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The work of John Snow, M.D. (1813-1858): a re-evaluation

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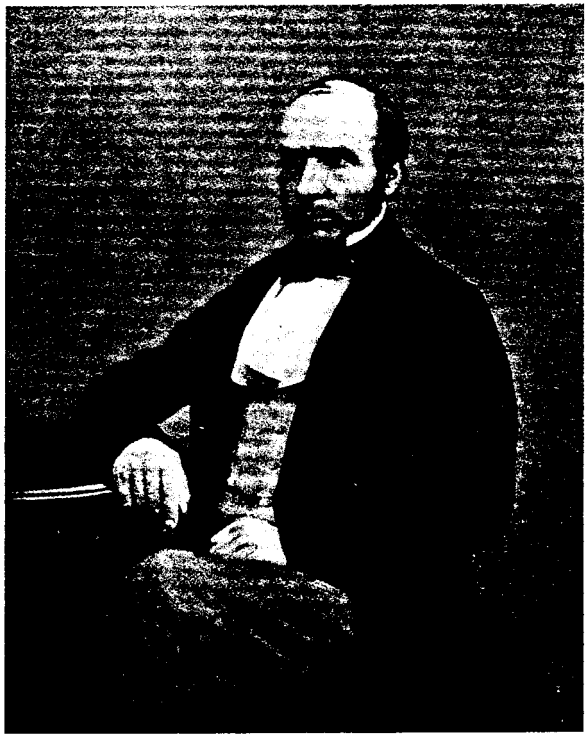


Fig. 1. John Snow, M.D. (1818-1858)

SUMMARY

John Snow (1813-1858) achieved leadership in two different fields - anaesthesia and epidemiology. Much of what he achieved was the outcome of rigorous research, which is, however, less well known than episodes in his career that are more the stuff of legend than of research. Snow's stature in anaesthesia rests principally on his research into techniques for regulating the concentrations of volatile agents and on his invention of efficient inhalers for their administration; he also performed basic research on these agents and published widely on various aspects of anaesthesia. Snow's stature in epidemiology derives from his investigation of cholera in 1854, which enabled him to prove that the disease was spread by water contaminated by human faeces. The significance of Snow's research largely lies in his providing paradigms for 19th century anaesthetists and epidemiologists in a period when these two disciplines were still young.

INTRODUCTION

John Snow (**Fig. 1**), who was born in York, England, on March 15, 1813, lived for only 45 years; he died in London on June 16, 1858. His career was therefore short. Yet, in little more than a decade (from 1847 to 1858), he accomplished much that advanced medicine in the 19th century. Soon after anaesthesia was introduced in 1846, Snow, more than anyone else, transformed a simple, practice-oriented craft into a scientifically based specialty; in a period when the cause of cholera was not understood he showed that the disease was spread by cholera-contaminated water, thereby providing a paradigm for the understanding of it. Snow's accomplishments benefitted countless individuals in his own day and thereafter; Henry Whitehead's praise of Snow that "he was as great a benefactor as any other in the 19th century" (1) was no hyperbole.

Yet a general understanding of Snow's work, especially of the details of the research that lay behind his achievements, is limited, incomplete and even inaccurate. This is true not only of the literature of anaesthesia and epidemiology but also of standard texts on the history of medicine. Garrison, for example, makes at least four simple errors in his account of Snow (2), Clendenning makes one (3) and Castiglioni makes two (4); Major does not even refer to Snow (5). (But Singer and Underwood give an accurate and well-balanced account [6].) As well, leading journals on the history of medicine (Bulletin of the History of Medicine, Journal of the History of Medicine and Allied Sciences and Medical History) contain very few articles specifically on Snow (7-9). In addition, a comprehensive, recent biography of Snow is lacking; the two biographic sketches by Snow's friend, Benjamin Ward Richardson (10,11), are useful but, though most of the accounts of Snow draw heavily on Richardson's contemporary accounts, the two sketches are subjective besides being out of date.

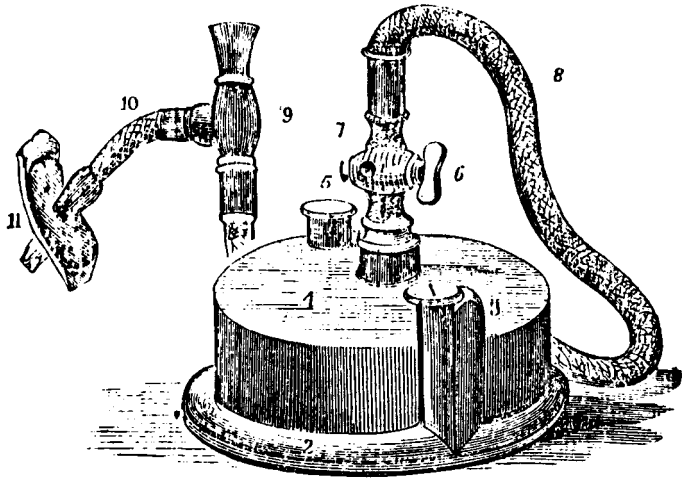
Snow, too, is better known for episodes in his career that have become part of the legends of the history of medicine than for his research, which is of far greater significance. Robinson, for example, refers to Snow's attendance on Queen Victoria in 1853 as follows: "Queen Victoria was pregnant; there was a quickening within the royal womb; the day for labor arrived; John Snow stood by her bedside; he put something on her face, and the royal mother inhaled chloroform". **(12)** Garrison misinterprets and devalues Snow's research in anaesthesia by stating that "he was a pioneer in anaesthesia, having delivered the Queen by chloroform in 1853 and 1857."**(13)** Snow's part in investigating the cholera epidemic around Broad Street in London in 1854 is frequently mentioned by medical historians, and usually in glowing terms; Clendenning, for example refers to it as "one of the romantic tales of epidemiology". **(14)** Singer and Underwood are among the few who have understood that Snow's research, rather than encouraging legend, actually contributed constructively to medical knowledge and that the evolution of anaesthesia and of epidemiology each was advanced as a result of his research **(6)**.

In this paper, Snow's work is re-evaluated, with particular reference to his research.

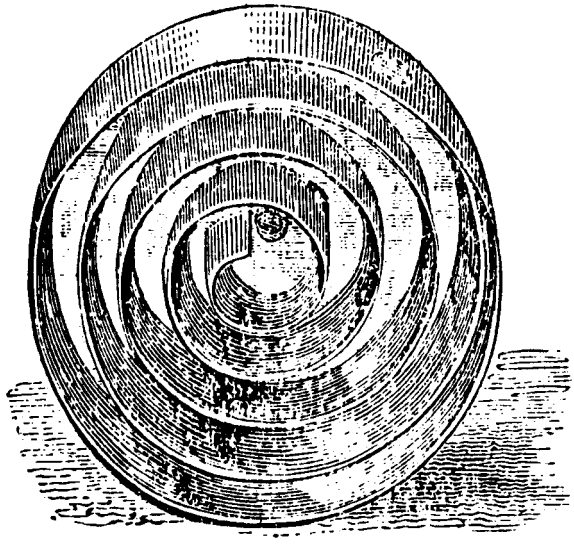
SNOW'S RESEARCH IN ANAESTHESIA

Snow's interest in anaesthesia dates from January, 1847 -- just a month after it was reported in England that W.T.G. Morton had first publicly demonstrated the efficacy of ether as an anaesthetic on October 16, 1846, in the Massachusetts General Hospital in Boston. From January 1847, when he identified the defects in the early ether inhalers and developed his own much more efficient, inhaler **(Fig. 2)**, until the summer of 1858, when he died (having just completed his great text "On Chloroform and other Anaesthetics: Their Action and Administration"**[15]**) Snow was actively involved in the development of anaesthesia. A fine clinical anaesthetist, he was a diligent and perceptive researcher whose endeavours laid the scientific basis of the practice of anaesthesia. His leadership in the specialty was manifest in several ways:

1. He identified the deficiencies in the primitive techniques of administering ether and chloroform and invented his own inhalers. He urged anaesthetists to deliver carefully estimated and regulated concentrations of these agents.
2. He conducted numerous experiments on a variety of volatile agents, always on animals and sometimes on himself, before applying the results of his research to clinical practice.
3. He studied the nature of anaesthesia, which most of his contemporaries equated with asphyxia. In investigating the metabolism of carbon dioxide during anaesthesia he developed the first closed-circuit breathing system, in 1850. These researches led him to formulate a rational theory of the mechanism of anaesthesia, which served as a paradigm for the times.



1, Cap which unscrews to admit the air to
2, Metal pipe.
3, Entrance of ditto into
4, Spial chamber.
5, Star closing aperture for putting in or pouring out ether.
6, Two-way tap.
7, External opening of ditto.
8, Flexible tube.
9, Ebony tube, containing ball valves of cedar wood.
10, Portion of flexible tube to admit of change of position of
11, Mouth-piece, with soft cushion, &c.



Interior of spiral chamber, the bottom being removed.
N.B.—The spiral tin plate is soldered to the top, and reaches nearly to the bottom.

Fig. 2. Snow's ether inhaler, January 1847. This was the prototype of the better known rectangular inhaler, which he illustrated in his monograph on ether of September 1847.

4. He published some 35 journal articles on various aspects of anaesthesia, together with a monograph on ether (1847) **(16)** as well as the text on chloroform and other anaesthetic agents.
5. He emphasized the need to develop an intellectual basis for the practice of anaesthesia and the importance of trained, qualified personnel administering anaesthesia.**(17)**

For Snow, research went hand in hand with clinical anaesthesia. He identified problems, investigated them experimentally and applied the results to clinical practice, which often stimulated further research.

Snow's leadership in anaesthesia was the natural outcome of a well-balanced integration of knowledge of basic science, intellect, technical skill, clinical competence, research facility, personal ethics and vision. It is not surprising that when he turned his attention to solving the problems presented by the spread of cholera he achieved leadership in this area also.

SNOW'S RESEARCH ON THE EPIDEMIOLOGY OF CHOLERA

Snow's clinical observations on cholera, which he first witnessed as an apprentice apothecary in 1831, and his wide reading on the subject, led him to formulate a new and original theory of the transmission of the disease. A rational and valid theory was essential in Snow's day, when neither the cause nor the means of spread of cholera was understood; **The Lancet** observed in 1853, "we know nothing; we are at sea in a whirlpool of confusion". **(18)** Snow's epidemiological research yielded a useful paradigm for the understanding of cholera.

Snow's approach to research in cholera was not dissimilar to his approach to research in anaesthesia. He made clinical observations, formulated a theory and to prove it (or disprove it) he conducted a classic investigation. His clinical experience led him to draw two important conclusions. First, in contrast to most of his contemporaries, Snow believed that cholera is primarily a disorder of the alimentary canal; second, again in contrast to many of his miasmatically oriented contemporaries, Snow held that cholera is communicated from one person to another, even though these persons might not exist in close proximity to each other. Astutely, he argued as follows:
people, of both sexes, of every age and occupation, and of every rank and station... were divided into two groups.. one being supplied with water containing the sewage of London... the other group having water quite free from such impurity". **(24)** The essence of Snow's findings was as follows: in the first seven weeks of the epidemic, the mortality for the population supplied with polluted water was 8.5 times as high as that associated with unpolluted water.

Snow had done what no one else had done: quantitate the effect of cholera-contaminated water. Acceptance of his theory meant that cholera could be prevented by quite simple means; as a result, England remained free of cholera from 1866 onwards.

JOHN SNOW'S ACHIEVEMENTS: A RE-EVALUATION

For John Snow, life was short and the art was long. Some of his art was the art of clinical medicine--the art of observation and of healing based on it. But much of his art was the art of research -- the art of clinical observation, deduction and the formulation and testing of hypothesis. In Snow these two aspects of the art of medicine were finely integrated, and in the practice of his art Snow is a notable example of the dedicated physician's healing role.

Although the value of Snow's work on anaesthesia and cholera is well recognized, it is generally appreciated only in outline; moreoever, in the literature of anaesthesia and epidemiology and even of the history of medicine discussions of Snow's work are all too often incomplete or even erroneous. Too often missing is a consideration of the details of his work, so much of it is unfamiliar to physicians and medical historians. There are two reasons for this: first, Snow's ideas on cholera, which in his day were more often rejected than accepted because they were novel and original, have long since been accepted; second, the knowledge that his research, in both cholera and anaesthesia, yielded was long ago incorporated into the matrix of medicine. But to fully assess Snow's achievements, an examination of the details of his work is essential.

The details of Snow's work are evident in his writings. On these we must depend for an assessment of Snow's contributions to medicine, for autobiographical and biographical material relating to Snow is sparse. Snow's publications indicate readily the magnitude of his achievements. In anaesthesia, his major works include the monograph on ether and the text on chloroform and other anaesthetics, together with a series of papers on narcotism, published from 1848 to 1851. **(25)** Besides these, many other papers emphasized the importance of the scientific basis of anaesthesia, while others concerned related topics, such as resuscitation. In cholera, Snow's major works were the

> ... the disease must be caused by something which passes from the mucous membrane of the alimentary canal of one patient to that of the other, which it can only do by being swallowed; and as the disease grows in a community by what it feeds on, attacking a few people in a form first, and then becoming more prevalent, it is clear that the cholera poison must multiply itself by a kind of growth changing surrounding materials to its own nature like any other morbid poison; this increase is the case [sic] of the materies morbi of cholera taking place in the alimentary canal. **(19)**

He added--and this in 1849, 34 years before Koch demonstrated the existence of the cholera vibrio -- that "the morbid matter of cholera having the property of reproducing its own kind, must necessarily have some sort of structure, most likely that of a cell."**(20)**

Snow also observed that, though lack of personal hygiene and overcrowding were usually associated with cholera, cases sometimes occurred in isolation from the main centre of an epidemic. This he explained as being the consequence of "the mixture of the cholera

evacuations with the water used for drinking and culinary purposes, either by permeating the ground and getting into wells, or by running along channels and sewers in the river." **(21)**

Snow was neither a contagionist nor a miasmatist. For him, cholera was an infectious disease caused by a microorganism and transmitted to healthy persons who ingested water that was contaminated by the faeces of cholera patients. But he had no proof of this; he had simply deduced it from his observations. He was not able to put his theory to the test until 1854, when "the most terrible outbreak of cholera" **(22)** was visited on the area around Broad Street, London. Within a few weeks in the late summer of that year he conducted the two-phase investigation for which he is justly famous.

The first phase of this investigation comprised studies of the Broad Street epidemic. He concluded that the "epicentre" of the outbreak was the water pump in Broad Street. He advised that the pump handle be removed; this done, the epidemic continued to wane, fewer and fewer new caes breaking out.

The second phase was more far-reaching. He was thorough; he wrote, "I resolved to spare no exertion which might be necessary to ascertain the exact effect of the water supply on the progress of the epidemic" **(23)**. He checked the mortality rates associated with the different houses affected with cholera in a number of parts of London against their water supply, one source of which was polluted, while another was not. The investigation was conducted "on the grandest scale", for "no fewer than three hundred thousand two editions of his monograph on the transmission of cholera, in which he stated his theory (1849) **(26)** and later produced the evidence by which he proved its validity (1855). **(27)** In numerous articles and letters, too, Snow brought his views to the attention of the medical profession. These writings demonstrate Snow's stature as a researcher who added new dimensions to the understanding of anaesthesia and epidemiology. Even so, these new dimensions, which permitted fresh advances in these two disciplines, are much less well recongized than they should be in comparison with those relatively unimportant yet almost legendary epidoses in Snow's career -- his administering chloroform to Queen Victoria and his urging the removal of the handle of the Broad Street pump.

In terms of the basic knowledge that grew from Snow's research and of the health of countless individuals who, albeit indirectly, have benefitted from the application of this knowledge to the practice of medicine, Snow's work must be judged of incalculable value and significance. But for its value and significance to be completely appreciated, further studies of John Snow and his work are necessary.

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