MEDICAL MAPS

Some design suggestions for mapping Health/Disease Statistics

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1. Most medical cartography assumes the existence of administrative boundaries, with disease or mortality statistics relating to each administrative subdivision. The great majority of maps or atlases dealing with health or disease portray administrative units shaded or coloured to represent particular statistical patterns: these are sometimes subdivided to show cause of death, age, sex, etc. We commence by offering some criticisms of the use of area colourings for such maps.

a. The geography of any particular pattern of disease seems to demand qualification by making comparisons with other subjects, such as housing conditions or associated diseases, or by analysis in terms of age groups or of sex or of variations over time (whether in weeks or decades). Simple one-shot distribution maps of a disease (whether in terms of percentages or of absolute numbers) may be unconvincing to the epidemiologist without other associated evidence, which may itself vary from subject to subject.

b. This suggests that there is much to be said for the medical researcher interrogating disease patterns in a database fashion and on an ephemeral computer graphic basis rather than by concentrating on producing a massive stack of simple subject maps. Maps and statistics have much in common, both should be capable of being used both for presentation of fact and for analysis of problems.

c. It is difficult, we believe, to memorise the patterns of separate maps so as to make reliable or rapid comparisons of details. Of course, some patterns are self-evident at the sweep of the eye: but more are not. It is also true that, despite many obvious advantages of book or atlas format, serious comparisons of detail are not aided, e.g., with maps printed back to back. So the ability to handle several parameters on one map should make life easier for the user.

d. The shading or colouring of administrative units is apparently the common sense way of mapping data of this kind. It does, however, require that the medical or disease data be organised into a limited number of classes. Often seven categories are a maximum for effective legibility; occasionally this can be extended to ten. The selection of the step size for such class intervals is of great importance; but any class selection has at least some theoretical danger of detracting from the objectivity of the original statistics.

e. The geographical size of most administrative units varies, decreasing inversely with population. So colour discrimination tends to be especially difficult in highly populated urban areas, which are often of particular interest.

f. To obtain maximum discrimination between categories, maps of this kind often use saturated colours that in effect compete with and obscure any base map or supplementary pattern.

g. In terms of computer cartography the representation of colours or tints still remains relatively slow/expensive, especially where subtleties of colour in fine rulings are involved over small irregular polygons. (Note that sophisticated colour CRT displays and television Viewdata systems, e.g., the Canadian Telidon, may eventually mitigate this difficulty.) But it is also important that the medium should not dominate the message: even the availability of rapid colour displays does not of itself justify area colouring.

h. The dilemma of mapping different parameters at the same time can, of course, be met by treating the relationships between the parameters on a statistical basis initially, and mapping only the result of such combinations of parameters. Such a procedure, while obviously desirable for simple relations, e.g., incidence of a disease to population, can reach complexities that make the map little more than a minor adjunct or gloss to the statistics.

2. We believe there is a cartographic alternative to the use of area colourings or "jigsaw puzzle" type maps for presenting medical and social statistics, and that it lies in the ingenious use of what might be called "unconventional signs" such as windrose or clock symbols. Symbols of this genre have been used extensively and successfully by ECU in mapping Geochemistry; and in practice geologists have now found that they have been able to come to terms with what was initially an unfamiliar representation of precise quantities. We attempt below some assessment of the pros and cons of such symbols in medical and sociological mapping contexts, and we shall demonstrate this with some slides.

a. It is of the essence that each such symbol must, if it is to represent an area, be clearly read as standing unambiguously in that area. At the same time it may need to be able to extend well beyond the boundary of the area if the largeness of the quantity represented makes that desirable. And extension beyond the area may well involve competition with - "crossing swords with" - symbols in adjacent areas.

b. Symbols of this kind can represent quantities by direct scaling of the length of arm (on an arithmetical or logarithmic basis), so the need for class groupings can be mitigated.

c. On the other hand, a very high quantity represented, say, by a NW pointing arm in the top left hand corner of the map, may shoot through the map border and complicate the format. In other cases the choice of arm direction may be determined by a wish to set them at right angles to a coastline or some other predominant lineation of the base map. While symbols of this kind offer a great (30-40) range of choice of direction, they deserve some preliminary design consideration.

d. Complex symbols can be developed by the use of several arms from one centre, each, if necessary, with its own scale. Also by the use of different arm styles - e.g., different line thicknesses, pecking patterns, colours.

e. Because the arm symbols are economic of map space they can very effectively overlay other distributions that may be mapped in colour. This is illustrated in the geochemical atlases, where the windrose arms representing mineral concentrations overlie the geology and the basic topography.

f. Arms of this kind are quick to draw by computer, either as final reproduction material for flat bed plotters or in a more tentative and experimental way as interactive graphics on a cheap CRT display: colour is not essential.

g. The design of windrose symbols for statistical mapping demands that each arm has a well defined centre, such as an open circle, which lies accurately on the site. Where the direction of the arm is being used to provide classification, the use of site symbols effectively doubles the number of direction classifications that can be read from the map.

h. Unfamiliar symbols of this kind often suffer because they are unfamiliar to those users who expect from a map no more than an instant message. Our experience with these symbols over some five years seems to have convinced our geochemists of their legibility. But, more experience of the legibility of the method is clearly desirable in other fields. In comparison with the more traditional circles or segments of thematic cartography these radial arms offer a great graphic economy.

3. So much for cartographic assertions: let us now consider the use of such symbols for a particular data set on the Surveillance of infectious diseases.

The Office of Population Censuses and Surveys for England and Wales publishes a weekly Monitor which supplies much data about births and deaths (with causes) also about the notification of infectious diseases. This is supplemented by data about infectious diseases for each local authority and organised to show incidence in fortnightly periods over an 18-month time span. This Surveillance information is regularly presented by particular disease, e.g., Tuberculosis (Respiratory) for each disease a left hand column lists local authorities , while reported outbreaks of the disease are indicated by black dots in some 40 corresponding (fortnightly) time columns opposite the local authority name. Thus, while the pattern of the dots gives a time dimension, the absence of any map effectively deprives the data of any spatial dimension. The question arises as to how cartography can effectively represent both dimensions, and can, in addition, quantify them by mapping the actual numbers of notification per authority, per period, thereby suggesting some pattern of movement in the spread of an infectious disease. This appeared to be a subject of some interest to medical statisticians and an appropriate one for cartographic experiment.

Two alternative design solutions suggested themselves. Both were at the same scale and, of course, involved the representation of the relevant boundary lines. One design shaded the different areas using the angle and the closeness of shading to indicate the past duration of the epidemic. The other used windrose type symbols. It was clear that while symbols might lack in immediate impact, they were able to provide information about incidence of the disease for many more time periods than by shading, and that they could also quantify the numbers of cases reported at each period. The sketches below illustrate this. It should also be noted that cost of mapping such data by symbol was about half that of mapping by shading - and this was true whether the output was displayed on a CRT screen or prepared as hard copy (reproduced material) by a flat bed plotter. These seem real advantages in favour of symbol technique and seem at least to suggest that users might find the effort of accommodating themselves to a new cartographic technique paid off in terms both of the additional information which they could obtain and of a new capacity for analysis that such maps can begin to give.

[The simple sketches included in this paper will be supplemented by slides giving finished examples of computer-generated map symbols of this kind.]

4. This work has assumed the existence of digital data both for the disease statistics themselves and for the local authority boundaries. The means of linking these two data sets may well involve the use of a common centroid for each area in both data sets. In many countries much health/disease data is organised in just this form. At the same time it is important to emphasise that data e.g., from ad hoc surveys may not be collected in terms of administrative boundaries - and for good scientific or administrative reasons: in such cases both the locational and the statistical data may need converting to digital form before experiments with appropriate ways of mapping them by computer begin.

Design Sketch 1

Mapping statistics from
Surveillance: OPCS
Notification of Infectious Diseases

Sample disease, say: Tuberculosis (Respiratory)

1. Local authority and its centroid.
   Shown by small star and boundary.

2. Time periods - each of 2 weeks.
   Present time period is shown by thick vertical line.
   Preceding periods are in anti-clockwise sequence (7 arms have been displayed here, more could be added.)
3. Number of occurrences per local authority.
   Shown by arm lengths: scale 1mm per occurrence.

Sample based on Boroughs within London
Scale 1: 250K.

Design Sketch 2

Mapping statistics from
Surveillance: OPCS
Notification of Infectious Diseases

Sample disease, say: Tuberculosis (Respiratory)

1. Local authority shown by boundary.

2. Time periods - each of 2 weeks.
   Present time period is shown by heavy/vertical line shading.
   3 Preceding time periods are shown by progressively lighter line shadings each at selected angle.
   N.B. difficulty of heavy overlaps.

3. Number of occurrences - not shown.

   Sample based on Boroughs within London
   Scale 1:250K.