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**MELTING SNOW:
A RE-EXAMINATION OF DR. JOHN SNOW,
HIS DOT-MAP,
AND THE 1854 BROAD STREET CHOLERA OUTBREAK**

by

Kari S. McLeod, B. A. (Honors) 1995

A thesis submitted to
the Faculty of Graduate Studies
in partial fulfillment of
the requirement for the degree of

Master of Arts
Department of Geography

Carleton University
Ottawa, Ontario
May 1, 1998
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Thesis Supervisor

Chair, Department of Geography

CARLETON UNIVERSITY

May 1, 1998

ABSTRACT

The mythical story of John Snow and the Broad Street outbreak is common in medical geography, epidemiology, and the history of medicine. In 1854, Snow identified the source of the cholera outbreak in Golden Square (in present-day Soho) as the Broad Street pump, possibly with a dot-map of cholera deaths, and successfully argued for the removal of the pump's handle. Many accounts state that this action ended the outbreak. In all three disciplines, Snow is presented as a hero because he showed how cholera is transmitted, because his ideas affected public health policy, and because he provided definitive proof of a hypothesis. For medical geography, Snow's heroic reputation is related to his determinative use of a dot-map, and many authors feature the map in their presentations of the story. However, the twentieth-century versions of this map can be quite different from one another. This thesis re-examines the myth of John Snow, his dot-map, and the 1854 Broad Street outbreak—informed by archival research—and challenges the taken-for-granted repetition of the story in the three disciplines. The process of retelling the story encourages future investigation of the meaning of the myth in disciplinary contexts; of the nature of proof of causation; and of how evidence, argument and authority work in science.

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Developing this thesis involved an idea followed by negotiating a maze of hints, references, leads, and blind alleys. To that end I owe a great deal to David Bennett for his guidance, suggestions, and patience and for allowing me to take over an idea that was his.

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Epigraph

As geographers, Sosius, crowd into the edges of their maps parts of the world which they do not know about, adding notes in the margin to the effect that beyond this lies nothing but sandy deserts full of wild beasts and unapproachable bogs.

Plutarch. *Lives, Aemilius Paulus, sec. 5*

If you call a tail a leg, how many legs does a dog have?

Abraham Lincoln

Dr. S.: Did you know that there's a direct correlation between the decline of the
Spirograph and the rise in gang activity? Think about it.

Bart: I will.

Dr. S.: No you won't.

The Simpsons

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CHAPTER ONE

INTRODUCTION

At the corner of Broadwick and Poland Streets in Soho, London there is a water pump—without a handle. The attached plaque reads:

Text Box 1.1

THIS WATER PUMP
WAS UNVEILED BY
COUNCILLOR DAVID WEEKS
LEADER OF WESTMINSTER CITY COUNCIL
ON
JULY 20, 1992
IT MARKS A PIONEERING EXAMPLE OF MEDICAL RESEARCH IN THE
SERVICE OF PUBLIC HEALTH.

The following story appears on both sides of this inscription:

Text Box 1.2

DR. JOHN SNOW (1813-1849) A NOTED ANAESTHETIST, LIVED NEAR THE FOCUS OF THE 1854 CHOLERA EPIDEMIC WHICH CENTRED ON BROAD STREET, AS BROADWICK STREET WAS THEN CALLED. IN SEPTEMBER OF THAT YEAR ALONE, OVER 500 PEOPLE DIED IN SOHO FROM THE DISEASE.

SNOW HAD STUDIED CHOLERA IN THE 1848-9 EPIDEMIC IN SOUTHWARK AND WANDSWORTH. HIS THEORY THAT POLLUTED DRINKING WATER

WAS THE MEANS OF TRANSMISSION OF THE DISEASE WAS CONFIRMED WHEN HE MAPPED CHOLERA DEATHS IN SOHO WITH THE SOURCE OF THE VICTIM'S WATER. HE FOUND THAT THEY WERE CONCENTRATED ON THE BROAD STREET PUBLIC WATER PUMP.

HIS THEORY INITIALLY MET WITH SOME DISBELIEF BUT SUCH WAS HIS CONVICTION THAT HE HAD THE PUMP HANDLE REMOVED TO PREVENT ITS FURTHER USE. SOON AFTERWARDS THE OUTBREAK ENDED.

THE ORIGINAL PUMP IS BELIEVED TO HAVE BEEN SITUATED OUTSIDE THE NEARBY 'SIR JOHN SNOW' PUBLIC HOUSE.

The John Snow public house (Dr. John Snow was never knighted) is at the corner of Broadwick and Lexington Streets, just metres away. On the north side of the building is a plaque that reads: "The Red Granite kerbstone marks the site of the historic BROAD STREET PUMP associated with Dr. John Snow's discovery in 1854 that Cholera is conveyed by water." The pub also sells t-shirts with Snow's image on the front and the following story on the back:

Text Box 1.3

THE JOHN SNOW

Situated at the corner of Broadwick St. and Lexington St. in the heart of London's Soho, The John Snow public house commemorates the life and work of Dr. John Snow (1813-1858). One of the first specialists in anaesthesia, John Snow is also renowned for his work in the field of public health. In 1854 an outbreak of cholera claimed the lives of inhabitants in 37 of the 49 houses in Broad Street (as Broadwick St. was then known). John Snow identified the source of the deadly disease as the street's public water pump -- proving his theory by disabling the pump and thereby saving many lives. The water pump can still be seen 50 yards from where The John Snow public house stands today.

The non-functioning replica of the pump, two plaques, and t-shirts are the physical encapsulation of the story of John Snow. They tell of a man whose insight, knowledge, and action saved lives. His dot-map of cholera deaths in Soho, London in 1854 is a commonly cited example in geography of the use of geographic methods to demonstrate a causal relationship. This thesis started as an investigation into this map as a way of examining the current debates in medical geography. Over the past decade, medical geography—or the geography of health and health care, post-medical geography, or health geography, some of the suggested replacement titles for the discipline—has experienced a period of intense self-examination. By engaging with the social theories introduced to human geography over the past thirty years, medical geography could be changing focus away from its two traditional concerns of spatial epidemiology and the analysis of provision, accessibility, and utilization of health care. Research that is critical of traditional medical geography has moved away from biomedical definitions of disease and an associated positivistic science method of problem solving and towards social constructions of health and illness and a social theory approach to problem investigation.

The recent history of medical geography forms the backdrop for this thesis, since for geographers the story of John Snow is firmly rooted in the tradition of disease mapping. It is his dot-map of cholera deaths, or rather the many reproductions of this map, that triggered the preliminary questions for this thesis. John Snow's discovery of the source of the 1854 cholera outbreak in Soho, London by mapping cholera deaths against the location of local public water pumps is a strong and persistent example in medical geography courses, as well as in cartography courses, of the utility of geographic expertise. However, different written sources contain different maps. What did Snow's

map actually look like? Was there an actual original map? If so, where is it, and how was it transformed during reproduction? Has the story undergone parallel transformations?

Examining the variety of map reproductions prompted questions concerning their accompanying written accounts of the story. In the medical geography literature there were as many different stories as there were maps. While some of the accounts were thematically similar, many contained contrasting details. Most accounts emphasized the role of the map, reinforcing questions about the original map and its reproductions. Similar discrepancies were found when the story was featured in the literatures of other disciplines. The story of John Snow, London's 1854 cholera epidemic, and the Broad Street pump is also prevalent in the histories of epidemiology, public health, disease, and medicine. As more accounts of his role in the Broad Street cholera outbreak were collected during this research, the more disparate the details became. Stories differed on the role of the map, the estimated death toll, and the effect of removing the pump handle, to the point where there were few threads of similarity holding the story together.

One theme common to many of the accounts was the presentation of Snow as an heroic figure. If a hero is a "person noted or admired for ... outstanding achievements" (*Oxford Dictionary of Current English*, 2nd ed., s.v. "hero"), then John Snow is certainly a hero in geography and epidemiology. He is less known in medicine where his reputation competes for attention with the likes of Hippocrates, Galen, Harvey, Lister, Koch, and Pasteur. An appreciation of Snow's work does not extend from medicine to science (Winkelstein, 1995). Nor does he share hero status within the social sciences where men such as Malthus, Marx, Durkheim, and Keynes have cross-disciplinary fame.

Leaving the academic realm, John Snow is not generally known by the public like Newton, Darwin, Einstein, Sagan, and Hawking. The water-pump and pub on Broadwick Street and Snow's former residence on Frith Street, all in Soho, London, are certainly not tourist meccas. Why is Snow such a hero in geography (particularly medical geography), epidemiology, and public health, and to a lesser extent in medical history?

The story of John Snow as presented in Text Boxes 1.1–1.3 has mythical elements. The word myth can mean many things. One definition of myth is “a traditional story of unknown authorship, ostensibly with a historical basis, but serving usually to explain some phenomenon of nature ...; myths usually involve the exploits of gods and heroes” (*Webster's New World Dictionary*, College Edition, s.v. “myth”). Another definition is “a widely held but false notion” (*Oxford Dictionary of Current English*, 2nd ed., s.v. “myth”). This thesis uses the word myth to describe the John Snow story, but not in the strict way of classical or religious mythology. Instead, myth is used to describe a story that may or may not be true: it is a way for us to make sense of something which is not truly knowable or understandable. At a recent conference of the Association of American Geographers (AAG), one professor remarked, “Mythologies, after all, are not false. They are our way of trying to understand the unknowable” (Gluck 1998).

For the moment, if we accept the version of the story presented in the earlier text boxes as being true, John Snow is a hero for four reasons. The first three of are not necessarily confined to a disciplinary context while the last is more characteristic of geography. First, John Snow showed how a disease is transmitted—clearly something laudable in science and medicine. Through his investigations he demonstrated that

cholera was carried in contaminated drinking water, not in miasmata (bad air), the popular theory at the time. The “historic BROAD STREET PUMP [is] associated with Dr. John Snow’s discovery in 1854 that Cholera is conveyed by water” (Snow plaque, Soho).

Second, his ideas affected public health and health policy decisions, at least at the local level. Snow convinced someone, or some group, to remove the handle from the Broad Street pump. “His theory initially met with some disbelief but such was his conviction that he had the pump handle removed to prevent its further use. Soon afterwards the outbreak ended” (Text Box 1.2). His argument was strong enough to compel an action that stopped a threat to public health.

Third, he provided definitive proof of a hypothesis, and as a result of the power of his evidence and his argument he changed scientific opinion to fact. “His theory that polluted drinking water was the means of transmission of the disease was confirmed [by his research]” (Textbox 1.2). He proved “his theory by disabling the pump and thereby saving many lives” (Textbox 1.3). This version of the story conforms to the conventional or lay view of how science works, in that it sets up definitive tests, then gathers evidence which is so compelling that minds are changed.

Finally, John Snow used the quintessential geographic artifact as a spatial analysis device to show that the pump was the source of the local epidemic. The map demonstrated the relative space of death-events arranged around a locationally fixed point. It also confirmed his theory that cholera was transmitted through polluted drinking water (Textbox 1.2). Geographers have a claim on Snow because the story gives pride of place to the map. Without that we would probably let other disciplines claim him, but the

map makes him ours. Snow matters to us because we “own” the map. He “is now recognized as a formative figure in both the development of medical cartography and in the understanding of disease transmission” (Smith 1993, p. 43). Snow links the expertise of geographers with the achievements of disciplines like epidemiology, public health, and medicine. To some extent this is prestige by association, something that seems important to at least one medical geographer: in response to Dear’s stating that “medical geography is dead but not discarded” at the 1995 AAG, Kearns wrote that “what followed was a welcome benediction from one outside the discipline” (1996, p. 123).

Discrepancies between the map reproductions, the lack of agreement between the accounts, and disparate valuations of Snow in various disciplines suggest that a re-examination of Snow is overdue, requiring a more documentably accurate telling of the story of Snow and the Broad Street outbreak and the re-placing of his contribution to the theory of cholera transmission in its historical context. This re-interpretation of Snow is consistent with the current problematization of the entire field of medical geography because it questions the discipline’s identity. It also coincides with the recent lively discussions on the capabilities of GIS and other types of cartography in mapping disease and illness at the AAG (1998). Other than an academic exercise of setting the story straight, why is it important to re-examine Snow?

This thesis will show how the unquestioning repetition of this attractive story has lead to an unscholarly—though not unusual—“taken-for-grantedness” of its details and meaning: “though history may not repeat itself, the writers of historical texts often do.” (Birkenhead 1969, p. 106) This is more than just examining the creation of myths. It questions the academic *modus operandi*. How often might this kind of blind acceptance

be happening in similar situations? Do academics often bother to engage with original texts? Indeed, does science go back to the originals (Newton, Darwin, and Einstein for example), or is scientific knowledge built on sanctioned pieces and quotations?

Can this thesis provide an “objective” account of John Snow through archival research? The answer is tied up in the question of whether there can be an objective reality in the past. John Snow presumably did certain things during the 1854 outbreak. Any investigation of his actions is hampered by the availability and accuracy of the archival evidence. Other than Snow’s publications on cholera, and a few publications which refer to him, his ideas, and his actions, this investigation did not discover other supporting sources. If Snow kept a personal journal or a notebook describing the development of his theory of cholera transmission, it has not been found. Using the word “accurate” and its derivatives is problematic if there is no objective reality in the past because it suggests an independent and objective truth against which we can evaluate the veracity of the evidence. The word appears in this thesis in relation to accounts informed or not informed by documented archival evidence. Even if we had access to one consistent account of Snow’s actions during the Broad Street outbreak, would that be enough to explain what Snow actually “did” and all of the implications?

Despite its appearance as a deconstruction of the Snow story, this thesis is not informed by a Realist, post-structural, or post-modern framework. Nor does it draw on formalized content analyses or discourse analyses for its methodology. However, this thesis is not a naive look at Snow: the decision to eschew the trappings of a definable epistemology and methodology was a conscious one. The aim was to examine Snow without becoming clouded by a theoretical mind-set or agenda. This is not to say that the

analysis and interpretation are “objective”, but that they were not conducted through a specific theoretical or methodological lens.

The thesis is organized into six more chapters. The current discussion on the nature of medical geography has created an increasingly precarious position for the academic study of disease mapping. Chapter Two sets the scene for the rest of the thesis with a brief examination of five themes in the current discussions in medical geography: positivistic science and absolute space, social theory and social space and place, the biomedical model, social constructions of health and illness, and methodology. This is followed by a summary of the history and importance of disease mapping from its beginnings in the nineteenth century.

Chapters Three and Four analyze the literature on Dr. John Snow. The third chapter begins with a discussion about the legitimation of knowledge through publishing and classroom teaching. It then moves onto a comparison of seven representations of Snow’s dot-map of cholera deaths in the geographic literature, presented in chronological order of publication dates. The rest of the chapter presents the views of Snow found in the geographic literature, organized into four thematic sections. First, there is the general view of Snow within the geographic literature including his reputation. The second theme recounts geographer’s views on the details of the Broad Street cholera outbreak and Snow’s reputed related actions. The third theme discusses how the geographic accounts present the impact of Snow’s involvement in Soho and his theory of cholera transmission. Finally, as a way of connecting all of this information, the last section draws together the disparate details of the various stories. The chapter concludes with questions arising from the similarities and differences between the maps and those in the

literature accounts.

Moving on from the geographic literature, Chapter Four outlines the written accounts of John Snow in epidemiology and the history of medicine. Each of these broad categories includes a number of disciplines. The epidemiology section includes stories from public health, epidemiology, and engineering for public health. The history of medicine portion includes histories of disease and medicine as well as other social-historical texts that refer to John Snow. These two sections follow the same thematic organization used in Chapter Three. It is through this investigation of the literature that Snow is revealed as a pioneer in anaesthesia as well as epidemiology. More questions are raised at the end of this chapter, and they, in conjunction with those in the previous chapter guide the rest of the thesis.

The first step towards a more accurate story of Dr. John Snow and the Broad Street outbreak is establishing who he was, biographically and in his historical context. Chapter Five begins by constructing Snow's biography with the limited information available, and includes a time line drawn from the details in Benjamin Richardson's memorial essay published shortly after Snow's death (in Frost 1936). It places him in an historical-social and -medical setting and briefly defines terms prevalent in mid-nineteenth century theories of disease transmission. This leads into a somewhat chronological description of the theories of cholera transmission and treatment in the mid-nineteenth century as a way of introducing and situating Snow's theory of how cholera was communicated. The final section of this chapter examines Snow's role as one of the early experts in the administration of anaesthesia.

Drawing largely on archival evidence collected in London, England in February

and March 1997, Chapter Six retells the story of the Broad Street cholera outbreak. The first section describes the general details of the 1853–54 cholera epidemic as it affected London and Soho specifically. Snow's actions and those of a local curate are presented with particular attention to discovering how the pump was identified as the source of the outbreak. The next section pulls together the scant historical evidence to examine the immediate response and its affect on the outbreak. But what about Snow's dot-map? There were three publications of investigations into the Broad Street outbreak. Snow published his conclusions in the second edition of his *On the Mode of Communication of Cholera* (1855) and in the Board of Guardians' Cholera Inquiry Committee's *Report on the Cholera Outbreak in the Parish of St. James's, Westminster* (1855). Both of these contain a dot-map of cholera deaths during the outbreak. The General Board of Health also conducted a study and published a map of the area with its findings. The final section in the chapter discusses, in a nineteenth century context, what Snow's Broad Street study actually showed as distinct from its portrayal in the twentieth century stories. What did his study demonstrate about cholera, and how were his ideas accepted by his contemporaries?

The seventh and final chapter initiates a discussion of the impact of Snow's evidence, argument, and reputation. First, it pulls together some of the information presented in Chapters Five and Six to see what the re-examined Snow story says about nineteenth century socio-medical authority. Second, the chapter addresses the impact of Snow's work in current contexts. There are sharp contrasts between some of the disciplinary accounts of Snow in Chapters Three and Four and the more accurate historical portrait of the Broad Street outbreak and his theory of cholera transmission in

Chapters Five and Six. These inconsistencies reveal more than just an unscholarly repetition of a tried-and-true story. They manifest the power of myth in defining the nature of disciplines, what is and is not important. More extensively, the story of Dr. John Snow and his theory of cholera transmission raises questions about causation, broader understandings of science, and how reputation, authority, and evidence can be inter-related in the pursuit, presentation, and acceptance of scientific knowledge. While the issues identified in this chapter are too wide-ranging for this thesis, they are themes for future research to be investigated from the central reference point of John Snow: Victorian physician, epidemiologist, and anaesthetist.

CHAPTER TWO

MEDICAL GEOGRAPHY AND DISEASE MAPPING

John Snow's influence in geography is primarily in the field of medical geography. Elements of medical geography can be traced back to the Hippocratic work *On Airs, Waters, and Places*, but the term first appeared in print in the works of Leonhard Ludwig Finke in 1792 (Barrett 1980). "Medical geography, in general, tries to describe, understand and ultimately explain spatial variations in health, disease, and health care" (Learmonth 1991, p. 51). Traditionally there have been two streams of inquiry in medical geography: the geography of disease and health and the geography of health care. The first of these is the longer standing and is often referred to as spatial epidemiology while the second is newer and examines the provision, utilization, and accessibility of health care and its facilities.

Over the past decade, medical geography has been influenced by epistemological and ontological ideas that have affected human geography for almost three decades. This has raised significant questions about the purpose of medical geography and has even thrown the name of the discipline up for debate (Barrett 1992). Questions about the nature of geography as well as medicine have lead to a sense of malaise in the field and have raised questions about the place of medical mapping. Each of the two streams of

medical geography has used mapping either as a research or an illustrative tool, and the second section of this chapter will discuss the history and *raison d'être* of disease mapping.

2.1 CURRENT ISSUES IN MEDICAL GEOGRAPHY

There is a ferment in what has traditionally been called medical geography regarding the purpose, future and name of the field. Although much of the debate has surfaced over the past ten years, Hunter discussed the “theoretical-empirical” tensions in medical geography in 1974 (p. 6). In part it is related to human geography’s questioning of research driven solely by positivistic-science and geometric/absolute space, and its exploration of a variety of social theories and social spaces. It also follows a change in focus in all health-related social sciences and in public health away from studying biomedical definitions and manifestations of disease and towards examining and interpreting the social constructions and experiences of health and illness. These queries have brought in discussions of methodology and a movement toward qualitative methods, discourse analysis, and ethnographic inquiry.

2.1.1 Questioning positivistic-science and geometric/absolute space

In the early 1970’s, there was a growing debate in human geography concerning the use of logical positivism and the scientific method, really positivistic science, for the

study of human subjects. Detractors maintained that geography based on spatial theory missed the richness of human experience by hiding it in the simplicity of scientific explanation. This led to quantitative human geography being called reductionist, aggregative, monistic, and atheoretical (Curtis and Tackett 1996; Hampson 1991 in Eyles 1993; Jones and Moon 1993; Mayer 1992). One geographer defines logical positivism as “the philosophy concerned with the acquisition of general statements obtained by accepted procedures, about observable phenomena; such statements can then be used in the manipulation of phenomena” (Johnston 1986 in Mayer 1992, p. 580).

However, that might be a better definition of positivistic science. The philosophical roots of positivism are in Comte’s nineteenth century writings (Unwin 1992). He believed that the natural or physical world and the human social world behaved in the same way and that they could be examined with the same methods. Logical positivism has been summarized in the statement, “The meaning of a proposition lies in the method of its verification” (*The Encyclopedia of Philosophy*, s.v. “logical positivism”) by the Vienna Circle. One of its members, Ernst Mach, advocated using the methods of physics to integrate all sciences. There are two main difficulties with the Vienna Circle’s Verification Principle. The first is that the principle itself cannot be verified, and the second is that the statement is not a scientific proposition (ibid.). Habermas claimed that it was positivist philosophy which equated science with knowledge (in Unwin 1992), but science and the scientific method are not the same as logical positivism.

Mayer (1992) presents two fundamentals of the scientific method. First, its purpose is to ascertain and discover facts, and second, its goal is to construct hypotheses

and theories. These underlie and guide the practice of science, and the search for causality which cannot be established without reasons is implicit in them. “*Reasons* are theoretical expectations which inform an otherwise empty connection, and they can be pursued at ever smaller scales down through living organisms, cell structures, to molecular levels, and on eventually to the behaviour of sub-atomic particles” (Bennett 1991, p. 341). This explanation can be seen to connect logical positivism with the biological nature of disease and to traditional medical geography.

The critiques of positivistic science in human geography have not convinced all medical geographers. In commenting on logical positivism’s monism—the belief in its axiomatic claims to knowledge and method—Mayer (1992) points out that this is more true in theory than in practice. Traditional medical geographers have not been solely attached to positivist definitions of knowledge and method. For Bennett, the criticisms are based on “myths” and “misunderstandings” of positivism; their “caricature ... hardly does justice to that movement’s subtlety” (1991, p. 343).

Traditional medical geography has conceived of space in geometric or absolute terms. Geometric space is defined by distance and location, and is the type of space found in spatial theory (Kearns and Joseph 1993). Drawing on the work of Blaut (1962) and Harvey (1973), Eyles describes absolute space as existing independently of the human actions within it (1993). This is also referred to as space as a container. Geometric or absolute space is demarcated by measurements like latitude and longitude, Universal Transverse Mercator co-ordinates, and quantifiable distances. Kearns and Joseph criticize medical geography studies that conceptualize space geometrically for making space a secondary concern to health and health care (1993). In other words, these

studies are not directly interested in the ways that space impacts health and vice versa, nor do they acknowledge that human activity may create and define space differently than geometry.

2.1.2 Adoption of new social theories and social spaces and places

The criticism that human geography based on positivistic science is atheoretical came first from humanist and Marxist epistemologies. Influenced by Husserl's phenomenology, humanist geography is the subjective and highly personal study of immediate human experience (Mayer 1992; Unwin 1992). Humanism does not offer total and complete understanding because of its qualitative ethnographic techniques. In medical geography, humanism aids in the investigation of lay and professional definitions of health, disease, and illness; people's perceptions of these; and how they relate to human behaviour (Jones and Moon 1987; Mayer 1992; Curtis and Tackett 1996).

The most influential text of the Marxist critique has been David Harvey's *Social Justice and the City* (1973). He challenged geographers who were using spatial theory for ignoring the growing problems of urban areas, and explained urban issues such as poverty, poor housing, and racism as the result of unequal accumulation of capital. Marxism and other structural analyses are founded on large, intangible structures which control our perceptions and behaviour. By delving beyond the surface to observe internal structures (Mayer 1992), structuralism and Marxism provide "a wider focus [which] challenges concepts of disease causation inherent in the germ theory of disease and the

doctrine of scientific etiology” (Curtis and Taket 1996, p. 17).

These are not the only epistemological movements in human geography to have surfaced in medical geography. Idealism, feminism, realism, post-modernism, and post-structuralism have all gained a presence in medical geography, particularly over the past five years. Kearns (1995) believes that they will make the field more strongly integrated within human geography. Their purpose is to extract deeper and more thorough meanings of human experience. “The critical, relational and contextual approach [of more recent medical geography] suggests ... an expanded role for theory and need for theory development with respect to conceptualizing the relationships between phenomena and society in general. ... In other words, theories of society are demanded” (Eyles 1993, p. 139).

New theories of space and place have gone hand-in-hand with these theoretical challenges. In 1973, David Harvey identified two classifications of space in addition to absolute space. Relative space is “an attribute of things in that human activities in space give it significance” (in Eyles 1993, p. 115). Space as “contained in objects insofar as an object contains and represents within itself relations with other objects” is relational space (ibid.). Much of the recent problematization of space and place has come from the new cultural geography, starting with the new forms and theories of cultural studies from the Centre for Contemporary Cultural Studies in Birmingham and adopted by cultural geographers like Derek Gregory and Denis Cosgrove.

Dorn and Laws discuss three types of space to explain the “*body politics of mobility*” (1994, p. 108). First, outsiders provide a relatively objective view of space in the representation of space, where place is locality. People who live outside a space can

only represent that space through words or images; they possess a different understanding from people who live in that space. Second, there are spaces of representation which are subjectively created and understood by insiders, where place is habitus. Here space is created by the people who live within it. Finally, there are material social practices which occur where the representation of space and spaces of representation converge: where outsiders and insiders meet.

A definition of place in human geography is just as elusive as one for space. This is not surprising since place is “one of the most multi-layered and multi-purpose words in our language” (Harvey 1993 in Kearns 1994, p. 113). Place has both subjective experience and objective knowledge (Entrikin 1991 in Kearns 1993), and people, either individually or collectively, have significant feelings towards place (Cosgrove 1986 in Kearns, 1994). Eyles conceptualizes the term as “place-in-the-world” (1993). Place is not just a physical location, nor is it solely our feelings towards it. It is how we feel about where we live as influenced by our position within society. This definition can be made operational since it allows for the examination of people’s physical environment, their location within the social environment, their actions within the two, and their feelings towards them.

Place and space are central themes in the current discussion of medical geography. Eyles identifies the tensions between their conceptualizations as a central challenge to the discipline (1993). In medical geography, the new cultural geography provides theories and methods to examine the intimate connections between people’s feelings toward place and space and toward their health (Curtis and Taket 1996). The main difficulty with the new ideas of place and space is their jargon-theoretical nature.

The definitions are difficult to comprehend and can make the research rather inaccessible. One geographer has warned that the break away from spatial analysis and the concerns of traditional medical geography, “of course, would be the renunciation of any claim for the independence and value of medical geography and its replacement by a political economy of health and health care in which geography would play a much less important role” (Mohan 1989, p. 176).

2.1.3 Critique of the biomedical model of disease

Medical geography has also been influenced by developments in other health-related social sciences and public health, particularly the critique of the biomedical model of disease. This model is founded on the Cartesian paradigm which involves the division of an object into its key components and the in-depth study of each (Curtis and Taket 1996). In terms of an individual’s health, this mechanistic view divides the body into separate parts with disease affecting one or more of the parts. The biomedical model is the predominant model of disease and treatment in Western medicine.

Drawing on Mishler (1981), Curtis and Taket (1996) describe four assumptions present in the discourse of biomedicine. First, there is a notion of normal biological functioning with disease as a deviation from this. Second, there is a “uni-factorial aetiology” (Jones and Moon 1987, p. 22), or a single cause, for every disease, with a distinct and knowable “pathogen agent, micro-organism, or disease vector” (Curtis and Taket 1996, p. 27). The third assumption is that the symptoms and stages of a disease will manifest themselves in the same way in every person and every place: diseases are

generic. Finally, the biomedical model assumes the objectivity, rationality, and neutrality of science and medicine. It may be difficult to conceive of these as assumptions, because we are used to thinking about science and medicine in these terms.

There are many reasons for the critiques of the biomedical model. In 1975, Illich, a radical critic of medical science, noted the overestimation of the power of medicine professing to make everyone healthy (in Kearns 1995): McKeown has also been an important contributor to this discussion (1976, 1979, 1988). Medical sociologists have turned to non-medical definitions of disease and health, finding medicine too restrictive (Coburn and Eakin 1993). The biomedical model is reductionist in nature since it splits anything into its component parts for individual study. This has often resulted in the disregard of non-biological factors and causes of illness. Changing views of health and biomedicine can be traced to lay perceptions of health, feminist research, a surge in alternative health movements, and the World Health Organization's less allopathic definition of health (Curtis and Taket 1996).

There are three main challenges to the biomedical model. First, our concepts of disease and health have been created by Western medicine which has gained hegemony particularly within the last one hundred and fifty years. This power is being questioned in lay discourses on health. The second critique comes from the New Public Health movement which views health more holistically. Finally, the sociological concept of social construction contests the biomedical definitions of disease.

The history of medical knowledge is usually portrayed in a linear fashion with progress towards greater understanding. Throughout this history, society has given physicians the power to decide who is sick, who is well, and what defines those terms.

This has resulted in the hegemony of Western medicine (Jones and Moon 1987). One threat to this power has been biomedicine's inability to cure chronic diseases as well as the recent scare of drug resistant bacteria. Another is society's realization that medicine can harm as well as cure: the iatrogenic effect of thalidomide is an example. However, the public's skepticism of biomedicine is muted by "technocratic science"—the belief that science is always progressive and productive (Bennett 1991, p. 339).

The New Public Health movement opposes the view of the body as a machine with mendable parts by looking at the body and individual health holistically (Curtis and Taket 1996). In this movement, health is considered more than just an absence of disease but as a "state of complete physical, social and mental well-being" (WHO 1946). There are two main themes in the New Public Health discourse: the social determinants of health and lay perspectives of health. Social determinants of health range from environmental details such as employment status to lifestyle decisions such as dietary habits (Coburn and Eakin 1993). Biomedical determinants of disease are given less importance than social causes of health and ill-health. This has influenced the popularity of preventive care over curative treatment (Kearns 1993). Lay perspectives of health are provided by non-medical persons (Jones and Moon 1987; Curtis and Taket 1996). The acceptance of lay views undermines the supremacy of scientific and medical privilege (Eyles 1993). It also acknowledges that people can feel ill without having a defined disease. Incorporating both themes, Jones and Moon variously describe the New Public Health as consumer, community, and postmedical approaches to health (1993).

The final critique of the biomedical model of disease is social construction. The twentieth-century idea that reality is socially constructed is attributed to Berger and

Luckmann (1966) who “define ‘reality’ as a quality appertaining to phenomena that we recognize as having a being independent of our own volition ... [and] ‘knowledge’ as the certainty that phenomena are real and that they possess specific characteristics” (p. 13).

Our perception and understanding of reality is shaped by our social environment and thus affects what we can know. The impact of Berger and Luckmann’s “Treatise in the Sociology of Knowledge” has rippled through the social sciences, and has reinforced questions about what is objective and what is subjective. The term “social construction” is so common that the authors are rarely cited.

This idea of social construction has influenced medical sociology and has encouraged the investigation of the construction of illness at the social, institutional, and individual levels (Coburn and Eakin 1993). The social construction of disease argues that health, illness, and disease are contextually, culturally, and socially specific (Jones and Moon 1987; Curtis and Taket 1996). It is opposed to the biomedical model of disease because it states that disease is more than a biophysical manifestation: it is contextually defined and experienced.

As bookends on the shelf of what constitutes knowledge, Berger and Luckmann’s *The Social Construction of Reality* (1966) sits opposite to Searle’s book *The Construction of Social Reality* (1995)—indeed, with the soft-cover versions of both books sporting the orange spines characteristic of Penguin publications, this could be both figuratively and literally true. That Searle disputes the usefulness of social construction is evident in the introduction’s opening sentence: “We live in exactly one world, not two or three or seventeen” (1995, p. xi). Searle does not dispute that “there are things in that exist [in the world] only because we believe them to exist [such as

money, marriage, government, and property” (p. 1), but denies that there are no objective facts about these things (for example, the date of a marriage or the amount of money paid as salary). In order to distinguish between objective and subjective knowledge, he uses the example of a mountain. That the mountain is there is ontologically objective—it exists outside of our knowledge of it. That the mountain is beautiful is a subjective judgement about it.

How would Searle then conceive of illness? He writes, “On the other hand, the statement ‘I now have a pain in my lower back’ reports an epistemically objective fact in the sense that it is made true by the existence of an actual fact that is not dependent on any stance, attitudes, or opinions of observers. However, the phenomenon itself, the actual pain, has a subjective mode of existence” (1995, p. 8). The argument is more subtle than that of straight social construction, and would allow for the investigations of both biomedical definitions and social construction constructions of disease, health, and illness.

2.1.4 Examining and interpreting social constructions of health and illness

Do proponents of the social construction of disease throw out any idea of biomedicalism? Not entirely. “Disease . . . may be *biologically caused* in terms of empirical science, but as long as it is observed within humans *by others*, it is inevitably a *socially constructed phenomenon*” (Kearns 1994, p. 112). Eyles notes many challenges for medical geography, one of which stems from the theory of social construction applied

to health (1993). The social construction of health has indeed been very influential in much if the recent research in medical geography. A recent book on health and society, with a focus on medical geography, regards all issues surrounding health to be socially constructed (Curtis and Tackett 1996). However, inserting the concerns of social construction into medical geography is not unproblematic.

What does a socially constructed definition of health look like? One of the most commonly quoted definitions of health is that of the World Health Organization (1946): “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” (in Kearns 1995, p. 251). This definition posits that health is not necessarily defined by disease which means that it can exist separate from, or at least in addition to, the biomedical model. The social construction of health and illness has the most power outside the biomedical model (Coburn and Eakin 1993). Unfortunately, the WHO definition is not easily operationalized. How can mental health or social well-being be “measured”? Another definition of health with a heavy flavour of social construction is from the Brent Community Health Council (1981 in Jones and Moon 1987, p. 8):

good health is possible if you are able to choose to do a job you enjoy in a pleasant and safe environment, to live in a warm house with enough space so that people do not get on top of one another, and with a safe place for children to play, to be able to have your children looked after during the day, eat the food you like best, to have a garden, ... it is having time with people you love and time on your own.

This interpretation attempts to define the less tangible elements of the WHO’s definition, but its Western-centric goals make health seem even less achievable. Kearns argues for the postmodern celebration of the intangibility of these kinds of definitions which are

arguably postmodern themselves (1995).

In what ways has the social construction of health become manifest in the less traditional medical geography? By investigating more than just the biomedical symptoms and distributions of an illness or disease, medical geographers inevitably bring social construction into the field. A prevalent example of this is the study of the social impacts of HIV and AIDS. There have been numerous publications on the spatial diffusion of the virus and on the accessibility of care: traditional medical geography (see Wood 1988; Smallman-Raynor and Cliff 1990; Shannon et al. 1991; and Gould 1993 for diffusion and distribution and Chiotti and Joseph 1995; and Smith 1990 for accessibility and service provision). More recent work examines the human experience of the virus and disease and the social construction of the illness (Brown, 1995; Wilton, 1995). It is conceivable that social construction will play a larger role in the geographical study of illnesses which are less biomedically defined, such as arthritis, Chronic Fatigue Syndrome, Alzheimer's Disease, and Attention Deficit Disorder.

Yet, how 'problematic' is the social construction of health and illness? The definitions of health quoted above are certainly more complicated and less tangible than ones simply focusing on the absence of infirmity. Coburn and Eakin warn that the focus on the structural determinants of health can be carried too far at the expense of the role of the individual (1993). This caution seems at odds with the focus on the individual in the challenges to traditional medical geography. It is not. The changes in the field demand a focus on the individual within social structures, or within power relationships in the case of post-structuralism. Coburn and Eakin are merely saying that this should not preclude individuals' responsibilities in their own health—a view associated with the biomedical

discourse. A larger question is the utopian nature of the WHO definition of health (Mayer and Meade 1994). What would that complete state of social, mental, and physical health look like? Is it in fact attainable? If not, the usefulness of the definition must be questioned.

Social construction is not the sole domain of social theory and new theories of space. The contributions of disease ecology to the study of the social factors of disease and illness are often downplayed in the new medical geography (see Kearns, 1993 for an example). “One of the important dimensions of disease ecology which is neglected [in this downplaying] is that culture actually *creates* disease... [Culture] underlies human behaviour, use and modification of environment, reactions to the environment, and the dialectical relationship between people and the environment generally” (Mayer and Meade 1994, p. 104). For Mayer and Meade at least, traditional medical geography incorporates elements of social construction. There must be more common ground between traditional and new medical geography than just history. Medical geography’s unique study of space, health, illness, society, and environment should be a call for inclusiveness.

2.1.5 Changing methods

Accompanying these challenges to traditional medical geography and to the biomedical model of disease has been the introduction of new methods and methodologies to the discipline. Some examples are qualitative methods such as

ethnographic studies, in-depth interviews, and focus groups; the study of biography and autobiography; and textual analysis (Moon 1995). These methods attempt to move beyond the uni-variate and multi-variate analysis found in traditional medical geography to explain what was previously unexplainable or unexamined (Kearns 1995). Social processes figure prominently in current research in medical geography, and new methods are the key in their study, problematization, and (perhaps) explanation. Eyles warns however, that these methods must be carried out critically (1993); they should not be adopted and implemented solely because they *seem* to be the most suitable. One of the ways to ensure this is through triangulation (Jones and Moon 1993). This is where a researcher or research team uses multiple methods in an attempt to pull out as much information as possible. When used effectively, triangulation can avoid gaps in information leading to misunderstandings.

One of the attacks directed at quantitative and some qualitative methods is that the questions are defined and imposed by the researcher on the researched. “New” methods such as participatory action research attempt to involve the researched in the study design, implementation, and interpretation (Curtis and Taket 1996). These methods are only new in a relative sense in that they are new to medical geography. In his 1976 book *Prisoners of Space*, Graham Rowles’s participant observation of one of his subjects led to the subject playing a key role in the interpretation and presentation of his experience of old age. Nevertheless, qualitative methods can provide a “much richer picture of people continually re-making sense of their experience and that of others close to them, with different accounts forthcoming according to the particular circumstances” (Curtis and Taket 1996, p. 42).

2.2 DISEASE MAPPING IN MEDICAL GEOGRAPHY

The ontological, epistemological, and methodological debates in medical geography have implications for the use and place of disease mapping in the discipline. The importance of mapping to the study of disease has a varied history. This section does not attempt to provide a thorough literature review of that history, rather it summarizes its key points. Howe's chapter on disease mapping in Pacione's book, *Medical Geography: progress and prospect* (1986) is a thorough look at the history of disease mapping to the early 1980's. Nothing similar has been completed for the past fifteen years. Beyond the history of medical mapping is a discussion about its purpose and meaning. This exists in a tension between acting in a supporting role to epidemiology and standing as an individually valid research tool. Can disease mapping determine the cause of a disease or the source of an outbreak, or is it better suited to the illustration of patterns of diffusion and prevalence?

2.2.1 Brief history

Mapping diseases is a type of thematic mapping. The cartographic display of health data in the nineteenth century coincided with similar illustrations of other populations characteristics such as sanitation, crime, and poverty (Wilford 1981; Thrower 1996). "Spot-maps" showing houses infected with yellow fever appeared in the United

States in the 1790's and 1820's (Howe 1986; Elliot 1993). Baker (1832) and Rothenburg (1836) produced general maps of cholera in England and Germany respectively (in Smith 1988; Thrower 1996). Other early disease maps "included a map of hernia in France by Joseph-Francois Malgaine (1840); one of cretinism in Canton Aargau, Switzerland, by Ernst Heinrich Michaelis (1843); and one of influenza in Glasgow, Scotland, by Robert Perry (1844)." (Thrower 1996, p. 150) Three German publications included disease maps, but their purpose was to learn about diseases themselves rather than their distribution (Berhaus 1848; Fuchs 1853; Mürhy 1856 in Barrett 1980). Disease mapping was prominent in mid-nineteenth century British reports of disease, particularly cholera. John Snow's Broad Street map is the best known of these, but there were others including Shapter's Exeter (1849), Petermann's British Isles (1852), Cooper's Hull (1853), and Acland's Oxford (1856) (in Howe 1986 and Smith 1988) as well as those by the General Board of Health (1855) and William Farr (1856) (Gilbert 1958; Smith 1988, 1993).

However, the work of Pasteur and Koch and the development of germ theory translated into a decrease in disease mapping later in the nineteenth century, save that in the three volumes by Hirsch (1883-86). The new focus in the study of disease on microbiology replaced the concern with environmental relationships (Barrett 1980). There was no perceived need in mapping the distribution of diseases with known causes in this "post-Pasteurian slump in medico-geographical thinking" (Hunter 1974, p. 1; Thomas 1990, 1992). This is not to say that there was a complete absence of medical cartography in this period (see Havilland's 1875 disease atlases and Booth's 1889 poverty maps for examples), but it became less important than it had been.

With Jacques May's *World Atlas of Disease* (1950), Learmonth's maps of cholera

in India and Pakistan (1954) and Rodenwalt and Juszat's *Welt Seuchen Atlas* (1952–61), medical mapping was on the rise again. It is probably not coincidental that Gilbert published a paper, which included a reproduction of Snow's dot-map of cholera deaths in Soho in 1854, on the history of disease mapping in Britain around this time (1958). May mapped the global distribution of diseases over time such as the plague, cholera, and malaria (1950, 1958), and his results showed not only the relationships between agent and host but defined areas of risk (Pyle 1979). The United Nations and the WHO began using medical mapping after the second world war to show global and regional distributions of diseases that concern the international community (ibid.). Much of this genre of mapping is connected with disease ecology, particularly tropical disease ecology in developing nations.

The effect of computer-aided cartography was felt in medical geography beginning in the 1960s (Pyle 1983). Much of the early work had to overcome technical concerns that went along with the new technology such as printer and memory capabilities. By the mid-1970s, medical cartographers could focus less on the technological barriers and more on computational capabilities for producing maps with resultant patterns and probabilities (ibid.). Nisen discussed some of the advantages of computer cartography in 1980. The process allows the producer to experiment with different projections, data types, and displays and map information can be updated easily. Maps can be made by non-cartographers, and computers can store information, reducing the demand for map storage. He also states that computer-assisted maps are quicker and cheaper to make than manually produced ones. However, while these maps may be faster to make, the high capital cost of hardware, software, and training—all of which are

incurred on a continual basis because of technological advances— must be considered before stating that these maps are less expensive. Nisen acknowledges some of the negative sides to his listed advantages. There is an increased chance for the production of a lot of maps showing very little useful information. Maps produced by people not trained in cartography can contain many technical and cartographic mistakes such as problems with scale and type of projection.

Much of the recent work in disease mapping has been concerned with chronic and degenerative diseases like cancers and AIDS (Shannon et al. 1991; Gould 1993; Jones and Moon, 1997). Mapping diseases with such multi-factorial causes as cancers raises questions about the process as a research tool. With increased population mobility and unknown or imprecise causes, the potential utility for this kind of medical mapping is more suited to locating areas of need for treatment than it is for researching possible causes.

2.2.2 Meaning and purpose

What is the meaning and purpose of disease mapping? The literature is filled with contradictory ideas. Thrower describes Snow's cholera dot-map as achieving "the highest use of cartography: to find out by mapping that which cannot be discovered by other means or, at least, not with as much precision" (1996, p. 150). May believed that "many secrets of nature" would have been revealed had humans accurately mapped disease throughout history (1958, p. 25). Disease mapping is a meaningful but

controversial part of medical geography (Pyle 1979). For McGlashan (1972), it is making use of geography's basic tool, the map, for the purpose of interpreting cartographic data. Medical maps link disease and possible environmental causes. They are research tools pointing to possible causal factors, but they do not offer proof (Howe 1986).

Medical maps provide a graphic impression of the geographic location of diseases. Their visual data of distribution patterns and spatial variations of health and illness, on a local, regional, national, or international scale, can be more accessible and comprehensible than statistics in tabular form (McGlashan 1972; Howe 1986). Well-designed disease maps immediately answer the question, "Where?" (Howe 1986, p. 54). However, medical cartographers risk losing or changing information in the quest for creating readable maps. This is one of the controversial aspects of medical mapping referred to by Pyle (1979).

A valuable component of many disease maps is the connection between diseases and environmental factors (Curtis and Taket 1996). This can include the natural environment like the influence of climate on disease (Pyle 1979) or the relationships between water and disease. Maps can relate social, economic, and cultural environments with the occurrence and disappearance of disease (Pyle 1979). The aim of these studies is to suggest possible contributing causes, and for Howe, this is an "aetiological endeavour" (1986, p.54).

There is something inherently geographical in the practice of medical mapping—a curiosity with the spatial, with mapping disease in time and place. Maps displaying global and regional distributions of disease are valuable for defining risk areas (Pyle

1979). Over time, this kind of mapping is useful for assessing risk areas for aid workers, travelers, and local residents. This information can then be used for planning and developing programs in areas of need (Vorob'yev 1969 in Nisen 1981). Avoiding the ecological fallacy is important in these cases—the assumption that the general aggregated data applies in the individual case (Pyle 1979). The spatial display of disease over time can demonstrate the modes and methods of diffusion (Howe 1986). Again, the purpose of studying the spatial manifestations of disease suggests finding causal links.

Medical geographers and analytical epidemiologists use disease maps as research tools. These maps complement traditional epidemiological methods and their focus on distribution and diffusion of diseases, sometimes coupled with environmental factors, challenges the “essentially anthropocentric viewpoint of the clinical and laboratory methods adopted by most medical scientists” (Howe 1986, p. 55). Few medical geographers claim that the goal of disease mapping, by itself, is to discover the cause of a disease. But words like “causal”, “cause”, and “causation” appear frequently in the literature, softened by words like “suggest”, “seek”, “relate”, and “factors”. Maps began to be used to test causal hypotheses in the 1830s (Curtis and Taket 1996), but their purpose had changed since then. “We are ... led to seek causative factors, to isolate and to map them. Usually it is to find that there are surely factors still unknown” (McGlashan 1972, p. 15).

Are medical maps decisive objects; do they *prove* anything? Pyle (1979) warns that small scale studies do not constitute epidemiological evidence and that they need support from additional scientific research before they can say anything about individual places. This is echoed by Howe who writes, “Proof of causation in the ordinary sense of

the phrase involves analytical epidemiology” (1986, p. 54). Although the disease map is not proof, it is a “factual document” that “offers valuable pointers” to the nature, diffusion, and distribution of disease (ibid.). Medical maps are evidence; they are pieces of the puzzles of factors in disease causation. The history, meaning, and purpose of disease mapping is being questioned by the recent discussion in medical geography as a whole.

“Even nowadays medical geography often begins and ends at description. ... I hope I have put up some kind of case that in our field cartography, though excellent and needed, is not enough. To maintain its place as a distinctive specialism within geography, medical geography needs to incorporate theoretical and methodological developments of human geography” (Learmonth 1991, pp. 58–59). One wonders at the future of disease mapping with words like these from one of the best known traditional medical geographers. Many of the criticisms of traditional medical geography make the discipline’s research appear unsophisticated. While the theories and methods of human geography offer new avenues of research for medical geography, they do not provide effective challenges to the usefulness of disease mapping for geography and other disciplines. Medical geography might do to keep in mind Eyles and Smith’s words about a potential merger between human geography and other social sciences. “Social geography’s greatest achievement may yet turn out to be the acceleration of its own destruction” (1978, p. 55).

This is an appropriate time to re-examine John Snow, medical geography’s hero. Questioning the discipline’s presentation of Snow’s map and the story of the Broad Street

outbreak fits into the current discussion and debate on the nature of medical geography.

Determining how Snow used his dot-map of cholera deaths in studying the outbreak gets at the heart of how we as medical geographers view the importance, place, and meaning of mapping in the study of disease. By pulling apart the representations of Snow, this thesis challenges what we value in the story of Snow and cholera: that he used a dot-map to determine the source of the outbreak, and that he successfully argued for public action to disengage that source which in turn stopped the outbreak.

CHAPTER THREE

SNOW IN GEOGRAPHY: DOT-MAPS AND STORIES

The story of John Snow as told in Text Boxes 1.1–1.3 is an attractive one. It has drama, death, and heroics, and it is enticingly short. However, recent papers in the epidemiological and historical literatures have begun to question the stories about Snow, specifically his role in the cholera outbreak in Soho and more generally in the history of disease causation (Vandenbrouke et al. 1991; Lock 1994; Winkelstein 1995). A similar re-examination has not taken place in geography.

Chapters Three and Four provide evidence that the story of John Snow has been uncritically repeated by many authors leading to a legitimation of questionable or inaccurate knowledge in academic papers, classroom teaching, and textbooks. As the traditional forum for academic ideas, papers in refereed journals possess credibility achieved from the process of their publication. Their ideas can be more transient and less codified than those found in textbooks, and their references to Snow begin to form the foundation of the story. The “history of oral teaching” (Vandenbrouke et al. 1991, p. 967) also perpetuates the variations of the story, but it is not easily examinable. Adopting Kuhn’s assertion that textbooks are the manifestation of “normal science” and that they train future scientists, this vehicle of knowledge has a level of authority over other

academic media (Kuhn 1962). It is here that stories of Snow are codified, legitimated, and become “true”. Other sources such as encyclopedias, general interest books, and the Internet repeat the accounts of Snow and derive their information from textbooks, journal articles, and perhaps an author’s memory from a class at university. If authors simply assume accuracy on the part of other authors, discrepancies become realities. Detail is lost in the act of summarizing a large amount of information, and meaning can vanish too. The whole process of repeating the story of John Snow without looking at archival evidence has lead to a generally unscholarly description and understanding of the significance of his role in the cholera epidemics in nineteenth century Britain.

Chapter Three focuses on how Snow is portrayed in geography. The first section compares seven alleged reproductions of his 1854 dot-map of cholera deaths in Soho, published from 1953 to 1991. The second section is an analysis of the condensed and partial ways the story of Snow and the Golden Square cholera outbreak are described in textbooks and journal articles—appearing like sound-bites. While the choice of literature is not completely exhaustive, it is representative of the types of accounts of Snow to be found in geography. The process of examining the seven maps and the myth of Snow in the discipline prompts questions that carry into the following chapter’s analysis of Snow in the epidemiology and history literatures.

3.1 THE TWENTIETH-CENTURY MAPS

The need for a more accurate telling of the story of Dr. John Snow arose from the

recognition of inconsistencies between reproductions of his dot-map of cholera deaths.

This section examines seven versions of the map presented chronologically by publication date. The components of each map such as symbolization, demarcation of study area, and the number of deaths in a residence near the pump are summarized in Table 3.1, and each map is followed by a discussion of its salient features.

The table needs some introduction because it contains categories and abbreviations that are not immediately comprehensible. The approximate scales were converted from the line scales contained on all but one map. They are labelled approximate because of the probability of error in measurement. The scale benchmark measurement was developed for the length of Broad Street, made along the top of the street from the corner of Marshall Street to the corner of Berwick Street (see Figure 3.5), in order to get a rough comparison of scale between the maps. The number of deaths at the workhouse (located in the rectangle below Gt. Marlborough Street) and at 38 Broad Street were used as benchmarks to illustrate the differences in quantitative information between the maps. Number 38 Broad Street was used because it is the residence on all maps with the greatest number of deaths. The number of pumps presented on each map were also counted. The streets are named alphabetically, and some of them were abbreviated to fit inside the column width. “Gt.” stands for “Great” and “Lt.” for “Little”. “Qd.” is “Quad”, “Rw.” is “Row”, “St.” is “Street”, and “Sq.” is “Square”. “Mar.” is short for “Marlborough”, “Pul.” for “Pultney”, and “Win.” for “Windmill”.

Table 3.1 Comparing the twentieth-century reproductions of Snow's dot-map

Map	Fig. 3.1 Gilbert 1958	Fig. 3.2 Stamp 1964	Fig. 3.3 Howe 1972	Fig. 3.4 Smith, D.M. 1979	Fig. 3.5 Learmonth 1988	Fig. 3.6 Jones 1990	Fig. 3.7 Monmonier 1991
Legend and Scale	Top l.h. corner	top l.h. corner	legend top l.h. corner, scale top r.h. corner	legend top l.h. corner, scale bottom l.h. corner	no legend, scale bottom l.h. corner	legend top l.h. corner, scale top center	legend top l.h. corner, no scale
Symbol -ization	X pump • deaths	⊕ Pump ∴ deaths	■ Pump • deaths	■ pump • deaths	• PUMP – deaths	⊕ Pump ∴ deaths	⊙ Pump • deaths
Scale Type	Line, yards	line, yards	line, yards	line, metres	line, yards	line, metres	none
App. Scale	1:5085	1:5505	1:5373	1:5556	1:2539	1:10 000	n/a
Scale Bench- mark	122m	110m	136m	133m	112m	260m	n/a
Study Area	dashed line	dash-dot line	not shown	edge of map	not shown	not shown	edge of map
Type- setting	street names <i>ALL</i> <i>CAPS</i> , others <i>italics</i>	ALL CAPS, except Conduit and Gt. Mar. Streets are 'St.'	street names ALL CAPS, others lower case with capitalized starts	caps on first letter of street names and "Street" rest lower case	ALL CAPS, except "Yards" on scale	ALL CAPS, except "metres" under scale	caps on first letter of main words, rest lower case
Work- house Deaths	6	6	6	6	5	6	6
Deaths at 38 Broad St.	16	16	15	15/16 messy cartography	18	15? messy cartography	20
Pumps	11	11	11	11	5	11	11
Named Streets	Brewer St. Broad St. Conduit St. Dean St. Golden Sq. Gt. Mar. St. King St. Oxford St. New Bond St. Piccadilly Regent St. Regents Qd. Saville Rw. Wardour St.	Berwick St. Brewer St. Broad St. Conduit St. Dean St. Golden Sq. Gt. Mar. St. Lexington St. Oxford St. Piccadilly Poland St. Regent St. Saville Rw. Wardour St. Warwick St.	Broad St. Conduit St. Dean St. Oxford St. Regent St. Regents Qd.	Broad St. Dean St. Oxford St. Regent St.	Berwick St. Brewer St. Brindle St. Broad St. Carnaby St. Golden Sq. Gt. Mar. St. Gt. Pul. St. Gt. Win. St. King St. Ltl. Pul. St. Ltl. Win. St. Marshall St. New St. Peter St. Portland St. Regent St. Silver St. Wardour St.	Brewer St. Broad St. Dean St. Oxford St. Piccadilly Regent St.	none but labeled arrow points to Broad St. pump
Source	Snow 1855	Snow 1855?	Snow 1855	Howe 1972	Gilbert 1958	Stamp 1964	unknown

Figure 3.1 Gilbert's reproduction of Snow's dot-map (1958, p. 174)

Gilbert's 1958 reproduction of Snow's map was published in his paper on "Pioneer maps of health and disease" which is widely referred to in relation to disease mapping (Fig. 3.1). The author calls the map "a very significant document in the history of medical geography" (p. 175). He cites Snow's 1855 edition of *On the Mode of Communication of Cholera* as his source, but footnotes Frost's 1936 reprint of the manuscript (p. 174). Deaths are symbolized by dots, the pattern of which suggests that streets have been omitted, and not all of the streets included on the map are named. This

display format could have been chosen to make the map more legible at such a small scale. In his text describing Snow's map, Gilbert mentions the original style of the map: the scale was thirty inches to one mile (1:2112) and the deaths were marked by black rectangles. He does not discuss the reasons for his changes. The features of Gilbert's map set the tone for most of the subsequent reproductions.

Figure 3.2 Stamp's reproduction of Snow's dot-map (1964a, p. 16; 1964b, p. 35)

While Stamp (1964a, p. 16; 1964b, p. 35) also cites Snow 1855 as the direct source of his map, the similarities in form and symbolization between his and Gilbert's map suggest otherwise (Fig. 3.2). The street patterns are markedly alike except for

Stamp's inclusion of Lexington Street, running essentially perpendicular between Broad and Brewer Streets. Lexington is actually the street's current name. In 1854, the northern section was called Cambridge Street and the southern extent was named Little Windmill Street. Stamp also omits the south-western extent of the study area. Using Gilbert's map as a reference (Fig. 3.1), there were no deaths west of Saville Row, and Stamp's excluding that part of the map could help to suggest a stronger visual clustering of deaths around the Broad Street pump. One of the mysteries of this map is the word or name "Regmarad" in the bottom right hand corner. Is this the name of the cartographer? Stamp's map appears as a direct reprint in Jones and Eyles book *An Introduction to Social Geography* (1977, p. 89) as well as in Eyles and Woods's book *The Social Geography of Medicine and Health* (1983, p. 81) which cites Jones and Eyles 1977 as the map source. de Blij (1977, p. 85; 1995, p. 233) also uses Stamp's map in his introductory geography textbooks with what could be called artistic licence—the dots are bright pink. The difference between Stamp 1964a and Stamp 1964b is his dating of the Broad Street cholera outbreak and of Snow's map. In the earlier publication, Stamp mistakenly dates them as 1848. An "ERRATA" insert asks the reader to change the date of the outbreak to 1854.

Figure 3.3 Howe's reproduction of Snow's dot-map (1972, p. 178)

Rather than implying that this is a copy of Snow's map, Howe (1972, p. 178) describes his map as an adaptation (Fig. 3.3). This is a more honest portrayal of the connection between his map and the original, but the cartography is too similar to Gilbert's to suggest that it did not influence Howe. While the typesetting and pump symbolization are different and fewer streets are named, Howe's street patterns and implied study area are similar to Gilbert's. There are three areas on the map where the

cartography is untidy. The circus at the corner of Oxford and Regent Streets and Piccadilly Circus, just south-east of Regents Quad, have been drawn off-center; they are not perfect circles like those on Gilbert's or Stamp's. Of the five dots between Regent Street and what would be labeled Saville Row, the three to the left are not more or less parallel to those streets as they are in Gilbert's and Stamp's. Howe's map has been reprinted directly in *Medical Geography* (Meade et al. 1988, p. 20), a widely-used textbook.

Figure 3.4 Smith's reproduction of Snow's dot-map (1979, p. 47)

Howe's reproduction is also the source for Smith's map (Smith, D. M. 1979, p. 47) (Fig. 3.4). Smith excludes all but four street names and cuts off the south and west

edges of Howe's map. The cartography at number 38 Broad Street is messy, and it is difficult to tell if there were fifteen or sixteen deaths at that location. Smith uses squares to symbolize the pump locations as opposed to the Xs and encircled Ps used in the three previous reproductions.

Figure 3. 5 Learmonth's reproduction of Snow's dot-map (1988. p. 147)

Learmonth's reproduction (1988, p. 147) symbolizes cholera deaths with black lines (Fig. 3.5). By imagining lines in the same residence location stacked one on top of the other, the map becomes a two-dimensional histogram suggesting a three-dimensional volume of deaths. Learmonth uses grey shading inside the streets and the workhouse, perhaps as a purely aesthetic device. He defines the study area much more tightly than

previous authors by omitting a number of streets, deaths, and pumps. The effect is that the map demonstrates a stronger clustering of deaths around the Broad Street pump.

Learmonth is one of the few geographers to question whether Snow actually used the map “as an actual tool of research” (p. 148) to locate the source of the outbreak, a skeptical attitude which seems contradictory juxtaposed to such a suggestive map reproduction. Another odd characteristic of this map is Learmonth’s citing Gilbert as the source for his map. Many of the major features hardly resemble Gilbert’s.

Figure 3.6 Jones’s reproduction of Snow’s dot-map (1990, p. 71)

There is some confusion as to the actual source of Jones’s reproduction of Snow’s

map (1990, p. 71) (Fig. 3.6). His citation of Stamp 1964, figure 9 corresponds to Stamp (1964b). However, he dates the Broad Street outbreak at 1848 which suggests that he used Stamp (1964a). In his reference list, Jones cites Stamp 1964: *The Geography of Life and Death* London: Collins which is Stamp (1964b) in this context. This map is a clear adaptation of Stamp's, leaving off the dash-dot line denoting the study area and many of the street names. As with that map, his street patterns are reminiscent of Gilbert's save for the inclusion of Lexington Street. The cartography is messy, making it difficult to determine the number of deaths at 38 Broad Street. The most alarming feature on Jones's map is the scale. Using the approximate benchmark distance, his scale is about twice as large as the other maps. This map shows the loss of detail that seems to accompany multiple reproductions.

Figure 3.7 Monmonier's reproduction of Snow's dot-map (1991, p. 142)

The final map reviewed in this section could almost be called a cartogram of Snow's original map (Fig. 3.7). In his book *How to Lie with Maps*, Monmonier (1991, p. 142) presents a map without a scale, a source, or any street names. He uses exaggerated symbols to situate the pumps and a dramatic arrow pointing to the location of the Broad Street pump. The streets are decidedly narrower than the other reproductions, and the street patterns correspond to those in Gilbert's map. Monmonier's map shows twenty deaths at the residence near number 38 Broad Street. In this context, the title of the book seems ironic.

3.2 REPRESENTATIONS OF SNOW IN GEOGRAPHY

In collecting the preceding seven maps, it became apparent that there were variations in their accompanying accounts of Snow. Further searching through geography textbooks and paper publications revealed textual similarities and discrepancies. The following section is an analysis of the representations of Snow in the geographical, mostly medical-geographical, literature. Instead of summarizing what each author has written about Snow's role in the 1854 Broad Street epidemic, the story is laid out in a thematic framework. Three themes were identified during the analysis and are used to organize the various accounts. The themes are not necessarily internally consistent since there are variations in detail and meaning. Parallels and discrepancies are then discussed as a way of bringing the themes together.

The first theme consists of the discussions about Snow himself. Geographers' presentations of Snow's reputation, any biographical information, his occupation, and his development of a theory of cholera transmission are discussed. Second, there is the theme of the Broad Street outbreak itself. Authors describe the general details and chronology of the episode including where it was located, when it began, when it became severe, and when it ended. Then there is Snow's role: how he determined the source as being the pump and who he convinced to remove the pump handle. Many accounts imply direct causation between the removal of the pump handle and the end of the local epidemic, but there are authors who question the effect that removing the pump handle had on the incidence of cholera in Golden Square. Third, there is a general discussion about what Snow's study of cholera in Broad Street showed or proved and who was influenced by his argument. Some authors argue that Snow clearly proved that cholera was transmitted by contaminated drinking water, while others are not as certain. The three themes are summarized by sorting out commonalities between, absences from, and anomalies in the accounts. The chapter concludes with questions arising from the process of examining the reproductions of Snow's map and the geographical accounts of Snow and the Broad Street outbreak.

3.2.1 Geography's view of John Snow: actions, reputation, theory, and background

John Snow is probably one of the best-known figures in geography, particularly medical geography. In the literature, emphasis is on his having located the source of

cholera in Golden Square at the Broad Street pump, and connecting the spread of the disease with contaminated supplies of drinking water. “It is well known that Dr. John Snow . . . was largely responsible for demonstrating the water-borne origin of cholera” (Gilbert 1958, p. 174). He was “[o]ne of the first to discover a radial contact diffusion of cholera in an urban setting” (Adesina 1991, p. 144). By mapping out the distribution of cholera deaths near Golden Square, Snow was able to determine both the spatial clustering and the focus of the outbreak (Eyles and Woods 1983; Gould 1985; Smith 1993).

Snow’s reputation within geography is that of a pioneering medical cartographer. “It was Snow’s map that showed that cholera was spread by taking in water from polluted sources contaminated by infected excreta” (Smith 1993, p. 43). His “critical mapping work” of the Broad Street outbreak is “‘the classic study’ in medical geography” (Jones 1990, p. 73). The map is portrayed as an early example of the power of medical mapping in identifying the cause of a disease (Copperwaithe 1972; Smith, D. M. 1979). It is referred to as “a celebrated” (Learmonth 1988, p. 147), “the most celebrated” (Thomas 1992, p. 267–68), and the “most famous 19th century disease map” (Meade et al. 1988, p. 20). One author describes it as “a very significant document in the history of medical geography” (Gilbert 1958, p. 175). “When asked about disease maps, most epidemiologists and geographers think of John Snow’s 1854 map of cholera deaths and the Broad Street pump” (Monmonier 1997, p. 263). This is not to say that geographers’ sole focus is on the map. Snow is a “formative figure” in epidemiology and medical cartography (Smith 1993, p. 43). Eyles and Woods (1983 p. 79–80) describe Snow’s Golden Square study as “one of the earliest and still most famous examples” of attention

to environmental health and disease causation.

The geographical literature is scant on biographical information on Snow that does not relate directly to the Broad Street outbreak. It does not provide much information on his career as a general practitioner (except Jones 1990) or his pioneering work in anaesthesia (except Gilbert 1953). Few authors acknowledge his work on cholera before the 1854 outbreak; however four authors trace his theory of cholera transmission to his 1849 publication of *On the Mode of Communication of Cholera* (Gilbert 1958; Howe 1986; Jones 1990; Smith 1993). One of the best known medical geographers of the twentieth century writes that in 1854 Snow discovered that cholera is water-borne (May 1958, p. 40). Geographers have also put little emphasis on placing Snow's ideas in the broader context of nineteenth century ideas of disease transmission and causation. Noteworthy exceptions are Smith (1993) who contraposes Snow's theory to miasmatic theory, Gilbert (1958) who includes Snow's policy suggestion of providing clean water, and Learmonth (1988) who stresses that Snow did not think "that water was the *only* route to infection" (p. 148).

3.2.2 Broad Street: cholera in Golden Square, Soho 1854 and Snow's investigation

During a ten day period from the end of August to mid-September 1854, five hundred people died from cholera near Golden Square in Soho (Smith, D. M. 1979; Eyles and Woods 1983; Smith 1993). This sounds even more catastrophic when combined with the knowledge that many of the residents fled the neighbourhood out of fear during

the outbreak (Smith 1993). According to Snow's research, the boundaries of this area, the "cholera field", were four streets called King, Great Marlborough, Dean, and Brewer (Gilbert 1958; Eyles and Woods 1983). Most of the deaths took place within 250 yards of the water pump on Broad Street (Smith 1993). The probable source of the well contamination was a nearby cesspool with a cracked brick lining (Smith, D. M. 1979). The handle of the Broad Street pump was removed on September 8, 1854 (Gilbert 1958).

The "smoking gun" in the story of the cholera outbreak in Golden Square is the Broad Street water pump, and each of the accounts in geography discusses or mentions Snow as the person who discovered the pump as the locus of the outbreak. How did Snow fix his attention on the pump? Many authors either state or imply that it was the map that provided him with this evidence or at least supported his claim (Gilbert 1958; Smith, D. M. 1979 ; Eyles and Woods 1983; Gould 1985; Jones 1990; Howe 1986; Meade et al. 1988; Thomas 1992; Smith 1993; Monmonier, 1997). Adesina provides a clear example of this: "Through cartographic analysis, [Snow] discovered that cholera deaths were clustered round a particular manual pump in Broad Street, London" (1991 p. 144). A less explicit form of the link between the map and the pump is implicit in other accounts where authors mentions the two objects without specifying the connection between them. For example, Gilbert writes that "the scale of the original map is 30 inches to 1 mile; deaths are shown by black rectangles and the pumps are also marked... Snow proved 'that the incidence of cholera was only among persons who drank from the Broad Street pump'" (1958, pp. 174–75). Only one author explicitly questions Snow's use of the map in locating the source of cholera in Golden Square: "It cannot be quite established that he used it as an actual tool of research" (Learmonth 1988, p. 148).

With the source of the outbreak identified, Snow “urged” (Meade et al. 1988, p. 19), insisted (Jones 1990, p. 73; Smith 1993, p. 43), or urgently requested (Gilbert 1958, p. 175) that the handle be removed from the pump. In the geographic literature surveyed, only Monmonier (1997) mentions to whom Snow would have done this (the local officials), and he also states that it was these officials who removed the pump handle. Other accounts tend to use phrases without subjects or in the passive voice about the pump handle being removed (Gilbert 1958; Eyles and Woods 1983; Learmonth 1988; Meade et al. 1988; Jones 1990; Smith 1993; Curtis and Taket 1996). Without a clear view of who Snow persuaded, it is difficult to tell what evidence he may have presented to support his case. Is it possible that Snow showed the authorities his map of cholera deaths in Soho to convince them of the contaminated pump water? While geographers do not confront this question, it is clear that for them the map is fundamentally connected with Snow’s work and its policy consequences. The map “helped to demonstrate that the bacillus could be transmitted in water-borne doses” (Thomas 1992, p. 267–68); it “supported Snow’s contention that cholera was a water-borne disease” (Meade et al. 1988). Howe writes that Snow augmented the “weight of positive evidence” of the map with the story of a woman from Hampstead who died of cholera, and had water brought to her from the Broad Street pump (1986, p. 38–40).

One of the earliest anecdotes in geography of John Snow and the Broad Street epidemic, states that “the handle of the Broad Street pump was removed and the incidence of new cases in the area ceased almost at once” (Gilbert 1958, p. 175). Other authors make similar causal statements (Gould 1985; Meade et al. 1988; Smith 1993; Monmonier 1997). However, several Snow stories describe the removal of the pump

handle as being symbolic since it appears that the number of cases had begun to fall a couple of days beforehand (Eyles and Woods 1983; Howe 1986; Learmonth 1988; Jones 1990; Curtis and Tackett 1996). Learmonth (1988, p. 147) cites Creighton, a nineteenth-century author, who also doubted the cause and effect relationship between the rapid decrease in local cholera deaths and the pump handle's removal.

3.2.3 The impact of Snow's evidence, argument and theory

What did Snow's study of cholera in the Broad Street area show or prove? The inclusion of the water pumps on the map suggests that Snow was testing his hypothesis that cholera was transmitted in contaminated drinking water (Jones 1990). By showing that local cholera deaths were concentrated around the Broad Street pump, John Snow's map helped identify the cause of cholera (Smith, D. M. 1979; Gould 1985; Meade et al. 1988; Smith 1993). Jones (1990, p. 73) states that "it was Snow's map that clearly established the critical role in cholera transmission of contaminated drinking water." Not all authors make the explicit link between Snow's map and his demonstrating the link between water and cholera (Eyles and Woods 1983; Howe 1986), but they juxtapose descriptions of the map with what his research showed.

With evidence as convincing as geographic accounts suggest, it would seem that Snow's ideas would have had a important impact on the wider medical and public health communities. However, "Snow died in 1858 without general recognition of his contribution (having even had to pay £200 to have his work published at his own

expense)” (Smith 1993, p. 43). His ideas were not widely accepted in the miasmatist dominated medical establishment even with a twelve hundred pound research prize from the Institute of France for his book *On the Mode of Communication of Cholera* (Smith 1993), and they predated Koch’s discovery of the *Vibrio cholerae* bacteria by more than thirty years (Learmonth 1988; Jones 1990).

3.2.4 Commonalities, anomalies, and absences

The primary common element running through the geographic accounts is the map. With such a high profile, one might expect to see consistent reproductions of Snow’s map. As illustrated and discussed in Section 3.1 this is not the case. Another commonality—the link between Snow’s research and his discovery of the cause of cholera—appears frequently in the geographic accounts. However, there is a discrepancy between what geographers claim Snow showed and how his research and ideas were received at the time. Noting this, can geographers plausibly claim that Snow “proved that cholera was a water-borne disease” (Howe 1986, p. 38–40)?

The geographical literature contains some anomalies in the accounts, and even a couple of outright mistakes. Smith (1993) is the only author who mentions that Snow paid money to have his work published and that he received prize money for his work. The role of money in this account seems incongruous since Snow’s receiving money suggests a wider acceptance of his ideas whereas his paying to have his ideas published suggests the opposite. Only one author questions the role of the map in Snow’s research

(Learmonth 1988). This is noteworthy considering the importance placed on the map in Snow's "proof" that cholera is transmitted in contaminated drinking water. This same author is unique in his referencing one of Snow's "contemporary detractors" (Creighton 1894) who noted that the Soho epidemic was waning by the time the pump handle was removed. This reference suggests some level of historical research on Learmonth's part. It appears that Howe mistakenly conflates Snow's Broad Street investigation with his examination of the piped water supply in the districts of south London when he writes that, "Snow is thought to have proved that cholera was a water-borne disease and to have traced the highest mortality to the low-lying areas served around Broad Street by the Southwark and Vauxhall Water Company" (1986, p. 38–40). Peter Gould, a well-known contemporary geographer, names the famous person who engaged in a medico-geographic partnership as "Dr John Hill" (1985, p. 225).

One intriguing anomaly occurs within one of the geographical Snow stories. In his 1997 book *Cartographies of Danger: mapping hazards in America*, Monmonier has a chapter titled "John Snow's Legacy". In discussing the effect of the local officials' removal of the pump handle, he writes, "As he predicted, new cases of the disease dropped precipitously²" (p. 263). The endnote reads, "Snow's fame might well exceed his impact. By the time he disabled the pump, the epidemic had already begun to subside." (p. 343)

In Jones and Moon's textbook *Health, Disease and Society: a critical medical geography* (1987), the authors provide a brief description of Snow's study of the water supply in south London in 1854 as an example of a natural experiment. However, they do not refer to the Broad Street map or study. Jones and Moon wrote the book to be a

medical geography textbook. Assuming that the map and the story are as important to the history of the discipline as the preceding analysis would suggest, they are conspicuous by their absence from the book. As the book is one of the first major works prefiguring the current shift in medical geography towards a constructionist orientation, where less emphasis is put on the tradition of spatial epidemiology and disease mapping in the discipline, the author's presentation of Snow might be a consciously chosen illustration of these changes.

Chapter Three has examined the geographical representations of John Snow in two ways. First, it has presented seven reproductions of Snow's dot-map of cholera deaths and discussed the similarities and differences between them. Second, it has analyzed the details of the story of Snow and the Broad Street cholera outbreak and revealed the central role of the map in determining the source. The process of reviewing the geographical literature on Snow has prompted many questions about the map, the historical details, and the meaning of the Snow myth for medical geography.

It seems incongruous that so much emphasis is placed on Snow's dot-map by geographers yet there are so many variations of the map itself. What does the original map look like; indeed, *is there* an original map? What are the incontrovertible details of the Broad Street cholera outbreak, and what was Snow's role? Did Snow have the pump handle removed, and if so, what evidence did he give and to whom did he present it? How did the removal of the pump handle affect the local mortality from cholera? Why did Monmonier contradict his main text with a statement in the endnotes, a place where only the hardest readers look? Did Snow "prove" that cholera is transmitted in

contaminated drinking water? What do possible answers to these questions say about geography as a discipline? Do medical geographers use Snow to define the meaning and purpose of what they do, that is, what being a medical geographer is all about? These questions will be addressed in Chapters Five, Six, and Seven, but first the next chapter will look at how Snow is presented in the epidemiological and the historical literatures.

CHAPTER FOUR

SNOW IN EPIDEMIOLOGY AND THE HISTORY OF MEDICINE

Geography is not the only field of study that has made a hero of John Snow. The mythical story of his role in the Broad Street cholera outbreak is prominent in several other disciplines. This chapter is divided into three main sections. The first is an analysis of the descriptions of Snow in the epidemiological literature drawing on accounts from epidemiology, public health, and related fields. The second is a similar examination of the presentation of Snow in the historical literature, most specifically in the history of medicine. These two sections follow the same format as Section 3.2 with a general focus on Snow, followed by his role in the Broad Street outbreak, the impact of his theory, and the similarities and differences among the accounts. Finally, the third section poses emerging questions.

4.1 REPRESENTATIONS OF SNOW IN EPIDEMIOLOGY

“Epidemiology has always been the basic discipline of public health” (Holland 1977, p. 12). It is the study of disease origin, pathology, transmission patterns, and prevention measures at a population—that is, not an individual—scale. Studies in public

health take the science of epidemiology and translate it into policies for promoting health in a population. This connection between the two fields of study has resulted in a similar representation of Snow in their respective literatures. One of the most important works on Snow is Frost's 1936 reprint of *On the Mode of Communication of Cholera* because it made that document more widely available. Portrayals have been taken from books and papers on public health and epidemiology, the history of the sanitary movement and public health, as well as engineering for public health. Recent articles by Vandenbrouke et al. (1991) and Winkelstein (1995) re-evaluate John Snow's work and theory adding a more critical point-of-view to the Snow story.

4.1.1 Epidemiology's view of John Snow: actions, reputation, theory, and background

The image of John Snow as a pioneer is popular in the epidemiology and public health literature which focuses on his research on the 1848–49 and 1853–54 epidemics, his role as a founding member of the London Epidemiological Society established during the earlier of the two epidemics (Stolley and Lasky 1995), and his theory “that the causal agent [of cholera] was a parasitic microorganism and was transmitted through the public water supply” (Winkelstein 1995, p. s9). By using information from the Registrar-General's office on mortality in the South London districts and by developing a chemical test for water purity, Snow was able to show that dwellings supplied with water from the Southwark and Vauxhall water company had a cholera mortality rate ten times higher

than those dwellings supplied by the Lambeth company (Levine and Lilienfeld 1987; Stolley and Lasky 1995). (The creation of the Registrar-General's office will be discussed in Chapter Five).

Snow first published his theory of cholera transmission in a pamphlet called *On the Mode of Communication of Cholera* in 1849 (Brand 1965; Winkelstein 1995). He later expanded his ideas in a book by the same name (Brand 1965; Stolley and Lasky 1995; Winkelstein 1995). Brand states that the book was published after the 1853 cholera outbreak, and Stolley and Lasky do not refer to the book as a second edition. According to Winkelstein (1995), Snow used deductive reasoning in 1854 as a base for his theories: he tested them by comparing the spatial distribution of cholera deaths in London to local water supplies, by examining the death rates of cholera victims in terms of their water supply, and by conducting a "case-control" study of the intense and localized Broad Street epidemic (pp. s7, s9). [As an aside, it might seem that Winkelstein is demonstrating Snow's inductive thinking here. But remember, Snow defined his theory of cholera in 1849. Presuming that his theory helped define his investigations, his research in the South London districts and in Broad Street involved more deductive than inductive reasoning.]

Within epidemiology, John Snow is widely recognized as the father of "shoe-leather epidemiology" (Lenihan and Fletcher 1976, p. 210) or even the "father of epidemiology" (Barker and Rose 1979, p. 91). The origin of this title lies in the story of Snow's visiting every dwelling in the South London districts where houses were supplied with water by either the Lambeth or the Southwark-Vauxhall water companies, a study that is "considered a classic in the field of epidemiology" (Page 1987, p. 108). Authors

writing in epidemiology are laudatory in describing Snow's place in the discipline's history. "John Snow wrote a description clearly proceeding through logical stages of evidence, from theory to case to experiment to implications" (Stolley and Lasky 1995, p. 39). Snow's investigations of cholera were "nearly perfect model[s]" of an epidemiologic study (Frost 1936, p. ix) and provided early twentieth-century epidemiologists with an example of a "cohesive approach" to the discipline (Stolley and Lasky 1995, p. 39). His "work marked a triumph for the young science of epidemiology" (Riley 1987, p. 125), and his 1855 book is a "*tour de force*" (Cairns 1997, p. 26). Holland (1977) places Snow's work alongside that of Virchow, Simon, and Farr in terms of its importance to public health.

In all of the epidemiological literature reviewed, there were no personal biographical references and very little professional biographical background on John Snow. With respect to his work on cholera, the focus is on the 1853–54 epidemic, the water supply in the south London districts, and the Broad Street pump. Stolley and Lasky (1995) observe that Snow linked the spread of cholera to international travel routes. They also mention his early investigations in Thomas Street and Albion Terrace in London, but they conflate these events chronologically with the outbreak on Broad Street. Three sources remark on Snow's role as a pioneer anaesthetist in addition to his work in epidemiology (Charles 1961; Brand 1965; Winkelstein 1995). Like the geographical literature, the epidemiological literature puts little emphasis on the contextual nature of Snow's ideas on disease transmission. Although the microscope was an emerging technology, Snow did not use it as a means of supplying evidence supporting his theory of cholera transmission (Winkelstein 1995). He showed that there

were many different types of transmission routes for disease, citing syphilis, “the itch”, and intestinal worms. In so doing, he perceived the link between forms of disease communication and alternative explanations for cholera transmission before the era of germ theory and a more sophisticated understanding of microscopic organisms (Vandenbrouke et al. 1991; Stolley and Lasky 1995).

4.1.2 Broad Street: cholera in Golden Square, Soho in 1854 and Snow’s investigation

There is certainly much less detail and emphasis on the 1854 Broad Street cholera outbreak in the epidemiological literature than in the geographical. Instead there is more focus on Snow’s work in the South London districts. Few accounts provide much detail of the Broad Street outbreak except Winkelstein (1995) who is the source of the following information unless otherwise noted. Snow began studying the Broad Street outbreak and the pump on September 3, 1854. After sampling the pump water, he did not immediately perceive any impurities, but he was aware of the proximal location of a sewer and several cesspools. Snow linked sixty-one local deaths to the pump over the following few days. He met with the Board of Guardians on September 7 to convince them to remove the handle from the pump, and they de-activated the pump the next day. The literature contains inconsistent death-tolls: fifty per day, over five hundred, or six hundred (Wohl 1983; Dadswell 1992; and Cairns 1997 respectively). Snow also noted

that only five of five hundred and thirty-five inmates in the local workhouse died of cholera, and none of the seventy employees in the local brewery died of cholera (Winkelstein 1995). Each place had its own well-water and the brewery provided beer to its workers (ibid.). Cairns refers to the workhouse and brewery as “significant controls” to the study (1997, p. 25).

It is not clear from the accounts how Snow determined that the pump was the locus of the epidemic or what evidence he provided to support his claim. Sterritt and Lester (1988) do not address these questions. Calkins (1987) writes that Snow came to the conclusion by observing that the cholera victims tended to draw their water from the pump more than people who were not affected. Winkelstein’s account (1995) has Snow starting with an observation of the pump water without explaining how he identified the pump as the source or describing how Snow determined that 61 of 73 local deaths were attributable to water from the Broad Street pump.

The map is not directly referred to as a research tool in this literature. Stolley and Lasky provide detail of a map (Figure 4.1) with a side-bar that reads, “... John Snow mapped the occurrence of cholera cases in these streets of London. ... He also marked the positions of the local water pumps. Snow deduced that water from the Broad Street pump was the source of cholera” (1995, p. 35). This map resembles Learmonth’s (Figure 3.5), but it is unclear whether the deaths are marked by individual black rectangles or cumulated into black bars. Their map shows more streets than does Learmonth’s, but fewer than the other maps presented in Chapter Three.

Figure 4.1 Stolley and Lasky's reproduction of Snow's dot-map (1995, p. 35)

Armed with his conviction of the focus of the Broad Street outbreak, Snow successfully “advised the Board of Guardians of St. James parish to remove the handle from the pump” (Winkelstein 1995, p. 88), a detail also noted by Calkins (1987). However, Barker and Rose (1979, p. 91) state that Snow “failed to convince the authorities that contaminated drinking water was responsible for its spread. Undeterred,

he removed the handle of the Broad Street pump.” A number of authors describe this course of events (Charles 1961; Sterritt and Lester 1988; Acheson 1992; Dadswell 1992; Godlee and Walker 1992). Winkelstein avoids the issue of who removed the pump handle by writing that it “was accomplished the next day [September 8, the day after Snow met with the Board of Guardians]” (1995, p. s8). Two accounts say that the number of cholera deaths declined following the removal of the pump handle (Barker and Rose 1979; Acheson 1992), while another two assert a more strongly causal effect: that the act ended the epidemic (Calkins 1987; Dadswell 1992). Winkelstein (1995) does not mention the immediate effect, and Charles (1961, p. 74) notes that the pump being disengaged was “not necessarily effective.”

4.1.3 The impact of Snow’s evidence, argument, and theory

There are a variety of view-points on the impact of Snow’s Broad street study in the epidemiological literature. Many authors stress that Snow was able to demonstrate causation with his investigations of London’s water supply in 1854: he showed that the cholera organism is transmitted through contaminated drinking water (Townsend et al. 1988; Acheson 1992; Stolley and Lasky 1995; Winkelstein 1995). Snow’s work provided “definitive evidence of the waterborne transmission of cholera” (Winkelstein 1995, p. s9; also Wheeler 1992). However, his findings were not fully accepted at the time by the British medical and scientific establishments (Vandenbrouke et al. 1991; Wheeler 1992; Winkelstein 1995). William Farr and John Simon, central figures in

England's mid-nineteenth century public health movement, did not accept Snow's ideas until after he died (Winkelstein 1995). It was not until Frost's 1936 re-print of Snow's *On the Mode of Communication of Cholera* that his ideas gained a wider audience and recognition in the United Kingdom, Europe, and the United States (Vandenbrouke et al. 1991; Winkelstein 1995). Snow's work has informed the methodology and techniques of epidemiology (Holland 1977; Stolley and Lasky 1995), and although his contributions have not been acknowledged in the history of science, they have been in the history of medicine (Winkelstein 1995).

4.1.4 Commonalities, anomalies, and absences

A common theme in the epidemiology literature is John Snow's prominent place in the history of the discipline, including public health. As the "father of shoe-leather epidemiology," Snow used techniques that became part of the field's accepted methodology. He developed "[c]onclusive evidence ... which established the Broad Street well epidemic as the first proved infection of human beings from a water supply" (Hopkins et al. 1970, p. 130).

There are a few anomalies in the various epidemiological accounts of John Snow and his work in Soho. Winkelstein calls the former Broad Street "Beckwith Street" (1995, p. s9), which is possibly a confusion between Broadwick Street and the nearby Berwith Street. Stolley and Lasky (1995) state that Snow's map illustrated the "occurrence of cholera cases" in Soho, but the geographical accounts discuss the map as

showing cholera deaths. Stolley and Lasky also describe Snow's first investigation of the South London districts in 1853 followed by another in 1854. Their layout of the development of Snow's theory and his supporting empirical evidence suggests that the Broad Street outbreak occurred before the 1853/54 epidemic, and they put the date of Snow's *On the Mode and Communication of Cholera* as 1854, without any mention of the first edition. The confusion of dates is common in the discipline's literature.

Townsend et al. (1988) write that the Broad Street outbreak occurred in 1849. Another author says that Snow investigated the water supply in the South London districts in 1853 (Mayson-White 1992), and yet another states that he published the second edition of *On the Mode of Communication of Cholera* after the 1853 outbreak (Brand 1965).

There are two noteworthy absences in the epidemiological literature, one specific and the other more general. First, in their book *Epidemiology and Health Policy*, Levine and Lilienfeld (1987) do not even mention Snow's work in Soho. Instead they focus on his work on the water supply of south London and his "shoe-leather epidemiology" (p. 210). Second, there is a general absence of an explanation of how Snow identified the pump as the source of cholera contaminated water in Soho. There is no mention of an intuitive flash, a map, or a connection between the addresses in the death register and the pump location.

4.2 REPRESENTATIONS OF SNOW IN THE HISTORY OF MEDICINE

The heading of this subsection, the "History of Medicine" is a catch-all phrase to

describe literatures from the history of disease, the history of medicine, and other historical literatures (such as social histories of Victorian England) that mention John Snow. One of the earliest references to Snow is in Scott's 1934 book *Some Notable Epidemics*. There is an impressive breadth of information on Snow in the history of medicine literature, in part because of a similar, albeit longer-standing, re-evaluation of the contribution of his life and work as in epidemiology. Much of this work will appear in the next chapter to support the historical research (for example Pelling 1978; Ellis 1994). Accounts have been taken from papers, books, encyclopaedias, and biographical dictionaries.

4.2.1 Medical history's view of John Snow: actions, reputation, theory, and background

John Snow is a lesser figure in the history of medicine literature than men such as Hippocrates, Lister, and Koch. Although Longmate states that Snow was a "shy, unfashionable doctor, who never achieved real eminence in his profession" (1966, p. 201), other authors write that he was and is recognized as a pioneer in the study and use of anaesthesia (Magner 1992; Bynum 1994; Ellis 1994; Lock 1994). He became so well-respected by some of his contemporaries, that he was called to administer chloroform to Queen Victoria during the births of her last two children (ibid.). In addition to this distinction, Snow is known in medicine for his foundational work in epidemiology. In 1849 he suggested that cholera was caused by a contagious poison that reproduced itself

in the bodies of the afflicted (Rosenberg 1992). Through “his classic study of the Broad Street pump in 1854” (Evans 1992, p. 155), and his “more mundane yet more brilliantly conclusive” study of the water supply in the South London districts (Bynum 1994, p. 79; see also Longmate 1966), Snow used the localized nature of water supply in London to show that the spread of cholera was tied to the contamination of water sources and to poor sanitary and hygiene conditions (Morris 1976; Smith, F. B. 1979; Evans 1992; Bynum 1994; Lock 1994; Weatherall 1995; Kudlick 1996). To [his] scientific insight was due the theory that cholera is communicated by means of a contaminated water-supply” (Power 1909, p. 615). Snow’s work influenced both the creation of the discipline of epidemiology and the provision of clean drinking water in cities (Lock 1994). He published his ideas while admitting that his evidence was not fully conclusive (Morris 1976).

Medical history’s accounts of John Snow contain various descriptions of his reputation within the discipline. “Snow’s special claim is that he made fundamental contributions to not one, but two completely unrelated aspects of medicine. These were his promotion of early anaesthesia, by establishing its scientific and practical foundations, and his discovery of the mode of spread of epidemic cholera” (Ellis 1994, p. ix). Snow’s study of cholera is “one of the most colorful episodes” in the “development of public health and preventative medicine” (Weatherall 1995, p. 4). In his account of Snow’s unique methods of diagnosing lung disease, Ellis describes Snow as “usually ahead of his time” (1994, pp. xxxvi–xxxvii). Snow could “inspect, palpate, percuss and auscultate the patient’s chest” (*ibid.*, p. xxxvii) In other words, he could diagnose by combining sight, touch, and sound clues. He even invented an apparatus to aid in removing liquid from the

chest cavity (*ibid.*). Lock (1994, p. 344) contrasts Snow's current reputation in epidemiology as the "father of 'shoe-leather' epidemiology" with a lack of recognition by physicians and the general public. However, Rosenberg writes that Snow is "deservedly and securely installed in the pantheon of medical history for demonstrating that cholera was a water-borne disease" (1992, p. 107).

The history of medicine literature provides the most detailed biographical information on Snow of all the literature surveyed. Most of this is from Longmate (1966) who draws largely on the memorial essay written by Snow's friend Richardson shortly after the former's death and reprinted in Frost (1936), and from Ellis (1994) who augments the memorial essay with more sources. It should be noted however, that Ellis expresses doubt that Richardson's account is entirely accurate. Longmate does not express this concern. Unless otherwise specified, the biographical information in this paragraph is summarized from both Longmate and Ellis. John Snow was born on March 15, 1813 in York into a poor family. He was the first of nine children, and his father was either a farmer (Longmate 1966) or a labourer (Ellis 1994). Snow left for Newcastle-upon-Tyne at the age of fourteen to apprentice for a career in medicine. According to Lock (1994), Snow's interest in cholera started in 1848. This is perhaps contrary to both Ellis and Longmate who write that Snow first encountered cholera while he was an apprentice in Newcastle, from 1827 to 1833. Snow moved to London in 1836 to study medicine and set up his own practice in 1838. He began using ether as an anaesthetic months after its announcement in 1846 and administered chloroform to Queen Victoria during the births of her last two children in 1853 and 1857 (Ellis 1994). In 1848, Snow began to study cholera. He published his theory of the disease's transmission the

following year in a pamphlet called *On the Mode of Communication of Cholera* and a second edition in book form in 1855, a publication that ended up costing him 200 pounds. Snow died of a stroke in 1858 at the age of forty-four.

The history of medicine literature is also the discipline with the strongest explanations of Snow's theory of cholera transmission and its place in an historical context. Rosenberg (1992, p. 117) argues that Snow's theory is an "artifact peculiar to the generation that produced it" because it was formed during a time when debates on hygiene, sanitation, and the fermentation theory of disease were commonplace. Rosenberg goes on to say that Snow's investigative methodology was also a cultural artifact: he could not have plotted individual deaths without the creation of the Registrar-General office. Snow's theory on the spread of cholera had five main points: "(1) cholera must be spread by some sort of poison; (2) this poison acts directly on the intestines; (3) the poison must be introduced through the mouth and not by inhalation; (4) all the signs and symptoms of cholera arise as a result of the tremendous loss of fluid from the intestines; and (5) drinking water, contaminated by water from dunghills and 'privies,' is almost certainly the cause" (Lock 1994). These ideas were formed before the work of Pasteur and the development of germ theory (Smith, F. B. 1979).

Snow was aware of the possible political and social implications of his theory and assured his contemporaries that his ideas did not imply the need for quarantine and the obstruction of trade and commerce (Morris 1976). Baly and Gull's rejection of Brittan and Swayne's fungus theory—a water-borne theory of cholera—around the time that Snow published his theory hindered the acceptance of his ideas (ibid.). Further opposition came from the *Edinburgh Medical Journal* and its disbelief that cholera

victims contracted the disease after using the same privy as someone already infected—
 “No one drank from the privy” (quoted in Smith, F. B. 1979, pp. 234–35). Despite this
 reluctance to accept Snow’s theory, his ideas influenced the General Board of Health’s
 examination of the 1853–54 epidemic where its reports had a stronger focus on water
 than those following the 1848–49 epidemic (Luckin 1986). (The creation of the General
 Board of Health will be discussed in Chapter Five).

4.2.2 Broad Street: cholera in Golden Square, Soho in 1854 and Snow’s investigation

The history of medicine literature contains numerous details of the cholera outbreak in 1854 Soho. During a ten day period at the end of August and beginning of September 1854, over 500 people died of cholera within a few hundred metres of the Broad Street pump (Scott 1934; Smith, F. B. 1979; Bynum 1994; Lock 1994). The “‘cholera area’ comprised Golden Square and Berwick Street, St. James’s, the adjoining part of St. Anne’s, Soho, from Wardour Street to Dean Street, and part of the sub-district of St. James’s Square enclosed by Marylebone Street, Tichfield Street, Great Windmill Street and Brewer Street” (Scott 1934, p. 21).

As described in two accounts, the first cholera case that contaminated the well-water was traced to the death of a baby at number 40 Broad Street (Morris 1976; Lock 1994). Reverend Henry Whitehead discovered that while the baby was sick, her mother had thrown the water used to clean diapers into the house’s cesspit which then leaked into

the well (Lock 1994). In his investigation, Snow found a few cases where people had visited the area, drank water from the Broad Street pump, and had subsequently died (Scott 1934; Longmate 1966; Bynum 1994; Lock 1994). He also determined the details of the fatal case of a woman who lived in Hampstead, but had water from the pump delivered to her daily (Scott 1934; Longmate 1966). He also discovered that employees at the local brewery were given beer to drink and seemed “immune to the disease” (Bynum 1994, p. 79; also Scott 1934; Lock 1994).

While many authors refer to the removal of the pump handle, only Scott (1934) and Lock (1994) put it in a specific time frame by writing that the event occurred on September 8 (Scott 1934) the day after Snow met with the Board of Guardians (Lock 1994). Soho’s population was severely affected by the local cholera epidemic through both the death toll of over 500 people and the large number of people who fled the area; this loss of population was enough to shut down one local doctor’s practice (Smith, F. B. 1979). In the introduction to his edited copy of *The Case Books of Dr. John Snow*, Ellis (1994) notes that the timing of the outbreak coincided with a relative break in Snow’s anaesthesia schedule, providing more time for his cholera investigations.

There are three possible explanations in the medical history literature for how Snow could have identified the pump as the cause of the outbreak. First, although Snow’s investigation of the epidemic concluded that the pump was the focus, he could have only done this with the help of Henry Whitehead, who knew the activities of the parish better than Snow (Morris 1976; Lock 1994). Second, upon reviewing the death records from the General Register Office [*sic*] during the beginning of the outbreak, Snow noted that all 89 recorded deaths were located near the pump and that 69 of these

people were known to have drunk the water from the pump (Lock 1994). Third, Snow's map of the location of cholera deaths "implicat[ed] a single contaminated well in Broad (now Broadwick) Street" (Bynum 1994, p. 79). Bynum includes a copy of a map from Snow's 1855 publication of *On the Mode of Communication of Cholera* (Figure 4.2) on which black lines indicating cholera deaths "cluster" around the pump. Longmate writes

Figure 4.2 Bynum's reproduction of Snow's dot-map (1994, p. 80)

that “Snow prepared a large-scale map of the area, with houses which had suffered cholera deaths indicated by black lines. The most casual glance showed at once the tremendous concentration of deaths in the immediate vicinity of the suspect pump” (1966, p. 205). Longmate reproduced his copy of the map with permission from the

Figure 4.3 Longmate’s reproduction of Snow’s dot-map (1966, p. 205)

Wellcome Foundation (Figure 4.3). The three maps presented in this chapter appear to be from the same source even though they show varying amounts of that map source.

According to some authors, once he determined the source of the outbreak, Snow persuaded the “local councilors” (Bynum 1994, p. 79), the “parish authorities” (Morris

1976, p. 209–10), or the “local Board of Guardians” (Lock 1994, p. 344) to remove the handle from the pump. How Snow accomplished this is not altogether clear. Bynum states that his “carefully prepared analysis convinced” the authorities to deactivate the pump (1994, p. 79). It seems the Board of Guardians may not have supported Snow’s theory of water transmission when they “reluctantly . . . followed his advice” (Lock 1994, p. 344). Other accounts do not mention the local authorities (McKeown 1988; Weatherall 1995; Kudlick 1996).

Three accounts claim that Snow himself removed the handle from the pump (McKeown 1988, Weatherall 1995; Kudlick 1996). Lock (1994), Bynum (1994), and Morris (1976) state that this was done by the Board of Guardians, or the local authorities. The accounts also differ on the effect this action had. “Snow protected a London population from cholera” by removing the pump handle (McKeown 1988, p. 212). When the pump was disengaged, “the epidemic faded” (Morris 1976, p. 209–10), “cases of cholera in the neighborhood around it plummeted” (Kudlick 1996, p. 224), and the epidemic was controlled (Weatherall 1995, p. 4). For Lock (1994), this causal link between the removal of the handle and the staying of the epidemic is a “version of the story” (p. 344). Snow’s action may have prevented a second wave of the epidemic, but by the time the handle was removed, the number of cases was already on the decline (Lock 1994). The removal of the handle was less effective than symbolic (Bynum 1994).

4.2.3 The impact of Snow's evidence, argument and theory

In the medical history literature, only two authors question what Snow's investigation in Broad Street actually proved (McKeown 1988; Lock 1994). McKeown (1988) doubts that Snow's evidence would constitute proof or provoke action today. Lock discusses how Snow used the study to help him develop his theory of cholera transmission, to suggest ways to prevent the disease, and to "graphically demonstrate his original hypothesis" (1994, p. 344). He also states that Snow's work was initially disregarded or refuted, and his theory was not supported by the General Board of Health inquiry into the 1853–54 epidemic which emphasized an atmospheric cause. However, Lock questions the definitive importance of Snow's Broad Street study in developing, confirming, and proving his theory of cholera transmission

Did Snow's work have any effect on changing the minds of the miasmatists or on influencing public health policy? Power (1909) states that Snow was awarded 1 200 pounds by the Institute of France for his 1849 essay *On the Mode of Communication of Cholera*. However, Longmate (1966, p. 208) writes that Snow was "under attack as an enemy of sanitary progress" after the publication of his book rather than "being hailed as a public benefactor". Not all authors describe the reaction to Snow's theory this harshly. In the write-up of its inquiry into the epidemic, the *Report of the Medical Council* expanded the doctrine of miasma to "accommodate both the observed data and the epidemiological logic and the structure of Snow's innovations" (in Luckin 1986, p. 83). Snow saw the medical establishment begin to view water as a predisposing factor in

cholera transmission while holding onto its belief in atmospheric and miasmatic causes (Luckin 1986). Morris writes that Snow did not cause a “sweeping conversion of the profession and received little attention in medical textbooks or subsequent works on cholera” (1976, pp. 209–10). His ideas were officially accepted—albeit grudgingly (Lock 1994)—in 1866 when William Farr of the Registrar-General’s office looked for role of water in that year’s epidemic (Morris 1976). Snow recognized that some of the resistance to his theory was more economic than medical, but he “had reconciled the needs of industrial *laissez-faire* society with contagionist theory” by arguing that his ideas would not endanger commerce (ibid. pp. 209–10). Lock claims that Snow’s ideas lead to the “establishment in London and other great cities of a safe water supply and proper sewage disposal” (1994, p. 348). Men who initially rejected Snow’s theory like John Simon, Thomas Acland, and William Farr, later published similar views, counseled similar preventative measures, or finally accepted his ideas (Morris 1976). While Snow’s ideas were not immediately accepted by his peers, these references suggest that his ideas eventually influenced public health policy.

The acceptance of Snow’s theory was hindered by two things. First, the miasmatic theory of disease transmission was well established in the mid-nineteenth century. This was a “theory whose followers resisted modification of innovation, specifically resisting reintroduction of the contagion theory of disease transmission directly from individual to individual, and introduction of the germ theory of disease” (Riley 1987, p. xv). The second was Snow’s inability to find or show the organism, the specific cause of cholera. It wasn’t until 1883 that Robert Koch discovered the cholera bacillus (Morris 1976; Kudlick 1996). “Ultimately, the discoveries of Snow, Koch, and others resulted in the

‘germ-theory of contagion’, in which the spread of infectious disease was attributed to bacteria or other microorganisms” (Kudlick 1996, p. 224). Despite this work, the Royal College of Physicians did not give substantially different advice in 1892 when England was faced with a possible cholera epidemic than they had in 1831 (Text Box 4.1).

Text Box 4.1 (Smith, F. B. 1979, p. 223)

It was a case of professional men talking to their upper- and middle-class comrades, oblivious of the masses. The house, the RCP declared, must be ‘clean, light, thoroughly dry and well-ventilated’. Its inhabitants must eat each day three or four ‘nourishing and ample meals’, but avoiding soup and cheese, as ‘indigestible’. Alcoholic beverages were permissible in moderation, but ‘sparkling wines were to be shunned, as well as over-fatigue, emotional excitement and undue strain’. Regular exercise was also advised, ‘early hours’ and the pursuit of ‘an occupied and tranquil life’.

Snow had acknowledged that water was not the only mode of transmission for cholera (Morris 1976), and by the end of the century, both contagionist and anti-contagionist explanations were seen by the scientific community to have validity in explaining the communication of cholera (Kudlick 1996).

4.2.4 Commonalities, absences, and anomalies

One of the ways that the history of medicine literature differs from geography or epidemiology is that it does not produce a cohesive image of Snow. There is no single detail, fact, or artifact—such as the map—that ties all of the reviewed accounts together, and only a few authors present similar types of material. This could be because of where

Snow stands in importance to other medical heroes, or it could be that discussions of his dual role as a pioneer in anaesthesia and epidemiology cut short the amount of detail authors can include.

While some authors stress Snow's achievements in these two fields, others portray him in only one of the two. In her book *A History of Medicine*, Magner (1992) never discusses Snow's work on cholera. Instead she relates the history of research on the disease in three different topics: with reference to Pasteur, Koch, and germ theory (p. 311, 315); in terms of Pettenkofer, the science of hygiene, and anti-germ theory (p. 327); and with respect to the present threat of other "old specters" like malaria, leprosy, tuberculosis, and measles (p. 365). Her references to Snow relate to his involvement with the development of anaesthesia and administering chloroform to Queen Victoria during the birth of her eighth child. Magner does not discuss British sanitary reform and she places the study of cholera in the context of Pasteur's and Koch's research, which might explain the absence of Snow's work on cholera. More of the authors in this section do not discuss Snow's place in the history of anaesthesia (McKeown 1988; Luckin 1986; and Kudlick 1996). There are two possible explanations for this absence. First, McKeown's and Kudlick's references to Snow are extremely brief and do not provide very much information on Snow even in terms of cholera. Second, Kudlick's book is a history of cholera in Paris and Luckin's book is a social history of the Thames; Snow appears as a character only in reference to their topics.

Rosenberg (1992) appears to anomalously date both the Broad Street outbreak and the South London districts study in 1849 by referring to them in the context of Snow's 1849 pamphlet *On the Mode of Communication of Cholera*. Also anomalous are

the two references to Reverend Whitehead and his investigation into the Golden Square epidemic (Morris 1976; Lock 1994). Both authors attribute Whitehead with locating the initial case of the outbreak as a baby who lived at Number 40 Broad Street. For Morris, Snow would not have been able to conduct his research without the help of Whitehead. Lock describes the curate as initially skeptical of Snow's theory, but then being convinced by his evidence and argument. The final and perhaps most important singularity in the accounts is Lock's questioning of the representation of Snow and the Broad Street epidemic. The "choice of the pump as a tribute is based on a legend that, however picturesque, misrepresents and even diminishes Snow's signal contribution" (Lock 1994, p. 344).

4.3 BUT WRITERS OF HISTORICAL TEXTS OFTEN DO

In discussing some of the inconsistencies in stories of John Snow, Birkenhead writes, "Though history may not repeat itself, the writers of historical texts often do" (1967, p. 8). Points of divergence and convergence on the story of Snow have become manifest from the reviews in Chapters Three and Four. They prompt historical questions about the story of John Snow, his theory of cholera transmission, the Broad Street epidemic, and the dot-map of cholera deaths. They also encourage a discussion of what the Snow story means for epidemiology, the history of medicine, and geography and what it says about how science works. The questions of historical accuracy and broader meanings will be addressed in the rest of the thesis.

4.3.1 Historical questions

Many questions of historical accuracy come out of the accounts presented in Chapters Three and Four. Who was John Snow? What are the biographical details of his life? With his dual reputation as a pioneer in epidemiology and anaesthesia, the historical record will be explored to determine how he got involved in the study and practice of both. These questions will be addressed in Chapter Five.

Then there are the many discrepancies in the details of the Broad Street outbreak and Snow's related actions in 1854. What did Snow actually do during the Broad Street epidemic? How did he decide that the pump was the source of the local outbreak? How does Reverend Whitehead fit in? With this in mind, does Snow deserve the title "father of shoe-leather epidemiology"? There are also ambiguities about whom Snow convinced that the pump was the source of the outbreak, how he did so, and who removed the handle from the pump. In terms of his evidence, did he use a map either to determine the source or to convince someone or a group of people of the source? What does this map look like? Finally, the accounts in Chapters Three and Four are not consistent in their evaluation of what Snow's Broad Street investigation and actions actually showed, and if the self-limiting nature of cholera can be seen in this example. They are also not clear on who accepted his argument and theory of the water-transmission of a cholera organism. These questions will be addressed in Chapter Six.

4.3.2 Present meanings of the history

Chapter Seven will introduce a variety of themes for future exploration that come out of the process of re-examining John Snow. With Snow as a prominent figure in the history of geography and epidemiology and at least a minor character in the history of medicine, there are implications of retelling the story of the Broad Street outbreak with archival evidence. In a nineteenth century context, a more historically accurate account prompts the examination of how socio-medical authority acted in the acceptance of his theory of cholera transmission (or lack thereof). In a current context, how does knowing that Snow's ideas were not accepted at the time affect the power of the story today for the three disciplines? What effects have Snow's theory and investigations had in the late twentieth century for each of these three disciplines, and what do the representations of Snow in the current literature say about the power of myth in academic disciplines?

The last chapter will also connect the original map with the twentieth century reproductions with questions for future research. Does Snow's map show a spatial clustering of cholera deaths around the Broad Street pump? Do the reproductions? How much information has been lost with maps made from maps made from maps? Re-evaluating the Snow story has an important meaning for geography, particularly medical geography because it threatens the dominant place of the map in the story. How does the story of the map reflect the "power of the map" in geography?

4.3.3 Meanings for science: evidence, argument, and causation

Taking a step back to the more general, retelling the story of Snow raises questions about the history, nature, and practice of science. These issues will also be discussed briefly in Chapter Seven as ideas for future investigation. Where does Snow's work fit into the history and development of statistics and the scientific method? Snow's investigations in the South London districts are early examples of what are now called ANOVA and levels of significance tests in statistics. Investigating medical phenomena in the mid-nineteenth century was not always scientific in terms of method, and some research was more empiricist than theoretical. What did McKeown (1994) mean when he said that Snow's evidence in the Broad Street outbreak would not constitute proof or provoke action today: has scientific proof changed in principle or practice since 1854?

Re-examining Snow provides an opportunity to explore how science works and what science means. In terms of making a convincing argument of the pump being the source of the outbreak, did Snow's reputation play more of a role than his evidence? Can this story be used to discuss the types and standards of evidence needed to prove causation? How do the reactions of Snow's contemporaries to his theory reflect the power/knowledge negotiations in science and medicine? These questions encapsulate a more historically accurate account of Snow, and they point to a fruitful opportunity to pursue more research.

CHAPTER FIVE

WHO WAS JOHN SNOW?

The next two chapters draw on archival research conducted in London, England over a three-week period in February and March of 1997. They construct a more historically accurate narrative of who Dr. John Snow was and what he most probably did or did not do during the Broad Street cholera outbreak according to the evidence available. Internet searches completed in Ottawa prior to the field work in London provided a list of possible research facilities. The research was conducted at the Wellcome Institute's Library, the London Metropolitan Archives, the City of Westminster Archives, and the Royal College of Physicians' library. This research did not include examining documents at the British Library because of time constraints. Sources included papers published in mid-nineteenth century medical journals such as *The Lancet*, *The British Medical Journal*, and *The Edinburgh Medical Journal*; government reports such as investigations by the Board of Health; Snow's first and second editions of *On the Mode of Communication of Cholera*; *The Cholera Gazette* published briefly during the 1832 epidemic; the *Report of the Cholera Outbreak in the Parish of St. James, Westminster* presented to the Vestry of St. James by the Vestry's Cholera Inquiry Committee; and microfilm images of the hand-written minutes of the

Board of Governors and Directors of the Poor for the Vestry of St. James's Westminster.

The account that emerges is the most plausible that could be constructed from the field research. It is not the only possible story, but this is not to say that there is no possibility of a true account. This kind of research raises questions about the possibility and probability of an historical objective reality. Certainly Snow acted in definite ways, said specific things, and wrote specific words. These provide the ontological context for the chapters. The question of whether or not we can ever know exactly what these things were is an epistemological question. The epistemological short-coming of the lack of evidence to show whether or not something is or is not true does not affect the correctness of an assertion (for example, that John Snow did not use the map to show that the Broad Street pump was contaminated with cholera)—it affects only what we can know about it. Rather than remaining hopeless at the prospect of being unable to uncover “the truth”, this chapter tries to move beyond the “multiple truths” found in the accounts of the previous two chapters.

Chapter Five provides a picture of who John Snow was in the form of a short biography. It places him in an historical social and medical setting and briefly defines terms prevalent in mid-nineteenth century theories of disease transmission. This leads into a somewhat chronological description of the theories of cholera transmission and treatment in the mid-nineteenth century as a way of introducing and contrasting Snow's theory of how cholera was communicated (see Appendix 1 for the modern understanding of cholera). The chapter ends by discussing Snow's reputation as a leading anaesthetist.

Establishing the details of John Snow's life in any comprehensive way is difficult. The only known personal documents written by Snow are his Case Books dealing with

his administration and experimentation with anaesthesia, a letter, and a testimonial which are all held at the Royal College of Physicians (Ellis 1994). These documents are augmented by the University of British Columbia's Clover/Snow Collection which includes personal correspondence to and about Snow (Thomas 1972). Shortly after Snow's death, his close friend B. W. Richardson wrote a biographical essay and had it published with Snow's *On chloroform and other anaesthetics* (Ellis 1994). A second, less informative and much shorter version was published in 1887 and reprinted in Frost's edition of Snow's *On the Mode of Communication of Cholera* (1936). Unfortunately, the accuracy of Richardson's accounts is questionable. "His *Memoir* of Snow was written, with Victorian prolixity, at a time when he was only twenty-nine years old and still mourning the sudden loss of his close friend and colleague. Accordingly, careful historical judgment needs to be exercised when assessing some parts" (Ellis 1994, p. xi).

5.1 BIOGRAPHY

In 1936 the first professor of public health in the United States, Wade Hampton Frost, had Snow's *On the Mode of Communication of Cholera* reprinted. This book also included the second edition of Richardson's memorial essay on Snow. "It gives the picture of a man singularly endowed with the ability to think in straight lines and the courage to follow his own thought [*sic*]. In medicine these abilities placed him in the front ranks of his day; in epidemiology they carried him a generation beyond it" (Frost 1936, pp. xx–xxi). The biographical information presented by Richardson has been

adapted into a time-line presented below (Text Box 5.1). Question marks and the word “UNKNOWN” appear when Richardson’s narrative does not specify dates or is unclear.

This is then augmented by some information absent from Richardson’s account and some noted characteristics of Snow’s personality.

Text Box 5.1 Biographical Timeline for John Snow

(Adapted from Richardson in Frost 1936)

JUNE 15, 1813 Born at York, father a farmer

UNKNOWN Attended private school at York

AGE 14 (1827?) Was apprenticed to Mr. William Hardcastle, Surgeon

AGE 17 (1830?) Became a vegetarian and at about this time took up the temperance cause and became a powerful advocate of the movement

1831–32 Cholera at Newcastle, worked at Killingworth Colliery

1833 Went to nearby Burnop Field, assistant to Mr. Watson for 12 months

1834–35 Went home to York, then to village in Yorkshire (Pately Bridge), assistant to Mr. Warburton for 18 months

1836 (?) Returned home to York, set up temperance societies

SUMMER 1836 Travelled York to Liverpool; Liverpool to London by foot Via North and South Wales and Bath (visited his uncle Mr. Empson)

OCTOBER 1836 Attended Hunterian School of Medicine in Windmill Street (Soho)

OCTOBER 1837 Had a hospital practice at Westminster Hospital

MAY 2, 1838 Passed exam for Royal College of Surgeons of England

SEPTEMBER 1838 Left residence at Bateman’s Buildings and set up practice at 54 Frith Street, Soho Square

OCTOBER 1838 Passed the Apothecaries' Hall. At about this time he began attending meetings of the Westminster Medical Society. Began speaking occasionally, and eventually gained the attention of members

OCTOBER 16, 1841 Read paper at Westminster Medical Society: "Asphyxia and on the Resuscitation of New-born Children"

NOVEMBER 5, 1841 Published a paper in the *Medical Gazette*

DECEMBER 18, 1841 Displayed instrument for thorax surgery to Westminster Medical Society

JANUARY 28, 1842 Instrument was described in *Medical Gazette*

1842–43 Presented and published more papers, especially on capillary action

NOVEMBER 23, 1843 Passed M.B. exam from the University of London. Became Dr. Snow

DECEMBER 20, 1844 Passed M.D. exam

SUMMER 1845 Attacked by symptoms of renal disease (years previously he had had symptoms of *Phthisis pulmonalis*—pulmonary tuberculosis)

AUTUMN 1845 Recuperated on Isle of Wight

? 1845 Returned to London and was elected Lecturer on Forensic Medicine at the Aldergate School of Medicine (held this until the school closed in 1849)

1846 Heard of ether experiments in the U.S. Developed an inhaler and carried out experiments on animals and himself before using it on patients. Administered anaesthetic to dentistry patients at St. George's Hospital and at University College

SEPTEMBER 1847 Wrote up his experiments on etherisation [Richardson does not specify the type of publication but implies that it was a pamphlet or book]

UNKNOWN Began using chloroform

1848–51 Wrote papers for the *Medical Gazette* on narcotic vapours and other issues surrounding the use of anaesthetics

1848 Focused on the cause and propagation of cholera

1849 Obtained more reliable evidence to support his theory that cholera is ingested through the alimentary canal. Published a pamphlet entitled "The Mode of Communication of Cholera"

1849–50 The Westminster Medical Society amalgamated with another society to become the Medical Society of London [Richardson does not name the other society]

1850 Consulted to administer chloroform to Queen Victoria during the birth of Prince Arthur—was not called

JANUARY 1851 Published a paper in the *London Journal of Medicine* on his Brompton Hospital experiments on remedies by inhalation

1851 Wrote a letter to Lord Campbell defending the medical use of anaesthetic. Campbell supported a bill in the House of Lords that had a clause making it illegal to "administer chloroform or any other stupifying drug" (p. xxxiii). Recorded the results of 20 months of inhalation experiments at the Brompton Hospital to the Medical Society of London

1852 Elected Orator for the following year of the Medical Society of London. On March 8 (1852?) delivered a speech on "Continuous Molecular Changes, more particularly in their Relation to Epidemic Diseases." Became vice-president at some point over the following two years

APRIL 7, 1853 Administered chloroform to Queen Victoria at the birth of Prince Leopold

1854 Conducted Southwark and Vauxhall Company and Lambeth Company experiment and Broad Street investigation

MARCH 10, 1855 Gave acceptance speech on being elected president of the Medical Society of London

1855 Published the book *On the Mode of Communication of Cholera*. Paid 200 pounds to have it published and did not see much of a return on his investment. Addressed the select committee on the "Public Health and Nuisances Removal Bill"

1856 Visited Paris with his uncle Mr. Empson. Entered his book into a competition at the "Institute" with a prize of 1200 pounds. [We can assume that Snow did not win because Richardson writes that there was "no notice of Dr. Snow's researches" in the judges' decision" (p. xxxvii)]

APRIL 14, 1857 Administered chloroform to Queen Victoria for the birth of Princess Beatrice

JUNE 9, 1858 Seized by paralysis while writing his book “On Chloroform and Other Anaesthetics”

JUNE 17, 1858, 3 pm Died. Buried at Brompton Cemetery.

Richardson’s memoir on Snow is the most comprehensive, but some of his details are questionable. Ellis (1994) gives a less complete but more accurate biography that challenges a few of Richardson’s details by drawing on archival evidence. First, Snow was born on March 15, 1813 not June 17, and second, his father was a labourer not a farmer. These details are supported by Brunskill’s reproduction of the appropriate parish record entry in his letter to the editor of the *American Journal of Epidemiology* (1992, p. 452). Third, Ellis clears up Richardson’s ambiguity of when Snow first attended court: he was presented to Queen Victoria at a summer gathering in 1857, months after administering chloroform to the Queen for the second time at the birth of Princess Beatrice. Finally, in another publication, Ellis (1991) states that Snow died on June 16, 1858, not the 17th—a detail confirmed by Snow’s obituary in *The Lancet* quoted on the following page.

When Snow began his medical career, he started his own practice as opposed to purchasing an existing one (Richardson in Frost 1936). While he waited for business to pick up, he attended out-patients from Charing Cross Hospital. People described him as quiet and somewhat peculiar, and Richardson noted Snow’s husky and sometimes painful-sounding voice. However, he also wrote that Snow spoke in an earnest and direct

way (ibid., p. xlv). Reverend Henry Whitehead wrote that Snow laid out his claims in a “‘calm prophetic way’” (in Chave 1958, p. 106). He was less reserved among friends than in public, and had a quiet, droll sense of humour (Richardson in Frost 1936). Living on less than 1000 pounds a year, Snow was frugal and dressed plainly. He saw an average of ten patients a day, which left him plenty of time for scientific and medical pursuits (Atkinson 1970). Snow was an active member of many of London’s medical, epidemiological, pathological, and surgical societies (Richardson in Frost 1936).

Upon Snow’s death, there was a brief obituary published in *The Lancet*: “DR. JOHN SNOW—This well-known physician died at noon on the 16th instant, at his house in Sackville-street, from an attack of apoplexy. His researches on chloroform and other anaesthetics were appreciated by the profession” (*The Lancet* 1858, p. 635). Soon after this was published a much longer obituary appeared, written by J. G. French who had worked with Snow during the Vestry of St. James’s inquiry into the Broad Street outbreak (1858, p. 103). He wrote, “I believe that since the days of Jenner no physician has rendered more important service to mankind than Dr. Snow. When his doctrine respecting the mode in which cholera is communicated becomes comprehended by secretaries-of-state and generals commanding-in-chief, as is the household word ‘vaccination’ then ‘outbreaks’ of cholera—that is, large numbers of persons attacked at once in a district (a phenomenon well known in the history of the disease) will become rare events.”

5.2 HISTORICAL CONTEXT

It is important to look at Snow's biography with an eye to the historical backdrop. Snow lived and researched in Victorian England. This was a era of expansion for the British Empire, of vigorous trading at home and abroad, and of tightly defined social mores constructed along class lines. Agricultural and industrial changes respectively pushed and pulled people from the country-side into cities, creating large areas of urban poor.

It was during this time that British officials began to collect data on the population in the form of censuses and birth and death records, partly as an effort to fix alleviate social problems existing in poorer neighbourhoods. The Registrar-General's office was established in 1837 to collect these vital statistics (Flinn 1965). The aim of the sanitary movement was to introduce hygiene measures to clean up the "filth" and refuse heaps in these neighbourhoods both out of Christian duty and to prevent the diseases of the working and poor classes from affecting residents of wealthier areas (see Simon 1890; Rosen 1958; Chadwick 1965; Pelling 1978; Smith, F. B. 1979; Wohl 1983; Hamlin 1988). Local boards of health were created on an ad hoc basis in large towns during the 1831-32 cholera epidemic, and the General Board of Health was set up under the Public Health Act of 1848 to oversee local boards (Rosen 1958; Flinn 1965). The purpose of these boards was to improve the sanitary conditions in cities to prevent disease outbreaks and to investigate the circumstances if outbreaks occurred.

The medical environment of nineteenth century England was also a factor in

Snow's work because it may have played a role in the acceptance of his theories by the medical community. Until the Medical Act was passed in 1858, men practiced medicine with a variety of qualifications ranging from formal degrees and licenses to no apparent accreditation, and they received their training from universities, apprenticeships, and self-teaching (Peterson 1978). There were three main divisions within the medical profession in the early nineteenth century: physicians, surgeons, and apothecaries, and these divisions were translated into social status groups both in the medical establishment and society in general (see Pelling 1978; Peterson 1978; and Bynum 1994 for more detailed histories). Snow began his medical career as an apprentice and, according to Richardson, became a certified Apothecary in October 1838 (in Frost 1936). He then completed his Bachelor's of Medicine in 1843, thereby becoming a Doctor, and received his MD the following year. While working one's way up the ranks of medicine was not an uncommon way of becoming a doctor, it did not carry the prestige of medical training and a medical degree from Oxford, Cambridge, or Edinburgh (Bynum 1994).

5.3 SNOW AND EPIDEMIOLOGY

The discussion of the causes and transmission of cholera in the mid-nineteenth century was influenced by the general debates on disease theories. Today we interchange the words contagious and infectious when referring to diseases. When Snow was writing, contagion and infection did not have the similar definitions as they do in our common parlance. The most common terms used in the literature were infection/infectious,

contagion/contagious, epidemic, and miasma, with spontaneous generation, fermentation, and putrefaction working their way into the discussion. It is important to remember that these debates occurred before the development and acceptance of what became called the germ theory of disease, despite the work of Henle in 1840 on living contagion, the growing use of the microscope, and advances in chemistry and physics (Pelling 1978; Bynum 1994). Writers of the time did not always agree on the definitions of these terms, and it was not uncommon to find brief explanations of them at the beginning of an article (Text Box 5.2). Nor were terms that were usually associated with one another, such as

Text Box 5.2 (Pettigrew 1831, p. 25)

On no one subject, within the whole range of medical inquiry, does such a contraricity of opinion exist as on that of contagion. Those who appear to be the best informed, are absolutely in the greatest doubt on the subject. The term is in such general use, and yet no one is so indefinitely employed. Contagion and infection have been very commonly used as synonyms; but many waters give arbitrary signification to them, and treat them as terms distinct from each other. Infection is generally understood to imply the communication of disease through the medium of atmosphere; contagion, the communication of disease by actual contact. Epidemic diseases are generally regarded as being contagious: yet this cannot hold true unless an individual under the influence of such malady be capable of inducing a similar disease in a health person in a situation removed from that in which he himself became infected: and this too without regard either to climate, temperature, or other local circumstances. The power of an individual, who is labouring under a contagious malady, of communicating the disease, will be more or less active, according to the pure or impure state of the atmosphere in which he is placed.

infection and miasma, always conjoined. For example, there were theories of contagion through bad air (see Philip 1832 and Common Sense 1854). By the time Snow was writing on cholera, the causes and pathologies of many communicable diseases were

understood, although according to Frost, “for certain diseases, including the enteric infections, this demonstration was lacking, and the indirect evidence of communicability was by no means so plain as to be incontestable” (1936, p. x).

Infectious diseases were transported in a variety of media such as miasma (bad air), filth, and refuse heaps, and transmitted to the human body. In their *Report on Epidemic Cholera*, Baly and Gull use “the words ‘infection’ and ‘infected’ ... in their most general significations of pollution and polluted, without any reference to the sources of the polluting cause of poison” (1854, note pp. 4–5). The theory of infection was usually used to support the miasmatic theory of disease transmission. It was this theory that was dominant in the mid-nineteenth century and was particularly forceful in the debate on the cause of cholera. “Miasmatic theories ... attributed the spread of epidemic diseases to air-borne poisons of putrefaction” (Bynum 1994, p. 127). On the other hand, contagious diseases were those that were spread by direct person to person contact (from the latin “*contagio*”, to touch). According to Baly and Gull, contagion was “morbid matter [that] multiplies in the body and is spread by ‘emanations’ from sick people’s bodies” (1854, note pp. 4–5). Nineteenth century literature on the transmission of disease is legion, and Pelling (1978) provides a solid overview of the debate.

How did Snow develop his theory of cholera transmission? Where did the initial burst of inspiration come from? It is possible that Snow’s work with coal miners in the Killingworth Colliery during the 1831–32 epidemic provided the first spark for his theory (Richardson in Frost 1936; Ellis 1994). However, Pelling (1978) notes that Snow did not claim that this was the case, and she states that Richardson’s memoir lacks detail and

seems retrospective in this regard. Whatever the origins of Snow's theory, he developed it at a time when the medical and sanitary establishments believed that cholera was an infectious disease spread through miasma. It was a disease of the poor and was the moral obligation of the rich to prevent. The first part of this section will discuss some of the theories of the causes, transmission, and propagation of cholera in the mid-nineteenth century. This sets up the second part which is an examination of Snow's theory of cholera transmission.

5.3.1 Contemporary cholera theories

Asiatic cholera left India and became pandemic in 1817, and first came to England in October, 1831 through the sea-port of Sunderland in Durham County (Pelling 1978). England suffered three more cholera epidemics: 1848–49, 1853–53, and 1865–66. The 1831–32 epidemic did not affect the entire country, but it worried enough people to prompt the publication of *The Cholera Gazette* in 1832. There was a belief that it was “essential that the public should be placed in possession of such useful information, whether medical or statistical, as the Central Board Of Health has hitherto been enabled to accumulate and still continues to receive” (*The Cholera Gazette* 1832, p. 33). The publication did not outlast the 1831–32 epidemic and was not started again in the succeeding epidemics. Regardless, there were many forums for the debate on cholera. Cholera was a confusing disease in that it did not always spread to people living in close quarters with the victims, it often appeared with no known first case, it was highly

capricious at the local level, and its preferred environment had as many exceptions as it did rules (Frost 1936). Sorting through mid-nineteenth century cholera theories can be a chore because conditions with similar symptoms as cholera were given the same name. This section summarizes theories of what was generally known as Asiatic cholera only and not what was also called cholera, summer cholera, English cholera, and diarrhoea.

Perhaps the most difficult theories for the late-twentieth century mind to take seriously are what Pelling labels the telluric, electric, and ozonic theories (1978, p. 148). Various theories tried to link weather or geological phenomena to cholera epidemics. Bryden wrote that they were spread through the atmosphere by monsoons in India (in Wendt 1885). Some authors argued that there was a connection between volcanic activity and cholera, but they had to admit that England was bereft of this kind of earth movement. Little was known about electricity in the mid-nineteenth century, but if one could draw similarities between atmospheric electricity and that in the human body, and if one believed that cholera affected the nervous system as Philip did (1832), a connection could be made. Although no longer a credible theory at the time of publication, Wendt (1885) attributed the theory that cholera was related to an insufficient amount of ozone in the atmosphere to a German author named Steihmer, which was later revived by another German called Lender. Pelling (1978) names Hunt as the main English proponent of this theory. He maintained that ozone provided a disinfectant role to the earth, and when it was deficient, diseases like cholera could take hold.

Jameson's writing on cholera in the early 1830's, particularly on the nature of cholera in India, set the miasmatic tone that would dominate the medical establishment's theory of cholera transmission for the following decades. He wrote that cholera was

caused by infection and miasma, and that the disease affected the blood. Persons in crowded, dirty living conditions were at the highest risk of contracting the disease. Unfortunately, during the short archival field season this thesis research did not appreciate the importance of Jameson's contribution, and references are, at this time, unavailable.

In his *Observation on cholera* (1831), Pettigrew used his experience with cholera in India to argue that it was not contagious. It had a "regular course of increase, maturity, and decay" (p. 25), and appeared in places far removed from one another, though it usually progressed from place to place rather slowly. For Pettigrew, cholera was located in miasma and was infectious. Venables (1832) agreed that cholera was not contagious unless it was connected with fever. He argued that climate and location played a fundamental role in the spread of the disease.

In 1832, Philip argued that cholera was indeed contagious: "any man who, without possession, compares the history of the disease with the way in which it often spreads in families, and the circumstance of many who had made up their minds to its non-contagious nature, ... will not, I think, long hesitate which side to adopt" (p. 23). He acknowledged that there are many possible ways cholera could be conveyed, but that good ventilation was the most effective way to prevent contracting the disease. Philip believed that cholera attacked the nervous system and that doctors and nurses were immune to the disease from repeated exposure. Like Pettigrew, he noted what is presently known as the self-limiting nature of cholera outbreaks.

The physician to the St. George's and St. James's Dispensary, Webster, pointed out that if cholera was contagious, the quarantine of patients and their caretakers should

be re-instituted (1832). By preventing the disease from spreading from person to person, the proponents of the contagion theory would be able to block the spread of cholera. However, he did not ever find proof of the contagious nature of cholera. Instead, Webster wrote that the “epidemic appears to originate in a peculiar state of atmosphere, joined to local miasmata, and other causes; which tend so to vitiate the air of a particular disorder or habitation, that individuals in such deteriorated places, and constantly breathing this tainted atmosphere, have their blood thereby less highly oxygenated [*sic*], than is consistent with perfect health” (1832, p. 9).

After the 1831–32 epidemic, England was not visited by cholera until 1848. Publications on the disease fell off during this interlude and picked up again with the news that it was in Europe once again. It was during the second epidemic in England that John Snow published his pamphlet “On the Mode of Communication of Cholera” (1849). Just weeks before the publication of this pamphlet, Brittain and Swayne presented their findings of ““peculiar microscopic objects in the characteristic rice water discharges of person affected with malignant cholera”” (in Birkenhead 1969, p. 104) at a meeting of the Bristol Medico-Chirurgical Society. Pelling (1978) writes that the authors did not necessarily agree with one another on what these objects were, with Swayne stating that they were characteristic of, if not the very cause of cholera, and Brittan thinking that this was going too far (Pelling 1978). Their findings were supported by Budd who worked with them on the research; however, Brittan, Swayne, and their research were not equally supported by the medical establishment.

A month after Snow’s pamphlet was published, Budd wrote a letter to *The Times* stating that “the cause of malignant cholera was a ‘living organism of distinct species’,

which seemed to be of the fungus tribe; these organisms were taken in by swallowing; their presence and infinite multiplication in the intestinal canal caused the peculiar flux of cholera, and thereby all the essential features of the disease” (in Pelling 1978, pp. 170–71). He acknowledged that Snow had priority over these views since he had published his findings first (1849, p. 19 n.). Budd played a central role in the cholera-fungus controversy (see Pelling 1978 for an in-depth discussion), and as such was less attached to the water-alimentary canal theory of Snow. He also felt that the cholera organism could be carried in fine dust. Snow wrote that Budd went too far with this (1855b).

Another publication from 1849 was the *Report on Quarantine* which drew on Sutherland’s view of cholera. He felt that “the degree of infectiousness developed in a given situation depended on the intensity of the epidemic influence, but that this influence was inoperative in the absence of ‘localising conditions’. ... [He declared,] ‘I look on the poison truly zymotic, but not contagious. Why may it not be the same with other pestilences?’” (in Pelling 1978, p. 66). Frost names this theory as the most popular at the time, even though it did not necessarily settle the questions of spontaneous generation, infection, contagion, or effluvium (1936, p. xii).

In 1851, Bryson argued that the British government was incorrect not to advocate quarantine during times of cholera. He refuted theories related to atmosphere, weather, and electricity stating that the spread of cholera did not follow atmospheric patterns or anomalies. He also disagreed with the theory that cholera’s cause was in the soil and discounted its connection to spontaneous generation stating that it “has the merit of being specific, although it hardly comes within the range of legitimate deduction; nor is it supported inferentially by the existence of any known agent or cause of a like nature ...”

(Bryson 1851, p. 17).

Farr made many important contributions to public health in Victorian England, most of which concerned the collection and statistical manipulation of vital or demographic data through the Registrar-General's office (Eyler 1979). He also studied the distribution of cholera, and published his first article on the subject in 1838. His *Report on the Mortality of Cholera in England, 1848–49* was published in 1852. In this publication, Farr used quantitative data to advance his theory that cholera was related to elevation. His analysis suggested that higher places were healthier than lower places, and the location of cholera outbreaks followed this trend.

Many doctors believed that there was no cure for cholera. An exception to this was Ayre who wrote a letter to the editor of *The Lancet* (1854) in an attempt to disprove Gull's assertion that there was no cure. Ayre argued that he had successfully cured cholera patients with an intense treatment of laudanum and calomel. The laudanum, he claimed, was administered to encourage the stomach to retain the calomel, and he cited the record of a Mr. Eccles of Plymouth who used this treatment on his patients with twenty-seven recoveries and twelve deaths.

The *Report on Epidemic Cholera* (Baly and Gull 1854) was published before the summer of 1854 and was a discussion of the results of four hundred returned questionnaires distributed country-wide to physicians at the end of 1849 and beginning of 1850 regarding cholera in their areas. Baly and Gull outlined six theories current at the time of the report (pp. 4–24). First, there is an “atmospheric influence of epidemic constitution” (p. 4) that causes cholera. In other words, there are places that are unhealthy and people get sick from breathing the bad air. Second, the disease is caused

by some type of unknown contagious process. Third, cholera is caused by a more definite form of contagion, as suggested by Snow. Baly and Gull were not only concerned with Snow's ideas on water transmission, but his argument that the cholera poison must be ingested and affects the alimentary canal, not the blood stream. Fourth, there is a morbid matter or poison spread through and reproduced in the air that produces the disease. In the fifth, a slight modification of the fourth, cholera ferments in the air but is transmitted through human interaction. Finally, the sixth theory combines their second and the fourth theories by positing that cholera is reproduced and spread through and by the air and the body. Baly and Gull admitted that the spread of cholera appeared to be linked with human interaction.

Staying with Baly and Gull for a moment, they argued that cholera, influenced as it was by weather and other atmospheric conditions, was not a contagious disease like those widely accepted to be so at the time: small-pox, measles, scarlatina, and whooping cough. They argued that *if* cholera was contagious, and *if* it flourished in victim's bodies and then left, then its effect was mitigated by the atmosphere. Instead of accepting this, Baly and Gull were strongly in favour of the "'miasm' theory—that, namely of a material substance distributed through the air and undergoing increase in the air on surfaces exposed to the air" (ibid., p. 47). They stated that hot weather augmented this process. The authors wrote that the theory which connected cholera with human interaction appeared to explain many of the features of cholera (like its appearance in sea-ports, its spread to successive towns, and its late presence in places dirty enough to warrant an early attack). However, they argued, these facts also pointed to "a morbidic poison partially distributed then to an agent or influence existing throughout the atmosphere"

(ibid., p. 107). Baly and Gull used every new piece of evidence to confirm the miasm theory.

The actual cholera bacillus—or disease organism—was discovered in 1854 (Pelling 1978). The man most commonly attributed with this discovery is Robert Koch who isolated the organism in 1883 or 1884 (accounts differ on the actual date). Apparently ignoring the work by Brittan and Swayne in 1849, the Judicial Commission of the International Committee on Bacteriological Nomenclature has given that priority to Filippo Pacini whose work on the subject was published in 1854 (Pelling 1978, p. 3). Pacini's discovery did not convince the medical establishment of a specific organism in the dejections of cholera patients (Bynum 1994).

Shortly after the 1854 epidemic, the third letter by Common Sense appeared in the *Association Medical Journal* arguing that cholera was “contained in the discharges from the sick body” (p. 974). Pelling's selected bibliography lists Common Sense as a pseudonym for Budd (1978). Using a case-study of a cholera outbreak in a workhouse in 1849 the author illustrated how two male wards were differentially affected by cholera. The only difference in their living conditions was that they had different privies. The privy used by the men affected by cholera “did not become infected with cholera because the privy was exhaling fetid gases, but because, in becoming the receptacle of the discharges from cholera patients, it had become tainted with the specific poison which is its material cause” (Common Sense 1854, p. 975). At first glance, the author's theory sounds similar to Snow's. However, he wishes to “establish the fact that cholera may be communicated by emanations from choleraic discharges *diffused through the air*” (p. 977). His argument is one of contagion through miasma, but at the end of his letter he

does acknowledge that the disease can spread in a similar way through drinking water.

5.3.2 Snow's theory of cholera

For Snow, the general characteristics of the spread of cholera were that it followed lines of human communication, never traveling faster than possible for people, and never occurring in ships coming from countries free from cholera until their sailors had contact with the ports or shores of places where cholera existed (1849a; 1855a). He cited the work of Dr. Simpson of York to show how cholera spread through a series of villages in 1832 by way of people coming and going to administer to those already affected and between people residing in the same house (1855a). After quoting the details of a few other studies, Snow wrote, "It would be easy, by way of going through the medical journals and works which have been published on cholera, to quote as many cases similar to the above as would fill a large volume. But the above instances are quite sufficient to show that cholera can be communicated from the sick to the healthy; for it is quite impossible that even a tenth part of these cases of consecutive illness could have followed each other by mere coincidence, without being connected as cause and effect" (1855a; p. 9). He cited the example of miners as a group where person to person transmission was easy to see (1849a; 1855a; Babington 1855). Miners would go down into the pits with no privies for long work days. They did not have facilities to clean their hands before eating their meals, and the pits became prime areas for communicating cholera.

Snow also argued against the theory that cholera was inhaled by its victims and then poisoned their blood. Snow reasoned that cholera could not be caused by an infection of the blood like fever. As a refutation of the poisoned blood theory, Snow argued that the thickened nature of victims's blood was caused by a rapid loss of body fluid, not by a blood poison. He offered his successful attempts at re-hydration therapy through the injection of a saline solution into patients as evidence of this (1854). Victims did not display the appropriate symptoms such as "rigors, headaches, and quickened pulse" (Snow, 1849a, p. 7) commonly associated with poisoned blood. If cholera was transmitted in the air, it was difficult to explain how those nursing the victims did not necessarily get sick, and that those who got sick did not have to be in the same room as the patient (Snow 1855a). "It used to be generally assumed, that if cholera were a catching or communicable disease, it must spread by effluvia given off from the patient into the surrounding air, and inhaled by others into the lungs. This assumption lead to conflicting opinions respecting the disease" (1855a, p. 9). Instead, the cholera organism had to be ingested by the victim (1849a; 1855b). It then multiplied in the body and was excreted along with pieces of the stomach lining and body fluid.

Snow described the different ways that syphilis, the itch, and intestinal worms were each spread to argue against limiting the conception of how cholera is transmitted (1855a). He maintained that cholera induced symptoms related to the digestive system, or the alimentary canal, suggesting that the disease was ingested into the body through the mouth. Concerning the source of the ingested poison, Snow wrote that, "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 there 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” (1849a, pp. 8–9).

Since the cholera organism was not visible to the naked eye, it would be difficult for someone nursing a patient to avoid ingesting it once it was on their hands. Snow noted that eating food with improperly cleaned hands was a common mode of transmission. He also used evidence from cholera outbreaks in Dumfries, Maxwell-town, Glasgow, Clyde, and London to conclude that “a most important way in which the cholera may be widely disseminated, viz., by the emptying of sewers into the drinking water of the community” (1849a, p. 11). His London examples included an investigation of the differential death rates between two neighbouring buildings in Thomas Street, Horsleydown and the death rate in Albion Terrace, Wandsworth Load (1849a; 1855a). In the first case, the death rate in the Surrey Buildings was much higher than that in Truscott’s Court where there was only one fatal and one recovered case. Through the work of the Assistant-Surveyor of the Commission of Sewers, Snow learned that the well which supplied water to the Surrey Buildings was frequently contaminated by overflow from an open sewer. The bed linens of the first victims in these buildings would have been washed and the water thrown into a channel that emptied into the sewer.

Snow’s second edition of *On the Mode of Communication of Cholera* contains countless similar examples of situations where cholera could be traced to contaminated drinking water (1855a). The connection between water and cholera is the best-known component of Snow’s theory of cholera transmission. However, Snow’s work contains more ideas about the role of water than just about how its ingestion causes the disease.

He connected the size of a locality with the length of the presence of cholera, with smaller places having shorter outbreaks than large cities (1849b). In addition to water transmission, Snow wrote that it was possible that cholera could be “transmitted a short distance through the air; for the organic part of the faeces, when dry, might be wafted as a fine dust” (1849a, p. 26); although he did not want to overstate this, a process to which he believed Budd attached too much importance (1855/56).

Although most of Snow’s contemporaries did not accept his theory wholeheartedly, it did have an influence on cholera investigations by the time of the 1853–54 epidemic and even more so during the 1865–66 epidemic. For some of the medical establishment, water became a “predisposing cause” for cholera, something that could increase the likelihood that one would contract the disease (Frost 1936, p. xiii). However, writing during the winter before Snow’s work in 1854, Baly and Gull were unwilling to accept the role of water: “We shall see presently additional reasons for believing that, even if the theory of Dr. Snow were generally correct, the influence of the character of the water must be very inconsiderable” (1854, p. 208).

His colleagues’ objections did not diminish Snow’s confidence in his theory (Text Box 5.3). He argued that the contagious communication of cholera should not be cause for alarm or worry that the workings of commerce would be interrupted by quarantine. Individuals had more control in avoiding cholera if it was spread by person to person contact and ingested than if it was infectious and breathed into the body (1849a). He was also quite prepared to defend publicly his theory. When asked where the first case of cholera came from: “‘Exactly,’ he replied, with a shrewd look. ‘But to begin, do tell *me*

Text Box 5.3 (Snow 1849a, p. 29)

These opinions respecting the cause of cholera are brought forward, not as matters of certainty, but as containing a greater amount of probability in their favour than any other, in the present state of our knowledge. Nearly all medical men admit a cholera poison, whatever their opinion may be with respect to contagion; and many of them even speak of the purging as an effect of nature to get rid of the poison: they cannot, then, in either case, suppose that the evacuations are free from it, or that, being swallowed, the stomach should always have the power of destroying it, and preventing its producing its peculiar effects; therefore the views here stated seem to have a fair claim to the consideration of the profession. At all events, the mode of communication of cholera is a question of the most vital importance with respect to its prevention.

where the first tiger or the first upas tree came from; nay, tell me where you came from yourself, and I will then tell you the origin of the first cholera cell, and give you the full history of the first case; but I want a model before I venture on the description of ultimate facts” (Richardson in Frost, 1936, p. xlv).

Not everyone disagreed with Snow’s theory. Carpenter (1854) recounts the case of a cholera outbreak at a school in Croydon where the water was obtained from a well, not the water mains. When Carpenter suggested that the school change to using water from the mains, there were sixteen new cases of cholera the first day, two the next, and none on the third. He argued that the case provided clear evidence for the fundamental role of water in cholera transmission. There were also acceptances of pieces of Snow’s theory in the press at the time. In its review of Snow’s book, *The Lancet* wrote, “It may now be regarded as a settled point that cholera can be communicated from one person to another” (1855, p. 524). Babington did not agree with Snow’s entire theory, but he did think that, “It was an error to suppose that cholera was always, or even generally,

associated with impurity of the air ...” (1855, p. 11).

Snow also knew the importance of his research. ““You and I’, he would say to me, ‘may not live to see the day, and my name may be forgotten when it comes, but the time will arrive when great outbreaks of cholera will be things of the past; and it is the knowledge of the way in which the disease is propagated which will cause them to disappear’” (Whitehead quoting Snow in Chave 1958, p. 106). Snow’s theory of cholera transmission was more complex than twentieth century accounts have portrayed, and given his large number of publications, participation in a number of professional societies, and contentious theory, he was probably well-known in the medical community. However, he was not only known for his theory on the propagation and transmission of cholera.

5.4 SNOW AND ANAESTHESIA

Dr. John Snow was one of the leading anaesthetists in the mid-nineteenth century. Although he is known as a pioneer of anaesthesia, the “true pioneer of British anaesthesia” is James Robinson, the man who first introduced Snow to the method (Ellis 1994, p. xviii). Today there are three volumes of Snow’s anaesthesia practice casebooks held at the library of the Royal College of Physicians in London. The casebooks were edited by Ellis and published in 1994, a process that took over ten years. Snow was meticulous in recording the details of administering anaesthesia, his experiments, and the effects on his patients and practice. “He kept a diary, in which he recorded the particulars

of every case in which had administered chloroform or other anaesthetic, with comments on the results of the administration, and hints as to dangers avoided or chanced. He kept a record of all his experiments and short notes of observations made by his friends” (Richardson in Frost 1936, p. xliii).

The introduction of anaesthesia into surgery and dentistry in England around 1846 was not unproblematic. Debates raged about the use of “stupifying drugs” (Richardson in Frost 1936, p. xxxiii) to alleviate pain, particularly during childbirth. During an 1847 meeting of the Westminster Medical Society, there was some disagreement on the acceptability of inhaled ether. “Hale Thomson regarded it as ‘a most valuable boon to humanity’ from which he had seen no ill results, whilst Hancock, another surgeon, reported that he had seen it produce convulsions in one instance and severe irritation of the throat in another, which remained until the patient, who was previously in a very low condition, died” (Birkenhead 1969, pp. 100–101). Dr. William Gull raised three questions regarding the use of anaesthesia in a paper presented at the South London Medical Society: “Firstly, is it useful to abolish pain during a surgical operation? Secondly, can this be done safely by ether? Thirdly, does the presence of ether in the blood modify the healing process?” (Birkenhead 1969, p. 101) (This was probably the same Dr. William Gull who had researched the 1848–49 and 1853–54 cholera epidemics in London for the General Board of Health.) The issue was even a political one. Lord Campbell attempted to pass the “Prevention of Offenses Bill” in the House of Lords which contained a clause forbidding the administration of chloroform following its use in recent crimes. John Snow wrote a letter to Lord Campbell in an attempt to have the clause omitted (Richardson in Frost 1936).

Richardson states that Snow heard about the use of ether in the United States in 1846 and began to experiment with it in England (in Frost 1936). This contradicts Ellis' description of Robinson acquainting Snow with ether (1994). Snow's anaesthesia practice was varied and included dentistry, many kinds of surgery, and obstetrics. In 1847 he developed an apparatus for inhaling ether which ensured a more constant flow of the anaesthetic than had previously been the case (Richardson in Frost 1936; Birkenhead 1969). Snow began using chloroform instead of ether by the end of 1847. When called on to justify the use of that narcotic (used in the nineteenth century to mean causing *narcosis* or sleepiness) rather than ether which was considered safer, Snow said, "I use chloroform" he resumed, 'for the same reason that you use phosphorus matches instead of the tinder box. An occasional risk never stands in the way of ready applicability'" (Richardson in Frost 1936, pp. xlv–xlvi). When experimenting with a new drug, Snow first tried the substance on animals and then on himself before using it on his patients (Richardson in Frost 1936). In his search for a safer anaesthetic, Snow experimented with Amelyne in 1856 (Bynum 1994) and published his results in four papers in the *Medical Times and Gazette* in 1857 (Ellis 1994). However, when two of his patients died, he published the details and seemingly abandoned the drug completely (ibid.). Amelyne is insoluble and causes the blood to clot (ibid.).

Despite these deaths, Snow became a well-known anaesthetist. He worked with some of the best surgeons in London (Atkinson 1970), and his reputation "spread far and wide, and the people throughout the profession, looked up to him from all ranks, as the guide to whom to entrust themselves in 'Lethe's walk'" (Richardson in Frost, 1936, pp. xli–xlii). Snow's articles on narcotic vapours in the *Medical Gazette* were often cited by

his contemporaries, but Richardson speculates that they were more talked about than read (in Frost 1936)—something to keep in mind when recalling the accounts of Snow and the Broad Street outbreak presented in Chapters Three and Four. Shortly after Snow's death, his major work on anaesthesia—*On Chloroform and Other Anaesthetics: Their Action and Administration* was published based on his notes. “Nearly a century was to elapse before any work on anaesthesia was published, commensurate in scope, quality and originality with that of Snow ” (Birkenhead 1969, p. 102).

Snow's most famous patient was Queen Victoria. According to Richardson (in Frost 1936), he was consulted prior to the birth of Prince Arthur in 1850, but was not needed. Ellis (1994) does not mention this in his introduction to the case books, but remarks, “It is, perhaps, surprising to note that Snow had administered chloroform to relatively few patients in childbirth before he was invited (or cajoled) into undertaking the enormously onerous, and extremely controversial task of giving chloroform to Queen Victoria during her last two labours” (1994, p. xxxiii). Snow administered chloroform to the Queen on April 7, 1853 at the birth of Prince Leopold and again on April 17, 1857 at the birth of Princess Beatrice (Sykes 1960; Atkinson 1970; Ellis 1994 dates Leopold's birth as April 14, p. xxxiv). This treatment actually took the form of an analgesic rather than an anaesthetic since Queen Victoria did not lose consciousness during either procedure (Atkinson 1970). Ellis notes that Snow improved his handwriting and replaced the nib on his pen for the entries describing these two events (1994). Queen Victoria's daughter, Princess Victoria, also gave birth with the help of chloroform. In a letter to the princess's mother-in-law, Princess Augusta, the Queen wrote, ““Vicky appears to feel quite well and to recover herself just as quickly as I always did. What a blessing she had

chloroform. Perhaps without it her strength would have suffered very much” (in Sykes 1970, p. 81). One of the arguments against using anaesthesia during childbirth was a religious one: pain during childbirth was God’s curse on women after Adam and Eve’s fall from Grace. With this in mind, it is noteworthy that Snow’s other socially prominent patient was the daughter of the Archbishop of Canterbury in 1853 (Atkinson 1970).

Did the administration of chloroform by one of the leading anaesthetists to the Queen end the debate of anaesthetics in childbirth? Upon hearing a rumour that the Queen had been given chloroform, Wakley, the editor of *The Lancet* declared his surprise that this was the case since people had died under the narcotic (Text Box 5.4). Then in 1858,

Text Box 5.4 (Wakley 1853, p. 453)

In no case could it be justifiable to administer chloroform in perfectly ordinary labour; but the responsibility of advocating such a proceeding in the case of the Sovereign of these realms would, indeed, be tremendous. Probably some officious meddlers about the Court so far overruled her Majesty’s responsible professional advisers as to lead to the pretense of administering chloroform, but we believe the obstetric physicians to whose ability the safety of our illustrious Queen is confided do not sanction the use of chloroform in natural labour ...

We have felt irresistibly impelled to make the foregoing observations, fearing the consequences of allowing such a rumour respecting a dangerous practice in one of our national places to pass unrefuted. Royal examples are followed with extraordinary readiness by a certain class of society in this country.

Attree wrote a letter on the topic to the editor of *The Lancet*, still Wakley (Text Box 5.5).

It is possible that Attree’s “undoubted authority” was Snow himself. Snow provided anaesthetic at Middlesex Hospital where Attree had been a surgeon, and the latter was at the very least familiar with Snow’s inhaler. So, Snow’s work in anaesthesia may not

Text Box 5.5 (Attree 1858, p. 389)

SIR, --After your Annotation and Mr. Henry Potter's letter concerning the danger likely to accrue from administering chloroform either upon a napkin or handkerchief, I trust you will allow me, through the medium of your scientific journal, to call on those to look out whose duty it is to keep watch. If truth be told (from what I have heard from undoubted authority) her Majesty the Queen inhaled chloroform, placed on a handkerchief, in her last accouchement.

--I am, Sir, your obedient servant, WM. HOOPER ATTREE,
Formerly House-Surgeon to the Middlesex Hospital
Bognor, Sussex, October, 1858.

P.S. -- In all cases where the inhalation of this great boon is advised by the faculty, or voluntarily desired by the patient, how much safer life would be if there were an Act enforcing the employment of three persons -- one to administer chloroform by Snow's apparatus, a second to watch the heart's action and the pulse, whilst a third be *solely* occupied as the operator. Each would have enough work to perform.

have ended the debate on its use and safety, but it did advance the science of the practice and it established his reputation in a medical discipline unrelated to disease and disease theories.

This chapter has provided a biographical sketch of John Snow and put him in a medical-historical context. His constant up-grading of his education, continual research, and prolific publications suggest a commitment to medicine and desire for knowledge. His theory of cholera transmission challenged many of his contemporaries' theories and established his reputation in the sanitation movement and the early stages of epidemiology—a reputation that was not always positive. By describing Snow's role in the development and administration of anaesthesia, this section has shown his place in the history of medicine quite unrelated to epidemiology and public health. Presenting him in

both the context of anaesthesia and of epidemiology serves another purpose: it prepares a discussion of how Snow's reputation in one field may have influenced the amount of attention and credence paid to his ideas in another. In other words, his reputation in anaesthesia may have affected the prominence of his theory of cholera transmission in medical and sanitary circles. In addition, his reputation as a leading anaesthetist in England may have been an important part of the decision to remove the handle from the Broad Street pump.

CHAPTER SIX

RETELLING THE STORY: SNOW, CHOLERA, AND BROAD STREET IN 1854

The discrepancies in the accounts of the 1854 Broad Street cholera outbreak laid out in Chapters Three and Four raised some significant questions. Chapter Six draws on archival evidence, including Snow's own work, to tell the story more authoritatively by exploring six themes. As with the previous chapter, the account that emerges is as correct as the historical evidence explored will allow; indeed, there are variations within the historical record. The first theme reports the general details of the 1854 epidemic focusing on Golden Square but starting with London as a whole. The second describes Snow's actions and investigations during the outbreak itself, and how he came to focus on the Broad Street pump. The third theme discusses how Snow managed to have the pump handle removed and the result. The next presents the three post-outbreak investigations in Soho. The fifth closely examines the three maps published with the reports of these investigations. The final theme explores what Snow's Broad Street investigation actually showed and the impact it had on his contemporaries.

6.1 GENERAL DETAILS

6.1.1 London as a whole

England's third cholera epidemic hit in the summer of 1853. It regressed over the winter, only to recrudescence the following summer. During this epidemic, about 31 000 people died of cholera in England, and London's cholera death-rate was 46 per 10 000 (Smith, F. B. 1979, pp. 230–31). Instead of describing events across the city, this section will examine Snow's work in the South London districts.

Aside from his investigation of the Broad Street outbreak, this is perhaps the best known example of Snow's work. During the 1849 epidemic, Snow determined the cholera death rates in each of the West, North, Central, East, and South districts by using 1841 census data for population and the death figures from Farr's "Report on the Cholera of 1849" (Snow 1855a, p. 61). He found that the highest death rate was in the South districts at 7.95 per 1000, over twice as high as that for the City at 3.38 per 1000 (Snow 1849a, p. 25). Snow claimed that the water sources of the companies supplying the South London Districts which were located down from the Vauxhall Bridge were to blame. This water was highly contaminated with sewage and had an offensive smell even when filtered.

These results provided evidence for Snow's investigation of the South London districts in 1854 (1855a, pp. 68–90). Two water companies had competed on a house-to-house basis to supply water to the districts, the Southwark and Vauxhall Company and

the Lambeth Company. In 1852, the Metropolis Water Act was passed stating that London water companies had to store their Thames water in covered reservoirs as part of a filtration process or take their water from a less contaminated part of the River upstream (Luckin 1986). Lambeth moved its source upstream while Southwark and Vauxhall continued to draw its water from the same spot without filtering it (ibid.). The Registrar-General's tables of deaths for November 26, 1853 showed that neighbourhoods partially supplied by Lambeth suffered much less than those solely supplied by Southwark and Vauxhall (1885a, p. 85). The only major difference in living conditions between the houses was their water supply. This being the case Snow wrote, "it is obvious that no experiment could have been devised which would more thoroughly test the effect of water supply on the progress of cholera than this" (1855a).

Snow resolved to investigate the circumstances himself. He communicated his initial results to Farr, and carried out his inquiry by going door to door. Snow ran into difficulties when he found that residents did not necessarily know which company supplied them with water. He tested the water quality in these cases with silver nitrate to determine the amount of sodium chloride in the water. Snow found that his evidence demanded extending the study into all districts served by either company, and at that point he enlisted the help of John Joseph Whiting (1855a, p. 79). There could be some discrepancy here because Snow names a Mr. Greenwood as helping him with the investigation in a later publication (1857, p. 864). The results of the investigation were that cholera death rates in houses supplied by Southwark and Vauxhall were eight and a half times higher than those supplied by Lambeth during the first seven weeks of the epidemic and five times as high over the following seven weeks (1855a, p. 86, p. 88).

6.1.2 Golden Square

While Snow was examining the effects of cholera in the South London districts, a virulent outbreak began in the sub-district of Golden Square, Soho. Snow called it the “most terrible outbreak of cholera which ever occurred in this kingdom” (1855a, p. 38). An article published in *The Times* on September 15, 1854 put the death toll near seven hundred (in Chave 1958, p. 93). This was an exaggeration. Using the death tables from the Registrar-General as well as personally locating the residences of other victims not recorded in the tables, Snow put the number of deaths between August 19 and September 30 at six hundred and sixteen. Closing the dates to the ten days usually associated with the outbreak, from August 31 to September 9, the death toll was five hundred and fifteen (1855a, p. 49).

Snow felt that more people would have died, had not three-quarters of the residents left within the first six days of the outbreak. This observation was not supported by the local curate who was surprised by the lack of panic among the neighbourhood’s residents. He “had always heard and read that great pestilences were invariably attended by wholesale demoralisation of the population” (Whitehead in Chave 1958, p. 93). The aftermath of the outbreak was recorded in *The Times* (Text Box 6.1).

Text Box 6.1 (in Chave 1958, p. 93)

The outbreak of cholera in the vicinity of Golden Square is now subsiding, but the passenger through the streets which compass that district will see many evidences of the alarming severity of the attack. Men and women in mourning are to be found in great

numbers, and the chief topic of conversation is the recent epidemic. . . . At every turn the instructions of the new Board of Health stare you in the face. . . . The most remarkable evidence of all, however, and the most important, consists in the continual presence of lime in the roadways. The puddles are white and milky with it, the stones are smeared with it: great splashes of it lie about in the gutters, and the air is redolent with its strong and not very agreeable odour. . . . The shopkeepers have dismal stories to tell—how they would hear in the evening that one of their neighbours whom they had been talking with in the morning had expired after a few hours of agony and torture. It has even been asserted that the number of corpses was so great that they were removed wholesale in dead-carts for want of sufficient hearses to convey them; but let us hope that this is incorrect.

6.2 SNOW'S ACTIONS DURING THE BROAD STREET EPIDEMIC

Most of the stories of John Snow and Broad Street coalesce on the importance of the pump. Some accounts discuss how Snow discovered that the the source of the outbreak was the pump, while others are tacit in this regard. Two authors cited in Chapter Four mention Reverend Whitehead's involvement in Snow's investigation of the outbreak. This section discusses each of these details in turn.

6.2.1 The methodology of focusing on the pump

Snow's own words provide the most effective source for examining how he decided that the Broad Street pump was the focus of the local outbreak (1855a, pp. 38–40). He writes that he suspected that contaminated water from the pump was spreading cholera in the area, but samples did not reveal the water to be particularly dirty. After a

couple of days however, he noticed white flakes had formed in the water sample. This prompted him to obtain a list of deaths in the area from the Registrar-General's office. The table showed eighty-nine deaths in the area for the week ending on September 2 in the sub-districts of St. Ann's, Berwick Street, and Golden Square. Eighty-three of these deaths had occurred on the last three days of that week, and Snow determined the addresses of these victims. He proceeded to the corner of Cambridge and Broad Streets, where the Broad Street pump was situated. Standing there, he realized that all but ten of the deaths were located closer to that pump than any other public water pump. He confirmed his suspicions by talking to five affected families who acknowledged that they always fetched their water from the Broad Street pump. In relating these events, Snow does not discuss the role of a map. From his description it appears that Snow operated alone in focusing on the pump. However, two accounts in Chapter Four suggest that Snow was helped by Reverend Henry Whitehead.

6.2.2 Reverend Whitehead

Who was this man, and how did he help John Snow? Henry Whitehead was born in 1825 in Ramsgate, Kent. He obtained his BA from Oxford and became a minister. He was posted at St. Luke's, Soho in 1851 and left for another post two years after the 1854 epidemic. Whitehead knew many of his congregation and had collected some form of census prior to the Broad Street outbreak (Chave 1958). Such close contact with the victims of the cholera outbreak in Soho provided him the opportunity to write a personal

account of the experience called *The Cholera in Berwick Street* (1854). Berwick Street intersected with Broad Street, but Whitehead did not mention John Snow, Broad Street, or the Broad Street pump. John Snow and Henry Whitehead were late additions to the Vestry of St. James's Committee of Inquiry into the local outbreak (Cholera Inquiry Committee 1855; Chave 1958), the nature of which will be discussed in Sections 6.3 and 6.4. Snow might have sensed an ally in Whitehead when he presented the curate with a copy of his recently published *On the Mode of Communication of Cholera* (Chave 1958). Instead, Whitehead wrote Snow a letter rejecting his views and set out to prove him wrong (Whitehead 1855).

With the help of his local census, Whitehead attempted to interview every family that had lived in the affected area during the outbreak. He was able to contact at least 497 of the 896 local residents, and determined that the death rate of people who drank water from the pump was 80:57 but only 20:279 among those who had obtained their water elsewhere (Chave 1958). In what would now be considered a form of Popperian Critical Rationalism, Whitehead focused particular attention on those cases that contradicted Snow's theory: people who drank water from the pump but did not get sick, and people who got sick but did not drink the pump water. Despite his intentions, Whitehead found that the evidence supported Snow's findings. "Of one thing I am certain, that the case against the pump is strong enough to render wholly unnecessary, on the part of those who state it, any impatience at objections, however formidable the may appear" (Whitehead 1855, p. 162).

Two important results of Whitehead's investigation were the precise dates of the most virulent period of the local cholera outbreak and the location of the initial case. The

Registrar-General's tables of deaths that Snow published (1855a, p. 49) support Whitehead's finding that cholera was at its worst in the pump water on August 31 and was cleaner by September 3 (Whitehead 1855). While looking at the Registrar's Returns of Deaths, Whitehead noticed the diarrhoea-related death of an infant on September 2. She had lived at Number 40 Broad Street, and had died four days after the diarrhoea started. Her mother had soaked and washed her diapers and thrown the water into the cesspool located at the front of the house. With the help of the Surveyor, Mr. York, Whitehead found that the brickwork in the cesspool was faulty, and that it allowed sewage to seep into the nearby Broad Street pump (Whitehead 1855). The child's father also died towards the end of the outbreak.

Whitehead's labours did not go unnoticed by his contemporaries. At a June 4, 1855 meeting of the Epidemiological Society, French (who was probably the same Dr. French who was the apothecary of the St. James's workhouse and on the Vestry Cholera Inquiry Committee with Snow and Whitehead) said that the cause of the cholera outbreak "had been entirely explained by the labours of Dr. Snow and of the Rev. Mr. Whitehead, a curate of the district" (in Babington 1855, p. 11). In its review of the Cholera Inquiry Committee's publication, *The Lancet* wrote, "[The Rev. Mr. Whitehead] had noted the facts relating to the pestilence, as they fell under his observation, with the greatest vigilance; he had charted out a map of the outbreak, which must ensure the discovery of some local cause, if sufficient labour were only bestowed on its detection" (1855, p. 525). Whitehead's Report does not contain a map, and it is possible that *The Lancet* is referring to Snow's map. In 1871 Radcliffe, the inspector of the Medical Department of the Privy Council, wrote that while Snow had been the first to advance the theory that cholera was

transmitted through water, “to Mr. Whitehead unquestionably belongs the honour of having first shown with anything approaching conclusiveness the high degree of probability attaching to it” (in Chave 1958, p. 99).

The 1854 Broad Street outbreak did not signal the end of Whitehead’s involvement in researching and writing about the transmission of cholera. In 1865, when the fourth cholera epidemic threatened England, he wrote an article in *MacMillan’s Magazine* on the topic. At this time John Simon was still referring to Snow’s theory of water transmission as a “peculiar doctrine as to the contagiousness of cholera” (in Chave 1958, p. 100). He helped the same Radcliffe mentioned above to investigate the 1866 cholera epidemic and its outbreak in East London. In 1867 he attempted to stop the rumour that the removal of the handle of the Broad Street pump in 1854, at Snow’s insistence, had ended the outbreak (Chave 1958). This section has attempted to stop the rumour that Whitehead helped Snow point to the pump as the source of the Broad Street outbreak.

6.3 THE PUMP

With the death rate soaring and people fleeing the neighbourhood, there must have been a sense of alarm in the local government. The governing body for the City of Westminster, The Vestry of the Parish of St. James’s, was affiliated with the church and was organized much like a present day city council with various departments and offices. One of these was the Board of Governors and Directors of the Poor (hereafter called the

Board of Governors), or what Snow refers to as the Board of Guardians. According to Snow's account, the Board held what must have been an emergency meeting regarding the local outbreak on the evening of September 7.

There is no official record of the meeting, which is curious since minutes of Board of Governors meetings were kept. The Board of Governors met every other Friday night at 6 P.M., and one of its committees met at the Workhouse the preceding Tuesdays at 10 A.M. (Minutes of the Governors and Directors of the Poor, 22 April 1853–19 October 1854, Vol. 37. _Westminster City Archives_[hereafter WCA], microfilm D1404). The minute book shows a meeting of a Committee of the Board of Governors at the Workhouse on September 5 at 10 A.M. (pp. 467–68) and a meeting of the Board of Governors at the Vestry on September 8 at 6 P.M. (pp. 469–71). Neither meeting mentions Snow or the pump. A search was conducted through other possible Vestry-related minute books, but to no avail.

There is an unfortunate absence in another possible source for a record of the September 7 meeting (Vestry Minute Book, 4 December 1851–1 November 1855, Vol. 6. _WCA, microfilm D1777, pp.384–87). Pages 377–83 hold the minutes for the Vestry meeting of August 11, 1854, and pages 388–91 hold the minutes for the meeting of November 2, 1854. Members of the Vestry made up the Board of Governors and Directors of the poor, and it is possible that what Snow called a meeting of the Board of Guardians was actually a meeting of the entire Vestry. This speculation cannot be supported by the historical record however. The WCA also has the rough copy of the Vestry Minute Book (Rough Minutes of the Vestry, 5 December 1830–24 January 1856. _WCA_, microfilm D1810). These show meetings held on August 11, September

14, September 21, and November 2, 1854. September 7 was a Thursday night which suggests that the meeting must have been called as an emergency measure whether it was held by the Board of Governors or the entire Vestry. It is possible that the rushed and intense nature of this meeting interfered with the regular practise of recording the minutes.

Snow recorded his contribution to the meeting in his book *On the Mode of Communication of Cholera* (1855a, p. 40) and in his Report to the Vestry's Cholera Inquiry Committee (1855b, p. 102):

I had an interview with the Board of Guardians of St. James's parish, on the evening of Thursday, 7th September, and represented the above circumstances to them. In consequence of what I said, the handle of the pump was removed on the following day.

It is impossible to know from this quotation what Snow said, and the absence of minutes from the meeting compounds this problem.

That the meeting actually took place and resulted in the removal of the handle can be assumed for two reasons. The first is that there are three independent accounts of the handle having been removed. Whitehead stated that the handle was removed on September 8, 1854 his report to the Cholera Inquiry Committee to the Vestry of St. James's (1855, p. 153). In a letter to the Medical Officer for St. James's Westminster, two men lamented the fact that the Broad Street pump had been reopened during the 1866 epidemic after months of having been closed (Miller and Frankland 1866). Although they do not state that the pump had been shut down in 1854, they do write, "It is well known that the pump in Broad Street was, in the cholera visitation of 1854, the centre of a terrible outburst of the disease" (ibid., p. unknown). Nichols also alludes to the event in

his letter to the editor of *The Lancet* in 1868 (p. 400). Such a public action as the removal of the handle of a public water pump would have required consultation of some kind.

The second reason is that Snow included this statement in his Report which was read by members of the Board. It is difficult to believe that Snow would have incorrectly referred to events surrounding the September 7 meeting and the resultant actions in a publication read by the very men who would have been present at that meeting. What is noteworthy with regards to the discussion of the importance of the map is that Snow does not refer to a map either as a method of locating the source of the outbreak or as a tool to demonstrate his argument to the Board of Guardians.

From Snow's account, it seems that the Board of Governors believed he was correct in his assertion that the local outbreak was spread by water from the Broad Street pump. After all, they acted in consequence of what he said. In Richardson's memorial of Snow, however, he writes that the "vestry was incredulous, but had the good sense to carry out the advice. The pump-handle was removed, and the plague was stayed" (in Frost 1936, p. xxxvi). If the Board did not believe that the focus of the outbreak was the pump, why did they remove the handle? Their decision could have been based on Snow's evidence and/or the persuasiveness of his argument. Alternatively, it is possible that Snow's reputation as a leading anaesthetist or his standing within the community (as a man who had only recently moved his practice out of the area) played a role in the Board's decision. By November, Snow must have convinced at least some of the members of the Inquiry Committee for the Vestry of the significance of the pump water because, "Dr. Lankester was requested to report on the well-waters of the parish. In his

Report, it was shewn that the Broad Street well-water contained 96 grains of solid matter to the gallon, the Bridle Lane water 96 grains, and the Marlborough Street water 50 grains; whilst the water from Marlborough Mews (a quick filling well) contained only 30 grains” (Cholera Inquiry Committee 1855, p. 71).

The way Richardson describes it, the disengagement of the pump handle had an immediate effect on the cholera outbreak. Snow never made this claim (Text Box 6.2).

Text Box 6.2 (Snow 1855a, pp. 51–52)

There is no doubt that the mortality was much diminished, as I said before, by the flight of the population, which commenced soon after the outbreak; but the attacks had so far diminished before the use of the water was stopped [Table 6.1], that it is impossible to decide whether the well still contained the cholera poison in an active state, or whether, from some cause, the water had become free from it.

**Table 6.1 Cholera deaths in Golden Square, Soho
from August 31 to September 11, 1854** (Adapted from Snow 1855a, p. 49)

DATE	No. of FATAL ATTACKS	DEATHS
August 31	56	3
September 1	143	70
September 2	116	127
September 3	54	76
September 4	46	71
September 5	36	45
September 6	20	37
September 7	28	32
September 8	12	30
September 9	11	24
September 10	5	18
September 11	5	15

Snow thought that after September tenth or eleventh all new cholera cases “must have been occasioned in the usual manner, and not through the medium of water” (1885b, pp.

118–19). By this he meant that the cholera poison was ingested after being contracted directly from a victim, not a local water source.

Birkenhead (1969) attributes to Richardson the creation of the myth directly linking the removal of the pump handle and the end of the outbreak. The story may have been reinforced with Lankester's written statement in 1866 that "the pump was closed ... and the *plague was stayed*" (in Chave 1958, p. 103). Efforts to set the story straight, beginning with Whitehead in 1867, have been unsuccessful (ibid.). This is not to say that the removal of the pump handle did not have an effect. The father of the identified first case, the infant at Number 40 Broad Street, died of cholera towards the end of the outbreak. It is conceivable that a second outbreak could have begun from the discharges of this man leaking from the house's cesspool into the pump water (ibid.).

6.4 POST-OUTBREAK INVESTIGATIONS

Snow's inquiry into the Broad Street outbreak did not end when the cases of the disease ceased, nor was his the only examination. That outbreak was so intense and so localized that it prompted other investigations. In addition to discussing some of the work Snow conducted after the epidemic, this section will present some of the features of the examination done by the Cholera Inquiry Committee for the Vestry of St. James's as well as the one completed by the General Board of Health.

6.4.1 Further work by Snow

Snow was well aware of the controversy surrounding his theory and that his detractors would try to find evidence that contradicted his indictment of the Broad Street pump (1855a). In order to stave off criticism by his opponents, Snow tracked down all cases that seemed to contradict his argument, and he published the details in *On the Mode of Communication of Cholera* (ibid.). He had already located the residences of eighty-three victims who had died before September 2, but later learned that a total of one hundred and ninety-seven people had died by that time—the rest having died in hospitals. Because he was busy investigating the South London districts at the time, Snow could not determine the residences for all of the one hundred and fourteen other victims. When he resumed his investigation two or three weeks later, the population had dispersed too much for him to make such inquiries. However, he did not think that obtaining the missing information would have provided different results.

There were cholera deaths that seemed unconnected to the pump as well as local areas that were unaffected by the outbreak. Some people drank water from the pump without realizing it, as in the cases of the customers of a local coffee shop and the employees of a local factory. There were almost no cholera cases in local workhouse or brewery. Snow found that the first was supplied by a deep well and that the employees of the second drank beer instead of water. There were also examples of people who had died of cholera but did not live near the neighbourhood. Snow argued that these cases in fact proved his point. One man came from Brighton to visit his sick brother who died of

cholera shortly before the man's arrival. This man did not see his brother's body, but ate a short lunch with a drink of whiskey and water, left, and died of cholera two days later. A woman residing in Hampstead died of cholera on September 2. Her son told Snow that she liked the water from the Broad Street pump and had some brought to her everyday. Her niece, who was visiting, also drank the water before returning to her home in Islington where she also died of cholera. By examining cases like these, Snow was able to account for every case that seemed to be an anomaly, but which in fact served as important confirmations of his theory.

6.4.2 Report on the Cholera Outbreak in the Parish of St. James's, Westminster

Snow's work in Soho was also published as a report by the Vestry of St. James's in its Cholera Inquiry Committee's Report (1855; Snow 1855b). The history of the committee and the document is interesting because each of them came close to being terminated before they started. The committee was created on November 23 (Vestry Minute Book, 23 November 1854, pp. 392–93. _WCA_, microfilm D1777), three weeks after the motion was presented by Dr. Lankester (2 November 1854, p. 391):

That a committee of this Vestry be appointed for the purpose of investigating the causes arising out of the present sanitary condition of the Parish, of the late outbreak of cholera in the District of Golden Square and Berwick Street.

The committee was given the power to add new members, appoint a secretary, and call for submissions (23 November 1854, p. 392). However, at the next meeting, a potentially disastrous letter from the Board of Guardians was read (Text Box 6.3). After much

Text Box 6.3 (_WCA_, 14 December, pp. 398–99)

respectfully convey[ing] to the Vestry their regret that such a proceeding should have been adopted, not only because of the expense that it is likely to enlist upon the Years Poor Rate, already wholly unequal to meet the ordinary expenditures, but in a greater degree on account of the mischievous effects which a renewed investigation of the subject so recently made by the Government Officers, in the opinion of this Board, [unknown symbol] calculated to inflict on the Householders and Inhabitants of the locality now but slowly recovering from the serious depression of their Trade and employment and by whom the enquiry instituted by the Vestry is consequently viewed with feelings of dissatisfaction and alarm.

discussion and a vote, the motion to dissolve the committee failed.

The importance of the investigation was expressed in the Report (1855). It was the “startling suddenness of the outbreak that has given it a scientific interest, scarcely less momentous than its social importance; and as few of us probably will ever witness its like again, it is most desirable that no pains should be spared in its thorough investigation” (pp. 23–24). The report itself was hotly contested by the Board and was only accepted because of a tie-breaking vote cast by the Chairman (9 August 1855, pp. 479–80). Because of the expense involved, the report came close to not being published. Only five hundred copies of the book were ever published (Chave 1958).

The Committee had asked for the General Board of Health’s co-operation in supplying whatever information it had on the local outbreak, but the President Sir Bittall, “principally on the ground that investigations of this kind were more valuable when independent, ... did not comply with the request” (p. v). Members of the Committee began their investigation shortly after November 23, 1854 by circulating a questionnaire,

but had to devise a new plan when the technique was not successful:

A subsequent attempt to obtain local information, by a house to house visitation, was more successful. By the assistance of a printed form or 'Visitors' Inquiry List', prepared by Drs. Lankester, and Snow, the following streets were visited by the undermentioned members of the Committee: [members included Whitehead, Snow, and six other members of the committee] (pp. v-vi)

These men visited a total of three hundred and sixteen houses, and asked a variety of questions (Text Box 6.4), however their work was hampered by the large number of homes vacated after the outbreak.

Text Box 6.4 (adapted from Cholera Inquiry Committee 1855, Appendix A, p. 176)

Name of occupier or rate-payer
 Resident or non-resident?
 Number of rooms in the house.
 Average size of each room.
 Number of persons (average) inhabiting each room in August 1854.
 In what rooms did Cholera occur in August and September last?
 How many cases were there?
 At what hour did the attack in each case occur?
 How are the rooms ventilated?
 Do the top sashes let down?
 Condition and position of the privy or water-closet.
 Is there a common sewer in the street?
 Does the main drain of the house communicate directly into the sewer, or into an intercepting cesspool?
 Do the drains of the house emit any stench?
 What drinking water was used in August last?
 What receptacles exist to contain the supply of water?
 How often are they cleaned out?
 Is the supply sufficient?
 Is the house provided with a receptacle for ashes, dirt, &c.?
 How often is it cleaned out?
 In what part of the premises is it situated?
 Does any offensive place or business exist in the immediate neighbourhood of the house?
 Is the basement of the house used as a dwelling?
 Is any, and what part, of the house lighted by gas?"

The report listed six hundred and thirty-six deaths, two hundred and ninety-eight men and three hundred and thirty-eight women (p. 28). In addition to the inquiry questions, the committee paid attention to local circumstances during the outbreak such as weather, soil, and local elevation. The men noticed that “the great mass of the persons inhabiting the densely crowded parts composed of the families of labourers, mechanics and journeymen (many of them tailors), of persons, in short, employed at fair wages and manifesting no peculiarity in moral characters, habits or occupation beyond those usual to their class” (p. 51). At the end of its investigation, the Committee wrote: “Anxious to give due weight to every fact and consideration that have offered themselves in this inquiry, the Committee is unanimously of opinion that the striking disproportionate mortality in the ‘Cholera area’ as compared with the immediately surrounding districts...was in some manner attributable to the use of impure water of the well in Broad Street” (p. 83).

Both Snow’s book *On the Mode of Communication of Cholera* and the Vestry’s *Report on the Cholera Outbreak* were reviewed together in *The Lancet* (1855, pp. 524–25). The reviewer gave a more positive review to the work done by Henry Whitehead than that done by John Snow. He complained that Snow’s hypothesis regarding Broad Street did not account for the rapid decline in the incidence of cholera, and he suggested that this could have been due to “the imperfect investigations hitherto made” (p. 525). These concerns are juxtaposed with the assertion that the Committee Report, especially the work by Whitehead, was a move towards gathering better information. Concerning the Report, the reviewer writes, it “is a most important document, and should be carefully studied by those who are interested in the question” (p. 525).

6.4.3 The General Board of Health

The General Board of Health (GBH) conducted a full inquiry of the 1853–54 cholera epidemic which included an investigation of the cholera outbreak in Golden Square—referred in the Board of Governors letter at the December 14 meeting of the Vestry of St. James’s and requested by the Cholera Inquiry Committee, both noted above. The Soho outbreak was of particular interest to the GBH because it “was of such severity as to suggest that some especial causes must be concerned in its production” (GBH 1855, p. 49). The methodology of the Committee for Scientific Inquiries was a door-to-door investigation conducted by Dr. Fraser, Mr. Hughes, and Mr. Ludlow, one remarkably similar to that of the Vestry’s Cholera Inquiry Committee. The GBH surveyed these from September 11 to at least September 18, months before the Vestry, and while the outbreak was waning.

The GBH Report contains all the schedules of inquiry, their questions, the corresponding addresses, and the responses. There were three categories of information on the first schedule (Text Box 6.5). These categories were followed by “Observations” and a space for general notes. The schedules were not the same for every street in the neighbourhood. Those for Silver Street and Marshall Street included a specific question about water supply from the Broad Street pump, and were carried out by a medical student, not the three men named above. The schedule concerning Broad Street followed the original format, but the survey was completed over two separate days. The authors

Text Box 6.5 (adapted from General Board of Health 1855, pp. 332–52)

- I. HOUSE AND PREMISES: Situation and No. of house, No. of rooms, Source of water supply, When the water was drunk, Necessaries (i.e. WC's, privies), Ventilation, Dust-bins, General state of premises, Complaints of outward nuisances;
- II. INHABITANTS: No. of inmates (i.e. inhabitants), Employment and habits;
- III. DISEASE: Cholera [Cases and Deaths], Diarrhoea [Cases and Deaths], Particulars as to the rooms attacked, Particulars as to the persons attacked.

noted which people obtained water from the pump but did not suffer from cholera (p. 343–45).

The results of the study were rather vague (Text Box 6.6). The authors speculated

Text Box 6.6 (General Board of Health 1855, pp. 51–52)

There is mentioned, however, a remarkable instance in which it seems probable that the water of this well did really act as a vehicle of choleraic infection; but (assuming the absence of fallacy in the case) this probability might easily be admitted, without its therefrom resulting that infection depended on the specific material alleged. The water was undeniably impure with organic contamination; and we have already argued that, if at the times of epidemic invasion there be operating in the air some influence which converts putrefiable impurities into a specific poison, the water of the locality in proportion as it contains such impurities, would probably be liable to similar poisonous conversions. Thus, if the Broad Street pump did actually become a source of disease to persons dwelling at a distance, we believe that this may have depended on other organic impurities than those exclusively referred to, and may have arisen, not in its containing choleraic excrements, but simply in the fact of its impure waters having participated in the atmospheric infection of the district.

that even though the area had been essentially free from cholera during the 1848–49 epidemic and the first part of the 1853–54 epidemic, “there must have existed a certain local state of uncleanness with putrefiable matters” (p. 51) which lead to the outbreak.

They did not have local weather data for the days of the outbreak, but recalled that the air was sultry, stagnant, and oppressive while they conducted their surveys. In referring to Snow's theory, they stated, "After careful inquiry, we see no reason to adopt this belief" (p. 51).

6.5 THE MAPS

As discussed earlier in the thesis, the focus of the story of John Snow for medical geographers is the map of cholera deaths around the Broad Street pump. Many versions of the story recount how Snow located the source of the outbreak by mapping the deaths in each household. When they clustered around the pump, Snow called for the removal of the handle. With at least as many variations of the story as maps, finding the original map was as important as determining the original events. Archival research uncovered three maps (Appendix B). The first was published in Snow's book *On the Mode of Communication of Cholera* (Figure 6.1), and the second was included with his report in the Vestry Report (Figure 6.2). A similar map was printed in the GBH report (Figure 6.3). This section will examine the salient features of these maps (Table 6.2) and some of the accompanying text.

Table 6.2 Comparing the historical maps of the cholera outbreak in Golden Square, 1854

Map	Fig. 6.1 Snow 1855a	Fig. 6.2 Snow 1855b	Fig. 6.3 GBH 1855
Legend and Scale	legend in text, scale bottom right hand corner	legend in text and bottom center; scale bottom right hand corner	legend bottom right hand corner, scale bottom left hand corner
Symbolization	⊙PUMP –deaths	⊙PUMP –deaths	⊙ <i>Pump</i> – <i>deaths of residents</i> <i>deaths of non-res.</i>
Scale Type	verbal, inches and mile	verbal, inches and mile	verbal, inches and feet
App. Scale	1:2112	1:2112	1:1056
Scale Bench-mark	175m	175m	n/a
Study Area	dash-dot line	outer: dash-dot line inner: dotted line district: dashed line	implied by streets
Type-setting	ALL CAPS	ALL CAPS	street names and notes on two grey areas <i>ALL CAPS</i> , other notes in <i>italics</i>
Work-house Deaths	5	5	5
Deaths at No. 38 Broad Street	18	18	19
Pumps	13	14	5?

Figure 6.1 is a photographic reproduction of the map contained in Snow's second edition of *On the Mode of Communication of Cholera* (1855a, between pp. 44–45) and reprinted in Frost (1936, between pp. 44–45). When twentieth century authors reproduce the original map in their publications (refer to Figures 4.1–4.3), this is the one they use. Snow also included an almost identical map in his report published in the *Report on the Cholera Outbreak in the Parish of St. James's, Westminster, During the Autumn of 1854* (Figure 6.2 is a photographic reproduction). Both maps are markedly different from all

of the ones presented in Chapter Three except for Learmonth's (Figure 6.4 is a copy of Figure 3.5), which bears a stronger cartographic resemblance, and are fuller versions of the maps presented in Chapter Four.

Figure 6.4 Learmonth's Reproduction of Snow's Map (1988, p. 147)

The base map for Snow's maps was probably a Parish Plan map like the ones reprinted in the book *Maps and Plans: for the local historian and collector* (Smith 1988, pp. 186–90), and was not altered when the cholera death data was superimposed. This is suggested by the inclusion of streets outside the study area which is marked with a dash-dot line. Both maps denote the location of cholera deaths with black lines or rectangles and the pump with a circle-inscribed dot. The effect of the death symbolization is that

the maps are two-dimensional representations of three-dimensional information. Try to picture the stacks of black lines standing out perpendicular from the page, giving the impression of volume of deaths. Both maps show that eighteen people died at Number 38 Broad Street, a detail where the maps presented in Chapter Three often disagreed.

What is curious about Snow's maps is where they differ from one another. The delimitation of the study area on Figure 6.2 does not strictly follow the street pattern on the left-hand side of the map as it does on Figure 6.1. Figure 6.2 also has another pump located at Hanover Square on the far left-hand side of the map. Figure 6.2 has a partial legend printed on the map to explain the additional demarcation of sub-districts, details not drawn on Figure 6.1. The most remarkable feature of Figure 6.2 which is absent from Figure 6.1 is an inner dotted line that marks the point of equidistance between the Broad Street pump and all neighbouring pumps. This line is not a measurement as the crow flies, but uses the street pattern to determine distance. Snow's reasoning was that people who lived outside the line would be more inclined to use another pump (1855b), that is, he assumed that their spatial behaviour was rational. Indeed, the deaths inside the line appear to cluster more strongly around the Broad Street pump. The significance of this line for geographers will be discussed in Chapter Seven.

Each map is explained in the accompanying text, however, the renditions are not exactly the same. Text Box 6.7 juxtaposes the two descriptions with bolded type indicating where the accounts differ. The first column is from Snow's *On the Mode of Communication of Cholera* (1855a, pp. 45–47) and the second is taken from his report to the Vestry Committee (1855b, pp. 107–10).

Text Box 6.7 (Snow 1855a, pp.45–47 and Snow 1855b, pp. 107–10)

The deaths which occurred during the fatal outbreak of cholera are indicated in the accompanying map, as far as I could ascertain them. There are necessarily some deficiencies, for in a few of the instances of persons who died in the hospitals after their removal from the neighbourhood of Broad Street, the **number of the house** from which they had been removed **was** not registered. The address of those who died after their removal to St. James's Workhouse was not registered, and I was only able to obtain it in a part of the cases, on application at the Master's office, for many of the persons were too ill when admitted to give any account of themselves. In the case also of some of the work people and others who contracted the cholera in this neighbourhood, and died in different parts of London, the precise house from which they **had been** removed is not stated in the return of deaths. I have heard of some persons who died in the country shortly after removing from the neighbourhood of Broad Street, and there must no doubt be several cases of this kind that I have not heard of. **Indeed, the full extent of the calamity will probably never be known.** The deficiencies I have mentioned, however, **probably** do not detract from the correctness of the map, as a diagram of the topography of the outbreak; for, if the locality of the additional cases could be ascertained, they would probably be distributed over the district of the outbreak in the same proportion as the large number which are known.

The **dotted** line on the map surrounds the sub-districts of Golden Square, St. James's and Berwick Street, St. James's

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The **outerdotted** line on the map surrounds the sub-districts of Golden Square and Berwick Street, St. James's together with the adjoining portion of the sub-district of St. Anne's, Soho, extending from Wardour Street to Dean Street, and a

together with the adjoining portion of the sub-district of St. Anne's, Soho, extending from Wardour Street to Dean Street, and a small part of the sub-districts of St. James's Square, enclosed by Marylebone Street, Titchfield Street, Great Windmill Street, and Brewer Street. All the deaths from Cholera which were restored in the six weeks from **19th August to 30th September** within this locality, as well as those persons removed into Middlesex Hospital, **are shown in the map by a black line in the situation of the house in which it occurred, or in which the fatal attack was contracted.**

In addition to these the deaths of persons removed to University College Hospital, to Charing Cross Hospital, and to various parts of London, are indicated in the map where the exact address was given in the "Weekly Return of Deaths," or when I could learn it by private inquiry.

The pump in Broad Street is indicated on the map, as well as all the surrounding pumps to which the public had access at the time. It requires to be stated that the water of the pump in Marlborough Street, at the end of Carnaby Street, was so impure that many persons avoided using it; and I found that the persons who died near this pump in the beginning of September, had water from the Broad Street pump. **With regard to the pump in Rupert Street, it will be noticed that some streets which are near to it on the map, are in fact a good way removed, on account of the circuitous road to it. These circumstances being taken into account, it will be observed that the deaths either very much diminished, or ceased altogether, at every point where it becomes decidedly nearer to send to another pump**

small part of the sub-districts of St. James's Square, enclosed by Marylebone Street, **Tichborne Street, Great Windmill Street, and Brewer Street.** All the deaths from Cholera which were restored in the six weeks from **August 19th to September the 30th** within this locality, as well as those persons removed into Middlesex Hospital, **are shewn in black lines in the situation of the houses in which they occurred, or in which the fatal attacks were contracted. In addition to these the deaths of persons removed to University College, St. George's, Charing Cross, and other hospitals, and to various parts of London, are indicated in the map where the exact address was given in the "Weekly Return of Deaths," or when I could learn it by private inquiry.**

The pump in Broad Street is indicated on the map, as well as all the surrounding pumps to which the public had access at the time **of the outbreak of Cholera.** It requires to be stated that the water of the pump in Marlborough Street, at the end of Carnaby Street, was so impure that many persons avoided using it; and I found that the persons who died near this pump in the beginning of September, had water from the Broad Street pump. **The inner dotted line on the map shews the various points which have been found by careful measurement to be at an equal distance by the nearest road from the pump in Broad Street and the surrounding pumps; and, if allowance be made from the circumstance just mentioned respecting the pump in Marlborough Street, it will be observed that the deaths either very much diminish, or cease altogether, at every point where it becomes decidedly nearer to send to another pump**

<p>than to the one in Broad Street. It may be noticed that the deaths are most numerous near to the pump, where the water could be more readily obtained. The wide open street in which the pump is situated suffered most, and next the streets branching from it, and especially those parts of them which are nearest to Broad Street. If there have been fewer deaths in the south half of Poland Street than in some other streets leading from Broad Street, it is no doubt because this street is less densely inhabited.</p>	<p>than to the one in Broad Street. At these points I ascertained that people did generally send to the pump which was nearer. It may be noticed that the deaths are most numerous near to the pump in Broad Street, where the water could be more readily obtained. The wide open street in which the pump is situated suffered most, and next the streets branching from it, especially those parts of them which are nearest to Broad Street. If there have been fewer deaths in the south half of Poland Street than in some other streets leading from Broad Street, it is no doubt because this street is less densely inhabited.</p>
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There are a few things to note from these descriptions. First, there is nothing in the text to suggest why there are discrepancies. The cover letter of Snow's book is dated December 11, 1854 (1855a, p. iii), the day before the date on the cover letter of his report to the Vestry Committee (1855b, p. 97) which suggests the accounts were written closely together. Second, many of the differences are semantic—a changed tense or plurality. However, Snow mistakenly calls Tichborne Street “Titchfield Street” in his book which is clearly an error since the street is labeled Tichborne on both maps. Third, the report version contains a description of the inner dotted line on the Vestry Report map. In his book, Snow alludes to the implication of this line, but does not include it on the map. Archival research did not reveal which version was published first, but taken together, these textual points suggest that the description and possibly the map printed in *On the Mode of Communication of Cholera* (Figure 6.1) were probably constructed earlier than

the account and map in Snow's report to the Cholera Inquiry Committee (Figure 6.2).

However, the seemingly less accurate study boundary line on the left-hand side of Figure 6.2 map suggests the opposite.

Something absent from both descriptions is any mention of the use of a map in locating the source of the outbreak. In both passages Snow states that the map contains deaths recorded from August 19 to September 30, 1854. The dates of the intense cholera outbreak in Broad Street were from August 31 to September 9. Unless Snow constructed a rough copy of the map earlier in the month, he did not use one to locate the locus of the outbreak. The function of the published maps appears to be illustrative, not determinative. It cannot be overstated that Snow suspected the pump water was contaminated upon first hearing about the characteristics of the outbreak, but found that a water sample appeared quite clean. When the sample became obviously more impure after a couple of days, Snow consulted the death records of the Registrar-General. He went to the pump and noticed that all but ten of the deaths were closer to the Broad Street pump than to any other public pump (1855, pp. 38–40). Again, there is nothing in Snow's description that suggests he used a map.

In addition to the two maps in Snow's writing, archival research uncovered a similar map published in the GBH Report (1855, after p. 322) (Figure 6.3). The map was prepared with data collected from the schedules outlined above in Text Box 6.4. The men responsible for the Broad Street investigation—Fraser, Ludlow and Hughes—cautioned the reader that because of inaccuracy surrounding people who were removed to hospitals and workhouses the data might not be complete. One of the most obvious differences between the GBH map and the two by Snow is that the GBH map is more

ornate. While Snow's maps appear to be constructed with data superimposed over a surveying map, it looks like the GBH base map was adapted from this or another map. Only the streets within the study area are included, with adjacent streets named for reference but ending shortly. The odd street corner is rounded, and the north arrow—a feature absent on Snow's maps—is somewhat decorated. This map also names many of the landmarks in the neighbourhood such as the Workhouse buildings and St. Luke's Church (Whitehead's church).

The GBH map is also much more detailed than Snow's. If we assume that the purpose of Snow's map was to show that the deaths clustered around the Broad Street pump and that the purpose of the GBH's was to show anything but, then this is not surprising. The sheer amount of information on the map makes the possibility of the reader perceiving a spatial clustering of deaths around the pump less likely. The map has lines and symbols showing old and new sewers, clear and trapped sewer grates, ventilators, and side entrances. Pump locations are marked with the same symbol as on Snow's maps, a circle-inscribed dot. The legend distinguishes deaths of residents from those of non-residents by horizontal and vertical lines respectively. This distinction does not seem consistent however. It does not seem possible that everyone who died at 38 Broad Street was a non-resident except one person, nor does it seem likely that most people who died in dwellings on streets running roughly north-south were non-residents. The map also shows the locations of a "pest-field" and the "erroneously supposed position of the ancient plague pit." The differences between Snow's maps and the GBH's illustrate how the type and amount of information contained on a map can either help to reach a conclusion or confuse a reader past the point of looking for one.

6.6 WHAT DID SNOW'S BROAD STREET INVESTIGATION SHOW?

Many of the stories in Chapters Three and Four do not hold up under the weight of the historical evidence. Snow's map of cholera deaths is not an example of the power of disease mapping in locating the source of an outbreak or epidemic. The removal of the pump handle did not necessarily affect the number of local cholera deaths, nor did it prove that cholera was carried in drinking water. However, this does not mean that there is nothing to be learned from Snow's study which illustrates many themes, two of which will be discussed here and the rest of which will be taken up in Chapter Seven. First, Snow's table of deaths during the outbreak illustrates that cholera is self-limiting. Second, the story allows us to consider how strong circumstantial evidence was received by Snow's contemporaries.

6.6.1 Cholera as self-limiting

Without a more modern understanding of disease organisms, transmission, and pathology, Snow could not have fully understood the self-limiting nature of cholera. However, it is this phenomenon that his investigation of the Broad Street outbreak actually showed. The spread of cholera is curtailed by a bacteria-phage that attacks the cholera bacteria. This process at the bio-chemical scale is evident in the numbers of cholera occurrences and deaths published by Snow (1855a, p. 49) and adapted in Table

6.1 above. The data shows that the largest number of deaths was 127 on September 2, a figure that decreased to 76, 71, 45, 37, 32, 30, and 24 over the next seven days. With the reported removal of the pump handle on September 8, the drop in the number of deaths between September 7 and 9 (32 to 30 to 24) is hardly as impressive as that from September 2 to 3 (127 to 76).

Snow did have an idea that there must be some process destroying the cholera organism. In reference to the Broad Street outbreak he wrote that at some point before the removal of the pump handle, “it is not improbable that the water had, from some cause or other, ceased to contain the cholera poison” (1885b, p. 118). Whitehead thought that the water must have been somewhat cleaner by September 3, a day during which he had drank some of the pump water with brandy and suffered no ill-effects (in Chave 1958). Here he gained an understanding through empirical observations of the effects, not the cause. Snow was not the first person to recognize that cholera had a cycle of increase, decrease, and cessation; Pettigrew (1831) noted this in his description of cholera in India.

6.6.2 Effects and acceptance of Snow’s study in the nineteenth century

The examples from Broad Street and South London districts had the potential to change some minds on the nature and communication of cholera in the medical establishment. What were the effects of Snow’s theory and studies in the latter half of the nineteenth century and into the twentieth century? Some of his contemporaries

agreed with his theory while many were opposed to it. Most of the medical men publishing after the 1853–54 epidemic stood somewhere in between. While Snow's contemporaries may not have agreed with him, or given him credit when they did, his theory of water transmission played an important role in how water came to be understood as fundamental in pollution and public health concerns (Frost 1936; Luckin 1986).

Text Box 6.8 1866 Pamphlet on Cholera Prevention (_WCA_, folder 614.514)

CHOLERA.

BOARD OF WORKS FOR THE WESTMINSTER DISTRICT.

THE Board are taking vigorous measures to carry out the Orders of Her Majesty's Privy Council for preventing the spread of disease, but, as all public measures must, to a great extent, be inoperative unless aided by individual exertion, they call upon every Resident in the District to assist them to the best of his ability, and especially in the following respects, viz:--

1. The strictest attention to personal and household cleanliness.
2. Cleansing and, otherwise, purifying all Water Cisterns, and taking care that the Water supply be abundant and good.
3. Causing all receptacles of Dust, and other refuse, to be emptied twice a week *at the least*, and oftener if necessary by the Public Scavenger.
4. Immediately burning, instead of placing in Dust Bins or other receptacles, all refuse, vegetable, and animal matter.
5. Limewhiting *at once*, and frequently, all Dust Bins and other receptacles for refuse.
6. Whiteing, and otherwise cleansing, all Rooms, Staircases, Vaults, Areas, and other Places, requiring to be whitened and cleansed.
7. Cleansing, and otherwise putting in order, all Drains and Drain Traps.

Note.--The Sanitary Inspectors of the Board attend daily at the Offices, between the hours of 10 and 11 a.m., and will assist and advise the Inhabitants of the District, as may be required.

BY ORDER OF THE BOARD,

W.F. JEBB,
Clerk.

Office--25, *Gt. Smith Street, Westminster.*
1ST AUGUST, 1866.

A poster from the 1866 epidemic demonstrated an improved acknowledgment of water transmission of cholera coinciding with a flavour of miasma (Text Box 6.8). The miasmatic sentiments were echoed in a letter “To the Members of the Board of Works for the Westminster District” (Holt 1866). In his final paragraph, Westminster’s medical officer described a notice “calling upon all stable keepers, &c., to remove manure every second day, and all others to give immediate notice to the Sanitary Inspectors of any collection of dust, refuse, or other material likely to be injurious to health ...” (1866, p. 3). These examples illustrate an ambiguous attitude toward the role of water and cholera in the city where Snow conducted his Broad Street study.

Snow certainly had his share of supporters and detractors. William Budd was perhaps Snow’s biggest ally. Although their theories were not exactly the same, their understanding of cholera as an organism that could be ingested through contaminated drinking water was similar. During the Cholera Inquiry Committee’s investigation of the Broad Street outbreak, Dr. Lankester, a member of the Committee, did not support Snow’s view on the pump. Twelve years later he wrote that more experience with and research on cholera had made him realize that “the condition of the water in the Broad Street well at the time was the main cause of the fatal and terrible outbreak of Cholera in the Golden Square district of the Parish in 1854” (1866, p. 36). Reverend Whitehead certainly agreed with Snow’s theory, and might have influenced Radcliffe’s investigation of cholera in East London in 1866 (in Chave 1958). Radcliffe worked for Dr. John Simon, and in 1871 he wrote that the theory of water-transmission of cholera was a “doctrine now fully accepted in medicine, [and] was originally advanced by the late Dr. Snow” (ibid. p. 99). It could have been Radcliffe’s belief in Snow’s theory that

influenced Simon to change his views thirty years after the 1853–54 epidemic from only partial agreement to writing that Snow's proof of water-transmission was 'the most important truth yet acquired by medical science for the prevention of epidemics of cholera' (1890, p. 262).

The controversy that erupted over Snow's theory after the publication of his pamphlet and papers in 1849 did not fade away after the next epidemic. Baly and Gull rejected Snow's theory in their report on cholera (1854). Their opinion did not change with their involvement in the GBH's investigation into the epidemic. In its report on the Broad Street outbreak, the GBH wrote that, "on the whole evidence, it seems impossible to doubt that the influences which determine in mass the geographical distribution of cholera in London belong less to the water than to the air" (1855, pp. 48–49). The Board pointed to some ferment in the atmosphere that had yet to be discovered, and used Snow's evidence to further expand its understanding of miasma and infection (1855; Luckin 1986). Following a presentation by Snow at a meeting of the Epidemiological Society Dr. Rogers, one of the members of the Society, remained unconvinced by Snow's theory (Babington 1855). Reverend Whitehead recalled a conversation in 1855 when someone in the medical profession told him that Snow's theory was "generally regarded in the profession as very unsound." 'If that be the case,' [Whitehead] replied, 'heresy may be as good a thing in your profession as some of you are apt to suppose in mine'" (in Chave 1958, p. 106).

There were far more men in the medical profession whose ideas on Snow's theory fell somewhere between the supporters and detractors. The Cholera Inquiry Committee of St. James's Westminster agreed with Snow that water played a role in the Broad Street

outbreak, but it hesitated in fully endorsing his entire theory (1855, p. 81, p. 83; *The Lancet* 1855). By this time water had become accepted as a “predisposing cause” for cholera. After the 1853–54 epidemic, Simon wrote that the cholera poison might be found in contaminated water *and* contaminated air (in Frost 1936). While this type of quasi-agreement was not acceptable to Snow (1849a), it revealed the influence his theory had on the medical profession. Farr, who’s theory that cholera was connected with elevation, recognized that Snow’s theory was supported by the evidence, however he gave the theory only partial support (Frost 1936). An editorial in the British Medical Journal included this statement, “There can be no doubt that the condition of drinking water has been at the bottom of much of the cholera in this country” (1857, p. 848). However, he wrote this while arguing that the infection theory had not been suitably disproved, and that appropriate precautions had been abandoned as a result. A final example of this kind of incomplete acceptance can be found in an 1868 letter to the editor of *The Lancet* where the agreement is not with water-transmission but with the cholera poison (Text Box 6.9).

Text Box 6.9 (Nichols 1868, p. 400)

In the year 1854 we were visited by cholera, and the death-rate in this parish (St. James’s) like that in what has been termed the cholera fields of the East, assumed, when compared with that of the rest of the metropolis, as fearful ascendancy. This ascendancy was so marked, the area in which it occurred so limited, it was so exceptional that it was impossible not to conclude that it was owing to some exceptional condition. Then, as in the later outbreak, the water was supposed to be at the root of the mischief, and the pump in Broad-Street was condemned as the disseminator of the poison. Now, setting aside the difficulty of believing that all the population of the parish were in the habit of fetching water from this pump, when every house was supplied with water, good for all purposes,

by the Water Company -- setting this aside, the question arises, was this pump an exceptional thing? Was it of recent construction, or had it been there for years, and though we had been visited by cholera before, yet the mortality of the parish had not on those occasions exceed that of others.

Then what was the exceptional condition? In my opinion it was the sewers. There was the only thing I could fix on that had been altered ...

Perhaps an even worse offense to Snow occurred when authors credited his theory to someone else. In its review of Farr's report on the Cholera Epidemic of 1866, *The Lancet* remarked that the author's data from the Registrar-General's office and his subsequent discussion "shows how entirely his original hypothesis of water contamination as the cause of the 'explosion' is borne out by subsequent investigation" (1868a, p. 217). In this report Farr argued that if cholera had been diffused through the air, there would have been even rates of cholera across the City of London. Water-borne cholera was the only appropriate explanation. This was not the only example of *The Lancet* endorsing Farr as first advancing the theory that cholera was disseminated through contaminated water. Later in 1868, the editor advocated full agreement with the theory based on Farr's incontrovertible evidence (1868b). A literature review of references to Snow over a hundred and forty year period found that Snow's theory and ideas were almost forgotten until Frost's reprint of *On the Mode of Communication of Cholera* in 1936, save a reference by Simon in 1868 when he began to acknowledge the role of water in cholera transmission (Vandenbrouke et al. 1991). The authors attribute this to the dominance of Pettenkofer's sanitation and hygiene theories following Snow's work. Koch did not cite Snow in his writings on the cholera bacillus (ibid.).

The story of John Snow and the Broad Street outbreak is certainly more complex than suggested by many of the accounts presented in Chapters Three and Four. Some of this can be explained by authors reducing and summarizing information into a paragraph, a few pages, or a paper. However, this does not account for the apparent errors in detail. A more accurate “sound-bite” might look like this:

During late August and early September, 1854, over five hundred people died of cholera in what is now known as Soho, London. A local physician, Dr. John Snow, investigated the outbreak soon after hearing about it. Snow suspected a local water-pump as the source and pictured the location of the residences of eighty-three cholera victims, taken from the Registrar General’s Death Returns for one week, relative to the pump. He successfully argued to the Board of Governors for the removal of the Broad Street pump handle. Later, a close examination of the next set of weekly Death Returns revealed that the incidence of fatal cholera attacks had begun to wane days before this event, but the disengagement of the pump handle may have prevented a second outbreak. After the outbreak had subsided, Snow located the families of as many of the victims as he could and confirmed that they had drunk water from the pump. Snow had published a theory of contagious cholera transmission through contaminated water and direct contact between cholera victims and as yet unaffected people in a pamphlet called *On the Mode of Communication of Cholera* in 1849. He used the Broad Street outbreak as evidence to support his theory in the second edition published in 1855. Snow’s famous dot-map of cholera deaths appears in this book, but contrary to many accounts of the story, it appears that he drew the map long after the outbreak as an illustration, not as a tool to identify the source of the outbreak. Most of Snow’s contemporaries did not accept his theory of

cholera transmission, and it was not until years after his death in 1858 that his idea of water transmission was officially incorporated into cholera investigations in England.

CHAPTER SEVEN

A SENSE OF SNOW

This thesis has presented the stories of John Snow and the Broad Street outbreak and re-evaluated the narrative with archival sources to reconstruct our understanding of the man, his research, and his actions. The process has challenged not only the uncritical repetition of the story, but also the heroic reputation of Snow and its use in defining the nature of three disciplines. These challenges have many implications. The image of Snow ending the outbreak by having the pump handle removed is far less dramatic when we know that the number of daily cholera deaths was already waning. His position as “the father of shoe-leather epidemiology” in epidemiology and public health may no longer be tenable now that it appears that his methodology was a common research tool. The value of the map and Snow’s role as a hero for geographers might also be reconsidered now that the map plays a less prominent role.

So, what do we do with all of this? Instead of diminishing the importance of his research and theory, a new understanding of Snow and the outbreak encourages the study of more complex themes. First, within a nineteenth century context, socio-medical authority functioned to preclude a general acceptance of Snow’s theory by his medical contemporaries and possibly to influence the Board of Governors’ decision to remove the

pump handle. Second, the practice of historiography is challenged because while the history of medicine literature was accurate in its portrayal of Snow as a pioneer in two fields of study, it drew many of its conclusions from inaccurate historical details. Third, epidemiology may have put too much value in Snow's methodology, but his theory anticipated the germ theory of disease by more than thirty years. By focusing on his advanced understanding of cholera's pathology, Snow becomes a more powerful image as a hero and as a representative of the discipline. Fourth, geographers' misplaced emphasis on the role of Snow's map exemplifies the myth of the map and the map as an icon, but the discovery of a second Snow map (1855b) allows for the possible continued prominence of the map in the narrative. Both epidemiology's and geography's stories of Snow illustrate importance of myth in developing their respective identities. Finally and most generally, the story of Snow opens up a discussion about our broader understanding of disease causation and how science works. The nature of this research is not conclusive and the purpose of Chapter Seven is to introduce each of these themes as concepts for future discussion, not as definitive statements.

7.1 NINETEENTH-CENTURY SOCIO-MEDICAL AUTHORITY

Taking an historical look at John Snow, nineteenth century theories of cholera transmission, and the circumstances of the Broad Street outbreak, raises questions about the role of social and medical authority in the acceptance of Snow's theory by his contemporaries. How did the hierarchy within the medical establishment affect the

acceptance of Snow's theory? The miasmatists were powerful men in the medical and sanitary professions. They had the ears of government and, in some cases, the Queen. Snow certainly had access to the Queen on a few occasions, but it is preposterous to think that the subject of cholera transmission would have come up at all during the births of her last two children or in any substantive way at Court.

Nevertheless, authority might have favoured Snow during the Broad Street outbreak. If the Board of Governors of the Poor for St. James's Parish did not fully accept Snow's conviction that the high rate of cholera near Golden Square was caused by water from the Broad Street pump, why did they remove the handle? Certainly there must have been a level of panic and bewilderment at that emergency meeting of September 7. Members of the Board could have acted on Snow's advice because they were at a loss for what to do. It is possible that some of the gentlemen present knew that Snow had written extensively on cholera. It is also possible that Snow's reputation in matters not connected with cholera was a factor. Even if the Board was unfamiliar with Snow's research and work with anaesthesia or that he had attended the Queen during childbirth, they would have known of Snow's work as a local physician. Could it have been the authority attributed by one or more of these things that influenced their decision?

7.2 CONTEXTUAL LEGACIES OF SNOW

It is improbable that all of the historical questions can be answered both because

of gaps in the record and because of the accuracy of the records themselves. What we can possibly know about John Snow is as socially constructed in the archival sources as in the twentieth-century literature. That John Snow is a contextual hero in geography, epidemiology, and to a lesser extent the history of medicine cannot be disputed. What a new understanding of the details of the story of the Broad Street outbreak does is it challenges how and why he came to be an heroic figure and whether or not he deserves the honour. From this standpoint, the story of Snow says less about mapping, his “discovery” of cholera transmission, and heroic measures than it does about the importance of myth in defining disciplinary identity.

7.2.1 History of medicine

Snow’s reputation in the history of medicine has not really been shaken by the findings of this thesis. He *was* a pioneer in both anaesthesia and epidemiology. It is doubtful that the position of Snow’s reputation in relation to other medical heroes is likely to change. As mentioned in Chapters One and Four, the history of medicine is rife with stories of famous men who made significant contributions to the study and practice of medicine, and Snow pales in comparison to Hippocrates, Galen, or Jenner.

What a re-examination of the Broad Street story does is it questions the historiography of Snow. Retelling historical events is the purview of history, but it appears that the discipline may be just as likely to repeat a story uncritically as any other discipline. The authority of history is questionable in light of Snow’s own

acknowledgment that removing the handle from the pump might not have had much of an effect (1855a) compared with a textual example from a prolific author: “Snow traced a localized outbreak of cholera to a pump in Broad Street and seemed to have abruptly checked this local epidemic by having the pump’s handle removed” (Rosenberg 1962, p. 194).

7.2.2 Epidemiology

John Snow developed a theory of cholera transmission that was implicitly causal more than thirty years before the germ theory of disease guided by an abundance of empirical evidence. His research and writing, and perhaps in the case of the Board of Governors his persuasive rhetoric, influenced public policy—even if Snow’s theory was not always credited to him, completely agreed with, or implemented in a timely manner. He also used quasi-statistical methods similar to significance tests and ANOVA long before these techniques were formalized. This is the legacy of Snow for epidemiology. However, his legacy in the discipline’s stories is usually illustrated by the pump and his methodology.

The pump stands as the physical manifestation of the myth of John Snow (Figure 7.1). It is an appropriate symbol for the outbreak itself; however, it is misleading as a symbol for Snow and his investigation of the outbreak. The myth that removing the pump handle led to the end of the outbreak, possibly originating with Richardson’s memorial essay on Snow, has been contradicted by Snow’s own writing (1855a, 1855b)

Figure 7.1 A replica of the Broad Street pump (McLeod 1997)

and again in the 1936 reprint of *On the Mode of Communication of Cholera* (Frost 1936). Refutations were reiterated in 1955 by the president of the Epidemiological Section of the Royal Society of Medicine (in Chave, 1958) and in subsequent publications (Chave 1958; Birkenhead 1969; Ellis 1994; Lock 1994). Apparently, the task of explaining that the removal of the pump handle may have prevented a second round of the outbreak, and that

the Broad Street story illustrates the self-limiting nature of cholera takes too much time and space. It is not neat and tidy like the tried-and-true story.

Snow's epidemiology and public health reputation has also extended into the public consciousness. In his book *Allergic to the Twentieth Century*, Radetsky (1997) paraphrases an allergist-immunologist's rendition of Snow to illustrate that the "history of medicine is replete with instances in which physicians acted first and looked for proof later" (p. 145). In a following side-bar, the author quotes a conversation between a sufferer of Multiple Chemical Sensitivity and a doctor at a Princeton conference:

"Why can't you be like John Snow and try to do something about the problem even before you understand the cause?" came the question.

"John Snow died forgotten and penniless," was one doc's answer. It's easy to talk about going against convention—it's harder to actually do it. You run the risk of ending up like John Snow. (p. 147)

This kind of understanding of Snow's work is not only inaccurate, it is simplistic. Snow understood the cause of cholera: he had published his theory in 1849 in the pamphlet *On the Mode of Communication of Cholera*. He did not act without proof: he had the location of the eighty-three deaths as evidence. And Snow was far from forgotten. With a long publication record and two obituaries published in *The Lancet*, his death in 1858 did not go unnoticed. His ideas may have been credited to other men in the decades after his death, but in their literature review of sources citing Snow, Vandenbrouke et al. (1991, p. 969) noticed a marked increase in references "to the 'excellent' work of John Snow" from 1900 onward.

The Snow myth is also being perpetuated through the Internet on The Centers for Disease Control and Prevention's web-page. Rosenberg (1962) and Frost's 1936 reprint of *On the Mode of Communication of Cholera* were the sources for the site, and excerpts

are included below (Text Box 7.1). Note that despite Snow's use of anaesthetic during

Text Box 7.1 (Centers for Disease Control and Prevention Website at <http://www.cdc.gov/ncidod/dbmd/snowinfo.htm>)

John Snow
(1813-1858)

John Snow, a creative if unassuming London physician, achieved prominence in the mid-nineteenth century as an obstetrician who was among the first to use anesthesia. It is his work in epidemiology, however, which earns him his position as a prototype for CDC's Division of Bacterial and Mycotic Diseases epidemiologists.

...

A striking incident during this epidemic has now become legendary. In one particular neighborhood, the intersection of Cambridge Street and Broad Street, the concentration of cholera cases was so great that the number of deaths reached over 500 in 10 days. Snow investigated the situation and concluded that the cause was centered around the Broad Street pump. He advised an incredulous but panicked assembly of officials to have the pump handle removed, and when this was done, the epidemic was contained.

The pump handle has remained a symbol of effective epidemiology, and today the John Snow Pub, located near the site of the former pump in London, boasts of having the "original" handle. A John Snow Society has been formed to honor the memory of the epidemiologist (the only requirement being that one visit the John Snow Pub while in London). Snow was a skilled practitioner as well as an epidemiologist, and his creative use of the scientific information of his time is an appropriate example for those interested in disease prevention and control.

childbirth, he was not an obstetrician. This web-page also contains a link to "John Snow's original dot-map." Despite the word "original", the map that appears is a scanned image of Gilbert's 1958 reproduction (Figure 3.1).

Does John Snow deserve the title "The Father of Shoe-Leather Epidemiology"?

The methodology used by the General Board of Health's study of the outbreak which took place months before the Cholera Inquiry Committee's, used the same door-to-door

questioning technique that Snow used. It is quite probable that this “shoe-leather epidemiology” was a common mode of inquiry.

7.2.3 Geography

Geographers have made John Snow a hero because of his dot-map of cholera deaths from the 1854 Broad Street cholera outbreak. As much as geographers cringe when people muse about what they do by asking, “Oh you mean like maps and stuff?”, cartography is undoubtedly part of the geographic consciousness. The map is our icon, our cultural artifact. The myth of John Snow in the geographic literature is as much a myth of the map as it is of anything else. The story of Snow helps to define what some medical geographers want the discipline to be about: one of the contributing sciences in the study of disease.

In comparing the maps presented in Chapter Three to the two Snow maps revealed in Chapter Six, it is clear that various degrees of cartographic licence have been used in the twentieth-century reproductions. Those in the epidemiology and history of medicine literature, displayed in Chapter Four, were direct reprints of one of Snow’s originals (1855a). Why is this so? One reason could be that geographers wanted to show the map in its entirety and the textbook format was not conducive to reproducing the full-size original. Changing the black rectangles symbolizing the deaths allowed for a clearer rendition of the information at a much smaller scale. Another reason could be that the cartographers who reproduced the map would not have been content to just reprint it.

Instead, they may have been inclined to add personal touches to a well-known and well-recognized image. This reasoning would explain the differences between the twentieth-century maps. Unfortunately, the continued redrafting of the map has led to a loss of accuracy, as seen by the discrepancies in death totals at Number 38 Broad Street.

Medical geographers have made Snow a hero because of their belief that he used the map to locate the source of the outbreak. The icon was used to construct the myth. Monmonier (1997) presents the example of Snow's use of his dot-map to identify the source of the Broad Street outbreak and states that disease mapping in the twentieth century is not as straight forward as it was in the nineteenth. However, this thesis has suggested that Snow probably used the map as an illustration, not as a research method. With the determinative use of the map in doubt, is there anything that geographers can hold onto in the story that is "inherently" geographic? Certainly Snow displayed a type of spatial thought when he stood in Broad Street knowing the locations of eighty-three deaths and realized that they were closer to the Broad Street pump than to any other. However, even the importance of the map itself can be salvaged.

On the map that he submitted with his report to the Cholera Inquiry Committee (1855a), Snow included a line of equidistance between the Broad Street pump and all neighbouring pumps. He clearly thought about the purpose of this line because he used street pattern distances, not straight-line or euclidean distance. The significance of such a line was noticed by Barry Boots from Sir Wilfred Laurier University when some of this thesis research was presented at the Canadian Association of Geographers conference in St. John's, NF (21 August, 1997) and confirmed through electronic and surface mail correspondence (personal communications, August 24-October 29, 1997). This line is an

early example of a “Voronoi diagram on a network. [Snow’s] example predates any others by at least 120 years!” (Boots, personal e-mail communication September 30, 1997). Voronoi diagrams can be explained like this: “Given a finite set of distinct, isolated points in a continuous space, we associate all locations in that space with the closest member of the point set.” (Okabe et al. 1992, p. 1) Paraphrased using the example of Snow’s map, this statement reads: “Given a finite set of distinct, isolated pumps in Figure 6.2, we associate all cholera deaths with the closest pump.” Now, the purpose of Snow’s map was not to argue that deaths falling outside the line were associated with other pumps. Rather it was to illustrate how few deaths occurred outside the line and how the deaths inside the line clustered even more strongly around the Broad Street pump.

The evidence does not support the myth that Snow used his map to discover that the pump-water caused the Broad Street outbreak. However, acknowledging this does not require medical geographers, and geographers in general, to abandon him as a hero. Instead, the map is an historical example of the long-standing tradition of disease maps as illustrations. Both of Snow’s maps serve this purpose very well, especially the one which also serves as an early example of a Voronoi diagram—a technique with a diverse history that is used in many different disciplines (Okabe et al. 1992).

7.3 BROADER UNDERSTANDINGS OF CAUSATION AND SCIENCE

The underlying theme to the story of Snow and the Broad Street outbreak is

causation and science. Did Snow's research illustrate the cause of cholera? Did he *prove* that cholera was caused by contaminated drinking water? Does the demonstration of transmission demonstrate causation? Many authors cited in Chapters Three and Four suggest that he did. Causation has occupied the minds and writings of philosophers and scientists for centuries, and their writings on the nature of causation can be quite different from how it is commonly understood. Furthermore, the popular understanding of how science works is often at odds with how it actually works. The language used to describe the connection between Snow's investigations and the proof of his theory could be used to illustrate some of their ideas.

Mackie (1967 in Hage and Meeker 1988, p. 7) discusses causation in terms of necessary, unnecessary, sufficient, and insufficient conditions. Using this structure, the cholera bacterium is a necessary but insufficient cause of the disease. In other words, ingesting the bacteria does not always lead to death or even to the contraction of the disease; however, one cannot contract cholera without ingesting the bacteria. Snow was conscious that this was the case: "animal poisons, when swallowed, are generally destroyed in the stomach by the process of digestion; and, indeed, it is not improbable that the material which gives rise to cholera is often thus destroyed, and its effects resisted, since the complaint is very often observed to come on when the digestive powers have been weakened by a fit of drunkenness" (Snow 1849, p. 26).

Snow demonstrated the relationship between contaminated water and cholera. However, his was not a knock-down argument of mythical science: his evidence was not so persuasive that it resulted in the wholesale adoption of his theory. To put this another way, Snow's research and theory did not cause a Kuhnian paradigm shift in thinking on

disease causation and transmission. Instead it contributed to the continuing evolution of ideas on the subject. What a clearer understanding of the Snow story demands is a much more sophisticated and flexible view of evidence, argument, and proof within the social contexts of institutions, authority, policy, and rhetoric.

7.4 FUTURE RESEARCH

The possibilities for future research opened up by this thesis are legion, and many of them are suggested by the discussions in Sections 7.1 to 7.3. Additionally, there are two explicitly empirical projects. The first involves more archival research and the second a technical analysis of the maps.

Three weeks in the field was not long enough to explore many of the archival resources that could have contained information on Snow and the Broad Street outbreak. One of the missing pieces is any record of the September 7 meeting of the Board of Governors and Directors of the Poor and its decision to remove the pump handle. Another is the identity of the cartographer of Snow's map, if it was not actually Snow himself. Future field research will examine resources held at the British Library, London Metropolitan Archives, Westminster City Archives, and the Wellcome Institute's Library including newspaper articles, more medical publications, personal correspondences, diaries, and maps.

Part of the allure of Snow's dot-map is that it is supposed to show that cholera deaths clustered around the pump. Various geoprocessing techniques will be used to

determine if this is in fact the case, as well as how much more accuracy is contributed by the Voronoi diagram. Using similar techniques, this investigation will be expanded to examine if repeated redrawing of the map in the twentieth century has altered the strength of its information and to compare and contrast these maps to one another and the originals.

Rather than offering a conclusion then, this thesis finishes with more questions and suggestions of more work to be done. The twentieth-century stories of John Snow and the Broad Street cholera outbreak have been successful because they have been short and dramatic. They offer a concise tale of a man who took an initiative based on his ideas and saved lives as a result. Telling the events more faithful to the historical record makes the narrative longer, with more twists and turns. As such, it does not translate well into the sound-bite format used in most Snow narratives. John Snow deserves a prominent place in the histories of geography, epidemiology, and medicine, but the story must be a more sophisticated version than has traditionally been presented.

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Appendix 1

The Modern Understanding of Cholera (Black 1986, pp. 242–46; Mohler 1986, p. 885)

Vibrio cholerae “is a small, curved, motile aerobic gram-negative organism” (Black, p. 242) that only affects human beings. It has an incubation period of six to forty-eight hours and it is transmitted to the “environment through the stools of infected persons” (ibid. p. 245).

Water is the most important vehicle of transmission, and person-to-person transmission is rare because of the large dose of the organism needed for cholera infection. [As an interesting connection to the miasmatic theories of the nineteenth century, the air does play a role in contemporary cholera transmission. “Air travel is a major intercontinental disseminator of cholera” (Mohler, p. 885).]

The organism does not tolerate dry air or sunlight and dies quickly when exposed. However, it can survive between one to three days on “moist, fecally contaminated clothing...; up to seven days on the surface of fruits, vegetables, and meat...; and up to three weeks in nonacidic fish and shellfish” (p. 245).

Symptoms of cholera “are entirely due to the loss of large volumes of isotonic fluid and resultant depletion of intravascular and extravascular fluid, metabolic acidosis, and hypokalemia. In addition to the diarrhea and vomiting, symptoms include lightheadedness, anxiety, thirst, and muscle cramps.” (p. 244)

Treatment is through hydration therapy, either oral or intravenous, and can be augmented with tetracycline therapy. Cholera vaccinations are no longer recommended by the WHO for travel to foreign countries.

Appendix 2

The Historical Maps of Cholera Deaths, 1854 Broad Street Cholera Outbreak

Figure 6.1 Snow's dot-map of cholera deaths (1), 1854 cholera outbreak, Golden Square (Snow, J. 1855a: *On the Mode of Communication of Cholera*, 2nd ed. London: John Churchill, between pp. 44–45. Copyright permission from London Metropolitan Archives.)

Figure 6.2 Snow's dot-map of cholera deaths (2), 1854 cholera outbreak, Golden Square (Snow, J. 1855b: Snow's Report. In *Report on the Cholera Outbreak in the Parish of St. James's Westminster, During the Autumn of 1854*. London: Churchill, pp. 106-107. Copyright permission from the London Metropolitan Archives.)

Figure 6.3 General Board of Health's dot-map of cholera deaths (General Board of Health Medical Council 1855: *Report of the Medical Council ... in relation to the cholera epidemic of 1854*. London: Her Majesty's Stationery Office, after p. 322. Credit: Wellcome Institute Library, London.), with explanatory text.

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Figure 6.3
PLAN
Shewing the Ascertained Deaths From Cholera
In the part of the Parishes of
St. James, Westminster
and
St. Anne, Soho
During the Summer and Autumn of 1854

Grey Oval reads: ERRONEOUSLY SUPPOSED POSITION OF THE PLAGUE PIT
 SHEWN IN THE MAP OF THE COMMISSIONERS OF SEWERS.

Grey Rectangle reads: EXTENT OF THE CRAVEN ESTATE. CORRESPONDS WITH
 SITE OF THE PEST-FIELD. 3 ACRES, 2 CHAINS.

Legend Reads:

Note: *The Old Sewers are represented in firm dark lines, thus —————*
The Sewers constructed by the late M^r. Forster in 1851, thus - - - - -
The Sewers constructed at the end of 1853, and completed on
18th Feb. 1854, thus
The Marks thus ≡ show the number of deaths of residents in each house,
and the marks thus ||| show the deaths of non-residents
Sewer Grates shewn ■, and when trapped □
Side Entrances ■ SE
Ventilators X
Pump □

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I am happy to give permission for you to use these two extracts and I would appreciate an acknowledgement to London Metropolitan Archives.

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NOTE. Boundary within which all the Deaths are
 Division between Sub-Districts, thus,
 Boundary of equal distances between Br.

NOTE. { Boundary within which all the Deaths are indicated, is shown thus,
 { Division between Sub-Districts, thus,
 { Boundary of equal distance between Broad Street Pump and other Pumps, thus,

aded, is shown thus,
to Pump and other Pumps, thus,

SCALE 30 INCHES TO A MILE.

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