

This issue and past issues are at <http://www2.wmin.ac.uk/coiec/nosokinetics.htm>

The on line archive is at <http://www.iol.ie/~rjtechne/millard/index0.htm>

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Nosokinetics
seeking a
better world

HSCMG Adelaide 2006: Heading for success

We have had an excellent response to our call for papers for the Adelaide meeting. We have a full programme with forty or more papers and plenary talks giving a broad brush overview of the current status of modeling health and social care systems.

Outlier' bed crises plague modern hospitals. Our interactive workshop considers the changing fortunes during twelve years of a New Zealand acute general medical service. Implementing change to solve a bed crisis. Living with change and the consequence of change.

Electronic medical records: Kaiser Permanente's experience

Scott, J.T. Rundall, T.G., et al. (2005). BMJ 331, 1313-1316

After a decision had been made to stop implementing one system and introduce another, four primary health teams in four clinics, and four specialty departments in hospitals were interviewed. Seven lessons were learnt.

1. Users perceived decision to implement was flawed.
2. Software design problems increased resistance
3. Doctor's productivity decreased, especially initially
4. Roles and responsibilities needed to be clarified
5. A co-operative culture created trade offs
6. Consensus building important
7. Implementation fostered conflict, which resolved when the initial system was with drawn.

Editor's comment: Conflict Theory applies. When a team is faced with task difficulty there is conflict, until a leader emerges. Also the First Aphorism of Hippocrates 300 BC is apposite.

'Life is short, the art long. The occasion fleeting and judgement difficult. The physician must not only do what is right himself, but also ensure that the patient, attendants and externals co-operate with him in treatment.'

The International Health and Social Care Modelling Conference (HSCM2006)

Adelaide - 19 April to 21 April 2006.

HSCM2006 provides a unique opportunity for practitioners and researchers to meet, exchange ideas, examine the current modelling trends and issues, and develop new solutions and research directions to ultimately improve patient and client care by:

- Widening understanding of the potential benefits of modelling health and social care systems;
- Highlighting instances where theory meets practice and practice meets theory; and
- Increasing understanding of the different modelling, computational and data analytical methods used to measure and model health and social care services.

Who should attend

Any professional interested in using modelling to improve decision-making in health and social care.

International speakers

Key speakers include:

Professor Peter Millard (University of Westminster)

Professor Sally McClean (University of Ulster)

Dr John Bass (Curtin University)

Dr David Dean (The Health Roundtable Ltd)

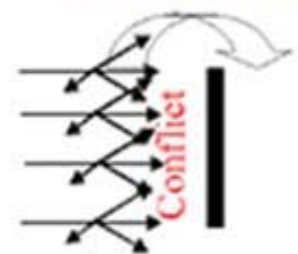
Registration: Full Registration AUD\$550

Hurry – Early bird registration ends soon.

For more information, please visit the conference website at:

www.psychology.adelaide.edu.au/hscm2006/

Conflict Theory

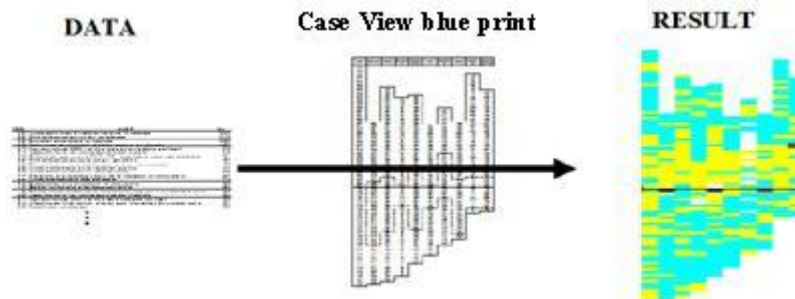


Nosological Case View

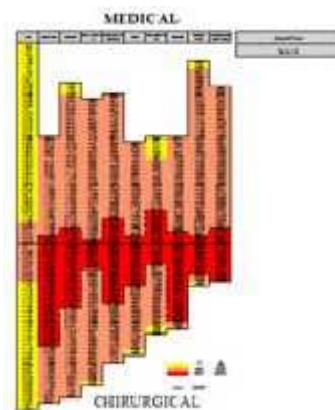
In the December 2005 issue we reported an exciting new way to describe inpatient workload. With kind permission of Pierre Levy we have been able to show the new method. The team developing Nosological Case Views is from the Hospital Hôpital Tenon and INSERM U707, Paris, France. The figures and words come from their [website](#).

In a Case View, a pixel represents a single DRG. All the individual DRGs which form the « pixels » come together to form an image which is the Case View.

Case View translates a large pool of data and information into an easy-to-read graph. The visualization process offered by Case View displays the cells or « pixels » corresponding to the individual DRG data and interprets the information according to a defined color scale for easy reference. The process is data to case view, case view to blue print and blue print to result.



The illustration below shows how the case view chart is structured.



Medical activity is in the (upper section) and Surgical activity in the (lower section.)

Nosological activity: at least one Major Diagnosis Category is included in each column.

Economic activity: The closer the DRGs are to the horizontal line the costlier they are (and vice- versa.)

Further information from

<http://www.b3e.jussieu.fr/caseview/drgview/index.htm>

Choice of Models for the Analysis and Forecasting of Hospital Beds.

MACKAY, M. & LEE, M. (2005). Health Care Management Science 8, 221-230.

The practical use of the Harrison two and three compartment hospital bed flow models is discussed. Using training and test data the goodness-of-fit achieved by optimisation was measured. Increasing model complexity resulted in over-fitting, and better prediction was achieved with a relatively simple model. In terms of generalisation, the seasonal models performed best. The performance of single day census models was similar, but inferior to that of the models generated from a full year of training data. The additional data make the models better able to capture the variation across the year in activity.

Data: Australian Hospital

See also: HARRISON, G. W. (2001). Implications of mixed exponential occupancy distributions and patient flow models for health care planning. Health Care Management Science 4, 37-45.

Queue-Theory and Bed Occupancy; Discussion continues

Background Notes: *In the October issue Roy Johnston wrote,*

'... The challenge to modellers is how to adapt the existing extensive and excellent body of queue-theory to describe meaningfully this complex situation, and to lead management to an understanding of the extent to which they need to supply surplus capacity in critical service areas, given that in a stochastic environment, 100% service utilisation implies infinite queues.'

Correspondence re '100% service utilisation implies infinite queues':

Philip Dawson, a Sussex GP wrote:

Peter: I quite agree that 100% occupancy leads to infinite queues. Technically correct well done 10 out of 10. There are however two flaws to the argument in real terms. If there is any change to the system and it only has 99.9999999999% occupancy the queue disappears! This is where the formula does not support the model of NHS efficiency. Certainly it does not reflect the bed states data. It seems rare that we find the beds in retrospect!

The other problem is that if you have an infinite queue to get in to the service the length of time you wait becomes a matter of degree. I would quite happily wait for 10^{-6} seconds but I would be annoyed if I had to wait 10^{+10} seconds. That would take me back to the original Christmas! I do have to apologise to my patients that I sometimes keep them waiting for up to 10^3 seconds [about 17 mins]! The surgery does have 100% occupancy and most people are happy with that.

There are problems of queuing on the telephone to get through in the morning for an appointment. It certainly does seem infinite but in fact that is not a queuing system. When you enter the system you are told if the phone is engaged or not. The BT system does not give you the option of waiting!

Any way, Thanks for making my work in the NHS more interesting! Kind regards, Philip

To which I replied: Dear Philip,

I am not sure, but I think, mathematically the queue is the rejection rate. The mathematical solution comes from the use of differential equations. If that is not untrue, at 99.99999 occupancy the queue is not infinite.

Depending on 'service time' (a mystical thing which in GP surgeries is based on average duration of consultation, but in constantly moving systems is much more difficult to calculate) rejections begin in computer servers at 65% occupancy. The theory would apply if every GP saw patients as they arrive i.e. each GP is a server unit and each is available to see patients as they arrive. Once you constrain it to individual GP's seeing their lists of patients the process becomes more complicated.

You made my day. I send NKNews into the ether - your reply encourages me - till we meet again
Yours, Peter

Clinical relevance: 100% bed occupancy, bed borrowing (Outliers)

Clinically, general medicine has an unconstrained bed stock. Figure 1 overleaf comes from Anne Connolly's 2000 BSc project with Sally McClean. Given an average stay of seven days, 100 beds are sufficient to cope with 12 referrals a day. However, if referrals increase to 16 patients a day 130 beds are needed if 15% of arriving patients are not to be turned away. This relationship between service time, arrivals and bed allocation explains why bed crises occur. Close empty

acute medical beds in summer – crisis in winter. Close empty beds in summer, open them in winter crisis goes away. It's not rocket science – just common sense.

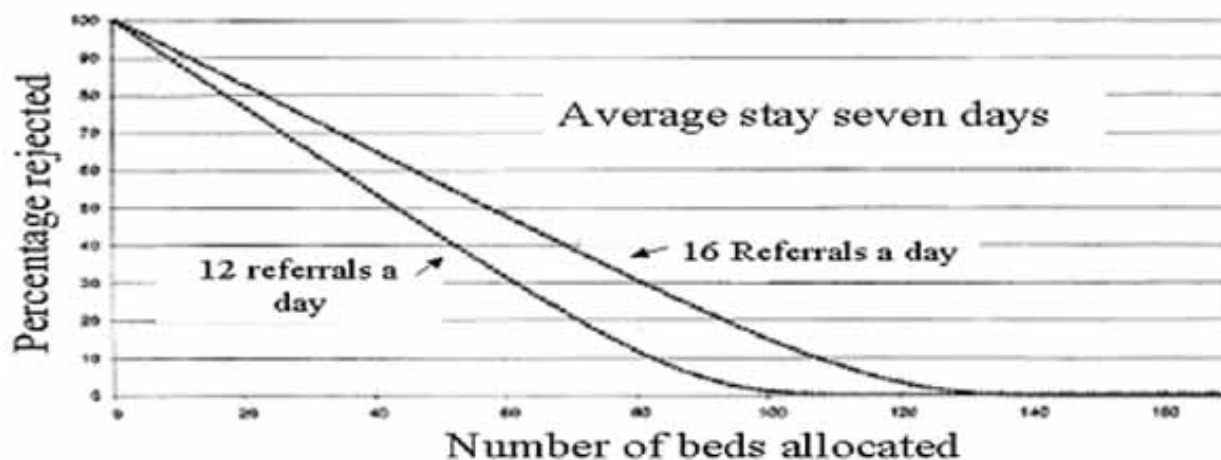


Figure 1. A simple queuing model showing the critical relationship between bed allocation and rejection.

NB. : The foregoing discussion about '100% utilisation' as somewhat simplistic: we are not dealing just with one queue, but a complex of queues, embedded in a multi-channel service system. The full text of the article below with the simulation parameters and the mathematical consideration is on the web at

<http://www.iol.ie/~rjtechne/millard/nsk61/rjq61.htm>

Some Queue-theory Experience from the Past

Roy H W Johnston (comments to rjtechne@iol.ie)

Editor's comment. *History teaches. Roy's background is in Physics and Mathematics. Here he explains why in 1964 average values crashed an innovative American Airlines booking system.*

Background: In 1963 I joined the team adapting the American Airlines (AA) real-time reservations system for Aer Lingus, the Irish National Airline. The system designers had previously worked on real-time computing with rocket-related (steady) data flows at Cape Canaveral. In 1964 the system collapsed, because they had used average values and had not reckoned with the effects of the stochastic environment. Using detailed simulation, IBM eventually found that the build-up of queues at data-access bottlenecks explained the problem. Meanwhile, at Aer Lingus, using queue theory, substantially the same results were achieved earlier with much less effort.

The AA Booking system model The AA model was defined in terms of a set of 'messages', each being a demand for some specialist service. The 'messages' had a variety of different structures, perhaps about 10 or so. The statistics of the resulting 'message mix' were known from the commercial environment; some types were frequent, others less frequent. The sequence of the 'transactions' was chosen using a 'Monte Carlo' type action selecting the 'next transaction', and their arrival-times were Poissonian, i.e. at a defined average rate.

The number of messages in the system was highly dependent on the lifetimes of messages in the system. 'Heavy' messages slowed down the processing of other messages, built up the numbers

being currently being processed, and expanded the queues. Thus the real-time booking system was a highly unstable non-linear process

Relevance to hospitals Hospital systems are somewhat similar, but much more complex. Using the foregoing nomenclature, there are two distinct populations of 'messages', emergency and planned. Both are stochastic, but neither is clearly Poissonian. Each has a mix of sequences of demands for specialised services, and the 'message mix' distributions differ; they should, however, be measurable. The service times are also measurably distributed; some may be quasi-exponential.

The number of available beds is the analogue of the fast-access memory in the computer model, in which the queueing messages were stored between specialist data-accesses. The analogy however is not exact, for bed-occupancy is itself a service, so 'recovery time' must also be taken into account. Thus in the hospital system, beds amount to a multi-channel service.

A typical bed-occupancy time will therefore consist of a combination of recovery time(s) and queue+service time(s) arising from a mix of service requirements. If there is a bottleneck in a particular specialist service domain, this will lead to extended occupancy-time, the distributions will become long-tailed, and the bed-queue on trolleys will expand.

Application The systematic application of queue-theory to this situation suggests itself as an approach enabling key bottlenecks to be identified, and the requisite levels of spare capacity to be identified, such as to avoid the excessive development of queues, taking into account the details of the differing statistics of the stochastic environments in the two distinct client populations.

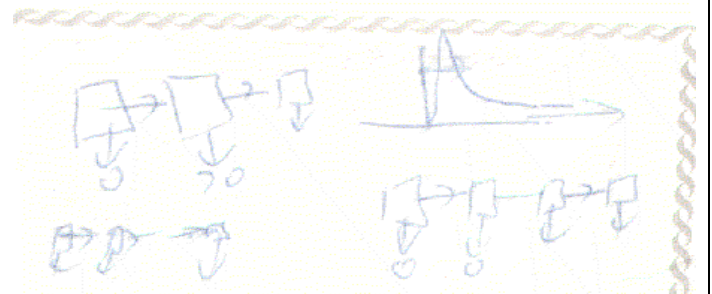
The math's of this is horrendous and challenging, and I am not going to attempt it, but if anyone does, I would be interested in being a friendly critical and marginally participating onlooker.

John Preater's 2001 'Bibliography of queues in medicine and health' can be found on the internet at <http://www.chcm.ubc.ca/comm682/QueueingBib.pdf>

See also GORUNESCU, F et al (2002). A queueing model for bed-occupancy management and planning of hospitals. JORS 53, 19-24.

How do modelers work?

The scanned image of a Belfast restaurant napkin doodled by Malcolm Faddy in discussion with Barry Shaw gives a clue. What's the problem? Modelling the different phases of patient flow.



What does the discharge data distribution show? Lognormal followed by exponential, which may be one, two or three streams dependent on the service being studied. Looks simple, easy to draw. Clinically relevant. Mathematically complex.

The social occasion was an evening meal following Malcolm's visiting lecture at Queen's University Belfast, arranged by Adele Marshall that Sally McClean and I attended. Malcolm's enthusiasm was contagious.

Look back at the October 2005 issue <http://www.iol.ie/~rjtechne/millard/nsk55/sal55txt.htm> "Hands across the world: 21st Century Magic" and see the benefit for patients and staff to be gained when these complex computational and mathematical problems are solved.



WELCOME TO MASHnews - the first edition !

Avid readers of NosoKinetics News will be well aware from coverage in previous editions of the formation and some of the activities of MASHnet - The UK Network for Modelling and Simulation in Healthcare. The Nosokinetics editor Peter Millard (a member of the MASHnet Steering Group) has invited the inclusion of this page which have its own distinctive style and will cover a range of MASHnet activities.

We hope MASHnews will develop organically over time in response to the needs and aspirations of readers and members of the network. The full text of MASHnews is also available as a downloadable pdf file from the MASHnet

MASHnet EVENTS AND ACTIVITIES

NHS Confederation/MASHnet Workshop: Modelling Solutions in Health Care
2nd March 10-4pm. NHS Confederation HQ, London.

This collaborative workshop is primarily for professionals working at all levels of the health service. Initial presentations outlining the potentials of modelling solutions in healthcare, followed by interactive sessions aimed at defining the key areas where modelling can most fruitfully be applied. More details on the [MASHnet website](#).

MASHnet Workshop - 3rd April, Cardiff University

Building on previous outputs. Bringing together a wide range of delegates from the health service, academic, research, and industry. Bridging the communication gaps and defining a more successful context for future implementation of healthcare modelling. To apply to attend email: mashnet@PenTAG.nhs.uk giving brief information about your current position and interest.

Website Data Resources

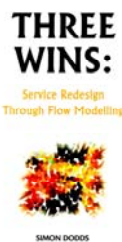
A key part of MASHnet's objectives is to develop useful information resources to support the activities of with an interest in healthcare modelling and help people make contact. Web based listings, available shortly and building over time, are:

1. A Practitioner Directory:- listing individuals in health , research, and industry with an active interest in health care modelling and simulation.
2. Case Study Examples: - listing models and simulation systems that have been used in areas of health service application.
3. Bibliography: - a comprehensive database of publications from a wide range of publications relevant to the development of successful health care models and simulations.

Book Review

THREE WINS: Service Redesign Through Flow Modelling

By Simon Dodds. Kingsham Press, Chichester. ISBN 1-904235-54-9



A practical, readable and thought provoking manual for change. Journeying through the necessary steps for successful reorganisation within the NHS. The three wins are the potential fruits of re-design: gains in service quality for patients, motivation for clinical staff, and system performance for service managers. The arguments of the book are crucially

underpinned by the reported, award winning, experiences of Dodds in transforming his own Vascular outpatient clinic and leg ulcer telemedicine service at Goodhope hospital. A full review of this book can be found on the MASHnet web site.



Queuing theory accurately models the need for critical care resources

MCManus, ML., LONG, M C., et al (2004).. *Anesthesiology* **100**, 1271-1276.

Modelling two years activity in a busy intensive care unit in Boston, the authors found that turn-away rates increase exponentially when utilization exceeded 80-85%. Small changes in staff numbers or longer stay patients caused rapid degradation of the system performance. They conclude that queuing theory provided an accurate means of determining the appropriate supply of beds.

How much does health care cost?

For most patients, the costs attributable to the last day of stay are an economically insignificant amount of costs. Physicians and administrators should focus change on altering care delivery during the early stages of admission. Last day cost just 420 dollars, 2.4% of the total. Approximately 40% of variable costs are spent in the first three days [1]. To reduce overall costs better understanding of cost-drivers and systems is needed; 35% of the costs of care are influenced by physicians [2].

1. Taheri, P. A., et al. (2000). "Length of stay has minimal impact on the cost of hospital admission." *Journal of the American College of Surgeons* **191**(2): 123-30.

2. Taheri, P. A., et al (2000). "Physician impact on the total cost of care." *Annals of surgery* **231**(3): 432-5.

Modelling the feedback effects of reconfiguring health services

Models the shift in cardiac catheterization services. Bringing services 'closer to home' is an established trend. Sounds good, but there may be unintended consequences, including extra referrals. Models clarify the roles for stricter clinical guidelines and capacity increases, and demonstrate the potential benefits of changing goals that drive activity.

Taylor, K. & Dangerfield, B. (2005). *Journal of the Operational Research Society* **56**, 659-675.

Factors investigating discharge destination of older hospital patients

Using univariate analysis, this cross European study involving 1,626 patients eight centres in six European countries, found that age, gender, living alone, physical function, cognition, the main body system effected (ICD classification) and the geriatric giants (falling, mobility, continence or cognition) were all statistically related to discharge destination. The authors concluded that case-mix systems to compare risk-adjusted hospital outcome in older medical patients need to incorporate information about physical function, cognition and presenting problems in addition to diagnosis.

Campbell, S. E., Seymour, D. G., et. al (2005). *Age and Ageing* **34**, 467-475.

Intermediate care can be safe and reduce hospital use, but is it and does it?

Randomised controlled trials show what is possible. However, we need also to establish the conditions necessary for success. Descriptive research methods such as systems analyses and case studies should be undertaken alongside controlled studies. Once these conditions for success have been established, we need a systematic quality assurance exercise to ensure that they are being met.

Gladman, JR *BMJ*, 2005;331: 1271 commenting on Crotty M., et al Transitional care facility for elderly people in hospital awaiting a long-term care bed: randomised controlled trial. *BMJ* 2005;331: 1110-3.

See also

A whole system study of intermediate care services for older people.

A city wide clinical trial in Nottingham, involving 1648 older people in control and interventions groups allocated to hospital or intermediate care services found that both had similar clinical outcomes, but intermediate care did not achieve its strategic objectives of reducing long-term care and hospital use.

Young, J.B., et al. *Age and Ageing* 2005 **34**, 577-583.

Effects of locality based community hospital care on independence in older people needing rehabilitation: randomised controlled trial

Green, J., Young J., et al.. BMJ 2005 331, 317-320.

220 patients needing rehabilitation after an acute illness requiring hospital admission. Median length of stay both groups 15 days. At six months the locality based community hospital was associated with greater independence for older people than care in wards for elderly people in a district general hospital.

Speakers talks from the Quantitative and Predictive Methods in Health Care

Management: Resolving the Queueing Quandary workshop organised by the Clinical Epidemiology & Health Service Evaluation Unit, Melbourne Health and the Department of Mathematics and Statistics, University of Melbourne in December 2005 are now available at the Melbourne Health web site link given below:

http://www.mh.org.au/Royal_Melbourne_Hospital/DEPARTMENTS/A-C/Clinical_Epidemiology_and_Health_Service_Evaluation_Unit/ARC_Linkages_Project/Workshops/

Forthcoming conferences

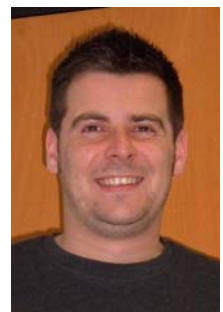
EURO XXI 21st European Conference on Operational Research, Reykjavik, Iceland July 2-5, 2006 OR in Health Care Sally Brailsford (S.C.Brailsford@soton.ac.uk)
Jan Vissers (vissers@bmg.eur.nl)

OR 48 The 48th Annual Conference of Operational Research Society, Bath, UK, 11-13 September 2006. deadline 15th February 2006

RSS 2006 International conference of the Royal Statistical Society. Queen's University Belfast, 10-14th December 2006. Deadline for submission dates 31st March 2006. contact p.gentry@rss.org.ukn

Congratulations to Barry Shaw PhD, Queen's University Belfast

Barry's thesis, "An Extended Bayesian Network Approach to Model the Health Care Costs of Patient Spells in Hospital", supervised by Adele Marshall, introduces a new mathematical approach for modelling the bed costs of geriatric inpatients. By integrating a cost function within the Conditional phase-type model, which may be used to model the influence of patient characteristics (e.g. age, gender, reason of admission) on their length of stay in hospital, Barry's model allows the expected costs to be estimated for a group of patients' accumulated time in care. By altering the parameters of the model, policy changes, such as discharging patients from earlier stages of care or changing the number of beds in the ward, are investigated as potential benefits of such a model to hospital managers.



Nosokinetics News is mailed to supporters and collaborators interested in developing a scientifically valid approach to measuring and modeling health and social care systems. To be added to / removed from the mailing list email nosokinetics. Editor: Prof Peter H Millard. For earlier editions <http://www2.wmin.ac.uk/coiec/nosokinetics.htm>

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