


Previous issues at <http://www2.wmin.ac.uk/coiec/nosokinetics.htm>

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Modelling Change: Caveat Emptor; Buyer Beware

The present UK hospital planning cycle generates a lot of heat, but little light. Constant change is the order of the day. The planning model now being used, seeks to solve the problem of bed availability in acute hospitals by preventing social admissions and early transfer of patients to alternative accommodation at St. Elsewhere’s or in local authority purchased residential or nursing home care.

Models are only as good as the theory on which they are based. Seeking to understand probability theory I came across Roy Weatherhood’s criticism of “a priori models”.



‘If I am interested in the probability that it will rain tomorrow (h), and I choose to evaluate it on the basis of evidence (e) that the Premier of China loves eggs, Carnap’s system will (ideally) give me a definitive number for c(he). If I choose to act on the value, I will break no formal rules of inductive logic, but I will be acting rather foolishly.’¹

The world population is ageing: like it or not, older people will not go away. Consider the cost per individual placed in long-term care below, and the flaw in the current model becomes clear.

1. The quote comes from Weatherford, R. (1982). *Philosophical Foundations of Probability Theory*. RKP, London p 110. Rudolf Carnap (1891-1970) extended John Maynard Keynes (1883-1946) approach to *a priori* theories of probability.

A framework for predicting gross institutional long-term care costs from known commitments at local authority level. Pelletier, C., Chausalet, T. & Xie, H. (2005). *JORS* 56, 144-152.

[Thierry Chausalet’s](#) group has developed a generic model for predicting the committed long-term care cost for current residents. Using data provided by the Social Service Department of the London Borough of Merton, the survival model estimates, on a seven year horizon, that residential care costs £56,000 per person placed and nursing home care costs £42,000, i.e. residential care costs 33% more.

In London (2001 data) the gross weekly cost of residential care was £364 a week, nursing home £511. On April 1st 2001, Merton had 372 older people in care: 217 residential, 155 in nursing. Over a seven-year horizon the total committed cost of care for this cohort is £24 million (se £1.04 million.). In [“Penny Wise, Pound Foolish”](#) the significance of these findings is discussed.

A user interface is being developed with [Peter Crowther](#) in the Social Services and Housing Department of the London Borough of Merton. For the mathematics underpinning the model see:

Xie, H., Chausalet, T. J. & Millard, P. H. (2005). A continuous-time Markov model for the length of stay of elderly people in institutional long-term care. *Journal of the Royal Statistical Society Series A: Statistics in Society* 168, 51-61.

Gips, Mips and Metaclinicians. [Dr Derek Meyer](#), Senior Lecturer, Information Resource Strategy, Harrow Campus, University of Westminster, London UK

Gips, Mips and Metaclinicians: the longer-term effect of Healthcare Informatics on clinical practice and education.

Predicting the effect of computers on clinical medicine has a long and dishonourable history. In the 1970s, Stanford's MYCIN project focussed the power of Artificial Intelligence on clinical medicine. This and other work on decision-support technology, was widely cited and appeared to deliver good results but had no lasting influence on the medical profession.

MYCIN advised physicians on the diagnosis of brain and spinal cord infections and listed antibiotics for treatment.

Since then Information and Communication Technology (ICT) has transformed the practice of architecture, journalism and banking, among others, but has had little effect on clinical medicine. From a pure informatics perspective, clinical medicine is the application of proven treatments to described conditions.

This is analogous to believing that an orchestra is a means of giving sound to the composer's score. This logic implies that computer programs capable of reading music will revolutionise classical music.

Extrapolating from what has already occurred may give a better indication of what will happen in the future than assuming that, because something is technologically possible and sociologically desirable, the detail of implementation will take care of itself. Three developments will have a major role in redefining clinical medicine.

1. The internet and the dissemination of medical knowledge.

It is still too early to assess the impact the internet will have, but it is already apparent that the dissemination of medical knowledge is a double-edged sword. On the one hand, it allows patients to take a more active and constructive part in the management of their own treatment, which is particularly advantageous in chronic diseases. On the other hand, some patients are becoming less compliant and utilising more clinical time to discuss inappropriate or unproven treatments. These two situations require different responses and different terminology. The term Expert Patient refers to the former, while the latter is an example of Google-Informed Patient Syndrome (GIPS).

**GIPS:
Google-Informed
Patient Syndrome**

2. The ubiquity of information technology.

Processing power (often measured in million instructions per second, or MIPS) and data storage capacity has grown exponentially for a generation. At the same time, computer applications have increased in complexity and consumed more computer resource, however there is evidence that this will not continue for much longer. So without a corresponding growth in demand, processing power and data storage will become so cheap as to effectively be free.

**MIPS:
Million Instructions
Per Second**

As electronic health records become widely used, a huge amount of clinically significant data will be collected. Medical knowledge has been obtained using sampling techniques and randomised control trials, though with vast amounts of data available, much more rapid, accurate and detailed Total Population Studies (TPS) may soon supersede these. This will lead to an explosion in the amount of clinical research available. (continued page 3)

GIPS, MIPS and Metaphysicians (continued from page 2)

When diagnoses are recorded in centralised electronic patient record systems, epidemics could be monitored in real-time and rapid interventions considered. It will also be possible to measure the quality of the traditional clinical skills of history taking and physical examination. This may allow professional proficiency to be formally recognised and may reverse the decline in emphasis given to these skills in undergraduate education.

3. Practitioner's need for knowledge

Primary medical research is published and analysed by academic specialists, who disseminate the knowledge through secondary research, teaching, conference presentations and textbooks. This process takes time. Soon, non-academic practitioners will face both supply-side and demand-side pressure. For the explosion in the amount of clinical research available will create a huge supply, and the internet will make this directly available to patients. Who will demand a response from their doctor, before the relevance of the new information can be digested and disseminated through traditional channels.

So a more focussed approach to the evaluation and dissemination of new research may be needed, based not on the interests of leading academics but on providing practitioners with the knowledge tools needed to manage the expectations of the patients in the waiting room. To some extent the UK's National Institute for Clinical Excellence (NICE) is doing this. However, a new kind of specialist physician may emerge, who constantly evaluates clinical practice and, in conjunction with colleagues, develops guidelines for other clinicians it follow. Well, a metaphysician means something completely different, but perhaps such a role will come to be called that of a metaclinician.

**Metaclinician:
A new kind of
specialist who
evaluates clinical
practice and
develops guidelines.**

Intelligent Technologies for Medical Tutoring

Professor [Salem Abdel-Badeeh M](#) Faculty of Computer & Information Sciences, Ain Shams University, Cairo, Egypt writes:



Editor: Artificial Intelligence based educational software can adjust its tutorial to the student's knowledge, experience, strengths, and weakness, and may be able to carry on a natural language dialogue. Automatic generation of exercises and tests is an important feature of Intelligent Teaching Systems.

The benefits are clear. Students can receive training at their own site, instructors can monitor progress from a distance and course authors can maintain and update training material across the Internet. However, they are complex to build and to maintain and face knowledge-acquisition difficulty. Furthermore, their efficiency is determined by the efficiency of their knowledge representation techniques and reasoning methodologies.

Case-based reasoning (CBR) provides both a methodology for problem solving and a cognitive model of people. CBR means reasoning from experiences or "old cases" in an effort to solve problems, critique solutions, and explain anomalous situations.

Ac = Lv: how does that help me? Peter Millard

Carl Long writes: OK. The fundamental equation is $Ac = Lv$, how does that help me? In our patch we do not have long stay hospital beds, only nursing home beds, and access to these is via social services unless private funding is available. In reconfiguration discussions there is talk of us having sub-acute step down beds and rehabilitation beds. Indeed, chaos theory may be more applicable to our situation!

Good point. Where should I begin? Before we get to chaos theory let us first consult the Oracle. Figure 1 illustrates two options for change: working harder and working smarter. Notice that, both options 2 and 3 achieve the same thing, they increase turnover to three events per line.

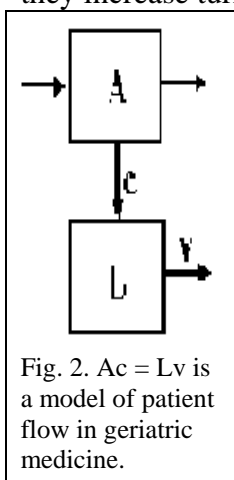


Fig. 2. $Ac = Lv$ is a model of patient flow in geriatric medicine.

Model 2 is not unlike your problem. Everyone is working harder, but the bed crisis doesn't go away. My understanding of the equations that underpin the mathematical solution¹ to Figure 2 is a little bit of patients moves in a little bit of time.

When hospital beds are full, new patients can only get a bed if other patient leaves. Like UK trains, however, patients do not always depart when they are expected to.

Consulting the oracle: changing lines

Average 2 events per line	Average 3 events per line	Average 3 events per line
1. Current status	2. Working harder	3. Working smarter

Fig 1. Six line hexagrams are the fundamental building block of the Chinese Book of Changes¹: six lines, either continuous — or split — —, give 64 options for change. Here we use the concept to illustrate a basic premise of the behavioural theory of change.

¹ The I Ching or book of changes. Richard Wilhelm translation. 1951 Routledge, Kegan & Paul, London.

Most medical patients leave in hours or days; they are the 'movers' (M). However, a few remain because they have complex illnesses or the consultant feels they need rehabilitation or alternative social placement; they are the 'stayers' (S). The benefit of having a method of analysing current bed usage, and an explanatory mathematical solution to the model, is that managers and clinicians can describe what is happening and pre-test the immediate and long-term impact of changes in bed allocation and patient management.

Perhaps it would be clearer, therefore, if I changed the basic equation for our discussion from $Ac = Lv$ to $Mc = Sv$. For the letters "A" and "L" imply structure and beds, but we are actually modelling how groups of patients move through beds in time.

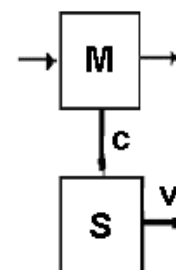


Fig 3. $Mc = Sv$

Look back at the three six line models in Figure 1. Standard hospital returns, report clinical events in allocated beds. There are twelve events in model 1 and 18 events in models 2 and 3. Clearly, models 2 and 3 achieve have different internal processes, yet using standard hospital returns clinicians and managers cannot demonstrate that.

Mathematically and clinically there are several plausible explanations for the problem you now face. Working harder may have changed clinical and nursing practice so the number of patients needing alternative placement and rehabilitation has increased. Alternatively, the case mix on entry may have changed, with more dependent patients being admitted due to closure of alternative admission services elsewhere. Or, something outside the system has changed the outflow (v) from your acute medical wards. Only by analysing the data could one actually tell.

What's in a day? Determining intensive care unit length of stay.

Marik, P. E. and L. Hedman (2000). *Critical Care Medicine* 28(6): 2090-3.

Length of stay (LOS) was calculated using four common methods: a) number of calendar days (LOS-calendar); b) midnight bed-occupancy days (LOS-midnight); c) exact LOS calculated in hours divided by 24 (LOS-exact); and d) the method described by [Pollack and Ruttimann](#) (LOS-Pollack). There was a poor correlation among the LOS-exact, log LOS-exact, LOS-exact of survivors, and LOS-exact below upper 95th percentile with the APACHE II and APACHE III scores: these scores are predictive of outcome, but should not be used to predict or adjust for LOS. Furthermore, because the LOS distribution is highly skewed, the geometric mean and median should be reported.

Patients are a virtue: get them if you can

An article in a [Baltimore business journal](#) describes how appointing hospitalists and software investment for bed availability shortened A&E waiting time and increased admissions by 7%.

Using industrial processes to improve patient care

Young, T., S. Brailsford, et al. (2004). *British Medical Journal* 328: 162-164.

Describes three established industrial approaches—lean thinking, theory of constraints and six sigma, and explores how the concepts underlying each might relate to health care.

Shipman's statistical legacy

Spiegelhalter, D. and N. Best (2004). *Significance* 1(March): 10-12.

Reviews statistical aspects of Shipman murders: 215 confirmed, 45 probable. Concludes, if we are not careful, even individuals whose performance is entirely as expected will eventually look odd, just by chance. Risk adjusted cumulative sum" (CUSUM) Alarm thresholds balance the probabilities of false and successful detection of a single GP over time. Theoretically, Shipman could have been detected in 1985 at the 65th death", but deaths by GPs are not collected. Methods are simply a "screening tool", indicating the need for further investigation.

An overview of heuristic solution methods.

Silver, E. A. (2004). *Journal of the Operational Research Society* 55: 936-956.

Written for operational researchers and managers interested in the use of mathematical models to aid decision making. Given a mathematical representation of a perceived problem, the paper focuses on the different ways that models can be used to find a solution. Each method discussed is referenced and guidelines are given.

Good news: Thanks to Andy Cowper, Editor of the British Journal of Health Care Management, four explanatory papers are on the [website](#).**[Health care modelling - why should we try?](#)**

Ivatts, S. and P. Millard (2002). *British Journal of Health Care Management* 8(6): 212-216.

[Health care modelling: opening the 'black-box'.](#)

Ivatts, S. and P. Millard (2002). *British Journal of Health Care Management* 8(7): 251-255.

[Mathematical modelling: how and why](#)

Harrison, G., P. Millard, et al. (2003). *British Journal of Health Care Management* 9(4): 144-150.

Local authority fines: [penny wise, pound foolish](#). Millard, P. (2004)." *British Journal of Health Care Management* 10(12): 366-370.

Forthcoming conferences: also see <http://www2.wmin.ac.uk/coiec/nosokinetics.htm>

Young OR, Bath? April 4th to 6th, 2005:

Further details or abstract submission contact [Adele Marshall](#) or submit at [Website](#)

25th Applied Statistics in Ireland Conference, Enniskillen, 18th-20th May 2005.

Abstracts due 31st March 2005. Contact [Adele Marshall](#)

IFORS Hawaii? July 11-15, 2005: [Website](#)

The First East European Conference on Health Care Modelling and Computation (HCMC 2005) Craiova, ROMANIA , 31 August to 2nd of September 2005

paper submission deadline 10 May Website <http://farmath.umfcv.ro/hcmc2005/dates.html>

OR Society Conference, University College Chester, 13th - 15th September 2005.

Papers would be most welcome for the Health Stream. Please send titles and abstracts to either Chris Sherlaw-Johnson (c.sherlaw-johnson@ucl.ac.uk) or Gillian Mould (g.i.mould@stir.ac.uk)

Factors influencing hospital length of stay of elderly patients with stroke illness.

Erich Teichmann MSC project.

Note the influence of seven day and fourteen day discharges of non-emergency admissions on the pattern of length of stay: holiday beds?

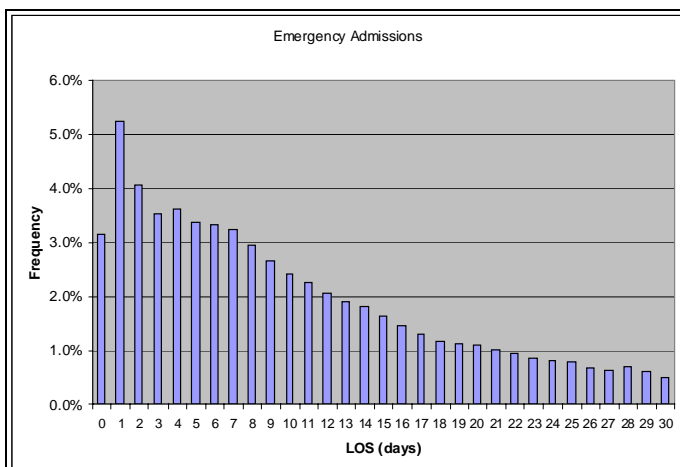


Figure 1. Length of stay distribution of emergency admission stroke patients aged 65 and over in English National HES database 1994 data . Occupancy time censored at 30 days.

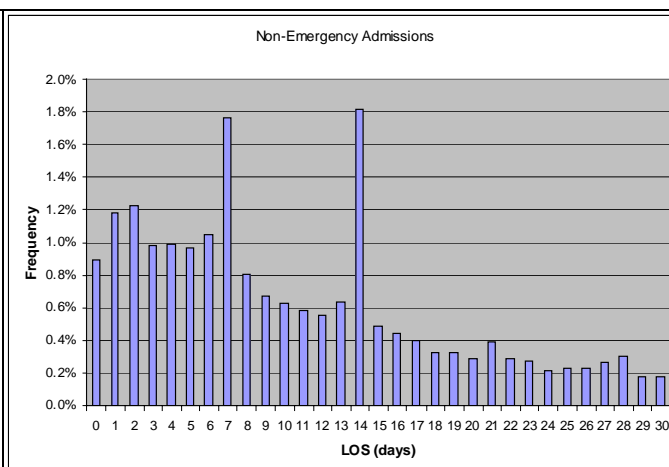


Figure 2. Length of stay distribution of non-emergency admission stroke patients aged 65 and over in English National HES database 1994 data. Occupancy time censored at 30 days.

Thank you for your continued support. Contributions welcome. Especially leads to articles and papers.

The next newsletter will come out in April. In the April issue, Chooi Lee uses flow models to explain how government changed the hospitals in the National Health Service from a hospital based total care, sickness and dependency, service, to an acute illness service. [Editor: Prof Peter H Millard](#)

For earlier editions <http://www2.wmin.ac.uk/coiec/nosokinetics.htm>