

Comparative studies across centres using data linkage

Michael Goldacre

Department of Public Health, University of Oxford

The aim of this note is to raise some possibilities for pooling linked data for international comparisons. There are a number of different levels at which this could be done, from the pooling of selected analyses as international reference tables (I will use the model of Cancer Incidence in Five Continents to illustrate an approach to pooling) to international collaborative research focused on specific topics and hypotheses. I will illustrate the suggestions for working methods with a few examples, to stimulate discussion.

Pooling of basic international reference tables: (1) hospital admission

One of the best examples of international pooling of epidemiological statistics is that of the cancer registries. Over a period of about 40 years, Cancer Incidence in Five Continents has published pooled data on age- and sex-specific incidence rates of all cancer sites from many centres across the world, see

<http://www.iarc.fr/en/Publications/PDFs-online/Cancer-Epidemiology/IARC-Scientific-Publication-No.-155>

As an illustration of international variation, data from the current edition show age-standardised breast cancer incidence rates of 25 per 100,000 women in Beijing, 29 in Delhi, 46 in Grenada in Spain, 85 in Oxford UK, and 104 in whites in Los Angeles; and they show age-standardised male colorectal cancer incidence rates of 5 in India, 15 in China, 28 in Spain, 33 in the UK, and 44 in Australia. Data from Cancer Incidence in Five Continents are available for use for international population-health monitoring, assessing the 'burden' of disease in different populations, and to contribute to epidemiological hypothesis-generating and hypothesis-testing.

International data on hospital admissions could be produced as age- and sex-specific rates and pooled. The contribution of linkage is to produce person-based admission rates, in addition to (or perhaps instead of) episode-based admission rates. In England, the Unit of Health-Care Epidemiology has linked English hospital data and, among other things, produced atlases of admission rates overall, for each age group, each clinical specialty, and a wide range of diagnoses and operations, see

<http://www.uhce.ox.ac.uk/Epidembase2/>

Many of these show wide geographical variation across England, but, generally, we do not know how much international variation there is, nor do we know whether the English rates are high or low by international comparison. As participants will know, the study of health-care variations within countries is almost as old as the collection of hospital statistics but there is still surprisingly little systematic, routine data comparing different countries.

The factors that influence variation include different rates of occurrence of disease, availability of services for treatment, clinical thresholds for admission, and so on, and comparisons of rates alone would not in themselves generally give insights into the reasons behind variations. Such comparisons would, however, have the potential to raise interesting questions and help formulate strategies for more 'in depth' study. A start could be to select diseases (or operations, or specialties) of interest to our different centres and to produce, and then pool, age-specific hospital admission rates.

Pooling of basic international reference tables: (2) hospital outcomes

Cancer registries also pool survival data. The English 'National Health Service Cancer Plan' heralded very substantial growth in expenditure on cancer services. The forward, signed by Prime Minister Tony Blair, specified that one major purpose of expansion was to ensure that "our five-year survival rates will compare with the best in Europe". Tony Blair (or his advisors) knew that survival rates for some cancers in England did not compare favourably with the best of Europe because of the evidence from international routinely pooled one- and five-year survival rates.

For outcomes of hospitalised care for non-malignant disease, we would probably be interested mainly in shorter-term survival: say, 30-day and 365-day fatality.

I will illustrate what I see as the potential value of this, drawing on examples with which I am familiar.

Using English national linkage, we studied 30-day fatality rates after elective operation for aortic abdominal aneurysm and compared our findings with the world literature (studies in the literature of various kinds, big and small). 30-day case-fatality in England was 6.8% - dauntingly high for an elective operation in people who may be asymptomatic - and was higher than the case-fatality rates in all but one of 66 published studies (*J Epidemiol Community Health* 2007, 61, 226-231). The labour of finding the studies, and the fact that there is no assurance that they were necessarily all comparable, suggests the value of routinely pooling data, with agreed definitions and methods, across centres to facilitate international comparisons.

In a linked study of mortality after fractured neck of femur, we reported that 30-day fatality rates (at over 10%) and 90-day fatality rates (over 20%) have not fallen for the past 20 years (*BMJ* 2003, 327, 1-5). We commented that we cannot judge whether, at these levels, fatality rates are at an irreducible minimum or whether further declines are possible. One way to judge would be to see, through the international pooling of data, whether better results are found elsewhere. We wrote: "We suggest that investigators with access to longstanding linked datasets in other countries might determine whether post-fracture mortality rates have levelled off in their countries in recent years."

In other studies we have found no decline in case fatality rates, over a 30-year period, after admission to hospital for meningococcal meningitis (rates 'stuck' at 9%, *BMJ* 2003, 327, 596-7); and no declines over 30 years in post-admission mortality for diabetes mellitus in children (*BMJ* 2004, 328, 741-2), acute pancreatitis (*BMJ* 2004, 328, 1466-69), or liver cirrhosis (*Gut* 2005, 54, 1615-21). We know what contemporary case-fatality rates are in England; but we do not routinely know how they compare with elsewhere.

A start could be to select certain diseases of interest to the centres and produce, and then pool, age-specific 30-day and 365-day case-fatality rates.

Analysing international linked data using standard 'networked' programs

An alternative (or complementary) approach to individual centres producing their own analyses, and pooling aggregated statistical results, is to develop the necessary programs in a single centre and 'network' them to others. This seemed to work well in the TECH collaboration on myocardial infarction and its treatment. Centres in 17 countries agreed to collaborate in a much more sophisticated comparative study than those envisaged above. In essence, the TECH coordinating centre distributed a protocol and a set of programs, developed by it, to each participating centre. The task for each participating centre was to organise its own dataset, extracted for myocardial infarction, into such a format that the networked programs would run (locally) on the data. The files of analysed results were then sent to the coordinating centre. This gave consistency of approach; it allowed data-sharing using analyses of individual patient-level data without the data leaving any of the individual centres (avoiding potential issues of confidentiality and security); and it allowed the use of analytical methods that were developed once for all to use (see *Technological change around the world: evidence from heart attack care*, Health Affairs, 2001, 20, 25-41; and Health Economics 2008, DOI10.1002/hec (currently online ahead of print)).

"Ad hoc" local analysis, for comparisons of results, according to agreed protocols

A further alternative, and perhaps the most obvious, is for centres to 'get together' on the basis of one-off studies, where there is interest in international comparisons of a topic of mutual interest. An example is the study of mortality after TURP and open prostatectomy using linked data from Oxford, Denmark and Manitoba (New England Journal of Medicine 1989, 320, 1120-24).

Comparable data for collaborative re-analysis; meta-analysis; repeat studies

Sometimes the decision to seek comparable data will be made well after early studies have been completed and published. For example, Beral et al re-analysed data from published studies on abortion and the long-term risk of breast cancer (Lancet 2004, 363, 250-255), well after some of the early record linkage studies had been published (including one from Oxford record linkage, J Epidemiol Community Health 2001, 55, 336-7). To aid comparability in pooled re-analyses, and in meta-analyses of linked data (eg Diabetologia, 2008, 726-731), it is obviously useful if the primary analyses are undertaken using similar approaches. This is a general reason for encouraging record linkage centres to discuss methodologies and study design, even if some do not necessarily intend at the time to do a similar study, in case they subsequently do!

Metadata

A related approach is for centres to develop work on metadata (data about data) and make it available to others. As a very simple example, in our English linked atlases for each diagnosis (web address above), we routinely specify in the atlas document (1) the precise version of the dataset used, (2) the diagnostic code or codes, (3) whether we analysed only those records with the code as the principal diagnosis, or whether at any diagnostic position on the record, (4) whether selection was qualified by the presence or absence of any other specified diagnosis or operation, (5) the date range for selecting admissions, (6) any selection or restriction by age or sex, (7) whether we selected all sources of admission, or just (say) emergency or elective admission, (8) how we handled successive admissions for the same disease in the same person - eg counting just the first in the year, as 'average annual' rates; counting just the first 'ever' admission; or, for myocardial infarction (as an example), discounting a new admission within 30 days of a previous one, but counting as a new 'attack' if more than 30 days had elapsed; and so on.

Different groups may have different ways of defining conditions that are problematic. For example, in studying fractured neck of femur, does one count ICD-10 S72.9 (fractured neck of femur, part unspecified) in people aged 65 and over as 'neck of femur' (as it is likely to be) or not? As another example, if we want to identify an operation done as an emergency (eg emergency Caesarian

section, or emergency colectomy for inflammatory bowel disease), do we identify it from an operation code that includes specification of 'elective' or 'emergency', or, less satisfactorily, do we have to use the operation code in combination with a 'mode of admission' code that specifies 'elective' or 'emergency'?

The English National Centre for Health Outcomes Development provides useful metadata for the specifications behind its health indicators, at

<http://www.nchod.nhs.uk/>

and no doubt there are other centres in other countries that do similar work. I am not aware of international collaborative studies on metadata and whether each (seemingly) similar disease, health condition or health indicator is defined in the same way across centres.

International annotated bibliography

I think that others may cover the possibility of compiling an international bibliography. This would be of great value, especially if it is to be comprehensive. In my view, in addition to the centres represented at the London meeting, this would at best include the Scandinavian countries and others. As one possible model, though covering a different topic, we have compiled a bibliography of the world literature (as best we could) on instruments used to assess patient-reported outcomes (PROMS), see

phi.uhce.ox.ac.uk/

It is intended to be key-word searchable and comprehensive.

As an annexe to this note, in case it aids the exchange of ideas at the London meeting, I have added an outline protocol on hospital statistics, with particular reference to uses of linked statistics, that I have singularly failed to persuade English funders to fund and have given up on!

Annexe: Bibliographic database of published uses of routine hospital statistics

Background

There is much interest currently, worldwide, in the use of routinely collected statistical data to monitor and investigate the health of the public and the use of health care. Although routine data in the British health service have been collected for many years – for example, routine hospital statistics - interest in their use has intensified recently. This is partly because of growing awareness of cost pressures in health care (and therefore awareness of the need to understand the inputs and outputs of the health care system); because of growing awareness of geographical variation in the delivery of health care; and because of increased and growing interest in the measurement of health outcomes. Interest in analysing routine health service data has also increased in recent years because of a growing recognition that use of such data can make important contributions to clinical audit and feedback to clinicians; and can make important contributions to public health and epidemiology.

Technical advances, too, have increased interest in health service and health statistics. The huge increase in affordable computing power means that far greater use can be made of data now than years ago. The advent of record linkage adds enormously to the value and versatility of such data. The development in England of a multi-billion pound project to computerise all patients' health records (Connecting for Health), and the potential for statistical and epidemiological studies that comes with it, has also fired the imagination of users of health statistics.

It may be tempting to think that little use has been made of routine health service data in the past, except in supporting local management with local statistics, and that in the next few years good ideas about important applications will need to be developed. It is true that in, many places in the past, uses have been modest. Overall, however, there is very substantial world literature of studies that have been based on routine hospital statistics (especially when enhanced by record linkage). For those becoming interested in the use of routine statistics locally, there is much to be learnt from what has already been done nationally and internationally.

Papers and reports that have used such statistics are not necessarily easy to find simply by searching on key phrases (such as 'hospital statistics', 'record linkage') because, typically, the title and abstract of such studies cover the topic and the substantive findings rather than the details of the sources of data used in the methods. Some will have come from centres or countries that have, over many

years, developed work programmes that focus on uses of routine data - these include, for example, Rochester (Minnesota), Manitoba, Oxford, Scotland, Western Australia, Sweden, Denmark, Holland, Finland and Norway. Many other examples will have come from departments or individuals who have undertaken work on routine statistics as one-off studies in the course of their other health service or research work.

Aim

The aim of this proposal is to compile an annotated bibliography of the world literature on uses of linked administrative health data. Its objectives are:

- To inform about types of uses and about specific individual uses, studies, reports and findings.
- To make information about individual studies accessible by key words that include cataloguing by type of application (eg resource allocation, service management, health outcomes, epidemiology, public health, clinical audit, feedback to patients); cataloguing by disease, operation, or other clinical characteristics; cataloguing by type of service or client group (eg neurology; care of the elderly; neonatal care).
- To annotate the references, giving a brief paragraph about each. A key purpose of this is to encourage people, becoming interested in a field of investigation, to see what has been done in the same field, where, by whom, and with what results.
- To inspire: to encourage people, interested in a particular topic area, to think "That's very interesting. Perhaps we should investigate that here."

Outline of resources

Such a project should aim to cover the literature comprehensively. Part of its value would be in the range of applications it identifies and documents. The database should be electronic, user-friendly in its search facilities, and available to all via the web. It is proposed that a small team for such a project should comprise, at minimum, two literature researchers and a webmaster, over a three year period.