Issue 5.2

Nosokinetics News

April 2008

Bi-monthly Newsletter of the UK Nosokinetics Group
Past issues at http://www.nosokinetics.org/

Highlights of this issue:

HCSM Portrush 2008 - Irish hospitality and a feast of papers

Thanks to Prof Sally McClean and her team, the University of Ulster and the staff of the Ramada Hotel, not forgetting the Irish band and dancers after the conference dinner, HSCM 2008 was a most successful conference. Moreover, the Irish dancers gave us a new meaning to fast-tracking care and further appreciation of the meaning of waves of flow as they got us onto the floor to dance the "Waves of Tory": couples in a long line ducking and weaving under each others arms.

Fast tracking after dinner

Opening the conference, Prof Alan Smart, Provost of Coleraine Campus of the University of Ulster, remarked on the benefit of small scale conferences in convivial surroundings, fostering friendship as well as scholarship. Six plenary talks and 22 submitted papers gave the 43 delegates a broad brush view of the state of the art and science, both academically and practically.

Involvement of researchers working at the Coleraine Campus on the EPSRC RIGHT (Research into Global Healthcare Tools) and the MATCH project broadened the scope of the conference, to include practical aspects of the development of computer assisted Smart Home tools to enable adults with early dementia to live safely in their own homes. We were also fortunate to have the support of the Co-ordinating Director of this EPSRC research, Prof Terry Young, at the conference.

Terry joined Brunel in 2001 after 16 years in industry. His background lies in photonics research (laser spectroscopy, numerical simulation and optoelectronics) communication systems and information architectures with allied experience in management and business development. His plenary lecture 'So, where do Simulation and Modelling Fit in?' began with a slide showing the basic hierarchy of healthcare provision—from policy at the top to materials at the bottom. Bottom Up, because the knowledge of materials provides a stepping stone on which to develop devices, systems, services and policy. And Top Down as policy makers influence research.

Terry explained how the MATCH (Multidisciplinary Assessment of Technologies Centre for Healthcare) project, involving the Universities of Birmingham, Brunel, Nottingham and Ulster explores medical device development and the way in which economic evaluation and access to user needs can enable better decisions in both device development and procurement. Meanwhile, the RIGHT project involving the Universities of Brunel, Cambridge, Cardiff, Southampton and Ulster is examining the use of simulation and modelling in service design.

Opening the conference I indulged myself by reminiscing about the development, during the 1970's, of the acute hospital based, community supportive, services to solve the problems of bed-blocking at St.George's Hospital.

Next Prof Thierry Chaussalet, University of Westminster, opened the academic component of the conference questioning whether 'Modelling Length of Stay - Real Benefits or Waste of Time?

Length of stay is considered to be a good proxy of resource consumption, yet simple averages loose a great deal of 'hidden' information concerning the heterogeneity of patient groups. Over the years researchers, e.g., the 'Nosokinetics' Network, have developed methods for capturing and exploiting this higher level information. However, although these methods are attractive, in so far as they describe the phases of care, they have the disadvantage for management purposes that the stages are virtual rather than real i.e. observable. *(Continued on page 2)*

(Continued from page 1: HSCM Portrush 2008)

Thierry briefly described the background to, and extension of, Harrison, and McClean mathematical models of flow, before describing the Coxian phase-type approach used implemented in FLoSC, a software tool which enables local authorities to forecast their costs of known residential and nursing care commitments. (Nosokinetics News 4.5 October 2007 page 3)

We were delighted that Prof Gary Harrison, from the College of Charleston, joined us and were only sorry that his wife Donna, at the last moment, could not accompany him and we wish her well. His seminal two compartment model of flow explained why mixed exponential equations fit the empirical distribution of time of bed occupancy in departments of geriatric medicine.

In his plenary lecture 'Hospital Patient Flows and Short Term Occupancy Prediction' Gary discussed the higher level benefits of multiphase or compartmental models. Combined with distributions of admission rates, models of long term hospital bed occupancy showing means, variances and trends are useful for long term planning. However, short term predictive models need more information.

Research using acute hospital medical data provided by Gabriel Escobar of Kaiser Permanente is moving towards that goal. Firstly, modelling length-of-stay distributions conditioned on elapsed length-of-stay, diagnosis and severity. Secondly, modelling internal hospital flows, such as movement between intensive care units and general medical units.

Dr Ken Fullerton's plenary asked "Why does Healthcare need Modelling? Ken is a Consultant Physician in Geriatric Medicine, in Belfast HSC Trust and Hon. Senior Lecturer at Queens' University and is collaborating with Sally Mclean in the RIGHT project, to model and cost the care of stroke patients. Ken has a long term interest in modelling and for ten years he was a Medical Director. His 1999 article in the *Quarterly Journal of Medicine* (QJM; 92: 199-206) described the seasonal nature of illness and its effect on hospital bed usage.

Health and Social Care systems are in crisis. Worldwide, the expectation and demand for healthcare expenditure is outstripping the financial capacity to pay for it. To achieve the best possible outcomes, healthcare needs to make the best use of resources now and in the future. Coupling Systems Thinking with Flow Modelling could give real gains in health care delivery, and the potential benefits need urgently to be explored. Ken concluded his presentation illustrating the potential benefit of the Theory of Constraints, an application of Systems Thinking which has a proven track record in

Our last plenary lecturer, Dr Don Campbell, had travelled far and lost his suitcase in Heathrow on his long journey from the other side of the world. His lecture 'Application of Operations Research to Inpatient Medical Care: Learning from Standing on the Shoulders of Giants' livened the last day with a frank Australian review of the need to reform care systems. With collaborating colleagues from academe, industry and hospitals, he has been studying the patient journey from front door to back door using Operational Research methods, which coupled with knowledge of the physiological impact of prolonged bed rest can guide reforms to redesign care.

Each part of the patient journey from presentation in the emergency department, through the acute medical department, to a sub acute (geriatric) department for rehabilitation has measures of capacity, occupancy and flow with their own distributions. Knowledge of the rates of movement between departments and the arrival and departure rates within a connected system of care could guide the creation of a system with minimal waits and queue formation. That's the opportunity.

However, concluding on a less optimistic note, having described the studies of patient movement that the team had undertaken, particularly with regard to Emergency Department congestion and demand, Don said 'The Romans forgot to make concrete' so its not surprising that this information has not been fully utilised.

Ignorance is bliss — its folly to be wise. That's the Rubicon we have to cross.

Our parting words to Don were "May your case go with you". We are grateful to our plenary speakers and all of the delegates who joined us for our Second International conference. We thank them for their participation and contributions in presentation and discussion and look forward to meeting them again at our next conference HSCM London 2010. This issue focused on the plenary talks. Details of other presentations will be in the next issue.

DGHPSim: Simulation to Support Smart Thinking

Murat Gunal & Mike Pidd {*M.Gunal | M.Pidd @ Lancaster.ac.uk*}
Lancaster University Management School, Lancaster, LA1 4YX, UK.
www.hospitalsimulation.info

Editor's comment: *Unexpected consequences plague the modernisation agenda. What changes can be made to achieve the latest target? How will proposed changes impact on the performance of other departments and services? Here Murat Gunal and Mike Pidd describe a discrete event simulation toolkit which can be used to understand better the traps and pitfalls which can follow changes made in good faith.*

Simulation and smart thinking

Discrete event simulation is very useful for understanding why patients wait for hospital care and for the re-design of processes to reduce those waits. The simulation literature contains many success stories, including applications in A&E, out-patient clinics, bed occupancy and ICUs. The simulations are often used to examine options for improved performance by reducing waiting time and improving capacity utilisation.

Over the last 10 years NHS performance targets have pressurised hospitals to reduce waiting lists and waiting times. As a result, in England, waiting times and waiting lists have been reduced. Some of this is due to the extra cash poured into the NHS and some to smarter operation. The current 18-week RTT (referral to treatment) target requires managers and clinicians to act much smarter if it is to be achieved.

One problem, though, is that different targets interact; that is, squeezing a hospital service at one point may just shift the pressure elsewhere. Hence managers and clinicians need tools to enable them to take a holistic view of options for service redesign and improvement. They need something that will help them separate smart from not-so-smart thinking.

District General Hospital Performance Simulation (DGHPSim)

DGHPSim is a suite of discrete event simulation models which simulate individual patients as they flow through a general hospital. It consists of four models that can be run separately or together.

- A&E (A&ESim),
- Outpatient clinic (OPSim),
- Waiting list (WLSim), and
- Inpatient facilities (IPSim).

Running them together allows the examination of the interaction between performance targets and options for change.

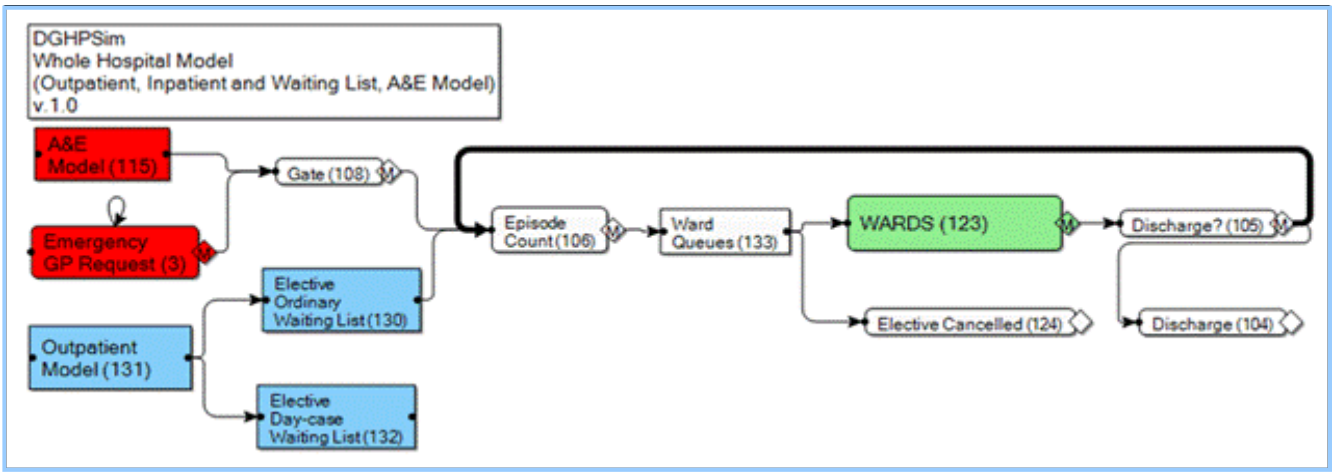
The DGHPSim suite focuses on individual simulated patients, includes stochastic elements (variation in length of stay, admission rates, case mix), and is designed to be tailored to the characteristics of individual hospitals. The models represent a typical district general hospital and enable clinicians, managers and planners to see the effect of different actions on waiting times for these units. They are built with generic features that can be tailored to fit specific hospitals.

It has been developed in the Micro Saint Sharp simulation environment and its outline process flow is shown in the network diagram (overleaf). As might be expected, simulated patients are admitted via the usual routes and treated in A&E, outpatients and inpatients, consuming resources and experiencing delays during their interactions.

(Continued on page 4)

(continued from page 3)

To fit generic models to a particular real hospital requires the user to specify parameters based on two main data sources: local Patient Administration System (PAS) data and national Hospital Episode Statistics (HES) data. The data from these two sources need to be integrated and processed to estimate the parameters of the model and a further software tool, the Hospital Activity Data Analyser (HADA) has been developed for this purpose.



Using DGHPSim

DGHPSIM can be used to explore a number of questions, such as:

- With this hospital's level of resources, what sort of performance characteristics (e.g. length of stay, use of day-case surgery) would be required to achieve an 18 week RTT?
- Given this hospital's performance characteristics, what sort of level of resources would be required to meet the 18 week referral to treatment: RTT?
- Hospitals are required to hold buffers against emergency demand, so how does performance against elective targets trade-off against targets for emergency admissions? Within the elective wait, how does performance against waits for those who only use outpatients trade-off against those who are admitted as inpatients?
- The NHS Institute for Innovation and Improvement makes a number of recommendations (e.g. combining queues and outlying patients) which will have an impact on waiting time performance. Are these impacts substantial or are they dwarfed by uncontrollable factors (e.g. seasonal fluctuations in demand)?

The answer to these questions is not obvious, as the relationship of waiting to resources is non-linear (twice the investment does not equal half the waiting time). Moreover, hospitals are complex systems dealing with stochastic demand flows and actions which often appear sensible when viewed in the context of one specialty (e.g. carving out bed space for patients with a particular condition) can often appear less sensible when viewed from the point of view of the interests of the organisation as a whole.

DGHPSim enables us to add quantitative detail to the qualitative insights on which policy is too often based, and provide useful advice both to those responsible for setting targets, and for those whose role is to help hospitals achieve higher levels of performance.

This research is funded by the Engineering and Physical Sciences Research Council (grant ref: EP/C010752/1) and research collaborators are Gwyn Bevan & Alec Morton (London School of Economics), and Peter C Smith (University of York).

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Compartmental Flow Modelling of Acute Care Hospital Bed Occupancy for Strategic Decision-Making

Mark Mackay, *Principal Project Officer, Department of Health, South Australia*

For further details, see http://digital.library.adelaide.edu.au/dspace/handle/2440/41204

Australia's total health expenditure for 2004-05 was $87.3 billion, the ninth highest among 29 other OECD countries. The use of health care services and expenditure pattern is well established and Australia follows the pattern found in most developed countries, with the greatest expenditure occurring on services for the elderly. Australia is experiencing a shift in population structure, with the proportion of older people forecast to increase. Consequently, it is expected there will be a need for a greater level of expenditure on health care as the number of elderly people increase.

There is an emerging gap between the ability to supply health services and the demand for them. Furthermore, acute care hospital treatment is generally considered expensive and governments have been keen to control this expenditure.

It is imperative that governments are able to make decisions based upon robust policy advice. There are serious consequences in both economic resource allocation and patient (and population) health outcomes if decisions about future health service structures are incorrect. In particular, there is a need for better decision-making around bed management at the strategic level. Strategic decision-making relates to decisions that will occur in a longer time frame.

Decision-making can benefit from the use of modelling. Models represent a simplified version of reality that preserve the essential features of the situation being examined and can be used as a tool to investigate decision-making options, particularly in complex environments such as the health sector. Historically decision-making relating to hospital beds has used either simple "back of the envelope" calculations or adherence to "rule of thumb" approaches. Most of the approaches have relied upon using the average length of stay metric. While the modelling of hospital bed numbers is not new, much of this work has relied upon the average length of stay measure, which is known to be flawed.

Harrison and Millard (1991) introduced the application of the compartmental flow model for modelling hospital bed occupancy and noted its potential to be used to influence policy decision-making. Their research relied upon data from a geriatric health service in the United Kingdom and used a single day census approach to collect the data. The flow model results are plausible and easily interpreted. However, relatively little work has focused on the ability of these models to be generalized and be used for predictive purposes.

The research presented in this thesis focuses on the investigation of whether the compartmental flow models of bed occupancy originally described by Harrison and Millard for decision-making around geriatric service care in the English National Health Service can be used to describe data from acute care hospitals in Australia and New Zealand. The research consisted of a series of modelling experiments that can be broken into two key stages: whether the models could be successfully applied to the acute care data; and whether the models could be used for novel purposes, such as forecasting, evaluation of service change, and benchmarking. This entailed the further development of the model, and a consideration of basic modelling issues such as the balance between data-fit and model complexity, in order to capture better variation in the data and also to facilitate linkage to population change.

While the research relied on approaches that are often mathematical or statistical in nature, it was deliberately presented in a style that is devoid of extensive mathematical notation to so that it could be communicated to a multi-disciplinary audience.

The findings of the research included: confirmation that acute care hospital data could be described by the Harrison and Millard (1991) compartmental flow model; the use of more data resulted in improved model fit; the introduction of the Bayesian information criterion to assist with model choice; application of the modelling approach to consider the impact of population change; introduction of new simulation and sensitivity approaches; modification of the approach to incorporate seasonality; and use of the model for benchmarking at the service and casemix level.

Harrison GW and Millard PH (1991). Balancing acute and long-term care: the mathematics of throughput in departments of geriatric medicine. Methods of Information in Medicine, Vol 30(3): 221-8.

Telling the story in OR

An Operational Research model is a 'sub-plot' of the intervention that generated the model. This paper is both descriptive—reflecting on the ways in which OR practice might be seen as storytelling—and prescriptive—offering some practical guidance to those keen to apply storytelling as an OR approach.

Klein JH, Connell NAD, Meyer IE. Operational research practice as storytelling. Journal of the Operational Research Society 2007;58:1535-1542.

Stopping simple cases coming to A&E doesn't stop delays in admission

The national target for admissions from A&E is that 98% of all A&E attendances are to be completed (discharged, transferred or admitted) within 4 hours of arrival. A generic simulation model, developed by Department of Health OR analysts, shows that stopping simple cases coming in doesn't solve the problem of delays in admission. The challenges of using a 'generic' national model for 'specific' local use is also discussed.

Fletcher A, Halsall D, Huxham S, Worthington D. The DH Accident and Emergency Department model: a national generic model used locally. Journal of the Operational Research Society 2007;58:1554-1562.

Seeing the trees in the wood: small numbers make big differences

Retrospective analysis of length of stay of all admissions (117,178 episodes) during five years to a large London teaching hospital showed that 0.6% (648 patients) stayed more than 100 days and occupied 11% of the beds. Excluding them made no difference to the overall median length of stay. Targeting them may better improve overall efficiency, compared to targeting mean or median length of stay.

Quinn, M. P., A. E. Courtney, et al. (2007). "Influence of prolonged hospitalization on overall bed occupancy: a five-year single-centre study." Qjm 100(9): 561-6

Modelling Medical Admissions Unit

Creates a decision support tool to model bed numbers and medical and nursing staff needed for a medical admission units in a district general hospital. Many hospitals have created medical admission units. However, *editor's comment*, in the long run I wonder whether the policy will succeed, as it takes the flexibility out of the acute medical beds and a priori will increase length of stay.

Oddoye JP, Yaghoob MA, Tamiz M, D.F. J, Schmidt V. Amulti-objective model to determine efficient resource levels in a medical assessment unit. Journal of the Operational Research Society 2007;58:1563 --1573.

UK Operational Research Society's Golden Anniversary conference

University of York 9 – 11 September, 2008.

Christos Vasilakis writes: Its being advertised as the conference of the year and given that Sally Brailsford and Paul Harper are co-chairing, I, for one, do believe the hype. I also expect the Health Stream to be as full and as interesting as ever. Follow the link below for more information.
http://www.theorsociety.org.uk/orshop/(00fjwwf0zpvb3o55uue2xhae)/orcontent.aspx?inc=or50_main.htm

Please consider presenting your work at the Health Stream. At this stage all we are asking is a short (and perhaps vague) abstract that you can submit either using the link below or email directly to me. It will be possible to amend the details of your submission at a later stage.
http://www.theorsociety.org.uk/conference/papersubmission/conference_submit.asp?cid=20

Looking forward to receiving your abstracts and seeing you at York in September.

University of Oxford: 10-week Online Course -- Statistics for Health Researchers

Date: 19th May 2008 Fees: £1500 (discounted rate of £1000 for registrations by 18th April)

This course is designed for busy health and social care professionals who need to understand the basics of health statistics without becoming statisticians. Students can study at the time of day and week that is best for them.

Online tutorial support is provided and concepts are applied to real-life scenarios. Full details can be found in the health sciences section of their website. http://cpd.conted.ox.ac.uk/shr08

Crossing the Rubicon? Length of stay-based clustering methods for patient-grouping


Elia El-Darzi at Portrush

At the Portrush conference Elia El-Darzi reported PhD research by Revlin Abbi which uses Gaussian Normal distributions to identify clinically relevant case-mix groups with stroke illness diagnosis in the UK National Data HES data set. If this is confirmed in other data sets then this collaborative research between Elia's group at the Harrow campus of the University of Westminster and Florin and Marian Gorunescu at the University of Craiova in Romania has opened a new, clinically explainable, way of analysing stroke data.

The concept of exponential flow in the process of inpatient care 'is central to dynamic models of bed occupancy modelling, using bed census data, and phase-type models using discharge data sets. Mathematically Harrison and McClean models of the process of care are similar, but the data they use is different. Bed census models identify and explain the presence of one, two or three streams of flow in the occupied beds. Whereas, phase type models reveal how admitted patients progress through the beds from admission to discharge. So, the insights differ. For the bed census models study the patients who have not been discharged, whereas the phase type models study the patients who have been discharged.

However, because both models explain what is happening in hospital beds in terms of exponential flow, there is a problem of clinical understanding. Doctors are used to discussing the distribution, absorption, metabolism and excretion of drugs in terms of compartments and flow (half-lives), however there is wide spread ignorance as to the meaning of exponential flow and half-lives.

I speak from personal experience. I once thought that semi-logs went on fires. And had no idea, until 1989 when Paula Rochon a visiting Canadian doctor to my department, told me, if you multiply a half-life by five you can tell when 97% of a drug is excreted.

Doctors are trained to think in terms of case mix, guidelines and evidence based clinical trials. Its difficult for us to grasp that our learnt behaviour coupled with the case mix and facilities inside and outside hospital interact to process patients in similar fashion to the human body absorbing, distributing, metabolising and excreting drugs. That's the credibility gap which we still need to cross.

Who knows, perhaps a revelation that there are clinically understandable, normally distributed groups, is the breakthrough we need.

The economic cost of wait times in Canada.

The Centre for Spatial Economics. Jan 2008.

Patients who wait longer than medically reasonable for treatment impose costs on the patients themselves, and on the economy as a whole.

See: http://www.cma.ca/index.cfm/ci_id/45087/la_id/1.htm

National health reform needs strategic investment in health services research

New funding has been given to the Australian National Health and Medical Research Council (NHMRC) to provide an evidence base for policy and practice reform. Following a broad review, looking back over twenty years, the authors conclude that three preconditions are necessary to influence policy:

- The political will;
- Sustained funding to encourage methodological rigour and build decision makers' confidence; and
- The development of sufficient capacity and skills.

Hall JP, Viney RC.. Med J Aust. 2008 Jan 7;188(1):33-5.
See: http://www.mja.com.au/public/issues/188_01_070108/hal10543_fm.html (Open Access Journal)

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Watch this space: call for papers

The Second International Health and Social Care Modelling Conference (HSCM2008) was a great success.

http://info200.infc.ulst.ac.uk/events/hscm2008/

A special volume on Intelligent Patient Management will be published as post conference proceedings in the Springer Verlag series of Studies in Computational Intelligence.

Guest editors Sally McClean, Peter Millard, Elia El-Darzi, Chris Nugent.

Papers in the broad areas of computational patient-centred practical and theoretical approaches for measuring and modelling, managing and evaluating health and social care systems.

All submitted papers will undergo the normal peer review process.

Deadline for paper submission: **30th June 2008**

Details concerning the call for papers will be available at the conference website.

For instructions to authors see
http://www.springer.com/series/7092?detailsPage=contentItemPage&CIPageCounter=149813

We thank Sally and her team for the magnificent effort they made to give us such a warm welcome and a great conference. These are the sort of tasks that one accepts in haste and repents at leisure.

At the conference dinner we gave a small memento to Sally which we hope she will carry with her to remind her of everyone who helped and came. It is difficult to see what it is - its a tiny glass cat with a kitten.

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* (sickness) 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.
Past issues in PDF at http://ww.nosokinetics.org/

Thanks to IMS our web archive of full texts of submitted papers between 2006-2007 is at:
http://www.iol.ie/~rjtechne/millard/index0.htm

To receive a personal copy follow the instructions at

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

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