Issue 1.6

Nosokinetics News

Modelling time in health care systems

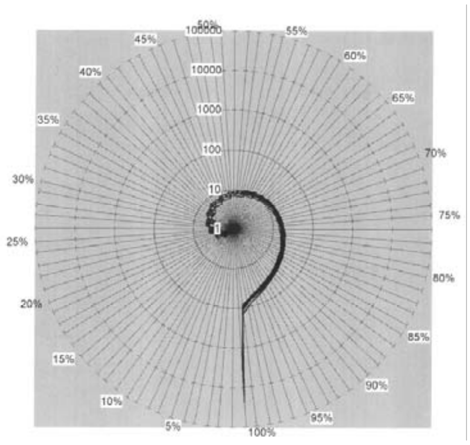
December 2004

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

In this issue

Building a better world

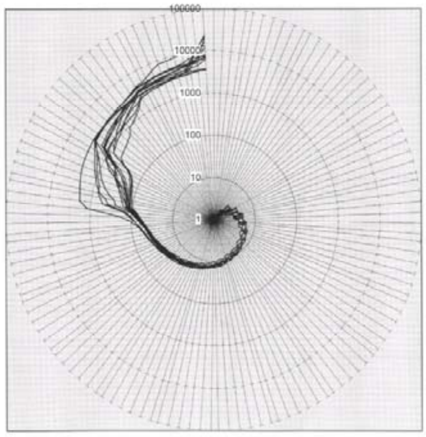
What's this?



As it's the last month of the year and the festive season will soon be upon us I thought I would give you a quiz. There's only one question and the answer is on page six.

What does it say? Where could it have come from? How was it made?

We have much to celebrate, thanks to you all we now reach over 500 people world wide.



Here's a clue.

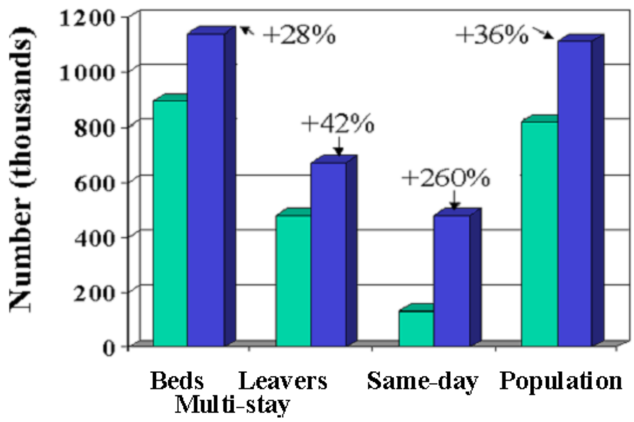
Depends on how you see it.

A recent paper in the Australian Medical Journal concludes, using bed usage per thousand, that ageing of the population between 1993 and 2002 was not associated with an increase in the proportion of hospital beds used by older patients. Indeed, in relation to the population aged 75 and over bed utilisation declined by 10%.

Figure 1 paints a different picture of bed usage. The problem arises, because beds per thousand of the population masks the trends in total bed days or separations and does not address the issue of supply. These issues have important ramifications for policy decision-making.

Gray LC, Yeo MA et al (2004) MJA;181: 478-481

Australian data 1993-94 to 2001-02 : 75 and over hospital bed usage and population change



Data Source: Australian Institute of Health and Welfare

For copy, comments, contributions mailto:phmillard@tiscali.co.uk?subject=Nosokinetics News

Modelling long-term care placement: 86% success using a computational evolutionary heuristic

Ruxandra Gorunescu, University of Craiova, Romania

Learning Classifier Systems is a sub-area of Symbolic Empirical Learning which considers the rules that underpin decision-making as IF-THEN rules. The aim is to create rules from a training data set, which make correct decisions in another data set. Given a set of training events, evolutionary computational heuristics are able to produce the classification rules. Expert opinion is an important starting step.

We applied a Genetic Chromodynamic approach to placement data from the Social Service Department of the London Borough of Merton. Starting rules: independent, continent, self-feeding to residential care, dependent, incontinent, needs feeding to nursing care. Initial computational results were encouraging and indicate the suitability of applying evolutionary algorithms to patient classification.

Prior Evolutionary Computing Approaches to Learning Classifier Systems		2000 Genetic Chromodynamics as a multi-modal engine (D. Dumitrescu, 2000)
Michigan Approach 1978	**Pittsburgh Approach 1980**	Maintains multiple solutions in a multiple sub-populations environment.
A chromosome is a rule. The entire population represents the rule set.	A chromosome is an entire rule set.	Forms and maintains subpopulations, of an arbitrary structure, that co-evolve and lead, at convergence, each to an optimum
The last population gives the correct rule set.	The best chromosome gives the correct rule set.	Uses a variable sized population and a stepping-stone search mechanism in connection with a local interaction principle
Standard evolutionary heuristics are doubled by a credit assignment system as a multi-modal engine.	Standard evolutionary heuristics may be used.	Crossover and mutation are exclusive operators when applied to the same chromosome. It introduces a new operator for the merging of very similar chromosomes.

Overall, 86.4% were correctly placed: four were incorrectly placed and ten were not placed.

Table 1. Comparison of actual and modelled placement decisions

Decision of Merton Social Service Panel		Placement made by the Evolutionary Model: Correct	Incorrect	Not placed
Residential Home	(39)	35 (89.7%)	0	4 (10.2%)
Nursing Home	(51)	43 (84.3%)	3 (5.9%)	5 (9.8%)
Nursing Long Stay	(13)	11 (84.6%)	1 (7.7%)	1 (7.7%)
Overall	(103)	89 (86.4%)	4 (3.9%)	10 (9.7%)

Possibly more of the same data would improve the results. Alternatively, and more likely, other facts concerning the clients or the hidden behaviour of the decision makers are needed to match the decision making of the panel. For some of the decisions made seem to break the panel guidelines and rules.

Reference: Dumitrescu, D., "Genetic Algorithms and Evolution Strategies", Blue Publishing House, Cluj - Napoca, 2000

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Using Ogive Plots to display occupancy statistics: Mark Mackay

In previous editions of Nosokinetic News, the issue of length of stay data being skewed has been raised. This article continues the theme of looking at how data may be displayed. On this occasion, one method of illustrating bed occupancy data will be described.

Ogive plots display cumulative frequency distributions. Figure 1. This example shows the number of beds occupied in an acute hospital on an average day and the number of beds occupied for x or more days. Using a discharge data set, and EXCELL 365 bed census days were used to create the average day.

This is the pattern of bed occupancy that we would find if we walked round the acute wards on one day collecting the dates of admission of all inpatients. Of course, dependent on the time of day the total beds occupied would change: more at midday, less at midnight.

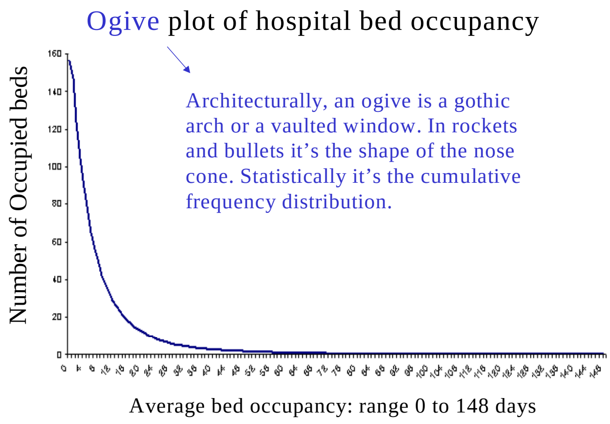

Figure 1: A cumulative frequency graph. Here the cumulative frequency represents the average number of beds occupied for x or more days. This is known as a "descending" or "more than ogive".

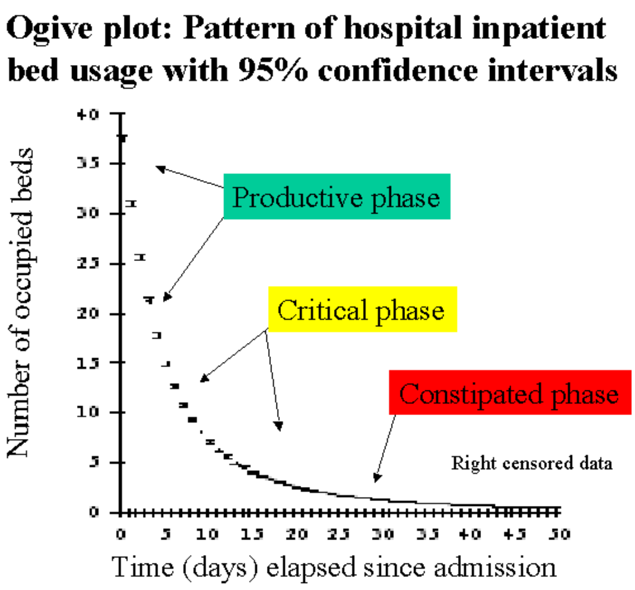

Figure 2: The inclusion of confidence intervals shows the extent of variation around each point in the cumulative frequency distribution (note a different data set).

The addition of confidence intervals provides some degree of indication of the variability around the profile. NB the line was dropped to show the confidence intervals.

The advantage of using this type of illustrative technique is twofold. First, an appreciation of the number of beds required for patients with particular periods of stay can be gained. Secondly, given data sets, where the admission and discharge times are recorded, then these graphs can be constructed for particular times of day and can be used to profile occupancy at the busiest time of day (see Mackay and Gorunescu, 2001). Thus overcoming the problem with the average daily length of stay statistic, which provides information but no knowledge about bed occupancy at differing times during the day.

Suggested additional information:Kirk RE (1990). Statistics: An Introduction. Holt Rinehart and Winston, Inc. Florida USA)Kohler, H (1984). Statistics for business and economics. Scott Foreman and Company. United States of America.Mackay, M and Gorunescu, F (2001). Midnight Bed Census, Patient Length Of Stay And Bed Occupancy Modelling. Proceedings of the 10th International Symposium on Applied Stochastic Models and Data Analysis, Vol 2 pages 711-717.

Editor's comment I couldn't resist putting in the traffic light colours. The words were first used in 1981 in a paper given at the Spring meeting of the British Geriatrics Society by Charles Huthwaite, the research assistant who showed me my first bed census plot.

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How can modelling help me? Peter Millard

Carl Long asked, “How can modelling help me?” That’s a good question. You’re a geriatrician. Conceptually, the basic idea is simple.

The first equation I heard from Gary Harrison in 1989 (Ac = Lv) neatly summarises the work of a consultant in geriatric medicine(Harrison and Millard 1991). A is the number of patients in short stay beds, L the number in long term beds; c the rate of conversion from short stay to long stay and v the discharge rate (death rate) in long stay care.

Given a constant bed allocation:

- If Ac = Lv the balance of short and long stay patients does not change (model 1).
- When Ac > Lv the number of beds needed for long-stay care increases and the beds available for short stay care decreases (model 4).
- Vice versa, if Ac < Lv the beds for short stay care increase and long stay beds decreases (model 7).

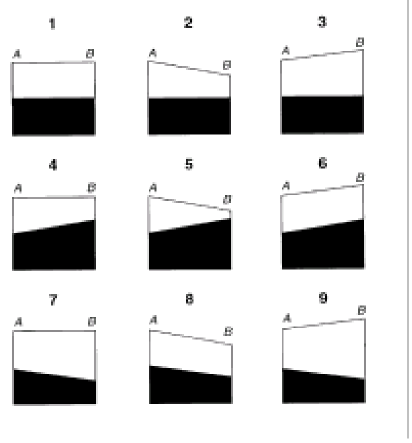


Figure 1. Nine options for change in bed allocation and use. Moving from time A to time B, the overall bed allocation is the same in models 1, 4 and 7, decreases in 2, 5 and 8 and increases in 3, 6 and 9.

Model 7, control of the interface is the secret of successful geriatric medicine (Exton-Smith 1962).

The world population is ageing. Clearly, the best option is number 9: increase the bed stock and control admission to long-term care. The worst is 5. It may not help Carl to know it, but that’s the problem that he faces.

Incidentally, adding rehabilitation (intermediate care) adds another factor to the equation. The stable state equation becomes

$$Ac - Rd = Lv.$$

Furthermore, rehabilitation at the interface between acute and long-stay care develops a new product, namely, potential long-stay patients with sleeping out passes but that’s another story.

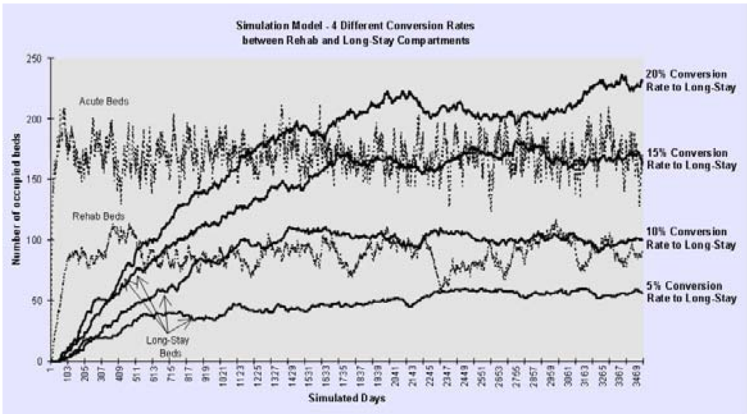


Figure 2. Simulation model showing the impact on long-stay patient numbers of four different conversion rates – 5%, 10%, 15%, 20% - between rehabilitation and long-stay.

Furthermore, bear in mind, as Figure 2, from Issue 1.2 shows, the results of ElDarzi and Vasilakis (1998) research that it takes five to six years for a system providing acute, rehabilitation and long stay care to reach stable state. So rehabilitation is not a quick fix.

References:

El-Darzi, E., C. Vasilakis, et al. (1998). "A simulation modelling approach to evaluating length of stay, occupancy, emptiness and bed-blocking in a hospital geriatric department." Health Care Management Science **1**: 143-149.

Exton-Smith, A. N. (1962). "Progressive patient care in geriatrics." Lancet **i**: 260-263.

Harrison, G. W. and P. H. Millard (1991). "Balancing acute and long-term care: the mathematics of throughput in departments of geriatric medicine." Methods of Information in Medicine 30(3): 221-8.

USEFUL SITE: Data Warehouse on Trends in Health and Aging www.cdc.gov/nchs/agingact.htm

Silver, E. A. (2004). An overview of heuristic solution methods. JORS; 55: 936-956

Written for operational researchers and managers interested in the use of mathematical models to aid decision-making 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..

Harper, P. R. and M. A. Pitt (2004). On the challenges of healthcare modelling and a proposed project life cycle for successful implementation. JORS; 55: 657-661.

The size, complexity, interactivity and continuous dynamism of healthcare represents a particular challenge for modellers who seek to develop workable abstractions of underlying systems. Organisational and strategic changes should not be considered in isolation, as changes in one part of the system can have adverse effect elsewhere. Based on their experience a 13-point project life cycle is proposed, beginning with a steering group and ending with promotion of the results. The paper ends with a plea for the greater dissemination of successful projects to a wider audience.

Good news

'MASHNET' - A new network for modelling and simulation in healthcare

The EPSRC has awarded a three year grant of £60K to fund 'Mashnet'. Starting in early 2005, Mashnet aims to bring together the three communities of health services, academic research and industry to establish a common framework of communication within and between these domains, to promote more successful research and implementation. For further information contact Dr Martin Pitt, decision analyst and health modeller, at the Peninsula Technology Assessment Group based in the new Peninsula Medical School in Exeter.

Primary Prevention in older people works

A meta-analysis of 19 randomised trials indicates that preventive primary care outreach interventions to older people reduces the risk of dying by 17% and increases the likelihood of living in the community by 23%. The trials are a mixed bag, but the findings support the concept that early intervention, when dependency changes, is beneficial. Yet, a surprising conclusion is that admissions to hospital do not increase. This is contrary to

Flying against the hype; disease management, quality costs

"Better management, improves quality and save costs". Going against the stream, a study of disease management (1996-2002) of four diseases in Kaiser Permanete showed that improving quality increased the costs. The authors conclude that the causal pathway -from improved care to reduced morbidity to cost savings - has not produced sufficient savings to offset the rising costs

Fireman, B., J. Bartlett, et al. (2004). "Can disease management reduce health care costs?" Health Affairs 23(69): 63-75.

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

IFORS Hawaii? July 11-15, 2005: Website

We have been invited to contribute a health stream session: contact Peter Millard

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

For further details or abstract submission please contact Adele Marshall or submit at Website

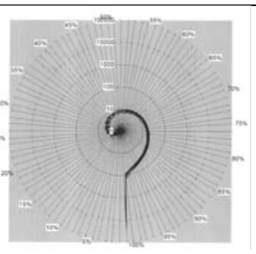
25th Applied Statistics in Ireland Conference, Enniskillen, 18th-20th May 2005.

Abstracts due 31st March 2005. Contact Adele Marshall

British Nosokinetics Group

On 4th November 2004, at Westminster University, the British Nosokinetics Group was founded. Chairman; Prof Sally McClean; Secretary, Dr Adele Marshall; Conferences, Dr Elia ElDarzi; President; Prof Peter Millard.

What is it?



It's a circular logarithmic plot of the percentile distribution of length of stay at discharge of patients aged 65 and over in English National Health Service Hospitals: 1994 data. Damian Kearney created the plot in 1997 when he was my research assistant. It beautifully shows the problem that we seek to solve and explains why a single number, the average length of stay at discharge, cannot possibly represent the reality of modern hospital care.

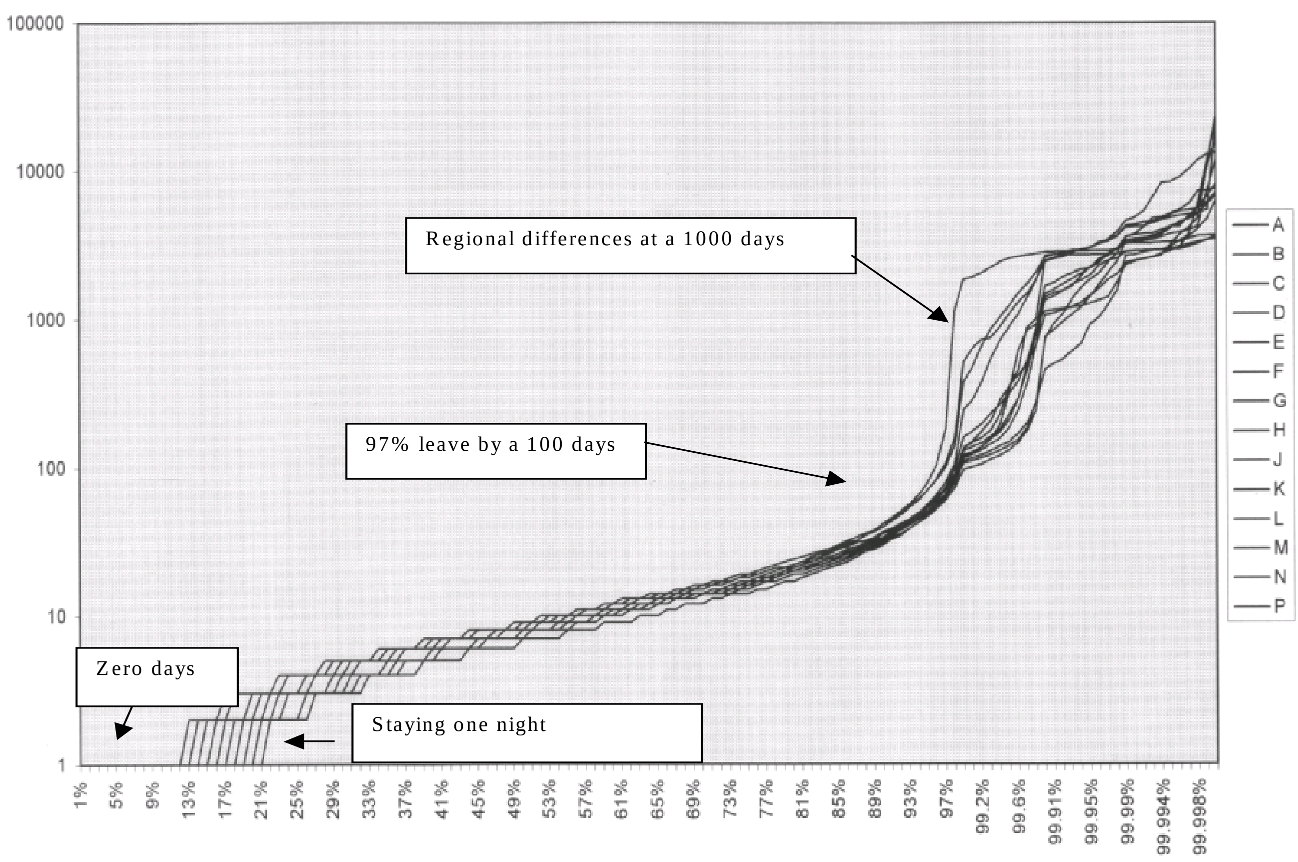


Figure 3 Logarithmic plot of the percentile distribution of length of stay at discharge of patients aged 65 and over in 15 English Health Districts

Epilogue: Thank you for your support during 1994. The Nosokinetics Group wishes you all the best for a Happy and successful 2005. For earlier editions http://www2.wmin.ac.uk/coiec/nosokinetics.htm
The next newsletter will come out in February. Editor: Prof Peter H Millard