THE BEGINNINGS OF MEDICAL MAPPING*

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If a mental geographical image is as much a map as is one on paper or on a cathode ray tube, then the concept of medical mapping is extremely old. The geography of disease, or nosogeography, has roots as far back as the 5th century BC when the idea of the 4 elements of the universe--fire, air, earth, and water--led to the doctrine of the 4 bodily humors--blood, phlegm, cholera or yellow bile, and melancholy or black bile. Health was simply the condition when the 4 humors were in harmony. Throughout history until some 200 years ago the parallel between organic man and a neatly organized universe regularly surfaced in the microcosm-macrocosm philosophy, a kind of cosmographic metaphor in which the human body was a miniature universe, from which it was a short step to liken the physical circulations of the earth, such as water and air, to the circulatory and respiratory systems of man. One of the earlier detailed, topographic-like maps definitely stems from this analogy, as clearly shown by Jarcho.[1]

The idea that disease resulted from external causes rather than being a punishment sent by the Gods (and therefore a mappable relationship) goes back at least as far as the time of Hippocrates in the 4th century, a physician best known for his code of medical conduct called the Hippocratic Oath. He thought that disease occurred as a consequence of such things as food, occupation, and especially climate. The parallel with

today is striking--diet, occupational hazards and air pollution! One of the best known writings attributed to Hippocrates, Airs, Waters and Places, is a kind of study of the patient in his environment, what we would call today human ecology.

In spite of the very early recognition that geographical factors did have a profound influence on health, there seems to be no instance of any medical mapping of consequence until the late 18th century. The first medical-geographical presentations of the occurrence of sickness in different parts of the earth include no maps,[2] nor even refer to them as an aid to medical science.[2] On the other hand, one of the more curious aspects of the history of both general and thematic mapping, as pointed out by Jarcho, is the surprising number of cosmographers and cartographers who had medical education.[3] The list is long, ranging from Nicholas Copernicus in the 16th century to Christopher Packe in the 18th. Even the maker of the first printed map with isobaths in 1730, Nicolas Cruquius, was a medical dropout. Perhaps the training that requires a practitioner to develop a mental image of the assembly of interconnected bodily components leads naturally to that sort of appreciation of the interrelation of geographical elements.

When we search for the beginnings of medical mapping, we must remember that widespread disease, sickness and early death was the normal human experience until less than 200 years ago, and therefore went largely unnoticed. When something especially virulent swept over an area, and people were aroused, one would think that that might have brought forth mapping that searched for causes, but it did not. The outbreaks of plague or black death which periodically devastated parts of the earth's population are a case in point. For example, in the 14th century one-fourth of the population of Europe, some 25,000,000, died during the great epidemic. The early medical mapping is not of the distribution of disease but of sanitary cordons on land and sea, established to keep a disease from spreading, even though the authorities had no idea of the mechanisms of transmission.[4] Real medical mapping only began when investigators started to suspect a causal relationship between environmental factors and the occurrence of disease. In the late 18th century a considerable controversy ensued after the outbreaks of yellow fever in the United States.[5] As Stevenson points out, some believed that

the disease was contagious, that is was transmitted from person to person, and therfore spread by contact with immigrants; they favored "sanitary cordons," in other words, quarantine. Others believed the disease was caused by "putrid effluvium arising from local conditions of filth and putrid matter." Stevenson argues that the latter, the anticontagionists, probably were the inventors of real medical mapping as a consequence of the idea that somehow local conditions fostered the occurrence of disease.

Even though yellow fever brought about the earliest mapping of the incidence of disease, the maps didn't do much good; they merely illustrated a general thesis. Since no one had any notion of the key concept of the insect vector, as Stevenson points out, "preventive measures...made little headway. Men and mosquitoes buzzed." and mosquitoes and yellow fever flourished."

Many things start slowly, and it is quite possible that the early spot maps of yellow fever made in the late 18th and early 19th centuries in the United States influenced later investigators on the other side of the Atlantic. That seems doubtful, given the communications of the time, especially west to east, but in any case the beginning of medical mapping that was destined to have some lasting effect took place after the great outbreaks of cholera in the first half of the 19th century. In the fifteen or so years after the first pandemic of cholera in India in 1817 more than a dozen maps appeared. These were maps showing the movements or routes of the spread of the disease in various ways, and they really contributed little to any understanding of where or why the disease occurred. The only real generalization that can be made is Jarcho's observation "that the cartography of disease owes its genesis to the abrupt, terrifying challenge which epidemic outbreaks presented, whereas endemic diseases, more or less constantly active, offered no comparable stimulus to cartographic creativity."[6]

Beginning in the 1830's the combination of a more inquisitive medical profession, the rapid growth of cities with their absolutely appalling squalor and filth, and the arrival of cholera seem to have been the major factors causing an increase in both the quantity and quality of medical mapping. One notable fact is

that the early medical maps are essentially like those we make today. Cartographically simple flow maps that show movement or spread. Another, more complex group, includes a variety of maps that show the distribution either of individual cases or relative incidence. When mapped along with other environmental factors, such maps can be used to demonstrate a thesis, to suggest correlations, or to test hypotheses. In those instances the map serves as a basic investigative tool.

Some of the early medical mapping is truly impressive, considering the problems involved in obtaining data and the lack of well-known, sophisticated symbolic methods for portraying it. It demonstrates that what counts is the clarity of the objective and the use of the appropriate cartographic technique, not the methods for manipulating the data and plotting the map.

First, we shall consider some of the distribution maps which were made. It is difficult to generalize adequately about the range because detailed historical studies of this kind of thematic mapping are rare.[7] A great many of the maps are buried in official reports, and many were manuscripts which have since been lost.

When cholera invaded America and western Europe in the early 1830's, maps of its occurrence soon followed. Most of these were maps showing routes along which it spread or the general areas of occurrence, but some were more detailed, such as Rothenburg's choropleth map of the incidence of cholera in Hamburg in 1832. The cholera reached Britain in October of 1831 and during the next 30 years there were four epidemics accounting for nearly 150,000 deaths. Many maps were made showing the incidence of cholera by either shading or dots added to base maps that showed conditions of drainage, degrees of poverty, relative elevation, and so on, with the hope that the maps might suggest some correlations. Grainger's map of 1850 is in the general class simply showing occurrence of the disease, but another map in the same report of the General Board of Health is much more sophisticated.[8] It is a map of the east London Parish of Bethnal Green made by a Dr. Hector Gavin, and both the subtitle "...showing the cholera mist..." and the legend indicating the symbolism for sewers suggests the idea of some connection between the two.

Many such maps of urban areas were prepared during the several decades after 1830, some very elaborate and some very simple. One rather good one was prepared in 1844 by Dr. Perry, the Senior Physician to the Glasgow Royal Infirmary and appeared in a report entitled "Facts and Observations on the Sanitory State of Glasgow during the Last Year; with Statistical Tables of the Late Epidemic, Shewing the connection existing between Poverty, Disease and Crime."[9] It is unusual in one respect: the printing of the report and the coloring of the map was entirely done by the inmates of the Glasgow Lunatic Asylum.

Maps of the distribution of cholera on a smaller scale also appeared, the most notable being that of Great Britain made in 1852 by the great German cartographer August Petermann, who lived in Edinburgh and London from about 1845 to 1854. That lithographic map used the technique of variable shading to show differences in the incidence of the disease during the epidemics of the years 1831-1833.[10] On the map sheet Petermann included two insets, one being a detailed map of London which again showed the greater occurrence of cholera to have been in the less well drained, poorer, south eastern districts, similar to Grainger's and Gavin's maps. The other inset is a graph on which the frequency of cases is plotted against the months of the year, a result of a then current idea that there might be some relation between cholera and average temperatures.

An association between poverty, filth, and disease was evident even though no one knew precisely the nature of that connection. Nevertheless, it led to a whole series of what were called "sanitary maps" of cities. An early example is the "Sanitary Map of Dublin" which appeared in a special medical section of the official Census of Ireland for the Year 1841. The streets were colored and ranked as first, second, third class, and so on. The journalists had a field day in poking fun at the dire consequences to Dublin's society of such ill-advised official judgments. Later the sanitary maps became more sociologically oriented and incredibly detailed, such as the poverty maps of Booth on which some areas were classed as being inhabited by the "vicious, semi-criminal."[11]

Even the topographic surveyors and engineers of the Ordnance Survey were drawn into mapping for medical purposes. To simplify a very complex story, after 1840 the Public Health movement in Britain began to lobby for a series of very detailed maps of urban areas as one means of combating the growing incidence of disease, and this was greatly fostered by Chadwick's 1842 Report...on the Sanitory Condition of the Labouring Population of Great Britain. His second Report... in 1844 strongly urged that official mapping be pursued rather than having it done by private surveyors. As sometimes happens bureaucracy got a bit carried away, and the most elaborate plans were laid to satisfy the less than precisely expressed desires of the General Board of Health. Some very detailed manuscript maps were made, but because of high costs and controversy over who would pay the bill, the cities or the central government, few were ever printed. The conflict between central and local government interests, born of the need for medical support mapping had profound, long-term results for Ordnance Survey town mapping, but not in the direct field of medical cartography.[12]

If one focuses attention on the mapping of non-epidemic disease, we still find a great variety in this early period of the 1830's to the 1850's. One example of a map made in order to test hypotheses is the choropleth map made in 1840 by the French surgeon J.F. Malgaine to show the incidence of hernia.[13] He was concerned about the validity of several hypotheses, among which were a) that incidence of hernia tended to be high in valleys, b) that incidence of hernia was low where cider was the common drink instead of wine, and c) that ingestion of olive oil favored the development of hernia. His statistics came from military recruitment examination records for 1836 and 1837. The statistical-cartographic evidence required that all the hypotheses be discarded.

Another example of the attempts to associate the incidence of disability with environmental causes is a map prepared in 1843 by the Prussian cartographer E.H. Michaelis to show the ratio of cretins and deaf-mutes to the total population in relation to elevation and land cover in Canton Aargau in Switzerland.[14] The symbolism was quite complex, and the map not very successful. Incidentally, it is also interesting as one of the first maps to employ shaded contours.

Numerous other such maps must have been made and lie buried in the medical literature or may only have existed in manuscript. For example, there is an intriguing reference to a map by one Dr. Hubertz of Copenhagen who plotted on a geological map of Denmark the number of deranged persons per thousand total population.[15]

The name of Dr. John Snow is properly revered by both the medical profession and the cartographic profession, on the one hand, for his contention that polluted water was somehow a carrier of cholera and, on the other, for his sensible use of statistical-cartographic methods. Less dramatic than his well-known dot map is another of Dr. Snow's maps which is equally if not more interesting as an example of a medical-geographical study. They both appeared in the same report.[16] Prior to 1852 two London companies, the Southwark and Vauxhall Company and the Lambeth Company, both distributed domestic water to an area south of the Thames with supplies obtained from that heavily polluted river. The incidence of cholera was high. In 1852 the Lambeth Company changed to a source of supply relatively free of pollution. Dr. Snow determined to map the water distribution of the two companies in order to compare the rates of incidence of the disease. He had considerable difficulty because the inhabitants, mostly tenants, had no idea which company supplied their water. Dr. Snow solved the problem by laboriously analyzing the water from each household for its salinity, that coming from the Thames being considerably more saline. The resulting map and the tabulation of cholera cases from the two areas showed the area receiving water from the river to have a ratio of 71 cases of cholera per 1000 houses as opposed to only 5 in the other.

Probably the most famous early medical map is the dot map prepared by Dr. Snow, which has been often reproduced. Unlike other investigators, Snow used the dot technique to study the "topography of the outbreak" of cholera and concluded that that water from one particular public pump at the corner of Broad Street and Cambridge Street in London was the source of the cholera in that area. He persuaded the authorities to remove the handle of the pump and immediately the incidence of cholera dropped dramatically.

One can conclude briefly. The techniques of medical mapping include the entire repertoire of cartography. With modern automated equipment the maps that were so laboriously prepared more than a century ago can now be produced in a fraction of the time, but the essential problems have not changed. The display of distributions, the mapping of correlations, and the testing of hypotheses still require adequate data and especially a clear understanding of cartographic capabilities and limitations.

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12. The foregoing is based upon the paper by J.B. Harley, "Cartography and Politics in Nineteenth-Century England: The Case of the Ordnance Survey and the General Board of Health, 1848-1856," read at the VIII International Conference on the History of Cartography, Berlin, September 1979.

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* This presentation was accompanied by a set of illustrations (slides) which are incorporated in the text of:

Robinson, Arthur H. (forthcoming), Early Thematic Mapping in the History of Cartography, Dawson Publishing, Folkestone, Kent, England