by gender; adult females, who habitually drank more milk than males, made up 69 percent of those attacked. On the latter, Ballard noted, "I am not aware that under ordinary circumstances typhoid shows any such decided preference for the female sex."[31] It is possible that Ballard had read Taylor's 1858 article; at the end of his MOH Report for 1870, Ballard noted that "I have long suspected the possibility of the propagation of Typhoid Fever by milk in this way, the water added to it being contaminated."[32]

Obtaining a list of the implicated dairy's customers and comparing it with his list of typhoid sufferers, Ballard found, "that the

30. Ballard, "On a Localised Outbreak," 612.
31. Ballard, *Annual Reports of the Medical Officer of Health for Islington*, 9.
32. Ibid., 18.

fever was confined to persons who had consumed milk from one particular dairy . . . in particular streets, rows of houses &c., the typhoid poison picked out as it were the customers of the dairy, leaving the others free from the attack."[33] Calling on the house of the milkman, Ballard found that the owner of the farm and seven other persons of the dairyman's family or staff, had died of typhoid directly preceding the Islington outbreak. A sanitary investigation of the dairy farm, including a thorough geographical survey and drainage excavation of the sewer drains, showed that the farm had inadequate water supply. Ballard found that an old underground wooden water tank had become rotten, and within was a series of rat burrows, which connected the tank freely to the water-closet drains. A plan of the dairymen's premises, showing the problem, was drawn by the surveyor of Islington and accompanied Ballard's report.[34] The unsanitary state of these superficial wells, as Ballard noted, was the principal reason for deaths from water-borne disease both in this case and around the country, as they led to the direct communication between water-closets and drinking water.

The typhoid-charged water, Ballard suggested, got into the milk in one of two ways: the milk was either deliberately watered (adulteration) or the milk pails accidentally polluted when they were washed with the water charged with the ejections of persons suffering from typhoid. About the former, which Ballard called "all but universal among milk sellers in London," the public was far too complacent in condoning the practice. Comparing the need to protect milk supplies in addition to water supplies, Ballard argued that,

> We take a great deal of trouble to secure the purity of the water in dwelling houses, and to guard against its contamination from house-drain emanations, and from the emanations from cesspools; but with all our care a wholesale poisoning may take place because the article received into houses and used as *milk* is diluted with water mixed with the contagium of typhoid fever.[35]

Ballard was initially careful not to place too much emphasis on what he first thought was mere coincidence. What started as

33. Ibid., 8–9.
34. Ballard, "On a Localised Outbreak," 616.
35. Ballard, *Annual Reports of the Medical Officer of Health for Islington*, 11.

skeptical suspicion, however, increasingly became the most plausible explanation.

Reading his paper before a meeting of the Association of Medical Officers of Health on 19 November 1870, Ballard warned his fellow MOHs that "the facts elicited have a bearing upon our sanitary practice, and impart a warning to health officers and to the public alike."[36] The Association paid for the publishing of Ballard's pamphlet, and to have it distributed to MOHs around the country. Reviewing the booklet in the *Lancet*, James Wakley said that "the pamphlet is one to be read carefully, and to be possessed by every medical man, not only as a model of careful investigation in etiology, but as a history of one of the most remarkable outbreaks of typhoid on record."[37] Ballard had concluded that "we all know how small, almost infinitesimal, an admixture of sewage will poison a well or running stream . . . future experience may show that milk, which has remarkable relations to chemical ferment, is a substance peculiarly adapted also to the reproduction of morbid contagia, or to the contagium of typhoid in particular."[38] The focus on preventive attention, according to Ballard, should be to eliminate the local causes of disease transmission—dairies with inadequate drains, water, and sewerage supplies—and to change dairy practices, including milk adulteration.

Ballard's investigation received widespread attention in the British medical press. It was the first epidemiological study to establish the hypothesis that milk could act as a vehicle for typhoid, and laid the groundwork for future investigations of milk-borne typhoid as well as scarlet fever and diphtheria. Writing Ballard's obituary for the Royal Society in 1897, William Henry Power, a long time colleague at the Medical Department, noted that the Islington study "necessarily served as a model to later investigators."[39]

Theoretically, arguing that milk acted as a vehicle in spreading typhoid was predicated upon the argument that water acted as a

36. Ballard, "On a Localised Outbreak," 611.
37. James Wakley, Review of Edward Ballard, "On a Localised Outbreak of Typhoid Fever in Islington during the Months of July and August, 1870," *Lancet*, 1871, *1*, 120–21, 120.
38. Ballard, "On a Localised Outbreak," 617.
39. William Henry Power, "Obituary Notice for Edward Ballard," *Proc. R. Soc. Lond.*, 1898, *62*, iii–v.

vehicle in spreading typhoid, and by analogy, cholera. Thus the epidemiological experience of Snow and Budd in the 1850s, and investigations by Simon's first inspectoral staff at the Medical Department in the 1860s and 1870s, was crucial to establishing the milk-borne hypothesis. The connection between Snow and Budd and the Medical Department's staff was forged through the Epidemiological Society of London. Although Ballard never cited Snow in his early work, in a paper he read in 1879 at the Annual Meeting of the British Medical Association in Cork, he called Snow, "my old friend," perhaps indicating his theoretical allegiance to Snow's water-borne hypothesis.[40]

## STATE EPIDEMIOLOGY AND THE MEDICAL DEPARTMENT

In late September 1887, George Buchanan, then Chief Medical Officer of the Medical Department of the Local Government Board, wrote to Ballard offering a promotion to Assistant Medical Officer. Ballard turned down the promotion. In a confidential memorandum to Buchanan on 6 October, Ballard replied,

> I regret that I cannot see my way distinctly to accepting your offer . . . like much greater men than my insignificant self, I am conscious of a "mission," a mission which is as yet incompletely fulfilled; namely, to add my quota of labour to the clearing-up of some obscure questions as to the causation of disease.[41]

Ballard's promotion to Assistant Medical Officer would have required more administrative duties, from preparing the Chief Medical Officer's Annual Reports, to drafting office memoranda and official responses to local sanitary authorities. The post carried with it more remuneration and elevated status; it was typically given to senior ranking inspectors who were nearing the end of their careers. What it also meant, on a practical level, was abandoning the daily rigor of extensively traveling around Britain investigating local outbreaks of disease, a job description he had fulfilled since the 1850s as an MOH for Islington.

40. Edward Ballard, "Observations on Some of the Ways in which Drinking Water May Become Polluted with the Contagium of Enteric Fever," *Br. Med. J.*, 1880, *994*, 82–84, 82.

41. G. Buchanan to E. Ballard, 30 September 1887, E. Ballard to G. Buchanan, 6 October 1887, MH.113.8, National Archives, Kew (hereafter NA).

The Chief Medical Officer and his assistant instead worked full time at the Medical Department's Whitehall office. Although Ballard was clearly unsettled at the prospect of becoming a paper-pushing Whitehall civil servant (he called the work "uncongenial to my tastes"), his chief concern appears to be his disdain for ending his position as "exterior" (or "out-of-doors") Medical Inspector.[42] When the memorandum in question was written, Ballard had been one of the Medical Department's most important inspectors for over twenty years; he was particularly noted for his investigations of typhoid, scarlet fever, infant diarrhea, and industrial diseases such as arsenical poisoning and effluvia nuisances. The Medical Department's other inspectors were also chosen for their respective strengths in public health; for example, Edward Seaton specialized in vaccination inspection, and John Netten Radcliffe in water-borne and foreign epidemics, particularly cholera. The Medical Inspectorate's defining feature, perhaps, was their collective epidemiological breadth.

Following the creation of the Medical Department in 1858, John Simon, the department's first Chief Medical Officer, appointed inspectors on a temporary basis. Through political clamoring however, by 1871, Simon had garnered the appointment of ten Medical Inspectors, whose reports provided the fuel for his project to "develop a scientific basis for the progress of sanitary law and administration."[43] Most promotions, as John Eyler has noticed, came from within; top ranking inspectors were typically made Assistant Medical Officers, and the most promising, or senior-ranking Assistant Medical Officer made Chief Medical Officer.[44] Medical Inspectors were typically young and aspiring public health minded medical practitioners.[45] Most were members of the Epidemiological Society of London, and many had previously served as local Medical Officers of Health, two qualifiers that Chief

42. E. Ballard to G. Buchanan, 6 October 1887, MH.113.8, NA.

43. John Simon, *English Sanitary Institutions* (London: Cassell & Company, 1890), 258. See also Royston Lambert, *Sir John Simon and English Social Administration* (London: Macgibbon & Kee, 1963); and Jeanne L. Brand, "John Simon and the Local Government Board Bureaucrats, 1871–6," *Bull. Hist. Med.*, 1963, *37*, 184–94.

44. John Eyler, *Sir Arthur Newsholme and State Medicine* (Cambridge: Cambridge University Press, 1997), 221.

45. C. Fraser Brockington, *Public Health in the Nineteenth Century* (London: E & S Livingstone, 1965), 192–269.

Medical Officers such as Simon, Buchanan, and Thorne-Thorne privileged in recruiting.[46] The epidemiological fieldwork these inspectors carried out was categorized by Ballard as the ultimate sanitary "mission," and served as the scientific foundation for Simon's vision of state medicine in Britain. Oftentimes, these epidemiological investigations blurred the distinction between the politically imbued Victorian notions of central and local.[47] Throughout the second half of the nineteenth century, the Medical Department was at the center of British epidemiology, whether through original epidemiological investigation, or in conjunction with investigations by Medical Officers of Health.

Simon's Medical Department provided the first institutional basis for epidemiological research. It should not be surprising therefore that Simon's inspectors were responsible for further establishing the link between typhoid and milk. Ballard, of course, led the way; in 1872, he was called to investigate a typhoid outbreak in Armley (near Leeds), and in 1873, he investigated an outbreak in Moseley and Balsall Heath.[48] In both cases, Ballard traced the outbreak to an infected milk supply using techniques similar to the Islington study. Other epidemiologists followed Ballard's lead, including M. K. Robinson's 1872 study in Leeds, and James Russell's 1873 study in Glasgow that continued until the 1880s. At the Medical Department, John Netten Radcliffe was at the center of probably the most famous outbreak of milk-borne typhoid to occur in the Victorian period, when a substantial proportion of London's west-end elite were struck with typhoid in 1973, detailed below. First, however, we must consider how epidemiological studies from 1870 to 1873 fuelled the anti-adulteration reform movement.

46. Of the early inspectors to serve under Simon, George Buchanan (St. Giles), Edward Ballard (Islington), John Burdon-Sanderson (Paddington), and John Syer Bristowe (Camberwell) had all served as local Medical Officers of Health.

47. The most important contributions to this field are Eyler, *Sir Arthur Newsholme*; Hardy, *The Epidemic Streets*; Jeanne Brand, *Doctors and the State* (Baltimore: Johns Hopkins Press, 1965); and Lambert, *Sir John Simon*.

48. "Dr. Ballard's Report upon an Outbreak of Enteric Fever at Armley, in the Borough of Leeds," and "Dr. Ballard's Report upon an Outbreak of Enteric Fever at Moseley and Balsall Heath, near Birmingham," MH.113/11, NA. See also M. K. Robinson, "The Cause of the Contagion of Typhoid Fever," *Br. Med. J.*, 1874, *692*, 451–52.

## ANTI-ADULTERATION REFORM

Early epidemiological studies of milk-borne typhoid, particularly those by Ballard, stirred veterinary surgeon John Gamgee to call for a complete reform of milk practices in Britain. In a paper read before the Association of Medical Officers of Health on 17 December 1870, Gamgee argued that,

> The simple dilution of milk has been regarded by many as the worst form of deterioration injuring the milk consumer. But when it I considered that impure water, used in washing milk-pails, or diluting the milk, transfers from the cesspool to the breakfast cup, or infant feeding bottle, the germs of enteric fever . . . it is high time that, as practical men, we should consider the whole subject, and devise a remedy at once efficacious, and of possible or probable application.[49]

Gamgee's solution included a complete re-evaluation of the transportation of milk from the country into towns, the supervision of dairy farms, and the thorough chemical analysis of milk samples, all measures that would not be passed until the 1880s and 1890s.[50] The anti-adulteration agenda had been predicated upon moral dishonesty and nutritional deprivation. However, it was only as the result of epidemiological studies that demonstrated the dangerous role milk could play in spreading typhoid (and later scarlet fever and diphtheria) that milk became perceived as a serious public health threat. Ballard argued this position as early as 1872, saying that,

> The Adulteration of Food Act of last Session enables local authorities to deal with persons who add water to milk; but if a dairyman's own drinking water is permitted by local authorities to be a fluid little better than sewage, is it not rather a reflection on those authorities than an aggravation of his commercial fraud that he, only meaning to dilute his milk, ignorantly supplies infection to his customers?[51]

Ballard clearly considered the impetus to be on local sanitary authorities to control and maintain clean milk supplies. Analytical

49. John Gamgee, "Country versus Town Milk," *Med. Times Gaz.*, 1871, *1*, 38–39, 67–68.

50. On the development of anti-adulteration laws in Britain, see Michael French and Jim Phillips, *Cheated not Poisoned? Food Regulation in the United Kingdom, 1875–1938* (Manchester: Manchester University Press, 2000).

51. "Dr. Ballard's Report upon an Outbreak of Enteric Fever at Armley, in the Borough of Leeds," 11, MH.113/11, NA.

chemists, posts made compulsory in 1875, were only slowing professionalizing at this time however, and scientific techniques of milk analysis were irregular and inconsistent.[52]

Armed with epidemiological, chemical, and microscopal evidence, anti-adulteration and agricultural trade journals joined the fray as well. The first edition of *The Milk Journal* in January 1871, for example, contained a lengthy article summarizing, and accepting, the epidemiological evidence linking milk and typhoid. *The Milk Journal* championed the use of epidemiological evidence, which could serve as a caution to both dairymen and milk consumers alike.[53] The opening issue of *The Milk Journal* also contained an article by Ballard, titled "On Some Sanitary Aspects of Cowkeeping, and the Trade in Milk in London," where Ballard argued that the highly flawed and unsanitary system of cowkeeping in the metropolis often led directly to public health dangers, from diseased cows to germ-laden milk.[54]

Far from a conservative warning, particularly considering that *The Milk Journal's* principal readership was dairy farmers, Ballard's article adamantly demonized dairymen who adulterated their milk;

> From this time forth, the water supply upon the premises of a dairyman will be jealously scrutinized by public authorities. Let us hope, too, that another session of Parliament will not slip away, without imposing upon milk adulterators, such a punishment as the gravity of their delinquency warrants. From henceforth no one can plead ignorance—no one ought to be permitted to plead the "custom of the trade."[55]

Other anti-adulteration journals such as *Food, Water, and Air*, edited by Arthur Hill Hassall, and *The Food Journal* were also begun in 1871, and were committed to presenting a plethora of evidence–epidemiological, chemical, and statistical–that food adulteration was not only a moral, ethical, and economical problem, but new to

52. The development of analytical chemistry in Victorian Britain is a much-neglected topic. See Derek Oddy, "Food Quality in London and the Rise of the Public Analyst, 1870–1939," in *Food and the City in Europe since 1800*, ed. Peter J. Atkins (Hampshire: Ashgate, 2007), 90–102.

53. Anon., untitled editorial, *The Milk Journal: A Monthly Review of the Dairy, Dairy Produce, and Poultry Yard*, London, 1871, *1*, 2–3 (hereafter *Milk J.*).

54. Edward Ballard, "On some Sanitary Aspects of Cowkeeping, and the Trade in Milk in London," *Milk J.*, 1871, *1*, 6–8.

55. Ibid, 8.

1871, a dangerous threat to the public's health. In the absence of compulsory anti-adulteration legislation, epidemiologists and analytical chemists, another group which was highly influential in framing the discourse about food adulteration in Victorian Britain, served as scientific arbiters between milk consumers, dairymen, and public health officials.

By 1873, there was a growing scientific and (albeit more limited) social consensus that under the right conditions, milk could spread epidemics of typhoid (and perhaps scarlet fever and diphtheria). Ballard's epidemiological evidence was primarily cited as scientific proof of the milk-borne hypothesis. In the fall of 1873, however, the most notorious outbreak of milk-borne typhoid occurred in the west end of London which made the milk-borne hypothesis not just an interesting etiological question of scientific medicine, but demanded the widespread notice of public health officials and the public alike.

## THE MARYLEBONE MILK CRISIS OF 1873

In 1881, at the International Medical Congress held in London, Ernest Hart, President of the British Medical Association (BMA), long-time editor of the *BMJ*, and sagacious reformer, gave a paper sketching the history of epidemiological investigations that linked milk to typhoid fever, scarlet fever, and diphtheria.[56] Hart's interest was both professional and personal; in 1873, Hart's London district of Marylebone had been attacked with a violent epidemic of typhoid fever which struck both his family and the families of several of his closest medical colleagues, including Charles Murchison and William Jenner.

Although Ballard had provided epidemiological evidence in several outbreaks between 1870 and 1873, Hart wrote that the 1873 Marylebone investigation "made so clear that the then sceptics became perforce converted to a belief in milk infection. The demonstration of this infection has indeed, by this time [1881] become so complete in this country, that its acceptance has now become practically universal."[57]

56. Ernest Hart, "The Influence of Milk in Spreading Zymotic Disease," in *Transactions of the International Medical Congress*, 7th session, (London: J.W. Kolckmann, 1881), 3: 491–505.

57. Ibid, 492.

On 8 August 1873, Charles Murchison sent a letter to *The Times* warning that an outbreak of typhoid fever was perhaps on the rise in the west-end of London. Five of Murchison's children had recently been taken ill with the disease, and upon inquiry, he found that thirty-two families had also been struck, representing seventy-five to one hundred new cases.[58] Murchison, "satisfied that the outbreak could not be traced to defective drainage or to a polluted water supply," believed that the cause of the outbreak was due to contaminated milk from the Dairy Reform Company, which supplied milk to most of Marylebone.[59] Murchison was suspicious of the Dairy Reform Company as early as 4 August, when he called upon John Whitmore, Marylebone's MOH. Whitmore visited the Dairy Reform Company's premises that day, located in Marylebone, and interviewed the manager and secretary, Mr. Maconochie. Whitmore's initial sanitary inquiry at the dairy, "proved that the company were in no way responsible for the supposed contamination of their milk, and that the causes must be looked for at the farms from whence it was supplied."[60]

As a precaution Whitmore first conducted a thorough inspection of the sanitary conditions in the district, finding neither the water supply nor drainage amiss, noting that, "I could have no doubt of their being in a good structural condition . . . inasmuch as the occupants of them were medical men of eminence, and other persons who were fully alive to the importance of living under the best and most perfect sanitary conditions that it was possible to obtain."[61] Perhaps because of Murchison's influence, Whitmore again visited the Dairy Reform Company on 5 August suggesting that the directors suspend the supply of their milk until the true cause of the outbreak could be ascertained, a suggestion which was denied unless the parish Vestry would compensate them for "the loss and injury they may sustain in loss of profit and reputation."[62] As

58. Unpublished letter from Charles Murchison to editor of *The Times* dated 8 August 1873. Charles Murchison, Personal Papers, MS 710, Royal College of Physicians, London (hereafter RCP).

59. Ibid.

60. James Whitmore, St. Marylebone, "On the Recent Epidemic of Typhoid or Enteric Fever," Annual Report of the Medical Officer of Health, dated 23 September 1873, in Parkes Pamphlet Collection, Box 89, Volume 53, Wellcome Library, London.

61. Ibid, 2.

62. Ibid, 3.

MOH, Whitmore had no legislative compulsory power to make the company stop selling their milk.

By 7 August, the number of typhoid cases in Marylebone and the adjoining districts had exploded; Whitmore called a meeting of the Marylebone Vestry to warn the parish of the outbreak, sent a circular to all of the medical practitioners in the area, and wrote to John Simon at the Medical Department asking for assistance, not "because I felt personally incompetent to the task, but because it was apparent that the origin of the outbreak was to be sought for in places far away from the Parish of St. Marylebone, beyond which I could exercise no power of authority."[63] Simon responded by sending one of his most competent inspectors, John Netten Radcliffe, to investigate the localized outbreak.

In the meantime, Murchison had garnered the support of distinguished physician and typhoid expert William Jenner, who also lived in Marylebone. The two began flooding the London press warning about the milk-borne outbreak in the west end, which they totaled to upwards of 470 cases. They also sent warning letters to the Dairy Reform Company to cease the sale of their milk. Ernest Hart also joined in the cause, publishing nearly the entire correspondence between Murchison, Jenner, Whitmore, and the Dairy Reform Company in the *BMJ* throughout the fall of 1873.

John Netten Radcliffe, the Medical Department's inspector called in to lead the investigation, met with Whitmore, Murchison, and Jenner on 8 August to obtain a general outline pertaining to the Marylebone outbreak. Radcliffe inspected the local water supply, which in Marylebone was provided by either the West Middlesex or the Grand Junction Companies, and inspected the house drains, finding that "the drainage of each house had, some time before the outbreak, been placed in thorough order."[64] Unconvinced that the cause of the disease was local in origin, Radcliffe concluded, "we have exhausted the known conditions which foster or determine the prevalence of enteric fever with one important exception, namely, the possibility of distribution of the

63. Ibid.

64. John Netten Radcliffe and W. H. Power, "Report on an Outbreak of Enteric Fever in Marylebone and the Adjoining Parts of London," in Report of the Medical Officer of the Local Government Board," *Annual Report to the Privy Council and Local Government Board*, n.s., 2, Parliamentary Papers, 1873, 109.

infective material of the disease with some article of food . . . [such as] the distribution of the infective material in milk."[65]

Once milk was suspected, and the other factors had been thoroughly examined, Radcliffe inquired at each household to determine where they received their milk. Tabulating the results and comparing milk service to cases of typhoid, he found that of the 244 cases of the disease, 218 (nine-tenths) were in households that obtained their milk from the Dairy Reform Company. Matching the milk supply to the mortality data, Radcliffe found that the disease "picked out the streets to which the milk was distributed, and the houses in those streets which received the milk."[66] Obtaining information from individual families, Radcliffe found that the disease picked out individuals who either alone among household members drank the milk or who consumed more milk on a regular basis.

The beginning of Radcliffe's report was largely quantitative, comparing mortality statistics between London districts and the affected areas. A large portion of the report, however, provided intricate case-tracing, evidence only obtained through rigorous fieldwork. The following examples are exemplary,

> The mistress and the kitchenmaid were the only persons in a family who habitually drank uncooked milk: they both had enteric fever. Two children in the same family who did not take milk in this form escaped. A physician, in the habit of taking nightly half a pint or more of cold milk, "as it came from the dairy," was the only person in his household who did so, he alone had enteric fever.[67]

Such examples were crucial to establishing the milk-borne hypothesis. They appear in most early epidemiological investigations of milk-borne typhoid by Radcliffe, Ballard, and Thorne-Thorne. While on one level they provided anecdotal evidence which needed to be corroborated with statistical, environmental, and clinical information, these personal clues were vital to demonstrating how diseases moved in populations.

Meeting with Mr. Hope, the director of the Dairy Reform Company, Radcliffe asked permission to allow himself and

65. Ibid, 112.
66. Ibid, 115.
67. Ibid, 116.

Whitmore to conduct a thorough investigation of the eight farms that supplied milk to the company. Reluctantly agreeing, the company stipulated that Radcliffe and Whitmore would be joined by two representatives hired by the company, Chalmers Morton, a Rivers Pollution inspector, and William Corfield, Professor of Hygiene at University College London. The group was, as several of the London medical press prescribed, akin to a "royal commission," and began their investigation on 11 August.[68]

Throughout the several-month investigation, the Dairy Reform Company remained committed to the conclusion that their milk was unadulterated and had nothing to do with the Marylebone outbreak. That the Dairy Reform Company was even accused of distributing adulterated milk charged with the germs of typhoid is perhaps ironic, considering that the company began as a new enterprise whose aim was to correct the rampantly adulterated and inconsistent supply of milk in the metropolis. In an advertisement for the Dairy Reform Company in the first edition of *The Milk Journal* in 1871, the company proudly publicized that "this Company established four years ago for the sale of Pure Milk and Cream, has met with such continued and hearty support from the Public, that its deliveries now cover a very large portion of London."[69] The advertisement also noted that the company was committed to seven principles: unadulterated produce, imperial measures, moderate prices, regularity of delivery, punctuality and correctness of accounts, immediate investigation of all complaints, and weekly payments, and for small quantities, cash on delivery. In February 1871, as a result of Ballard's Islington investigation which linked milk to typhoid, the company filed to conduct their business under the Law of Limited Liability, which in Victorian Britain provided a kind of shareholder immunity, so that if indicted, investors could not lose personal assets.[70] The directors of the company wrote that "the means the Directors possess of preventing

68. The Dairy Reform Company's choice of selecting Corfield as their own private investigator is perhaps odd, considering that Corfield was a colleague with Radcliffe; both had served as joint secretaries for the Epidemiological Society of London from 1870 to 1872.

69. Dairy Reform Company advertisement, *Milk J.*, 1871, *1*, 6.

70. Dairy Reform Company, "Memorandum of Association of the Dairy Reform Company, Limited," Board of Trade, BT/1591/5277, NA.

Adulteration of the Produce . . . are complete and absolute, and [we] will continue in the future as in the past to give that personal attention to the business which has made its success."[71] By 1873, therefore, the Dairy Reform Company was fully aware of the etiological hypothesis that milk could under certain circumstances spread typhoid fever. Admitting their responsibility in the Marylebone outbreak, however, could potentially destroy the precise platform on which they built their company.

According to Whitmore, the investigation of the eight farms that supplied milk to the Dairy Reform Company was directed to ascertaining five different facts: (1) the system of drainage carried out at the different farms and nature of the soil, (2) the quality and quantity of the water supply, (3) the general condition of the cows and nature of their food, (4) the health of the occupants and laborers on the farms and of the surrounding parishes, and (5) the mode by which the washing and cooling of the milk cans was carried out at each farm, the quality of the water used for the purpose, and arrangements generally adopted for preserving the milk free from pollution of any kind.[72] Investigating the first seven farms, most of which were situated in Oxfordshire, the group found nothing amiss. At the eighth farm, however, called the Chilton Grove Farm, the sanitary conditions were deplorable, and several people either living at the farm or working there had died of typhoid preceding the Marylebone outbreak, most notably the farm's owner, Mr. Jessop.

The group first questioned the local medical officer and tabulated the cases of typhoid that occurred between June and August 1873. Led by Radcliffe and Corfield, they next carefully surveyed the farm for defects in drainage, water supply, and sewerage. They were particularly concerned with the drainage. The position of the well in the bottom of a shallow funnel was such that it was highly probable that soakage from either the privy, the drains, or the pigsty had occurred. Radcliffe found that the water from the well had been disused in the farm for drinking and cooking purposes on account

71. Dairy Reform Company Advertisements, *Milk J.*, 1871, *3*, 30; and *The Pall Mall Gaz.*, 1871, *1870*, 46.

72. Whitmore, St. Marylebone, Annual Report of the Medical Officer of Health, 1873, 3–4.

of increasing "distastefulness." Although the family obtained their water from a nearby spring, they still used the well water for dairy purposes. Upon a series of excavations to test the drains, Radcliffe and Corfield found that the reason the well water had been polluted was because of leakage from the pigsty and ash heap and a small leak in the well drain.[73] This was vitally important because the local physician who gave medical attention to the farm's owner told Radcliffe that he instructed the typhoid discharges to be specifically placed in the ash heap instead of the privy so that dangerous miasmas would not harm other members of the family. As Radcliffe ruefully noted, "by an unhappy and altogether unforeseen chance, and in carrying out precautions to obviate any possibility of mischief the matters from which mischief was most apt to arise were deposited in perhaps the only spot on the farm premises where they would certainly find their way into the water used for dairy purposes."[74] The group could now explain how the typhoid discharges from the owner of the farm had gotten into the farm's well water, and subsequently into the milk. Although the Chilton Grove Farm denied adulterating their milk with the tainted water, they did note that they regularly used the well water to cleanse the churns, utensils, and other materials at the dairy. Satisfied that he had epidemiologically traced the Marylebone epidemic to the Chilton Grove Farm, on 13 August, while still in Oxfordshire, Radcliffe sent a telegram to Murchison in London, which merely said, "source dis-covered and stopped."[75] Corfield and Chalmers Morton also telegraphed the Dairy Reform Company, and urged them to stop the supply of their milk from this particular farm.[76]

The Dairy Reform Company was attacked on several fronts, mainly for not analyzing and inspecting the sources from which they obtained their milk. Alfred Smee, analytical chemist and sanitarian, wrote that "The defiant tone of Mr. Hope, after the lamentable events which have lately occurred from the want of sagacity shown by the Dairy Reform Company, under his management, is

73. Radcliffe and Power, "Report on an Outbreak of Enteric Fever," 125.
74. Ibid.
75. Telegram from Radcliffe to Murchison, 13 August 1873, Murchison, Personal Papers, MS 710, RCP.
76. *Marylebone Mercury*, 23 August 1873, newspaper clipping from Murchison Personal Papers, MS 710, RCP.

as much to be wondered at as deplored."[77] The epidemiological evidence gathered by Radcliffe, Whitmore, and Corfield forced the Dairy Reform Company to admit their mistake.[78] In an issue of the *Pall Mall Gazette* for 26 August 1873, the company announced that they would conduct weekly sanitary, veterinary, and chemical inspections of all the dairy farms from where milk was supplied, the central London distribution center, and households of families who were associated with the company. The company was poised to hire a veterinary surgeon, and two analytical chemists, and provide arrangement for any London MOH to visit any of their farms upon request.[79] Without any compulsory legislation, this kind of sanitary supervision of a dairy company was rare until the 1880s and 1890s, when Parliament enacted such compulsory legislation.[80]

The 1873 Marylebone milk crisis, as it was often later referred to, was widely covered in the British press, and served as a focal point in the history of Victorian public health.[81] The *Daily Telegraph* noted that "the light thrown by this report upon the powers of Science ought to arouse, and must arouse, the activity of those who are entrusted with the power to protect society."[82] Murchison believed that the Marylebone investigation produced three highly beneficial outcomes: it gave publicity to the fact that milk-borne typhoid was not an etiological obscurity, but a common occurrence, it encouraged preventive legislation to curb unsanitary milk practices, and it made milk consumers more aware of the potential danger of adulterated milk.[83] Budd echoed Murchison in his 1873 *Typhoid Fever*, noting that, "in order to have a just estimate of the share it takes in the propagation of this fever,

77. Alfred Smee, *Milk, Typhoid Fever, and Sewage*: *A Series of Letters* (London: W.H. & L. Collingridge, 1873), 5.

78. D. Maconochie, "The Late Typhoid Epidemic," *The Times*, 1873, no. *27778*, 8.

79. Anon., "Occasional Notes," *The Pall Mall Gaz*., 1873, *2261*, 8.

80. For his part in the Marylebone investigation, Murchison was given a formal testimonial from both the Marylebone Vestry and the customers of the Dairy Reform Company. See Anon., "Milk and Typhoid Fever," *The Marylebone Mercury*, 4 October 1873; Anon., untitled editorial, *The Daily Telegraph*, 13 December 1873; Anon., untitled editorial, *The Observer*, 19 April 1874; Anon., "Presentation of Address and Testimonial to Dr. Murchison," *Med. Times Gaz*., 25 April 1874. All clippings from Murchison, Personal Papers, MS 710, RCP.

81. Ibid. See also, *Br. Med. J.* from August to December 1873.

82. Anon., untitled editorial, The *Daily Telegraph*, 1873, clipping in Murchison, Personal Papers, MS 710.

83. "Presentation of Address and Testimonial to Dr. Murchison."

we must include the cases in which fever-tainted water is drunk as a diluent of milk. . . . I have no doubt that this mode of infection is much more common than it is generally supposed to be."[84]

By the 1880s, knowledge about the transmission of epidemic disease through food, milk being the most important, was widely accepted. Francis Vacher, MOH for Birkenhead, noted in 1881 that food might spread disease in three ways: the food itself could be in a pathological state, the food could serve as a medium, or nidus for the multiplication of disease germs, or the food could serve simply as a vehicle where germs rested.[85] It was unclear, however, even as late as the early 1900s, whether milk could act in all three ways, or was exclusive to one or two.

## REDEFINING AN "EPIDEMIOLOGICAL MYTHOLOGY"

In 1868, John Netten Radcliffe read a paper at the Epidemiological Society of London which outlined the scope of Victorian epidemiology. Rhetorically, Radcliffe compared epidemiology with meteorology, arguing that "epidemiological inquiries have to be conducted in much the same way as meteorological inquiries; and that to be fruitful of good, both must equally rest on accurate data collected in a wide area of observation, and over periods of time more or less extended."[86] Radcliffe's vision of epidemiology was defined by a six-point approach that outlined how to conduct an epidemiological investigation, which was the first of its kind in the history of epidemiology and specifically detailed the importance of field-based inquiry and observation. For an epidemiologist to complete an investigation, they needed to know:

1. What were the exact dates of the earliest recognized or ascertained cases of the disease, whether the cases proved fatal or not?
2. Did these cases occur among strangers or persons recently arrived in the place, or among residents who had not been recently away from it?

84. William Budd, *Typhoid Fever* (London: Longmans Green & Co., 1873), 103.

85. Francis Vacher, "The Influence of Various Articles of Food in Spreading Parasitic, Zymotic, Tubercular and Other Diseases," in *Transactions of the International Medical Congress*, 7th session (London: J.W. Kolckmann, 1881), 3: 489–90.

86. John Netten Radcliffe, "Report on the Recent Epidemic of Cholera (1865–1866)," read 6 April 1868 in *Transactions of the Epidemiological Society of London 3*, Sessions 1866 to 1876 (London: Hardwicke and Bogue, 1876), 232.

3. Had there been any unusual amount of bowel disorders, or other form of sickness, prevalent among the inhabitants prior to the occurrence of these cases?
4. What part of the town or village did the first cases occur, and what part or district suffered most during the visitation?
5. What was the nearest place where the disease was known to exist at the time of the occurrence of the first cases, or to have existed shortly before such occurrence?
6. What precautionary measures have been taken by the authorities to avert, or to meet, the visitation?[87]

Radcliffe's epidemiology was field-based, observational, environmental, and statistical. His programmatic statement substantiates Anne Hardy's claim that an epidemiological tradition was well established by the last two decades of the nineteenth century, and helps define a period in British epidemiology that has been neglected. Hardy argues that in the late nineteenth century, British epidemiology (unlike its American and German counterparts) was cautious in adopting the methodologies and theoretical explanations of laboratory-based bacteriology.[88] Instead, British epidemiologists remained committed to a field-based, observational approach to epidemiology, whose origins can be traced to the mid-century precedents set by John Snow and William Budd.

However, while Snow and Budd were clearly vital in establishing the theoretically important water-borne hypotheses of cholera and typhoid, respectively, it is possible that the historical attention given to them has overshadowed the complex nature of British epidemiology, and thus created a historiographical black hole that has underestimated the importance of epidemiology in the second half of the nineteenth century. Hardy has dubbed the phenomenon an "epidemiological mythology," meaning that research on Snow and Budd has "perhaps made it too easy to forget subsequent research

87. Ibid, 233.

88. Anne Hardy, "Methods of Outbreak Investigation in the 'Era of Bacteriology' 1880–1920," in *A History of Epidemiologic Methods and Concepts*, ed. A Morabia (Berlin: Birkhauser Verlag, 2004), 199. See also Michael Worboys, "Was There a Bacteriological Revolution in Late Nineteenth Century Medicine?" *Stud. Hist. Phil. Biol. Biomed. Sci.*, 2007, *38*, 20–42. It is clear, however, that John Simon, as Chief Medical Officer, believed laboratory-based science played a vital role in public health, evidenced by his appointments of John Burden-Sanderson and J. L. W. Thudichum. See Terrie Romano, *Making Medicine Scientific: John Burdon Sanderson and the Culture of Victorian Science* (Baltimore: John Hopkins University Press, 2002).

which contributed to the shaping of epidemiology as a discipline, and to the establishing of its identity."[89] An institutional and political identity, one might add, which was first making extensive claims about its scientific authority precisely at the same time it was resisting new types of laboratory models. Indicative here, are the programmatic statements by Radcliffe explored above.

Furthering Hardy's claim, how are we to understand epidemiology in the second half of the nineteenth century? Future topics might include exploring the theoretical, institutional, and methodological discourses in which late Victorian epidemiology was entrenched; or, we might focus on how contests of professional and scientific authority between (or within) different facets of Victorian public health, for example, between epidemiology, chemistry, or sanitary engineering, led to the development of a professional identity. Predicated upon either approach, however, is the need to understand the practices of late Victorian epidemiology. The practices of Victorian epidemiology were firmly rooted in a larger, politically motivated, practically reinforced discourse largely framed by public health leaders such as John Simon which necessitated that medical research was to be conducted not only in the laboratory and the hospital, but, most importantly to epidemiologists such as Radcliffe, the community.[90]

Scientific practices are an important topic in the history of public health. They provide unique access into how knowledge claims about the natural world were constructed, circulated, and contested. Michael Worboys' *Spreading Germs* has made clear that the complex, and often conflicting debates over germ theories were at the heart of British public health in late Victorian Britain.[91] Worboys has shown that contemporary theoretical questions of etiology were predicated on what he terms "germ practices." The example explored here of investigations of milk-borne typhoid further substantiates Worboys's claim that public health practices included not only laboratory work of isolating microbes, remedial work such as disinfection, and

89. Hardy, "Methods of Outbreak Investigation in the 'Era of Bacteriology,'" 200. On Snow, see Peter Vinten-Johansen et al., *Cholera, Chloroform, and the Science of Medicine* (Oxford: Oxford University Press, 2003). On Budd, see Pelling, *Cholera, Fever, and English Medicine.*

90. William Bynum, *Science and the Practice of Medicine in the Nineteenth Century* (Cambridge: Cambridge University Press, 1994), 84.

91. Michael Worboys, *Spreading Germs* (Cambridge: Cambridge University Press, 2000).

preventive work such as quarantine, but practical work of disease investigation, namely epidemiological field-work. From the 1870s, the sources and routes of disease transmission were often more important than the nature of the germ itself. This was represented as early as 1853 by John Snow in his paper "On Continuous Molecular Changes," presented to the Medical Society of London, in which he deliberately used the word "communicable" as opposed to older, politically loaded "contagious," or Farr's newer "zymotic," to describe disease transmission. As Vinten-Johansen et al. have argued, "he [Snow] considered the term *communicable* preferable to *contagious* or *zymotic* because communicability can be direct as well as indirect, and it emphasized the process of change."[92] Snow's water-borne theory was predicated upon an indirect communicability, which led subsequent epidemiologists of the 1860s and 1870s to consider indirect vehicles alternative to water.

Establishing routes of indirect transmission often required statistical methods of case tracing in populations, and John Eyler has shown how Victorian epidemiology was firmly rooted in a statistical tradition largely attributable to William Farr.[93] Medical Officers of Health and inspectors at the Medical Department of the Local Government Board were dependent on the activities and statistics of the General Record Office (GRO). John Simon, for instance, keenly watched GRO reports in deciding where to send his inspectorate. The inspectorate, in turn, often relied on many of the simpler statistical methods developed by Farr to compare risks of dying, and by implication, risks of getting sick. We know less, however, about other crucial epidemiological practices, such as tracking disease, fusing theory and practice, mapping disease onto the body and onto populations, and testing etiological hypotheses in the field, a historiographical deficiency this paper only begins to address.

## CONCLUSION

In the late 1980s, William Coleman identified three aspects of modern epidemiology: clinical specificity, meaning accurate diagnosis of individual cases; epidemiological specificity, meaning

92. Vinten-Johansen et al., *Cholera, Chloroform, and the Science of Medicine*, 379.

93. John Eyler, *Victorian Social Medicine* (Baltimore: Johns Hopkins University Press, 1979).

knowledge of the broad-based ecological and population aspects of a disease; and causal specificity, meaning the identification of a unique causal organism for a disease.[94] Late Victorian epidemiologists claimed scientific authority based on their ability to understand the transmission of epidemic disease (Coleman's second characteristic), often irrespective of speculations about disease agents (his third characteristic). What this means to public health historians, is that we should take these epistemic claims more seriously, particularly in crucial testing grounds such as the one examined here on problems surrounding milk and disease. Such cases, and there were many in the late Victorian period, were testing grounds where the discipline made extensive programmatic claims about scientific and professional authority, and drew disciplinary boundaries, distinguishing itself from other public health sciences such as chemistry, bacteriology, and clinical medicine.

Taylor, Ballard, and Radcliffe provided the first epidemiological evidence that milk could spread epidemic disease. Such epidemiological inquiries continued into the 1880s and 1890s by MOHs such as James Russell in Glasgow, Charles Cameron in Dublin, David Davies in Bristol, Arthur Newsholme in Brighton, and inspectors at the Medical Department such as Thorne-Thorne, Power, and Buchanan. Ernest Hart was probably the most prolific writer on milk and disease in the 1880s and 1890s. His editorials in the *BMJ* give unique privilege to the role of epidemiology. Typhoid continued to be a problem in the last few decades of the nineteenth century; despite improved clinical diagnosis via the Widal test, outbreaks of food-borne typhoid, either through milk, water, shellfish, or human carriers, still claimed the lives of a substantial number of Britons.

My main point is that the 1870s served as a fundamental turning point, one in which milk only became exposed as a public health threat as a result of mounting epidemiological evidence that traced outbreaks of typhoid fever, often localized, to dairy farms, often located far from the actual outbreak. The concept, and practical utility of a localized outbreak, was vital to Victorian epidemiologists, as it provided an opportunity to carefully trace cases to sources of

94. William Coleman, *Yellow Fever in the North* (Madison: University of Wisconsin Press, 1987), xiv–xv.

infection, and ultimately, to test etiological hypotheses. Budd summarized this position aptly, noting that "in the propagation of disease by human intercourse, rural districts, where the population is thin, and the lines of intercourse are few and always easily traced, offer opportunities for its settlement which are not to be met with in the crowded haunts of large towns."[95] Local epidemiological investigations were, in other words, at the heart of British epidemiology in the Victorian period.[96] We often describe Victorian epidemiology as primarily urban centered, and population-based. However, it is clear that epidemiology was also being practiced in rural areas, or in cases of milk-borne typhoid, both urban and rural spaces. Although epidemiological investigations were often fuelled by urban- and class-predicated pressures of milk consumption—wealthy Londoners needed pure milk for instance—the practices of epidemiology were often local.

Following Hardy, this article disrupts Lilienfeld's assessment that:

> Beginning in 1870 and until 1910, the Bacteriological Era overshadowed epidemiology. During these 40 years, epidemiology hibernated in Francis Galton's and Karl Pearson's biostatistical laboratory. Here, the next generation of English epidemiologists were trained. It was to be under the leadership of Major Greenwood and Percy Stocks that "epidemiology" was to undergo a Renaissance in England.[97]

We have long known in the history of medicine that epidemiology played an important role in the creation of modern public health. We have assumed, however, that epidemiological methods, practices, and theories were quickly overtaken by bacteriology starting in the 1870s. This article redresses this imbalance, arguing that epidemiology was alive and well in the second half of the nineteenth century. Late Victorian epidemiology was committed to a field-based, observational methodology, and was being practiced throughout Britain (and lest we forget, the British Empire), most notably by Medical Inspectors at the Medical Department of the Local Government Board and Medical Officers of Health. Victorian epidemiology, as

95. Budd, *Typhoid Fever*, 70.

96. By the 1930s, William Pickles could lament the loss of a locally based, rural epidemiology. William Pickles, *Epidemiology in Country Practice* (Bristol: John Wright & Sons, 1939).

97. David Lilienfeld, "The Greening of Epidemiology: Sanitary Physicians and the London Epidemiological Society (1830–1870)," *Bull. Hist. Med.*, 1979, *52*, 503–28, 527.

practiced by these epidemiologists, was dependent upon a wide web of circulating knowledge about disease causation, etiology, and practical methodology that traced disease in individuals, populations, and environments. Epidemiological knowledge was often created locally, and made general to fulfill etiological hypotheses such as the milk-borne theory. How that localized knowledge was created, in this case through epidemiological practices, is as important as how it was then politically used and scientifically advanced.

ACKNOWLEDGEMENTS

I would like to thank those who attended earlier versions of this paper at the Three Societies meeting, Oxford, and the meeting of the American Association for the History of Medicine, Rochester, especially Anne Hardy, Chris Hamlin, and Michael Worboys. Particular thanks are due to Jane Seymour, who commented on an earlier draft, and John Eyler, whose critical commentary and assistance have been invaluable. Thanks also go to the editor and two anonymous referees for JHM.

FUNDING

None.