

## A new dawn

This issue heralds a new beginning: not only the BMJ can change its image. Joining and leaving the mailing list has been simplified. Publishing software is now used to create the Newsletter. A new feature 'PhD research in progress' begins in this issue. During the year we also intend to make changes in the newsletter content and to further develop the [www.nosokinetics.org](http://www.nosokinetics.org) website. The main focus in this newsletter is on the seven articles in the February issue of Australian Health Review from the Adelaide 2006 conference.



## Adelaide 2006 papers in Australian Health Review

Dr Sandra Leggat, Editor of the Australian Health Review writes:

*'AHR is pleased to introduce "nosokinetics", the science of measuring and modelling patient flow through health and social care systems. This science was new to me and may be new to many AHR readers. The editorial by Peter Millard and Mark Mackay which outlines this relatively new science convinced me of its applicability to the health system. Please see the diverse collection of conference papers in this section.'*

### What do the papers say?

- The use and misuse of probability theory in clinical practice: risk assessment is poor.
- Hospital avoidance and discharge programs: customer satisfaction, but little evidence.
- Bed closure - bed crisis. Reengineering - bed emptiness. Bed closure - bed crisis.
- Using simulation to design a podiatry service: spin-off benefit, it clarifies the rules.
- Much activity in developing predictive tools, but a framework is needed to evaluate results.
- Time series analysis forecasts emergency department presentations.
- Modelling the four phases in geriatric medical care: slow stream rehabilitation revealed.

## The mailing list

### Joining, leaving or changing your email address on our mailing list

Nosokinetics News is mailed bi-monthly using the academic JISCmail to members, supporters and friends of the UK Nosokinetics Group. To join, leave or change your email address, visit the following web page

<http://www.jiscmail.ac.uk/lists/NOSOKINETICS-NEWSLETTER.html>

then follow the instructions to join or leave. The only information needed is your email address and your name. To change your email address, leave the list and then rejoin with your new address. Your changes made will be acknowledged automatically.

### Security

The Nosokinetics-Newsletter mailing list is only used by the list moderators to send email. The current moderators are Haifeng Xie at the University of Westminster (taking care the maintenance of the list) and Peter Millard, the editor of Nosokinetics News. They are the only people who have access to the names, and email addresses of recipients.

### JISCmail

JISCmail is the UK Academic Mailing list. All messages we sent using JISCmail are returned to us for confirmation before they can be sent. All mail is scanned for viruses and access to the mailing list can only be made by the moderators.

### Feed back and contributions

Thank you for your support. Any email that you receive from us through JISCmail will always have a return email address either to Haifeng Xie or to Peter Millard. Feedback, contributions and ideas are always welcome.

## A Method for Determining an Emergency Readmission Time Window

Eren Demir, PhD student, HSCMG, , University of Westminster. Email: demirer@wmin.ac.uk

The National Health Service defines readmission (based on expert opinion) as an emergency admission to the same hospital within 28 days following discharge (Healthcare Commission, 2005). Due to lack of consensus in defining readmission time interval, we develop a modelling approach in determining an appropriate time window, within which an admission is classified as a readmission.

### Modelling Framework

The population of patients discharged from hospital to the community can be divided generally into two groups, namely, one of patients at “high risk” of readmission denoted as ( $c_1$ ), and the other of patients at “low risk” of readmission ( $c_2$ ) (Figure 1). However, for each patient, we observe the time between successive hospital admissions (time to admission) and do not know which group the patient belongs to. Therefore, the random variable time to admission (denoted by  $x$ ) can be expressed to follow a mixture distribution with probability density function (pdf), where  $p$  is the probability of a patient being in group  $c_1$ ,  $f_1(x)$  and  $f_2(x)$  are the pdf of time

$$f(x) = pf_1(x) + (1 - p)f_2(x)$$

to admission for group  $c_1$  and group  $c_2$  respectively.

### Results

Using the hospital episodes statistics dataset from 1997 to 2004, we focused our study on chronic obstructive pulmonary disease (COPD), one of the leading causes of readmission. The mean time spent in the high risk and low risk group is 25 and 171 days respectively. The estimated probability of a patient being in group  $c_1$  is 0.26 and the cut-off time, where the two curves intersect,  $x$ , is 26 days (Figure 2).

We further estimated time window for 5 strategic health authorities in London, which clearly shows that there is a marked difference among the regions.

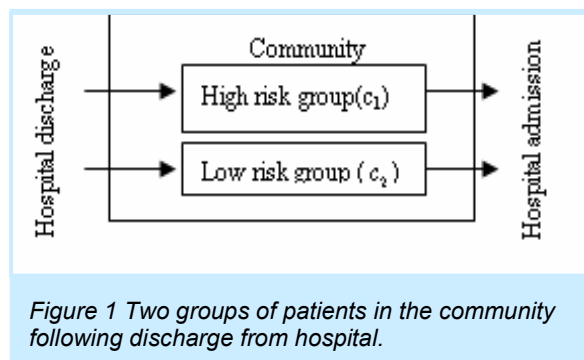


Figure 1 Two groups of patients in the community following discharge from hospital.

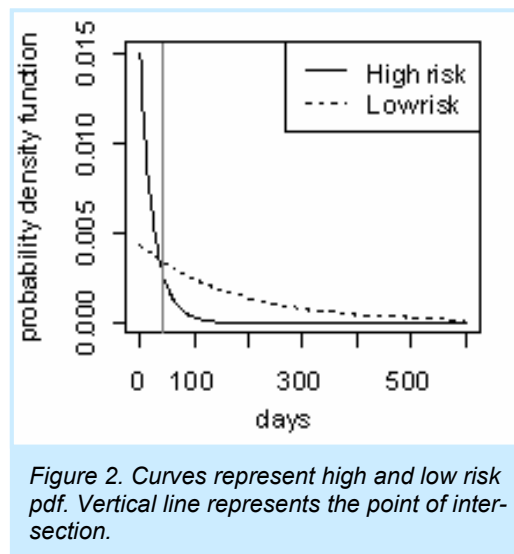


Figure 2. Curves represent high and low risk pdf. Vertical line represents the point of intersection.

Table 1. Optimal time window for the 5 strategic health authorities and probability of being in high or low risk of readmission

Strategic Health Authority	Optimal time window (days)	Probability of belonging to high risk group
North East	31.8	0.302
North Central	28.2	0.278
North West	28.8	0.288
South East	26.9	0.271
South West	18.7	0.212

Demir, E., Chausaulet, T., Xie, H., and Millard, P. (2006). A method for determining an emergency readmission time window for better patient management. In *Proceedings of the 19th IEEE Symposium on Computer-Based Medical Systems*, pp 789-793.

## Seven papers from Adelaide 2006 in the February Issue of the Australian Health Review

**R**isk management. "Implications of conflicting definitions of probability to health risk communication: a case study of familial cancer and genetic counselling."

Kieran O'Doherty, from the School of Psychology at Adelaide University, takes a close look at the concept of probability and its use in health science - and finds it wanting. Doctoral research into genetic counselling for possible cases of familial cancer, found that risk was being discussed in four different ways: measuring risk, reducing risk, detecting the disease and optimising treatment. Despite the wide spread use of probabilistic reasoning in health sciences, few users are aware of the widespread debate in philosophy and statistics about what probability actually is. His scholarly paper calls for a deeper engagement with the ways in which probability and risk are understood in health research and practice.

*Aust Health Rev 2007: 31(1): 24-33*

**H**ospital avoidance "A synthesis of the secondary literature on effectiveness of hospital avoidance and discharge programs."

Hospital avoidance and discharge programs are in vogue, but the evidence base is unclear. Searching 17 electronic databases, Saravana Kumar and Karen Grimmer-Somers from the Centre for Allied Health Evidence at the University of Adelaide, had more than 800,000 hits. Over half, 55%, came from the UK, emphasising the NHS modernisation strategy of social admission avoidance and early discharge.

Pitfalls in these studies mean the results may not be applicable in Australia. Overall, in terms of principles of best practice 48 studies met strict criteria of safety (69%), effectiveness (96%), timeliness (25%), equity (23%), efficiency (96%) and patient-centeredness (79%). Generally, the efficiency of hospital avoidance and discharge programs was equivocal. There was encouraging evidence regarding improved patient-centred outcomes with most hospital avoidance and discharge planning interventions. However, lack of evidence of cost effectiveness was particularly noticeable.

*Aust Health Rev 2007: 31(1): 34-49*

**F**ast-tracking. "Fast-tracking acute hospital care — from bed crisis to bed crisis."

Brendon Rae and Wendy Busby, senior physicians in internal medicine and geriatrics at Dunedin Hospital, New Zealand & Peter Millard, from UK describe the changing fortunes of an acute medical service.

Cash limits; bed closure: bed crisis. Delayed discharge project; care process reengineering, daily consultant led ward rounds and closer cooperation with geriatric medicine solved the first bed crisis. Average length of stay dropped by 2.6 days (6.5 to 3.9), readmission rates did not rise, costs of service delivery dropped by \$2.4 million, patient admission numbers increased by 145 (2445 to 2590), while bed numbers reduced from 56 to 32 and ward outliers all but disappeared, suggesting success.

However, 2 years later the new system crashed as a result of additional bed closures and organisational restructures. The inter-quartile range and destination at discharge show that the two stream - recovery and rehabilitation - acute medical service changed into a one stream service with a constant form of discharge behaviour. Thereafter, changes made out with the control of the acute physicians crashed the process of care.

*Aust Health Rev 2007: 31(1): 50-62*

**S**imulating clinical services. "Designing a podiatry service to meet the needs of the population: a service simulation."

What has happened in the past often determines what will happen in the future. Here Jackie Campbell, Research Co-ordinator for the Society of Chiropodists and Professor of Neuro-Physiology at the University of Northampton describes a different approach.

Given simple audit data on podiatric pathologies presenting for treatment, the model quantifies the effects of a range of different service considerations, such as staffing levels and seniority, on the number of patients treated, discharged and waiting. The simulation model demonstrates the importance of understanding the relationship between staffing levels, duration of treatments and the ability to provide acute care.

The process of designing the model has also had spin-off benefits for the participants in making explicit many of the implicit rules used in managing their services. An interesting finding is that increasing patient throughput after a temporary staff reduction is to the detriment of non-urgent chronic conditions.

*Aust Health Rev 2007: 31(1): 63-72*

**P**roviding clarity. "A framework to provide clarity in the use of predictive technologies in health care management."

Christopher Bain, Group Leader, and Management Information systems and Modelling Group. Melbourne Health and Leon Au, Research Fellow, Dept of Mathematics and Statistics report a survey of health care managers and other stakeholders to determine the need for a framework.

Predictive technologies enable an insight into, or measurement of, events yet to occur. The IT community stresses the need for standards; the health care community needs a framework if the advances in science are to be practically applied. Classifying the problems confronting managers, and the tools and techniques that could be used would be of mutual benefit to health care managers, technologists and modellers.

Twenty percent (64) of stakeholders with live email addresses responded: 53% worked in hospitals. 97% indicated that a framework would be possibly or very useful. A low level of background knowledge in relation to existing tools, techniques and technologies was found. Their draft framework includes dimensions relating to problem and tool definitions, scenarios to be investigated and the findings of those investigations.

*Aust Health Rev 2007: 31(1): 73–82*

**F**orecasting need. "Forecasting emergency department presentations."

A team of nine researchers, eight in Melbourne and one in Washington, USA, led by Robert Champion and Terry Mills at the Department of Mathematics and Statistics at La Trobe University, Bendigo, involving the School of Nursing and Bendigo Health underpin this evaluation into the use of time series to forecast attendance at the emergency department of a hospital in regional Victoria.

Time series analysis are widely used in business, but rarely use in health care. Data used were the monthly number of presentations to the emergency department between 2000-2005. Comparing exponential and Box-Jenkins models, a simple seasonal exponential smoothing model provided optimal forecasting performance. The first five months in 2006 compare well with the observed attendance data.

Although every hospital is unique, the approach and lessons from this experience may assist other hospitals and emergency departments to conduct their own analysis to aid planning.

*Aust Health Rev 2007: 31(1): 83–90*

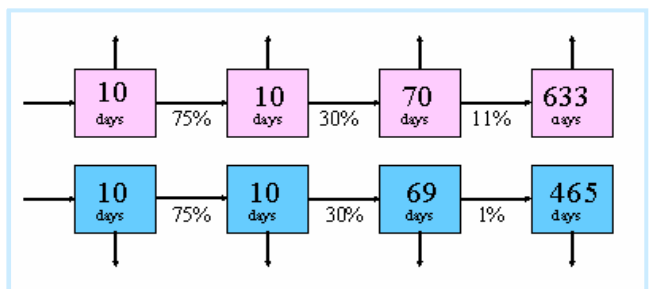
**M**odelling phased of care. "Using a multi-state model to enhance understanding of geriatric patient care."

Malcolm Faddy, from Queensland University of Technology, and Sally McClean from the University of Ulster collaborate to gain unique insights into the process of geriatric medical care. For fifteen years, little by little and step-by-step Sally has been analysing Millard's 16 year s data set. The mathematics is complex, professorial level. Bear in mind, Sally McClean's aphorism "For every mathematical equation in a paper one loses 50% of the readers" and look at the results.

Note that differences in the duration of stay of 70 year old male and female patients only begin in the third and fourth phases of inpatient care. Here, at last, is evidence for the benefit of slow-stream rehabilitation at the interface between demand for and need of long term care.

Clinically the four phases represent—early death or quick recovery, regaining fitness, prolonged rehabilitation and long term care. For mathematicians, multi-state Markov chain modelling is used to estimate, from observed data, covariate (age of patient and date of admission to hospital or community care) dependent parameters of statistical models for time in care and subsequent events.

*Aust Health Rev 2007: 31(1): 91–97*



*Figure 1. Four phases of time related care in the Merton geriatric medical service. Pink for girls, blue for boys. 1977 data: aged 70. No gender differences are apparent for the first two phases of care. Bear in mind that the distribution of the data is exponential, so given the half-life of that data the slow stream process lasts for ten months. Notice also the gender differences in survival in long-term care.*



## Seven papers in AHR—Editor's musing

Kieran's paper on probability theory took me to 'self fulfilling prophecies'; the lack of evidence for admission avoidance in Sarvana and Karen's contribution made me think of the benefit of therapeutic intervention; Jackie's work focused my mind on team work and coherent plans; Brendon and Wendy's saga resonated because it mirrored my past trauma's in building services to have them closed down; Chris and Leon's contribution describes the magnitude of the task ahead if a common language and appropriate tools are to be developed; Robert and his co-workers' contribution showed order within disorder, and Malcolm and Sally's contribution opened my eyes to what I knew, because I was taught it, but I hadn't seen. Hence I decided to indulge myself by musing about things past and things present.

### Points of view

Everyone sees the world from the point of view on which they stand. I am no exception to that rule. In 1962, one year after qualifying in Medicine at University College Hospital in London, aged 25, I was in sole charge of Ekona hospital, a 60 bedded hospital in the West Cameroons. I'm in the picture. My sons' as children couldn't find me. I'm the white one in the middle.

For six months before my arrival the hospital had no doctor. Surprisingly, to the credit of my teachers (especially Joseph, the man sitting at my right hand) the death rate went down. Eighteen months later I was a junior doctor in an English Hospital department of Geriatrics, and I didn't know what to do.



### Teaching

Looking back, my medical education taught me to be a 'jack-of-all trades' general practitioner. Ideally suited to run an African Hospital. My teachers had a sound knowledge base, developed over centuries, right back to the time of Hippocrates in 300 BC if not before. In Africa there were books; it's a life changing experience to operate, having given the anaesthetic oneself, with an assistant holding an open book. Yet when I was taught - Geriatrics had no books.

Hippocrates, kept the chronic sick out of the temples, because they would mar the reputation for cures; likewise planners and clinicians in modern hospitals seek to do the same. Their talk is of 'inappropriate' admissions, 'delayed' discharges and 'blocked' beds, but geriatrics in the early days of the NHS was different.

### Prophecy

The problem of basing plans for hospitals on random allocation, controlled, clinical trials of service delivery is that prophecies have their own fulfilment. Hence, statistical differences between the old and the new do not occur by chance.

In 1948, when the NHS began, responsibility for the medical care of the chronic sick was taken from local government and placed on the newly formed Regional Hospital Boards to solve the problem of 'Bed-blocking' in acute hospitals. All services had to be developed. From the unlikely beginning of wards full of bed-bound patients the specialty of geriatrics, with its emphasis on consultant physician leadership, in acute, rehabilitative and long-stay care services began.

### My dowry

In 1968, I was appointed St. George's Hospital, London, first consultant in geriatric medicine. My dowry was

- a waiting list of 68, classified according to degrees of urgency as A, B, or C;
- 186 beds: four at St. George's; 182 beds in four other hospitals, three of which had less facilities than I had in Africa.
- No junior medical staff, no office and no secretary.

My task was to solve the problem of bed-blocking at St. George's by radically reorganising the process of inpatient care.



1973: Medical student demonstrating how to get out of a cot—sided bed

## Reengineering

Building a new therapeutic service meant radical change in both the location and use of beds and in nursing practice. An admission office and secretary was provided at St. George's. The waiting list was reviewed (28 dead). All inpatients were examined, and those who had potential were identified. Patients and beds were relocated and three upgraded wards, one in the teaching hospital, the others in two small hospitals with access to radiology services were developed. Four years later, in modern jargon, a no waiting list 'just-in-time' service was provided. Figure 1 shows the changing fortunes between 1969 and 1984 of the Merton service.

## Pygmalion in the classroom

In 1968, Rosenthal and Jacobson published their educational classic, placebo, research. In an American School on the borders of Mexico, they told the teachers they had invented a new IQ test that would identify pupils with phenomenal potential for intellectual growth. After testing the pupils, they selected the winners by random number and told the teachers who was going to succeed. One year later they returned to the school and their prophecies had been fulfilled.

On the advice of my brother-in-law, Geoff Burgess, a teacher, we adopted that approach and only at the bedside what they could do. Figure 2 shows that the early increase in admissions was due to change in the process of care of short stay patients. Thereafter, admissions increased as beds for long stay changed to short stay, and vice versa, admissions decreased when beds used for short stay changed to short stay. Percentile analysis of length of stay supported this conclusion.

## Feldstein's Paradox

In 1962 Feldstein observed that physicians under pressure to admit created waiting lists rather than change discharge behaviour. This 'Behavioural Theory' explains the relationship between time, space and behaviour in the Merton data set and in the Dunedin Hospital data. In both services percentile analysis of the duration of stay of admitted patients supported a conclusion that comprehensive change in clinical care systems establishes a new constant form of discharge behaviour. However, with different outcomes. Faced by bed shortages the geriatric medical service decreased admissions, while the acute medical service borrowed beds. Hence, in modelling terms, geriatric medicine had a constrained bed stock, whereas the bed allocation to general medicine was unconstrained.

## Slow stream rehabilitation

In the 1960's Professor Norman Exton-Smith, my mentor, introduced progressive patient care. In my hands, because our admission beds were on three sites progressive patient care did not work. Nevertheless the principles of fitness for discharge and slow stream rehabilitation continued in our three one-stop shops. Looking back I know that the professor whom I sat beside, writing down numbers, as he measured the internal and external dimensions of metacarpal bones, would have been excited by the numerical findings in Sally McClean's and Malcolm Faddy's research for they have revealed the engine room that underpinned our success.

## Conclusion

The Adelaide 2006 Health conference occurred because Mark Mackay had the courage to propose it and the commitment to carry it through. We thank him, our sponsors from Adelaide University and the SA Department of Health for their support, the contributors for their contributions, and the editor, Sandra Leggatt, of the Australian Health Review for allowing us to showcase our work.

Rosenthal, R. and L. Jacobson (1968). *Pygmalion in the classroom*, Rinehart and Winston Inc.

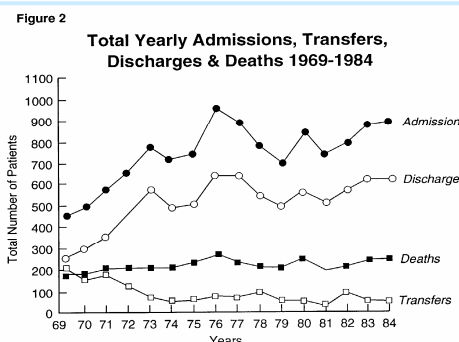


Figure 1. Rising and falling admissions in the Merton Geriatric Medical service 1969-1984. The data that Malcolm and Sally analyse in the AHR review.

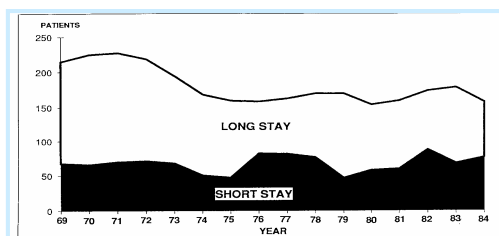


Figure 2. Bed occupancy in the Merton geriatric medical service 1969-1984. The black section is the short stay, the white the long stay. The inflation in bed occupancy at the start is due to the exchange of patients made to construct the therapeutic service.

Bi-monthly Newsletter of the UK Nosokinetics Group

## CORU: Clinical Operational Research Unit, University College London

Principal Research Fellow / Senior Research Fellow (£34,943 - £48,767)  
Research Fellow (£28,105 - £33,997)

The Principal / Senior Research Fellow post would suit an outstanding researcher with a good track record of applying Operational Research to health care. For the Research Fellow post, although some knowledge of Operational Research would be beneficial, applications are encouraged from candidates with analytical skills from other areas seeking a fresh challenge. For more details of CORU's research and the posts, visit

<http://www.ucl.ac.uk/operational-research>.

## FIFTH IMA INTERNATIONAL CONFERENCE ON QUANTITATIVE MODELLING IN THE MANAGEMENT OF HEALTH CARE

Goodenough College, Central London on 2nd - 4th April 2007.

Registration is now open at

<http://online.ima.org.uk/>

Details of conference at <http://www.healthcareinformatics.org.uk/imahealth2007>

## CALL FOR PAPERS FOR THE MODELLING IN HEALTHCARE STREAM OF THE OPERATIONAL RESEARCH SOCIETY CONFERENCE.

As I'm sure many of you know, this year's OR society conference is being held in Edinburgh on 4th - 6th September. This will be a great opportunity for people who would like to present their work involving operational research techniques within the healthcare field; be it academics, practitioners or people working in industry. This stream gives all three fields the chance to interact and share ideas. Presentations can be based on case studies or methodological issues. If you would like to present in this stream at the conference, you could either fill in the form at [http://www.orsoc.org.uk/conference/papersubmission/conference\\_submit.asp?cid=14](http://www.orsoc.org.uk/conference/papersubmission/conference_submit.asp?cid=14)

Thought for the night, left on my bedside table in a hotel in Rome, January 28th 2007

***I believe my theory of relativity to be true. But it will only be proved for certain in 1981, when I'm dead.*** (Albert Einstein)

## Nosokinetics News is the newsletter of the UK Nosokinetics Group.

Nosokinetics is the science / subject of measuring and modelling the dynamic aspects of patient and client movement (flow) through health and social care systems. From the Greek, literally, *noso* (disease) and *kinetics* (movement).

The group collaborates to organise conferences and disseminates news of our and others research and practical use of modelling to enhance decision making in health and social care systems. Our next International conference will be in Portrush, Northern Ireland in 18th-20th March 2008.

To join or leave our JISC mailing list copy the link below and follow the instructions at

<http://www.jiscmail.ac.uk/lists/NOSOKINETICS-NEWSLETTER.html>

Past issues in PDF format at <http://www.nosokinetics.org/>

The web archive of full texts of submitted papers is at <http://www.iol.ie/~rjtechne/millard/index0.htm>

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