Dr John Snow and an early investigation of groundwater contamination

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Abstract: John Snow was a physician but his studies of the way in which cholera is spread have long attracted the interest of hydrogeologists. From his investigation into the epidemiology of the cholera outbreak around the well in Broad Street, London, in 1854, Snow gained valuable evidence that cholera is spread by contamination of drinking water. Subsequent research by others showed that the well was contaminated by sewage. The study therefore represents one of the first, if not the first, study of an incident of groundwater contamination in Britain. Although he had no formal geological training, it is clear that Snow had a much better understanding of groundwater than many modern medical practitioners. At the time of the outbreak Snow was continuing his practice as a physician and anaesthetist. His casebooks for 1854 do not even mention cholera. Yet, nearly 150 years later, he is as well known for his work on cholera as for his pioneering work on anaesthesia, and his discoveries are still the subject of controversy.

The life of John Snow shows several similarities with that of William Smith (Torrens 2004). Like Smith, Snow came from a humble background and – at least in his early life – had little formal education. Both men pioneered new fields of study and achieved fame and respect but not without some controversy and reluctance on the part of their contemporaries to accept some of their views. Both also followed dual careers: Smith as a surveyor and geologist, Snow in two new fields of medicine – epidemiology and anaesthesiology. In the latter field he was accepted and respected in his own lifetime; in the former, in which he is probably best remembered today, at least by those outside the medical profession, he faced opposition and sometimes ridicule.

Snow’s childhood

Much has been written about Snow and his work but biographical details are lacking. There is one contemporary account of Snow’s life and work, written by a close friend and colleague, Dr (later Sir) Benjamin Ward Richardson, and published within two months of Snow’s death. This was written as a Memoir to preface Snow’s work On chloroform and other anaesthetics (Snow 1858) which he had just completed at the time of his death in 1858 and whose publication was overseen by Richardson (Ellis 1994). It has to be remembered that Richardson wrote this work at the age of 29, when he was still mourning the death of the man he regarded as a close friend and mentor. Consequently it is affectionate in tone and some of the detail may not be totally reliable. More recent biographies include the summary by Ellis (1994), the book by Shephard (1995) and papers by Roberts (1999) and Stephanie Snow (2000a,b). All of these are forced to draw heavily on relatively limited personal details (mostly Richardson’s work) but from them a picture of Snow and his life emerges.

John Snow was born in York on 15 March 1813. Ellis (1994) notes that Richardson erroneously records the date as 15 June. He was the oldest of nine children of William and Frances (Fanny) Snow who had married in 1812. His mother had been born in 1789, the illegitimate daughter of John Empson and Mary Askham, who married when Fanny was nearly three (Snow 2000a). Fanny’s brother, Charles Empson, was to have a major influence on John Snow’s early life.

At the time of Snow’s birth, the family lived in North Street, alongside the River Ouse in a poor part of York that was badly drained and prone to flooding. His father’s occupation was recorded as ‘labourer’. Given these inauspicious beginnings, the family’s subsequent history and improvement are remarkable (Ellis 1994; Snow 2000a). Of the six sons of William and Fanny, the youngest died in infancy and nothing is known of the third, Charles. Of the other four, John became a doctor, William a businessman, Robert a colliery manager and Thomas a teacher and subsequently a vicar. Of John Snow’s three sisters, Mary and Hannah both became teachers, remained spinsters and eventually ran their own school before retiring to Harrogate. His youngest sister, Sarah, married a farmer.

Five or six years after John Snow’s birth, his...
father changed his occupation from labourer to driver and sometime between 1821 and 1823 the family moved their home a short distance to Wellington Row (Snow 2000a). There appears to have been a major improvement in the family's fortunes by the time of the birth of Hannah, Snow's younger sister, in March 1825, for it was then that William Snow purchased a house in Queen Street. In 1832 William Snow is listed as a farmer in Queen Street, and Richardson describes John Snow as the son of a farmer. In the 1830s William also bought four more houses in Queen Street and rented them out. In 1841 the family moved to a farm at Rawcliffe, then a village to the NE of the city.

This transition from unskilled manual worker to farmer, from labourer to landowner, albeit perhaps on a small scale, is notable. Snow (2000a) speculates that William Snow may have made money to buy the farm at Rawcliffe by selling the Queen Street property to a railway company, but where did he get the money to buy these properties in the first place? It is clear that William and Fanny (or at least one of them) had energy and the foresight to ensure that their children were educated and provided with the best possible start in life given their circumstances. Even so it would have been difficult for a labourer or cart driver to amass the money needed to buy property, especially while trying to feed, house and clothe a wife and several children. Snow (2000a) suggests the possibility of a generous benefactor.

Richardson records that John Snow was educated at a 'private school at York'. Ellis (1994) is at pains to point out that 'private school' in this context does not refer to anything approaching a modern British public school with its expensive fees, but something more akin to what would later be called a 'dame's school'. This would have been some form of local school, organized by parents from the poorer classes who were trying to give their children the elements of an education. Snow (2000a) agrees and comments that education at such a school would probably have cost around 6d (2.5 pence) per week, a substantial outlay from William's probable weekly wage of around 15s (75 pence or £0.75). This is an indication of the determination of Snow's parents to improve the lot of their children.

Ellis suggests that the education would have given him little more than the basic reading, writing and arithmetic. He notes that at some point in his later medical training Snow would have needed Latin and possibly Greek. Snow (2000a) speculates that he might have acquired this in York. However, this seems at odds with Richardson's comment that at this school 'he learned all that he could learn there' with the implication that this was not enough for his later life.

**Snow enters medicine**

In 1827, at the age of 14 and with his elementary education as complete as it could be, Snow left York to seek training in medicine. At that time, there were four classes of medical practitioners - physicians, surgeons, apothecaries and a group referred to as 'those in practice prior to the 1815 Act' (Ellis 1994). The physicians alone were entitled to be called 'Doctor'. They were the medical élite and enjoyed high social status. In England they belonged to the Royal College of Physicians of London, to join which they had to be graduates of Oxford or Cambridge universities. Physicians could prescribe medicines but not dispense them. They regarded themselves as greatly superior to the surgeons, who were regulated by London's Royal College of Surgeons and were Members of that College. Most combined surgery with midwifery and were able to prescribe medicines for non-surgical conditions. A few 'pure' surgeons were eligible to be Fellows of the College.

The surgeons in turn were superior to the apothecaries, mere pill-makers (Ellis 1994). They were licensed to practise by the Worshipful Society of Apothecaries in London, were allowed to prescribe and supply medicines, and by established custom advised on the treatment of non-surgical illnesses. The fourth group, those with no formal qualifications in any branch of medicine but established in medical practice before the Apothecaries Act of 1815, were allowed to continue in practice until their retirement. The 1815 Act was part of the progress of medical reform that took place in the early 19th century and led to the development of the class that would become known as general practitioners.

Clearly, for John Snow the route via Oxford or Cambridge was out of the question. Instead, on 22 June 1827, he became apprenticed to William Hardcastle in Newcastle. Snow's reasons for choosing a medical career are unknown, though Snow (2000b) points out that at the time medicine, entered via an apprenticeship, still offered one of the cheaper routes for the lower classes to rise up the social scale. However, the whole episode of his training gives rise to many questions. To begin with, why go to Newcastle, some 80 miles from home, when he could presumably have trained in York? Ellis (1994) suggests that his uncle, Charles Empson (his mother's younger brother) may have been the influence, because he had business connections in Newcastle and later had business premises near the centre of the town. Snow (2000b) however points out that Empson did not establish his business in Newcastle until after Snow had settled there with Hardcastle; she points out that Hardcastle had served his own apprenticeship in York and that a connection could have been established then.
A more intriguing question is how the Snow family found the money for this apprenticeship. Snow’s apprenticeship fee was 100 guineas (£105), an almost inconceivable sum for a labourer’s family to find. In addition there would have been the outlay for books and instruments and the considerable cost of travel between York and Newcastle. The most likely source of the money, and probably the reason for the choice of Newcastle, seems to be Charles Empson.

Snow generally seems to have got on well with his master, who appears to have been well respected in the local medical community. (He was among other things doctor to the family of Robert Stephenson who lived at Killingworth and was a friend of Snow’s uncle, Charles Empson (Snow 2000b). In addition to the training he would have received under Hardcastle, Snow attended classes at a rudimentary medical school that was established in Newcastle on 1 October 1832. It was at Killingworth Colliery that he saw at first hand the effects of cholera.

In 1833, his term of apprenticeship with Hardcastle completed, Snow took a post as assistant to Mr Watson of Burnop Field, near Newcastle. This may have been to gain more clinical experience before going on to formal medical training, or it may simply have been because he lacked the funds for that education. Study at a formal institution required the student to find the money to pay for accommodation, food and books as well as tuition fees, putting such education generally beyond the reach of the poorer classes.

Snow appears to have been less happy with Watson than he had been with Hardcastle, and left the post after just a year. Richardson (1858) remarks that Snow “worked too hard for his money”. As Snow’s later life reveals that he was not one to avoid hard work, it seems that Watson must have been a demanding master.

Snow left Burnop Field to return to Yorkshire, again to work as a medical assistant. His principal this time was Joseph Warburton, who practised at Pateley Bridge in Nidderdale, which at that time was a small lead-mining and quarrying town with a population of about 1500 (Ellis 1994). Farms were small, the land was steep, the climate cold and wet and the living hard, but Snow seems to have enjoyed himself there; Richardson states that he thought highly of Mr Warburton. In 1836 he returned to York to stay with his family for a few months. In this period Richardson records that he made long walking expeditions into the countryside, ‘collecting all kinds of information – geological, social, sanitary and architectural’. Although he never seems to have had any formal geological training, it is noteworthy that later, in London, he was to show evidence of clear thinking on geological matters.

Later in 1836 Snow moved to London to take up his formal medical education. He made the journey on foot, via Liverpool, Wales and Bath where he visited Charles Empson. He arrived in London in October and enrolled at the Hunterian School of Medicine where he studied for one year. The cost of a complete course of lectures, demonstrations and practicals was 29 guineas (£30.45); by paying £34 a student could be entered as ‘perpetual’ with the right to attend future courses of lectures without further charge (Ellis 1994). The Hunterian School was in Great Windmill Street, on the western edge of Soho, an area that Snow would come to know well. In the very heart of London, it was within walking distance of several of London’s teaching hospitals, including the Westminster Hospital at which Snow continued his studies in 1837–1838 by walking the wards (Ellis 1994; Snow 2000b).

During his time at the Hunterian School, Snow needed convenient and cheap lodgings. The once-fashionable area of Soho was moving socially downward, as the genteel classes who had once been its principal residents moved further west to Piccadilly and beyond. Many parts of Soho were occupied by poor families who welcomed lodgers as a source of income and who did not charge the rents that would have been asked nearer to Piccadilly. Snow took up lodgings at 11 Bateman’s Buildings, running south from Soho Square. Today, Bateman’s Buildings is a narrow, non-descript, dank alleyway, gloomy and smelling of urine. In Snow’s day, we can assume that it was less attractive. Similar alleys and ‘courts’ formed a large part of the residential property of Soho. Snow shared his lodgings with a fellow student at the Hunterian, Joshua Parsons (Snow 2000b).

On completing his hospital practice in 1838, Snow applied for the post of apothecary in the Westminster Hospital, which became available in July of that year. He had successfully sat the examination of the Royal College of Surgeons in May 1838, but ran into the immediate problem that he had not yet passed the examination of the Society of Apothecaries, who because of a technicality would not allow him to sit the examination until October of that year. Snow sat and passed the Apothecaries’ examination on 4 October, but the chance of a hospital appointment, with its attendant kudos and the basis it provided for establishing a private practice, was lost (Snow 2000b). Instead, at the beginning of September 1838, he moved from his student lodgings in Bateman’s Buildings around the corner to a house at 54 Frith Street, where he set up in practice.

For the first few years of his life as a medical practitioner, Snow supplemented his income by working in the outpatient department of Charing Cross Hospital. He attended meetings of medical societies and continued to gain medical qualifications (Ellis...
1994). In November 1843 he became a Bachelor of Medicine of the University of London, and in December 1844 he attained that university’s doctorate, the MD. In June 1850 he passed the examination to become a Licentiate of the Royal College of Physicians, a qualification equivalent to the Member (MRCP) status of today.

Ellis points out that none of these qualifications was necessary for Snow to practise as a family doctor, so his acquisition of them probably indicated a desire to continue to better himself. Perhaps also they may indicate a need to prove that he, despite his humble origins, was as good as the products of the traditional training; perhaps it was a feeling of insecurity, and the desire to ensure that he was firmly established in his profession. With or without these qualifications, it was possible that Snow would have continued in practice as a family doctor in Soho, competent and respected, but unremarkable and unremembered, but for two events; the introduction of anaesthetics and the return of cholera.

The advent of anaesthesia

The first recorded use of anaesthesia is by a Boston dentist, William Morton, who administered sulphuric ether to perform a dental extraction in his own practice on 30 September 1846. Two weeks later, on 16 October, he gave the first public demonstration of the use of ether in surgery at the Massachusetts General Hospital in Boston (Ellis 1994). Initially, Morton attempted to maximize the financial benefit of his discovery by keeping the details secret. This secrecy was largely counter-productive, because it led to a slow acceptance of the use of ether in the USA. Instead the idea spread to Britain, where it was first used on Saturday, 19 December 1846 by another dentist, James Robinson. Ellis records that within a few days, Snow had heard of the use and visited Robinson’s home in London to see anaesthesia in practice.

Snow realized the significance of Robinson’s demonstration. He also realized that for anaesthesia to work effectively and safely, its use must be on a scientific basis. He designed an inhaler for the administration of ether. He also studied his patients closely and in late 1847 published ‘his small but classic textbook’ (Ellis 1994) On the inhalation of the vapour of ether in surgical operations. This book was published by John Churchill, who was later to publish much of Snow’s work on cholera.

Within a few years he had established himself as London’s leading expert in the science and practice of anaesthesiology. He administered chloroform to Queen Victoria at the births of Prince Leopold (1853) and Princess Beatrice (1857). By then, he had embarked on another area of study.

The coming of cholera

The word cholera derives from the Greek word for bile, the illness being characterized by severe diarrhoea and bilious vomiting. An illness described by various names such as ‘British cholera’ had long been recognized in Britain but in the 19th Century Western medical men became increasingly aware of a much more serious, often fatal, illness that originated in Asia and was termed ‘Asiatic cholera’ to distinguish it from the milder, home-grown version.

Snow wrote in 1849 that cholera had first been recognized in India in 1817. In 1855, he commented that:

‘The existence of Asiatic Cholera cannot be distinctly traced back further than the year 1769. Previous to that time the greater part of India was unknown to European medical men; and this is probably the reason why the history of cholera does not extend to a more remote period.’

A few years later, Macpherson (1867) recorded that the Portuguese reached the coast of India in 1497 and began settling there around 1502, with Goa founded in 1510. In 1503, during a campaign, they noticed cholera and smallpox proving fatal to Europeans. Then, in 1543, they reported ‘an epidemic of cholera of frightful intensity at Goa’.

It seems now accepted that, however long cholera may have been present in India, the major outbreak that really drew it to wider notice occurred in Bengal, in and around the Ganges Delta, in 1817. (It is possible that the bacterium responsible may have undergone a mutation at around this time.) It then began to spread rapidly. Some geologists have linked this spread to the displacement of populations caused by poor harvests following the eruption of Tambora on 10 April, 1815 (Robock 2002). Other workers attribute it more prosaically to the expansion of the British Empire, the increase in trade between India and Europe, and the general increase in movement of people and commodities (see, e.g. Evans 1987). By 1819 it had reached Mauritius and by 1824 it covered the whole of South-East Asia. Westward, it was carried by traders across Afghanistan. It was then halted by a military cordon sanitaire around Astrakhan in 1823, but reappeared in Persia and again crossed the Caspian Sea. This time the cordon sanitaire failed to work and it spread up the Volga, eventually reaching Moscow in 1832. By July 1831 it had reached Riga on the Baltic (Evans 1987).

A namesake of John Snow, writing on the other side of the Atlantic, recorded its progress as reaching Berlin and Vienna in August 1831. From Berlin it spread to Hamburg and thence to Sunderland, on the coast of NE England, where the first case
was recorded on 24 October 1831 (E. M. Snow 1857). Stephanie Snow (2000c) reports his name as William Sproat. The arrival from Hamburg is significant. In the subsequent epidemic of 1848-1849, John Snow recorded that the first case in London 'was that of a seaman named John Harold, who had newly arrived by the Elbe steamer from Hamburg, where the disease was prevailing' (Snow 1849, 1855). In 1857, the influential journal The Builder, fearing the return of the disease from Europe, remarked 'Hamburg has ever been our warning'.

Snow (1855) remarked perceptively that cholera 'travels along the great tracks of human intercourse, never going faster than people travel and generally much more slowly. In extending to a fresh island or continent, it always appears first at a sea-port.'

In the present day it is almost impossible to imagine the impact that cholera had on populations in the 19th Century. Fatal diseases, including smallpox, tuberculosis and typhoid, were no strangers, but they generally acted slowly or at least spread by obvious contact with infected persons. Cholera came suddenly and without warning; its victims could be perfectly healthy in the morning and dead by nightfall. Perhaps worse was the manner of their demise. Those with tuberculosis showed few outward symptoms of their ailment - as Evans (1987) remarks 'on the whole they merely became pale and interesting'.

Cholera typically begins with a vague feeling of being unwell, followed rapidly by internal cramps and intense and prolonged vomiting and diarrhoea. The diarrhoea continues, the evacuations usually becoming almost colourless and odourless and having the milky appearance of water in which rice has been boiled, and referred to as 'rice-water evacuations'. The victim goes through a period known as the 'blue, cold stage'. This is brought about by the massive loss of body fluid (up to 25%), which results in the blood becoming thickened and ceasing to circulate properly. The reduction in ability to transport oxygen and heat means that the patient takes on a blue colouration, and feels cold and clammy to the touch. The general loss of fluid volume results in the skin becoming corrugated, and the eyes becoming sunken and dull. The victims are frequently described as having apparently aged many years. In about half of the cases this cold blue stage was fatal, and gave rise to the common name for Asiatic cholera of 'The Blue Death'.

In some cases there was no preliminary feeling of being unwell, and the cramps and evacuations were the first sign of the illness. In rare cases, the cholera sicca or dry cholera, there were no evacuations, the intestines being found after death to be distended with the watery excretion. This was apparently the case of Gustav von Aschenbach in Death in Venice: Thomas Mann spared him the indignity that, for the Victorians, was probably one of the most distressing aspects of cholera symptoms - the loss of control, often in public, of bodily functions.

Patients who survived the blue stage went on to the 'warm pink stage' in which they exhibited fever and began to sweat. Normal colour returned and with the taking of fluid recovery was relatively rapid.

If the symptoms of cholera were bad, the treatment was if anything worse. Medical science had no clear idea of the causative agent of the disease. The general belief was that the disease entered the victim's bloodstream and caused the diminution of the blood by expelling fluid into the intestines. If the body was trying to reduce the volume of blood, it was argued that the best course for the physician to follow was to encourage it. Thus bleeding, either by opening a vein or by the use of leeches, was considered one of the safest courses of medical action.

One of the leading cholera 'experts' of the day was John George French. He comments that the 'first object for the relief of the patient is the diminution of the circulating fluid' and goes on to say that workers in India agree 'that bleeding is beneficial and that a very large quantity of blood should be abstracted in order to derive advantage from this operation' (French 1835). Other treatments recommended included purging (it is not quite clear what would be left to purge) and electric treatment. How severely ill patients responded to such treatment does not seem to be recorded.

The communication of cholera

As there was no effective treatment for cholera, it was obviously best to avoid catching it. The problem was that, as with the treatment, there was no real idea on how the disease was transmitted. One of the most frightening things about cholera was the way it would suddenly appear in a community and then proceed to strike simultaneously people who had never met. In recent decades, only AIDS in its early days can have had anything like the same ability to terrify.

Two competing schools of thought developed to explain the way cholera was spread. One, the contagionists, argued that cholera could clearly be transmitted from one individual to another who had been in close contact. The other group, the miasmalists, argued that for the illness to appear suddenly in a district and strike unconnected people simultaneously, there must be a different mechanism. Noting that cholera was often more prevalent in low-lying areas with bad drainage, or where sanitary facilities were lacking, they claimed that the disease was transmitted by a 'miasma' or foul air. Hence those living near overflowing sewers or cesspits were considered especially vulnerable.

When cholera first arrived in Britain in 1831, it
spread quickly from Sunderland to other towns and settlements in the NE of England. William Harcastle, Snow’s master in Newcastle, was one of two doctors appointed to tend the poor who were suffering from cholera. One locality that was badly affected was the area around Killingworth Colliery, the base of George and Robert Stephenson. Snow accompanied Harcastle, or was sent by him, to Killingworth. He was thus among the first medical men in the country to see the disease at first hand and it is clear from his later writings that the episode stayed in his memory.

Cholera returned to Britain in 1848. There is some dispute over its first appearance, but Snow (1849) reports that ‘the first decided case . . . in London’ was that of the seaman John Harndol, who brought it from Hamburg as described above. He went to live in Horsleydown, ‘was seized with cholera on 22 September, and died in a few hours’.

It is not clear when Snow began to think about the way cholera is communicated. He himself wrote (Snow 1855, p. 125) that he had formed his views in the latter part of 1848. He had seen cholera at first hand in the epidemic of 1831–1832 and took an early interest when it returned to London, studying the circumstances of several cases in detail. Snow set out his evidence (Snow 1849) and his arguments in a pamphlet ‘On the mode of communication of cholera’, which was published by John Churchill. He formed the theory that rather than being caused by some ‘poison’ that alters the blood so that its watery and saline parts begin to be extruded, ‘it is more consistent with observation to say that exudation begins as a result of irritations of the mucous membranes of the alimentary canal’ (Snow 1849).

He went on to say (Snow 1849, p. 8–9) that:

‘if the disease is communicated by something that acts directly on the alimentary canal, the excretions of the sick at once suggest themselves as containing some material which, being accidentally swallowed, might attach itself to the mucous membrane of the small intestines, and thereby multiply itself by the appropriation of surrounding matter, in virtue of molecular changes going on within it, or capable of going on, as soon as it is placed in congenial circumstances.’

This certainly makes it possible that the disease can be transmitted through contact, by for example, persons handling soiled clothing or bed linen and then handling food or putting their fingers in their mouths (a particular problem with small children). This could explain how the infection is transmitted between members of the same family, within lodging houses or down coal mines and would satisfy the contagionist argument. But it also opens up for consideration ‘a most important way in which cholera may be disseminated’ — by sewers emptying into sources of drinking water (Snow 1849, p. 11). Snow showed that in all the cases he had considered, there was clear evidence that the disease was associated either with direct or indirect personal contact or with contamination of drinking water by human excrement. Thus, without resorting to some fanciful ‘miasma’ it was possible to explain how the illness could strike many people, who had never been in contact, simultaneously in a town or village.

He considered this theory ‘less dreary’ than the miasmatic theory, because it offered some way of checking the disease — by hygiene and the provision of a proper water supply. The most urgent need was in south and east London for a supply ‘from some source quite removed from the sewers’ (Snow 1849, p. 30).

Snow’s 1849 pamphlet was reviewed by an anonymous reviewer in the London Medical Gazette who reported that the experimentum crucis would be for the suspected water to be conveyed to a distant locality and there produce the disease in all who drank it (Shephard 1995; Snow 2000e). Otherwise, there was no evidence that infection had not been passed from one victim to another or that all victims had not suffered from some common cause such as a ‘miasma’. It was to take five years and cost more than six hundred lives, but that experiment was to take place.

**Cholera returns**

After the 1848–1849 epidemic, cholera returned to London in 1853. By this time neither the nature of the disease nor its cure were generally recognized. Theories of its communication were multiplying, though the idea of the ‘miasma’ seemed to hold sway. One interesting idea was the ‘geological theory’ propounded by John Lea of Cincinnati (1850). Lea had noticed that when cholera arrived in the United States, it seemed more prevalent in limestone areas than in those underlain by sandstones — ‘it passed around the arenaceous, and spent its fury on the calcareous regions’. He thus concluded that calcareous water was ‘a proximate cause of that disease’—that calcium or magnesium salts were necessary for it to act. Most hydrogeologists would conclude that the effect arose because sandstones are able to filter bacteria from groundwater, whereas limestones, with predominantly fissure permeability and porosity, do not do so; the apertures are large enough to allow bacteria to be transported and the flow speeds great enough that the micro-organisms do not die. John Snow heard of this theory and, though no geologist, was quick to point out that sandstones have the effect of oxidizing and thus destroying organic matters; while the limestone might not have that effect’. He acknowledged the
likelihood of the truth of Lea’s assertion that people who used rain water escaped almost entirely the effects of cholera.

Ironically, by 1854, both the true nature of the disease and an effective treatment were known, but not widely. The German scientist, Robert Koch, is generally credited with identifying *Vibrio cholerae*, the ‘comma’ bacillus and the causative agent of the disease, in 1885, but an Italian, Filippo Pancini, is now acknowledged to have discovered it in 1854 (Evans 1987). The modern treatment for cholera includes intravenous rehydration with saline solution; this technique was suggested in 1831 by William O’Shaughnessy and first used by Thomas Latta in 1832. Snow was clearly aware of the use of injection of saline solution and described its effectiveness in overcoming the symptoms of cholera, commenting that ‘the patient is able to sit up, and for a time seems well’. This last phrase suggests that the treatment was not a permanent cure; it seems that it was not widely used because it was regarded as dangerous, something to be tried only as a last resort on patients who were near death. Usually it seems to have been administered too late, so that in Snow’s day it had not often been successful and was not in favour.

By 1853, water closets and sewers were replacing privies and cesspits in many towns and in many parts of London, in response to the work of Edwin Chadwick and his fellow sanitary reformers. Unfortunately, in many cases the cesspits were neither emptied nor removed, but merely covered over (The Builder 1854). Perhaps more unfortunate, until Bazalgette installed his great ‘interceptor’ sewers, these apparent advances served mainly to convey raw sewage quickly into the tidal reaches of the River Thames, from which many individuals and some companies were still drawing their water supplies. In dry weather in particular, when the flow of the Thames was reduced, the action of the tide served to move this sewage up and down the river through the capital, mixing it thoroughly with the river water from which part of London derived its water supplies.

The Metropolis Water Supply Act of 1852 prohibited companies, after 31 August 1855, from taking water from the Thames below its tidal limit at Teddington Lock (Binnie 1981). It also required that within five years every company must lay on a constant supply of water, for it was still common for many properties to receive water intermittently. Occupiers of buildings stored it in tanks and cisterns, where it was open to disease.

One company, the Lambeth Water Company, had anticipated that act by moving its intakes from opposite Hungerford Market up river to Thames Ditton, above the tidal limit of the Thames and above the worst-polluted stretch of the river. In the 1849 epidemic, Snow had noticed that the southern districts of London appeared to suffer disproportionately from the cholera. Many professionals attributed this to factors such as poverty, overcrowding and bad ventilation, but Snow recognized that it struck in particular houses supplied by two water companies – Southwark and Vauxhall Water Works and the Lambeth Water Company. By the time cholera returned in 1853, the Lambeth Company was operating its new intakes, while the Southwark and Vauxhall was still taking water from its intake at Battersea Fields, on the tidal reach of the Thames with its burden of sewage. Snow realized that the comparison of deaths among the populations served by the Lambeth Water Company and the Southwark and Vauxhall Company was a major piece of evidence in his campaign to identify the means by which cholera was communicated (Snow 1855). The two companies served the same areas. In Snow’s words:

‘The pipes of each Company go down all the streets, and into nearly all the courts and alleys. A few houses are supplied by one Company and a few by the other, according to the decision of the owner or occupier at that time . . . . The experiment, too, was on the grandest scale. No fewer than three hundred thousand people of both sexes, of every age and occupation, and of every rank and station, from gentilefolk down to the very poor, were divided into two groups without their choice, and, in most cases, without their knowledge; one group being supplied with water containing the sewage of London, and, amongst it, whatever might have come from the cholera patients, the other group having water quite free from such impurity . . . . To turn this grand experiment to account, all that was required was to learn the supply of water to each individual house where a fatal attack of cholera might occur.’ (Snow 1855)

Snow duly turned the ‘grand experiment to account’ and found, among other things, by comparing fatal attacks of cholera with source of water, that in every 10000 houses supplied by the Lambeth Water Company there were 5 attacks, and in every 10000 houses supplied by the Southwark and Vauxhall Company there were 71 attacks (Snow 1855, 1857).

**Cholera in St James’s Parish: the ‘Broad Street Pump’**

In 1852 Snow had moved from Frith Street to more prestigious premises at 18 Sackville Street, off Piccadilly. He seems to have retained many of his contacts and patients in Soho, some of whom, according to Richardson, he treated for little or no payment.
In September 1854, while busy with his investigation into the outbreak in south London and the relative quality of the water supplied by the two water companies, Snow became aware of what he described as the 'most terrible outbreak of cholera which ever occurred in this kingdom...the mortality in this limited area probably equals any that was ever caused in this country, even by the plague'.

The outbreak occurred in the Parish of St James, and was particularly severe in Broad Street. There had been a few cases of cholera in the neighbourhood during August 1854, but a dramatic increase occurred on the night of 31 August. The weather had been hot and dry; the weather reports in *The Times* indicate day after day of dry, fine weather, often with cloudless skies and with the daytime temperature in the high sixties to low eighties Fahrenheit (around 20 to 29° Celsius). These are conditions that, as Snow points out, tended to favour the spread of cholera in England. He attributed this partly to the fact that the British, unlike the French and other Europeans, tended not to drink cold water except when the weather was warm, preferring hot drinks at other times.

Snow seems to have become acquainted with the outbreak on 3 September and immediately suspected contamination of the water of a pump in Broad Street, which was much used by the local people. He examined the water on the evening of 3 September but found little visible evidence of any contamination. Over the next two days, he continued to examine the water and found varying amounts of organic impurity, visible to the naked eye, in the form of small white floculent particles.

Snow obtained a list of deaths from cholera registered during the week ending 2 September in the sub-districts of Golden Square, Berwick Street and St Ann's Soho. In these three sub-districts there had been 89 deaths; six had occurred in the first four days of the week, four on Thursday, 31 August and the other 79 on the Friday and Saturday, 1 and 2 September. Snow therefore regarded the outbreak as having started on the Thursday and made detailed enquiries about the 83 deaths that occurred on the Thursday, Friday and Saturday.

He found that nearly all the deaths had occurred within a short distance of the Broad Street pump. Perhaps more significant, there were only ten deaths in houses situated decidedly nearer to another pump. In five of those, the families of the dead told Snow that they always obtained water from the pump in Broad Street, as they preferred the water to that from the nearer pump. In three other cases the victims were children who went to school near the Broad Street pump. Two had been known to drink the water and the third was believed likely to have done so. The other two deaths, some way from the pump, Snow regarded as merely representing the background mortality from cholera that was occurring before the outbreak took place.

Of the 73 deaths that occurred near the pump, Snow found that 61 of the victims had been known to drink water from the pump in Broad Street, either continually or occasionally. Six of the others had been known not to drink the water, and in the other six cases he could get no information because everyone connected with the dead individuals had either also died or had left the area.

Snow therefore concluded that 'there had been no particular outbreak or increase of cholera, in this part of London, except among the persons who were in the habit of drinking the water of the above-mentioned pump' (Snow 1855). He sought a meeting with the Board of Guardians of St James's Parish, in which the pump was situated, on the evening of Thursday 7 September. What was said is not recorded. Richardson (1858) records Snow telling him that his explanation for the disease was treated initially with incredulity but the Guardians nonetheless had the handle removed from the pump on the following day.

Earlier in the week, *The Times* (1854a) had reported that:

>'The severe outbreak of cholera in part of St James's parish, and in the adjacent parts of the parish of St Anne, Soho, has been promptly met by the sanitary and other preventive measures carried out by the boards of guardians, under the advice of the General Board of Health.'

It went on to say that the President of the Board of Health (Sir Benjamin Hall):

>'has directed special attention to the supply of water in the several localities, the source of supply, and whether filtered or not before supply; and when two companies supply in any one district, the inspector is to state whether the disease is more prevalent in one district than the other, having due regard to similar classes of dwellings.'

It seems either that Snow's message was getting through, at least in some quarters, or that other people were thinking along similar lines or possibly that the authorities were anxious not to leave themselves open to criticism for not covering all possibilities.

Figure 1 shows the deaths from cholera in St James's Parish during August and September 1854. (When using this figure it is important to remember that it shows the dates of the recorded deaths, which typically occurred two or three days after the date of infection). It is clear from the figure, and Snow readily admits, that the outbreak was in decline by the time that the handle was removed. Generally speak-
In Broad Street itself, near the pump, was a brewery owned by Mr Huggins. It employed more than seventy men, yet none had died of cholera. The brewery had its own deep well and a supply from the New River company. Mr Huggins believed that the men never drank water from Broad Street, and probably never drank water at all, being given a free allowance of the brewery’s produce! In contrast, on the other side of the pump was a percussion-cap factory owned by Mr Eley. This employed two hundred people; for them to quench their thirst, two large tubs of water were kept there, filled from the pump. Of these two hundred, 18 died of cholera.

As Snow went around, asking questions, checking facts, he kept finding evidence of the link between water from the well and infection with cholera. Perhaps the most striking example was drawn to his attention by a colleague, Dr Fraser. This was a perfect answer to the anonymous reviewer who, following Snow’s 1849 pamphlet, had said that the experimentum crucis would be if suspect water could be conveyed some distance away from an outbreak and there produce cholera in those who drank it. Fraser drew Snow’s attention to a death recorded in Hampstead on 2 September. This was of the widow of a percussion-cap maker (probably, though Snow does not say so, of the former owner of the factory in Broad Street; Chave (1958) states that she was Susannah Eley).

Snow found from the lady’s son that she had not been in Broad Street for many months, but that she had a liking for the water from the Broad Street well. A cart went from Broad Street to Hampstead every day and conveyed to her a large bottle of the water. Water was taken to her on Thursday 31 August and she drank some of it on that evening and the next day.
She was attacked by cholera on Friday evening and died on Saturday 2 September. Her niece, who was visiting her, also drank some of the water before returning to her home in Islington; she too died of cholera.

Snow recorded his findings in the second edition (1855) of his work *On the mode of communication of cholera*. This is a substantial enlargement on the 1849 edition, and deserves the name monograph rather than pamphlet. Richardson records that its publication cost Snow £200 and that only 56 copies were sold, for which he received the princely sum of £3.12s (£3.60).

As part of his work, Snow produced a map of the area (Snow 1855) on which he marked the occurrence of each death from cholera (Fig. 2). There has been some speculation about this map. It has been widely stated that Snow drew the map and inferred from it that the deaths from cholera occurred around the Broad Street pump. (I admit to the same error (Price 1985)). Brody et al. (2000) point out that, in all likelihood, Snow did not draw the map until he was preparing his monograph of 1855 and his contribution to a report to the Cholera Inquiry Committee of St James's Parish. The map was therefore drawn to illustrate his argument that the disease had spread from the pump rather than as the means of deducing the fact. Brody et al. are almost certainly correct in this assertion. However, Snow (1855) says that he suspected the pump as soon as he ‘became acquainted with the situation and extent of this irruption of cholera’. This implies geographical knowledge, which of course Snow had living in the area for 18 years. In effect then, the map was in his head. He had no need physically to plot it for himself, but he did need it to convince others.

Here, and elsewhere, we have a problem. We do not have Snow’s notes of his investigation. Snow was known to be a meticulous worker. Richardson reports that:

‘He kept a diary in which he recorded the particulars of every case in which he had administered chloroform or other anaesthetic . . . He kept a record of all his experiments and short notes of observations made by his friends.’

We know also that Snow kept case books in which he recorded the details of his operations, administration of anaesthetic and other day-to-day work of a physician. Presumably, therefore, he kept similar detailed notes of his work on cholera. Unfortunately, no such notes survive. When Snow died it seems that his family handed over to Richardson his medical papers, which presumably included three volumes of casebooks. Those three volumes were found among Richardson’s papers when he himself died in 1896 (Ellis 1994). They were duly published and in 1938 were given by Richardson’s daughter to the Royal College of Physicians. They have been edited by Ellis and published. They are virtually all that survives of Snow’s papers and they contain no mention of cholera beyond the fact that in 1849 Snow administered chloroform to cholera patients to help relieve the pain of the cramps. In the sections of the books that deal with the summer and autumn of 1854, there is no mention of cholera whatever but it is clear that Snow, in addition to his work on cholera in South London and on the outbreak in St James’s, was continuing with his routine medical work. He was clearly a man of considerable energy.

In looking at Snow’s maps and others of the time, and relating them to present-day London, there are various points to be considered. The street plan remains largely unaltered — Snow probably still be able to find his way around the area — but some of the street names have changed. Broad Street is now Broadwick Street (though it is still ‘broad’) and many of the buildings have been renumbered. Cambridge Street, which met Broad Street at right angles, is now Lexington Street, and the public house on the corner, which Snow would have known as the ‘Newcastle Arms’, is now called the ‘John Snow’. The site of the workhouse in Poland Street is now occupied by a multi-storey car park and Huggins’s Brewery has disappeared, though it is possible to identify clearly the site that it occupied.

The map that Snow incorporated in his monograph contains an interesting error (Brody et al. 2000). The pump is marked as being exactly on the corner of Broad Street and Cambridge Street, whereas in reality it was a little further along, outside what was then number 40 but is now 41. In his report to the parish, Snow incorporated a slightly revised version of the map (Fig. 3). This has the pump in the correct position and it incorporates a dotted line inside which it was quicker to walk to the Broad Street pump than to any of the other street pumps. This was even more conclusive in indicating that the deaths from cholera seemed to have been related to the Broad Street well.

For all his certainty that the Soho outbreak had its origin at the Broad Street pump, Snow could not explain how the well had itself become infected, or for how long the infection remained in it. He commented that the area contained a great mix of social classes, from the well-off of Poland Street and Great Pulteney Street, who lived one family to a house, through intermediate areas such as Broad Street, to streets occupied largely ‘by the poor Irish’. Tailors, employed in making clothes for the fashionable shops of Piccadilly and around, made up a large proportion of the population. The disease had struck among them with indifference. The deaths columns of *The Times* for the period record several deaths from the better-off streets such as Great Pulteney
Fig. 2. Part of John Snow's map (Snow 1855) showing deaths from cholera. Each black bar represents one death.
Fig. 3. Part of Snow's later map (Cholera Inquiry Committee 1855), on which the dotted line encloses the area inside which it was quicker to walk to the Broad Street pump than any other pump.
Street, Poland Street and Berwick Street, as well as Broad Street. Cholera was rarely mentioned—the usual form was to refer to death 'after a sudden illness' or 'a few hours' illness'. But however indiscriminate the appearance of the disease, Snow was well aware that once the cholera came among the poor, who lived in overcrowded conditions, it was more likely to spread than among the rich, who were less crowded, had better sanitary conditions and were more able to nurse the sick in rooms separate from those where the rest of the family was living.

Snow described the well in Broad Street as being 'from twenty-eight to thirty feet in depth' (about 9 m) and passing through gravel to the surface of the clay beneath. This is a good description. The latest geological map (British Geological Survey 1993) shows that the Soho area is underlain by Lynch Hill Gravel, a post-diversionary Thames River Terrace Deposit, resting on London Clay. Snow ascertained that a sewer passed at a depth of 22 feet (about 7 m) 'within a few yards of the well.' He described how the well had been opened and inspected, and that the brickwork contained 'no hole or crevice . . . by which any impurity might enter'. This reveals some ignorance on the part of the inspectors. The well was later described as being lined with brick laid without mortar, so that water could enter, and presumably so too could contamination. It seems that in the 1850s, as now, many people felt that groundwater (and contaminants) would flow only through sizeable conduits.

Subsequent investigation records the well as 6 feet (1.8 m) in diameter, and the water level about 21 feet (6.5 m) below ground level. There is no record of this well, or any of the others mentioned as being in the vicinity, in the British Geological Survey National Well Collection, nor are any mentioned by Barrow and Wills (1913).

Snow's monograph was not greeted with the acclaim that he, and we, might have expected. It seems strange that a man who was hailed as at the forefront of the medical profession as an anaesthetist and who had given medical services to the queen, should be disregarded in this way. Perhaps the Victorians reacted to a man stepping outside his acknowledged area in much the same way as people today might react to a footballer pronouncing on the Middle East or the Archbishop of Canterbury on nuclear physics. People should stick to what they know. In any event, he was at best largely ignored, at worst opposed or ridiculed. In an editorial, The Lancet (1855) derided him for saying that offensive smells were not in themselves injurious, commenting that 'the fact is that the well whence Dr Snow draws all sanitary truth is the main sewer'.

The committee of the General Board of Health appointed to inquire into the cause of the outbreak dismissed Snow's arguments and the idea of contaminated water as possible causes of the cholera outbreak (Snow 2000c). Fortunately, help came in the form of Edwin Lankester, FRS. He established a Cholera Inquiry Committee to look in more detail into the outbreak in St James's. The committee dated its report 25 July 1855 (Cholera Inquiry Committee 1855) but it may have been some time before it was published. The Builder (1855) greets its report in its edition of 20 October. The report was reprinted as Appendix 10 of the Rivers Pollution Commission (1874).

The report contained a new map (Fig. 4), apparently based partly on that produced in September 1854 by Edmund Cooper, an engineer for the Metropolitan Commission of Sewers. The Commission, and Cooper, were anxious to show that the outbreak was not linked to the recent excavations for sewers or to the presence of gases emanating from gully-holes and gratings (Brody et al. 2000). The map in the report had several advantages over Snow's earlier maps. First, it showed the street numbers of the houses and other buildings. Secondly, it included deaths that Snow had not known about. It showed, for example, the deaths of workmen involved in building 'Model dwelling houses', between Hopkins Street and New Street behind the Huggins Brewery, to replace some 'of the lowest and filthiest description' (Whitehead 1854) that had been demolished. Thirdly, it distinguished between deaths of residents and those of non-residents, particularly useful in cases like that of the percussion-cap factory. Incidentally, the factory is shown on this map as being at 38 Broad Street, but Snow describes it as being No 37.

One of Snow's initial opponents was the Reverend Henry Whitehead, the curate of St Luke's Church in Berwick Street, who was a member of the committee of inquiry. Whitehead (1854) wrote that the cholera was sent by God as a chastisement for sin, the sin apparently being to allow the poor to live in such wretched conditions. (Quite why the poor themselves had to be so heavily punished to meet God's purpose, Whitehead does not make clear). Whitehead knew many of the local families intimately, had visited the sickbeds of many of the deceased and was able, probably better than anyone, to know of their habits. At first dismissive of Snow's arguments (he had himself drunk water from the Broad Street well on the evening of 3 September without ill effect) he then began to realize, like Snow, the connection between the well and the illness (Whitehead 1867; Chave 1958), and he became an ardent supporter of Snow and a tireless worker in the fight against cholera. He later wrote

'Few habitual drinkers of the pump water, to my knowledge, escaped with impunity. Few survivors were able to assure me that they so drank it regularly during the week ending September 2nd. But on and after that day several
Fig. 4. Part of the map from the Report of the Cholera Inquiry Committee, 1855. The grey shaded area represents part of an area on which the Earl of Craven had houses constructed during the Great Plague of 1665–1666 for people suffering from the illness and which was also used for burial of plague victims. It became known as the pest-field and some residents claimed that the cholera epidemic was in some way linked to the pest-field or to its disturbance for the construction of new sewers.
persons, who had not been in the habit of drinking it, began doing so, at least occasionally, from a notion (due to the enormous quantity of it taken by some patients who revived from collapse) that it was “good for cholera.” More of these drinkers than of habitual drinkers of the pump-water escaped with impunity, I myself being among the number as I drank some of it at 11 p.m. on September 3rd, though not from any idea of its beneficial qualities.’ (Whitehead 1867)

Whitehead then discovered what had eluded Snow – the probable original source of the infection in the well. He noticed that among the returns of death was that of an infant on 2 September. The child, a girl of five months, had lived at 40 Broad Street, the house outside which the well was situated. The child’s mother had survived the epidemic and told Whitehead that the child had been taken ill with diarrhoea and that, beginning on 28 August, she had washed the child’s napkins and emptied the water into the cesspool at the front of the house (Fig. 5). She had continued to do this on 29 and 30 August. Whitehead reported that a man who did not normally drink from the Broad Street well had done so at noon on 31 August and had been seized with cholera at 9 a.m. on 1 September. From this Whitehead concluded that it could have taken no more than three days for the discharged water to reach the well. (The warm weather may again have been a factor here: the intermittent supply of mains water meant that water stored in cisterns would become warm and less palatable, causing people who might otherwise rely on mains water to seek the cooler, fresher water from the pump).

There was some debate about the cause of the child’s death, for the illness was recorded only as exhaustion after diarrhoea, not specifically cholera. The committee were generally satisfied, however, that given that cholera symptoms are rarely well marked in young children, and that diarrhoea during a cholera epidemic can generally be regarded as cholera, this was a true case of cholera. The question still remains, however, of how a child so young came to be infected with cholera in a district where it was not widely prevailing at the time.

As part of the investigations into the outbreak, and as a direct result of Whitehead’s discovery, a Mr Jehosephat York, evidently a local surveyor who was secretary to the local Cholera Inquiry Committee, opened the well again in April 1855 (Chave 1958). It appears that the well in Broad Street (Fig. 6) was like many others in the area in being sunk to the top of the London Clay. ‘The sides are built in brick, laid dry, through which the water readily enters, the arches are turned over with brick laid in mortar or cement, and covered in with a key stone, also secured in mortar or cement’ (Cholera Inquiry Committee 1855). The Committee reports that some of the wells in the parish are ‘rapidly fed from the water bed in the sand, that they cannot be pumped dry’ while most, including the Broad Street well, can be ‘laid dry by continuous pumping in four or five hours’. It is significant that the water level in the Broad Street well is shown as 6.5 m below ground level. This is about the maximum depth from which a surface pump can lift water, so if the Broad Street pump was of the lift type – the cylinder being at the surface instead of down the well – the pump would effectively cease to lift with a small depression of the water level. There is no information available on the type of pump that was fitted.

The Committee also noted that if the natural supply into the wells was limited, there was more likelihood of contamination entering. This seems unlikely, in that the contaminants would probably arrive from above, through the unsaturated zone, rather than through the saturated zone.

York’s examination showed that the well was very close to the vault (cellar) of 40 Broad Street. The main drain from the house to the sewer beneath the street passed through the vault and had a flat bottom, about 0.5 m wide, with brick sides about 0.3 m high, covered with ‘old stone’. The base of the drain was filled with ‘soil’ about 5 cm deep. On clearing this away, York found that the bottom was ‘like a sieve’ and that the sewage from the house must have been able to pass through it with ease. In the front area of the house (the sunken area open to the sky) there was a ‘convenience’ with a cesspool about a metre deep that was intended to serve as a trap to prevent sewage, vermin and gases from entering the house but which had been wrongly constructed (apparently a common fault of the time) and which instead was filled with ‘soil’ and preventing the easy outflow of sewage from the house. It was into this cesspool that the mother of the sick child had thrown the infant’s evacuations.

York found that the brickwork of the cesspool was also badly decayed, so that the bricks could be easily lifted from their bed. He found that the earth between the cesspool and the well was black and saturated. Perhaps the worst aspect was that it transpired that the same cesspool had been found to be contaminating the well 17 years previously.

Analysis of the water from the Broad Street well in November 1854 showed that it contained 96 grains per gallon (1370 mg l⁻¹) of total solids. A more detailed analysis in June 1855 showed the chloride level to be about 11 grains per gallon (about 160 mg l⁻¹). This was taken as confirmation that the well was polluted by ‘débris, refuse and excreta’ (Cholera Inquiry Committee 1855).

Whitehead also raised an interesting point about the length of the cholera outbreak. It seemed clear that the outbreak was declining by the time the handle was removed from the pump. Snow’s advice did not, therefore, halt the epidemic. But Whitehead
discovered that cholera continued to be present in the house at 40 Broad Street, so that the well could constantly have been re-contaminated from the cesspool and the drain. Fortunately, the first three victims of the outbreak lived on the upper floors of the house, and their relatives saved themselves the trouble of carrying their 'discharges' down to the cesspool by the simple expedient of throwing them out of the upstairs back windows into the yard below. But the next victim, the father of the child who was supposed to have been the source of the outbreak and who slept in the same kitchen, was taken ill on 8
September, the day the pump handle was removed. His evacuations undoubtedly went into the cesspool and re-contaminated the well, so that it was only the removal of the handle that prevented the cycle from being continued (Whitehead 1867).

John Snow: the man and his memory

It is always pleasing for a biographer to report that his subject was a charismatic individual, handsome, eloquent and witty. By contemporary description, John Snow lacked some of these qualities. Richardson (1858) records that 'He laid no claim to eloquence, nor had he that gift. A peculiar huskiness of voice, indeed, rendered first hearing from him painful'. He also notes that Snow's long periods as a student and in comparative isolation had made him reserved with strangers. However, Richardson also notes that he had a kindly nature, that with friends he was always open and of 'sweet companionship' and that in later life he had regrets that he had never married, 'the fates had been against him permanently on that score'. As he became famous and more popular, he was less reserved. All this suggests shyness. But there was also the fact that 'he moderated every enjoyment, and let nothing stand in the way of his scientific pursuits'.
At the age of 17 Snow became a vegetarian (Richardson 1858), and firmly committed to the vegetarian diet. For the first eight years, he supplemented his vegetable diet with eggs and dairy products and was proud of the fact that he could equal or better his meat-eating friends at physical pursuits, especially swimming at which he excelled. Then, when he was sharing lodgings, a fellow student (probably Joshua Parsons) questioned him as to the nature of the ‘vegetables’ (milk) he was taking for breakfast. It was probably meant in fun, but Snow took it seriously and became a Vegan. In his thirties he began to suffer a renal disorder which was attributed to the Vegan diet and he was forced to resume eating animal products.

At around the same time that he became a vegetarian, Snow also became a teetotaller, and firmly committed to the temperance cause. He remained a member of the York Temperance Society until his death but from about 1845 was persuaded to take a little wine as an aid to digestion.

Richardson describes him as ‘of middle height, of somewhat slender build, and of sedate expression’ though it seems that in his later years he filled out slightly.

Snow disliked reviews (perhaps the memory of that anonymous reviewer in 1849 stayed with him). He believed that ‘a good book carried the review of its own merits. If it were bad, it were better left untouched’ (Richardson 1858).

Snow’s studies seemed absolute confirmation of the fact that cholera was transmitted by water. It would then be gratifying to record that by the time cholera again appeared in Britain, in 1866, the mode of transmission was fully understood and the authorities fully prepared. Sadly, this was not the case. The miasmists and contagionists stuck to their theories, the one group warning against inhaling the breath of cholera patients and the other of the dangers of bad smells from drains. In 1866, Alexander Hamilton Howe MD wrote that cholera was attributable to ‘a peculiar state of the atmosphere’ and that the only cosmical body that can influence the atmosphere is the moon. He then went on to link the outbreaks of 1831–1832, 1848–1849 and 1866 to the 18-year lunar cycle (conveniently overlooking the epidemic of 1854!).

But by then, John Snow was dead. On the morning of 9 June 1858, he wrote the last sentence of his book, *On chloroform and other anaesthetics*, laid down his pen, and suffered a severe stroke from which he did not recover. His death certificate records the date of death as 16 June 1858.

A year after Snow’s death, Richardson wrote to the British Medical Journal inviting contributions to a fund to place a monument over Snow’s grave in Brompton Cemetery. The monument was duly put in place, but it has not been without its own history.

Evidently the original did not stand up well to the local conditions, because an inscription on the plinth records that it was restored ‘by Sir Benjamin W Richardson FRS and a few surviving friends’ in 1895, the year before Richardson’s own death. Another inscription was added in 1938 to record that the original inscriptions had been restored again. Finally, the whole memorial was destroyed by bombing in April 1941 and a replica put in its place in 1951. It may be significant that this was placed by anaesthetists rather than epidemiologists.

Apart from this, there are few tangible monuments to Snow. In gloomy Bateman’s Buildings there is no memorial. The house where he lived and practised in Frith Street has been replaced, though a blue plaque does commemorate his time there. There was a similar plaque on his house in Sackville Street, but the house was demolished in the 1970s and replaced by the store of Austin Reed. In Broad Street there is a small plaque, and a pink granite kerbstone outside what is now No 41 marks the alleged site of the infamous pump. A replica pump, without a handle, has been set up in the wrong place, on the opposite side of the street. Otherwise, all that is left in his memory is the renamed public house, the former ‘Newcastle Arms’, now the ‘John Snow’. For a man who was a teetotaller and a member of the temperance movement, it seems a strange memorial.
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