The N-condition problem in healthcare

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The more medical conditions you have, how are your health prospects affected? People do get described as frail, but the notion cuts across medical paradigm.

Conventional medical science starts from conditions regarded and treated separately, with some known particular connections (such as A can lead to B). Here we seek to quantify more general propositions such as whether carrying N conditions makes you more vulnerable to developing one more, and so on.

At the empirical level, the General Practice Research Database is a key asset. Through Warwick Medical School we have both a limited sample (ca 5000 patients) and the possibility of access to the full dataset (several million patients). The database includes conditions (by code) and their seriousness (in terms of priority for the patient), consultations and prescriptions, all with dates. At the level of this miniproject we aim to just work with these as codes rather than getting into their medical interpretation.

On the theoretical side, one aim is to construct Markov chains modelling the observed transition rates in the data, between states identified in terms of each or combinations of:

- number of conditions,
- number of prescriptions or other treatments,
- number of consultations.

If it is not practicable to derive the number of concurrent conditions or treatments, then we can work in terms of cumulative number ever suffered. There are further twists, such as the need to add to the set of states: new entrant (to the datset), leaver (from the dataset), and deceased.

The linear Markov chain $0 \to 1 \to 2 \to 3 \to ..$ should be straightforward to build from observed transition rates, and to check for its prediction of the population dynamics. More challenging is to address emerging limitations - for example if the speed for an individual to progress from N to $N+1$ significantly correlates with their speed for $N-1$to N then the Markov model needs augmenting with a direct $N-1 \to N+1$ transition to capture that. We might need to build a more fully history-dependent model.

The GPRD data itself is amenable to processing with Microsoft Acccess or other SQL software, leading to numerical tables which can be analysed with computational tools of choice.

The project outcome might be interpreted as a Model of Frailty. With a modicum of success, there should be excellent prospects of developing the work further in to a full PhD project. The idea is quite generic - in areas where reductionist approaches have been taken we can now use the era of mass data to look for less specific more aggregated trends. One can also pursue the direct health applications - both in terms of healthcare prioritisation and also in terms of drill-down to expose the medical underpinning of what has been detected at aggregate level.

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