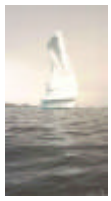
Nosokinetics News

Issue 1.2 (no-so-ki-net-ics) April 2004

In this issue

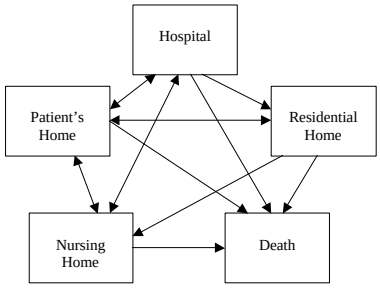


Targeting Care: faster care is better care. Or is it?

Throughout the world constant downward pressure is being placed on hospital managers and staff to speed up inpatient care. Resources are finite and demand is infinite; the faster the better is the order of the day. Or is it? At the Salford conference Brendon Rae, from Dunedin Hospital in New Zealand reported that bed closure was his reward for fast-tracking acute medical care.

I used to think that the purpose of the golf swing was to hit the ball. Peter Ballingall, a teaching golf professional, opened my eyes when he said "The purpose of the golf swing is to move a stationary object (the ball) from one place on the golf course where it can be easily hit to another place where it can easily be hit." Similarly in health and social care.

All parts of the total system of care must work well if the demand for long-term care is to be controlled. Gina Christodoulou, and Damayanthi Kuhanendra, a medical student developed the target.[1]



Clinically and mathematically, the key to the control of resources in acute care lies at the interface between rehabilitation and long term care. Sally McClean developed the semi-Markov model of movement of older people through the total system of care. Her early research into movers and stayers in employment underpins the development of Markov models of flow. The nosokinetics challenge is to develop a model that describes the total system of care.

Australian Developments: Terry Mills (La Trobe University) Reports

In Bendigo, Victoria, a multidisciplinary team - three mathematicians, a computer scientist, a director of nursing, and Mark Mackay (Adelaide) - are trying to model patient flow in an entire hospital using compartmental modelling techniques. Once substantial progress is made, the team would be very interested in collaborating with people in other parts of the world.

State governments are planning to spend large amounts of money on health information systems and related matters. A front-page article in the Australian Financial Review on 13 April 2004 highlights the reasoning behind this development. Perhaps international collaboration would improve the possibility of getting research funding for these projects on patient flow modelling.

[1] Millard PH, Christodoulou G, Kuhanendran D. Targeting the priorities of health and social care for an ageing population. *CME Journal Geriatric Medicine* 2000;2(3):119-121.

Overview of Mathematical Models in the Australian Mathematical Society Gazette[2]

Peter Goddard and Terry Mills, from La Trobe University, Bendigo, provide an overview of ways in which mathematics is being used to improve understanding of congestion in hospitals. The paper contains no new models; rather it is an expository paper.

The problems caused by congestion in Melbourne Hospitals are described and a mathematical solution to Bagust et al's 1999 paper[3] is presented. Figure 1 shows the relationship found between bed occupancy and bed crises: the code written in C is available from the authors.

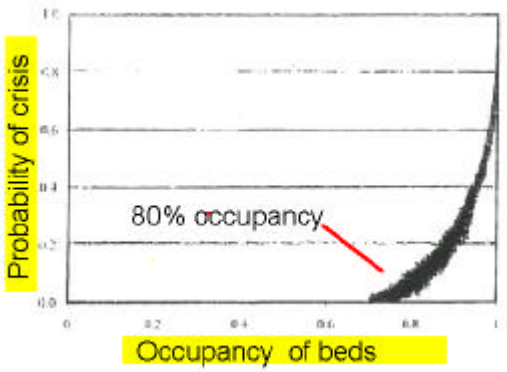


Figure 1, Probability that a day is a crisis day as estimated by simulation

Next the problem of queues for surgery and transplants are discussed and Gary Harrison's mathematical solution to the two-compartment model of flow[4] is considered as an exemplar (Figure 2). Finally, the need for more transparency and accountability in a sector spending $13 billion a year is considered and the authors conclude: This sounds like opportunities for mathematicians.'

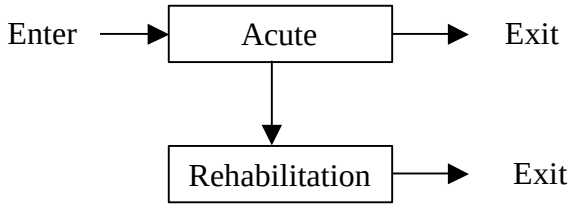


Figure 2. Two compartmental model of flow

Further Information: t.mills@bendigo.latrobe.edu.au or p.goddard@latrobe.edu.au

Addressing bed costs for the elderly

Adele Marshall and Sally McClean have developed a conditional phase-type model that has the potential to be used for considering the costs where different costs are attached to the various phases or subgroups and the anticipated cost of care is estimated in advance. Using a database from a UK department of geriatric medicine with 4772 patient records a strong relationship was found between Barthel Grade (a measure of dependency), patient outcome and length of stay showing various groups of patient behaviour.

The paper describes a methodology that uses Bayesian Belief networks and Coxian phase-type distributions to form the conditional phase-type (C-Ph) to model patient duration of stay in hospital. The patients whose final outcome is transfer consume the largest amount of hospital resources. However, not all patients who stay a long-time are transferred, the model identifies a small amount of non-transfer patients who spend a considerable time in phase 2 of their hospital stay distribution. These patients are characterised as being 'heavily' dependent leaving hospital by death or discharge home and 'slightly dependent, discharged home.
Further information from a.h.marshall@Queens-Belfast.AC.UK

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[2] Goddard PW, Mills TM. Models of congestion in hospitals. *The Australian Mathematical Society Gazette* 2003;30(3):127-141.
[3] Bagust A, Place M, Posnett JW. Dynamics of bed use in accommodating emergency admissions: stochastic simulation model. British Medical Journal 1999;319:155-158
[4] Harrison GW, Millard PH. Balancing acute and long-term care: the mathematics of throughput in departments of geriatric medicine. Methods of Information in Medicine 1991;30(3):221-8.

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Simulating the flow of patients: an OLAP- enabled decision support network

Dr Christos Vasilakis PhD, University of Westminster. Email: C.M.Vas@westminster.ac.uk

Chris's early research developed a simulation model that explains why prolonged rehabilitation has an important place in the control of long-stay bed numbers. Figure 1 shows:

- The rapid rise and random fluctuation in need for acute beds.
- The slower rise and random fluctuation in rehabilitation beds.

The six-year delay before policies relating to admissions from rehabilitation to long-term care take their effect.

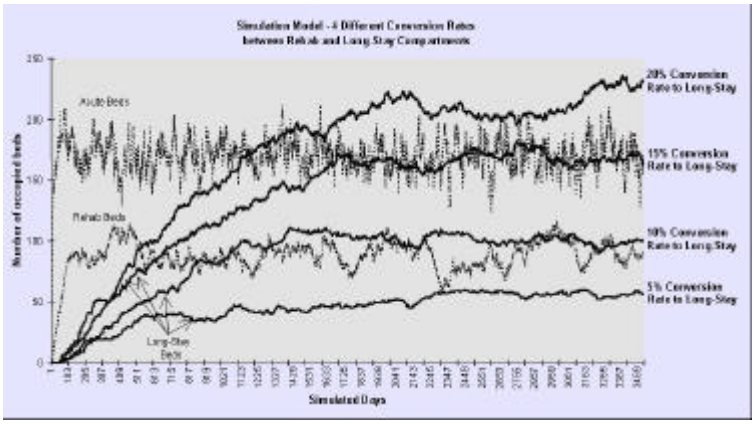

Figure 1. Simulation model showing the impact on long-stay patient numbers of four different conversion rates – 5%, 10%, 15%, 20% - between rehabilitation and long-stay. [5]

Recognising the need for data to speak for itself, Chris's PhD research simplified the whole process of data analysis in large data sets. Figure 2 shows the star schema he developed. Figure 3 uses the star schema to show the impact of public holidays on admission and discharge of stroke patients.

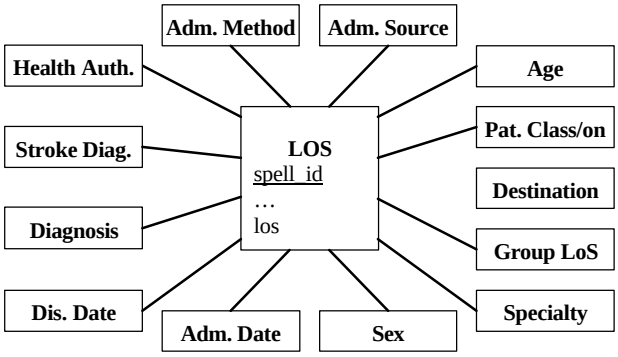

Figure 2. Star schema for stroke data set. By putting length of stay and patient ID in the centre of the schema and creating data cubes for other variables the whole process of data analysis is simplified.[2]

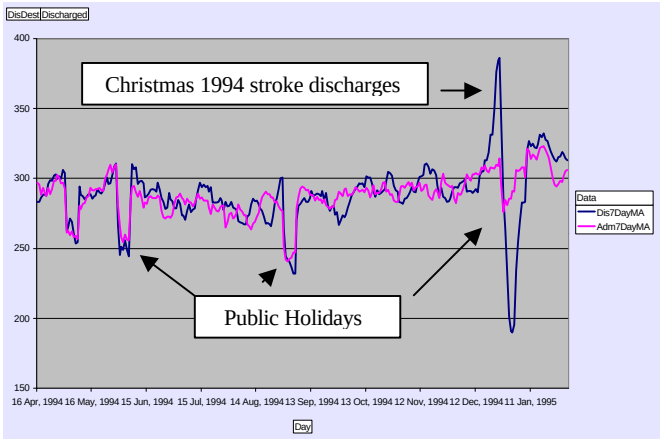

Figure 3. Seven day moving average of stroke admissions and discharges in 1994 from English Hospitals.[6]

The proposed framework incorporates discrete event simulation modelling and data warehousing techniques into a decision support framework for modelling the flow of patients through hospitals and health care systems. The framework can be easily applied to model different levels of health care operations e.g. Figure 4. The scalability makes the framework unique in its kind. One of the benefits being that processes that took days now take minutes.

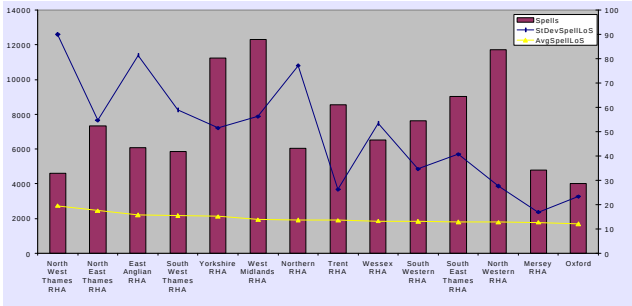

Figure 4 Regional differences in stroke discharges (red), average stay (yellow) and standard deviation (blue).[2]

[5] El-Darzi E, Vasilakis C, et al. *Health Care Management Science* 1998;1:143-149.

[6] Vasilakis C, ElDarzi, E and Chountas P. 2004 An OLAP-enabled environment for modelling patient flow. *Journal of Computational Methods in Science and Engineering* (forthcoming).PhD thesis, University of Westminster

Correspondence: "Any system must be a whole system".

Stephen Aitken. Managing Director TheStrateg-e Ltd. www.theStrateg-e.com

For reasons of cost and effective management any model has to have boundaries, so there will always be real world entities and events outside the model, possibly in other models. Nosokinetics group might support a framework where different models can interact with each other with standards set for defined interfaces and definitions e.g. get primary care models linking with various secondary specialisms, plus social services, police etc. where relevant.

The analogy with the car is stronger, if you see the car as a means of transport and examine the maintenance scheduling, accidents etc. Manufacturing the car is the birth. It then requires maintenance and repair if in an accident. Some cars are born with defects. New car models introduce new technologies and methods of repair and maintenance, as do the advances in medicine. At the end the car parts are recycled – organ donors.

Birkbeck College Technical Report:

Age and condition dependent treatment rate for analysis of base -line bed provision.

Kevin Davis and Boris Mirkin. Contact KDavis5908@aol.com

Data from a UK Regional Health Authority is analysed using single and two piecewise exponential length of stay models that fit the data very well. A formula is developed that represents theoretical values of the number of baseline beds required to accommodate inpatients with a condition classification modelled by the treatment rate.

Correlations are condition specific, and the analysis shows that for each ten-year increase in inpatient age the expected mean length of stay increases by 0.63 days. The dependence of the proposed lengths of stay are robust. And the authors propose a condition based value-added performance measure has similarities to performance measures used in education.

Discharge planning from hospital to home.

Shepperd S, Parkes J, et al Cochrane Database Syst Rev. 2004. ;(1):CD000313

The impact of discharge planning on readmission rates, hospital length of stay, health outcomes and cost is uncertain. This reflects a lack of power as the degree to which the authors could pool data, which was restricted by the different reported measures of outcome. They conclude, possibly even a small reduction in length of stay, or readmission rate, could have an impact on the timeliness of subsequent admissions where there is a shortage of acute hospital beds.

The many faces of access: reasons for medically non-urgent emergency department visits.

Guttman, et al. Journal of Health, Politics, Policy and Law 2003;28(6):1089-1120.

Investigating why people use hospital emergency departments for non-urgent medical matters can enhance understanding of people's expectations of health care services, of their conceptions of prudent lay judgement and of difficulties in negotiating primary care services. This study concludes that the concerns that influence people's decision to attend the emergency room cannot be solved by expanding primary care services or by educational interventions. Its application yields recommendations for services and interventions.

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Successful Salford conference. 31st March – 2nd April 2004

Fifty-one people attended the Fourth IMA Conference on Quantitative Modelling in the Management of Health Care. First prize for longest distance travel, 32 and a ½ hours goes to Dr. Brendon Rae from Dunedin in New Zealand. Mark Mackay and Chris Bain came from Australia; Gary Harrison from Charleston, South Carolina, America; Lucia Barroso and Valerie Baltar from Brazil, via Spain; Henrik Støvring from Denmark; and Ludwig Kuntz from Germany. The prize for contributing to our joys is a special mention in this newsletter.

Four lectures by Steve Gallivan, from CORU at UCL, on Performance Measurement; Sheila Dixon from the Department of Health on the NHS Episode Statistics Database; Eric Wolstenholme from Cognitus, UK on Systems Dynamics in Health Care; and Terry Young from Brunel University on the place of industrial management techniques in health care and thirty short papers gave a feast of knowledge. Special thanks go to Lucy Nye from the IMA for arrangements and to Rose Baker Sally Brailsford, Thierry Chaussalet and Margaret-Mary Nelson for the academic program.

Forthcoming conferences

Applied mathematical programming and modelling conference APMOD2004
June 20 – 23, 2004. Brunel University, London, UK. http://www.apmod.org.uk
Papers presented in the health care modelling and optimisation stream will be considered for publication in a special issue on "Health Care Modelling and Optimisation" of the Computational Management Science Journal published by Springer. Contact eldarze@westminster.ac.uk

The European Conference on Combinatorial Optimization, ECCO 2004
June 24-26, 2004 American University, Beirut, Lebanon Lebanon. http://www.ecco2004.org
Theme: New Opportunities for Management Sciences and Information Technologies.
Elia El-Darzi is organising a session on Health Care Modelling eldarze@westminster.ac.uk

OR46 Health Stream - Annual Conference of Operational Research Society
York, UK, September 7-9th 2004. Details web site http://theorsociety.com/
Paul Harper, University of Southampton P.R.Harper@maths.soton.ac.uk and Martin Pitt, University of Exeter M.Pitt@exeter.ac.uk are organising the Health Stream.

Nosokinetics no longer a 'Google' whack

Thanks to Chris Vasilakis the first news letter is on the web and nosokinetics is now a Google hit. Visit www2.wmin.ac.uk/coiec/**nosokinetics**.htm you will find a photo of collaborators present at the Salford conference.

Nosokinetics is the mathematics of flow through health and social care systems. Nosokinetics News seeks to bridge the gap between academe and practice in health and social care. The newsletter is circulated bi-monthly free of charge. To be added to the mailing list contact Peter Millard phmillard@tiscali.co.uk

The next newsletter will be circulated in mid-June. Contributions, comments, feedback welcome. You may circulate the newsletter in photocopy or electronic form without permission, however, if cited the source must be acknowledged.