

Nosokinetics News



The purpose of travel is not to spread discontent

Preparing my plenary lecture for the ICICIS 2007 conference in Cairo, I recognised the significance of zero days. During the conference I slipped out to visit Dr Tamer Farid's academic department of geriatric medicine at Ain Shams University hospital. There I was given the professorial dog. In tribute to Prof Salem who organised the computational conference, and the enthusiasm of the young medical staff I met and the quality of care, I give the little dog and conference program centre page.



Back to basics: getting the numbers not too wrong

Researching my plenary talk on "Nosokinetics, getting the numbers right" for the ICICIS conference I realised I was wrong. My eyes opened when searching the web I came across the work of Mahommed ben Musa al-Khwarizmi, who in his 9th Century treatise created algebra - *al-jeb wa'l-muqābal* - the transposition and removal of terms of an equation. Then I found the positional number system and looking in the 1911 edition of the Encyclopedia Britannica (which I bought for £10 in 1973) I realised that we could never get the numbers right, we could simply get them "Not too wrong".

In the 12th Century, translations of Khwarizmi book on *Arithmetic* brought the numerical number systems to the West. (see Box 1). Note that Zero on its own means 'nothing there' and read on.

Human beings have five fingers on each hand and five toes on each foot. It should surprise no one, therefore, that the Abacuses used to calculate numbers by the Romans, and in China, count in fives and tens. Nor should we be surprised that distance, in the Roman Empire, was measured in yards (the step of a cohort of marching soldiers). But, what may surprise you, is that hospital length of stay is counted in nights, not days, probably as a hangover from the occupancy function of the workhouse [1].

BACK TO BASICS

Abacuses use nine numbers
123456789

Indian numerals introduced 0
0123456789

The positional number system
139; 13.9

Zero—Nothing there unless of course its 10

Binary Numbers
10110111 = 183

Days as inpatient	Percent discharged	
	Surgery N= 7723	Medicine (COPD)
0	3	3
1	30	8
2	45	14
3	55	21
4	60	29
5	68	37
10	84	65
20	95	85
Maximum	110 days	417 days
Average	5.8 days	10 days

What chance is there of getting policy decisions right, if the numbers used to describe bed usage are incomplete [2]. The table show that three percent of surgical and medical patients are not there, and that the average stay does not describe the distribution of the data. Given the widespread ignorance about measure and measurability, it is hard to see how we can get decision makers to use algebra instead.

In this issue, Louis Gibbs, from Adele Marshall's group, in Belfast, analysing length of stay in minutes in an A&E Department, reveals two streams of patients: those discharged and those admitted, the latter having four phases of care. Also we consider Brijesh Patel's PhD research from Thierry Chausaulet's group, in London, which uses structured equation modelling to create performance maps which show the links and traps in the NHS Performance Indicators.

The computer era brings great benefits to mankind. Thousands of facts can be stored and analysed. Yet the results are only as good as the methods used to create them. Now, at the beginning of the 21st Century, to get the choice between Arithmetic or Algebra into perspective, it is worth returning to the start of the 20th Century and the following quote from the Arithmetic section of the 1911 Encyclopaedia Britannica:

"From the educational point of view, the value of arithmetic has usually been regarded as consisting in the stress it lays on accuracy. ... even then accuracy was not found always to harmonize with reality in getting the numbers right. However, 'the development of physical science has tended to emphasize an exactly opposite aspect, viz. the impossibility, outside a certain limited range of subjects, of ever obtaining absolute accuracy, and the consequent importance of not wasting time in attempting to obtain results beyond a certain degree of accuracy.'" (Encyclopaedia Britannica 1911)

So be it. If we can't get the numbers right, the 21st challenge is to get the numbers not too wrong.

1. White, R., *International Journal of Nursing Studies*, 1977. 14: p. 19-27.
 2. Harrison, G.W. et al., *Health Care Management Science*, 2005. 8(4): p. 325-34.

Nosokinetics News

PhD research

Modelling patients' total time in an A & E Department in Northern Ireland

Louise Burns, research student, CenSSOR, Queen's University Belfast

Editor's comment: The two streams of time related flow in A&E in Louise's research, support Ben Tovim and his colleagues finding at Flinders University Hospital in Adelaide that creating two value streams, those to be admitted and those to be discharged, increased patient satisfaction and improved performance. (See page 5).

Background

Improving the efficiency of A&E departments is a priority for the NHS and new targets are being introduced to assist this. In Northern Ireland the new target states that by April 2008, 95% of all patients should spend no longer than 4 hours in total in the department. Analysis of a local hospital dataset, recording all new A&E attendances over a one year period, indicates that currently, only 80% of patients are meeting this target.

Identifying heterogeneity

From the dataset it was possible to identify patient pathways and two streams of patient passing through the department – patients who require a decision to admit to hospital (DTA patients) and patients who don't have a decision to admit (no DTA patients). The results indicated that the DTA patients spend significantly longer in A&E than no DTA patients (p-value <0.001). Therefore, when considering total time in A&E, the two streams should be accounted for and modelled separately.

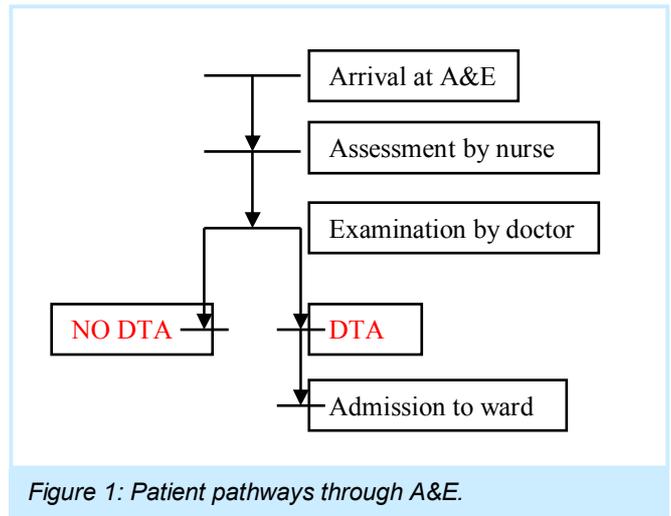


Figure 1: Patient pathways through A&E.

Results

It was found that a lognormal distribution with probability density function (pdf)

$$f(t) = \frac{1}{\sigma t \sqrt{2\pi}} \exp\left(-\frac{(\ln t - \lambda)^2}{2\sigma^2}\right)$$

where s and l are parameters estimated from the data and t represents waiting times, gave the best fit to waiting times for *no* DTA patients (Figure 2(a)). For patients with a DTA, a 4-phase Coxian phase-type distribution gave the best fit to the data (Figure 2(b)). The Coxian phase-type distribution is a probability distribution function capable of describing the movement of patients between a series of ordered phases (pathways). For the DTA patients, the pdf describing their waiting time can be given by $f(t) = \mathbf{p} \exp\{\mathbf{Q}t\} \mathbf{q}$. \mathbf{p} is a matrix of initial probabilities and \mathbf{Q} and \mathbf{q} are matrices consisting of the parameters of a 4-phase model, which are estimated from the waiting time data.

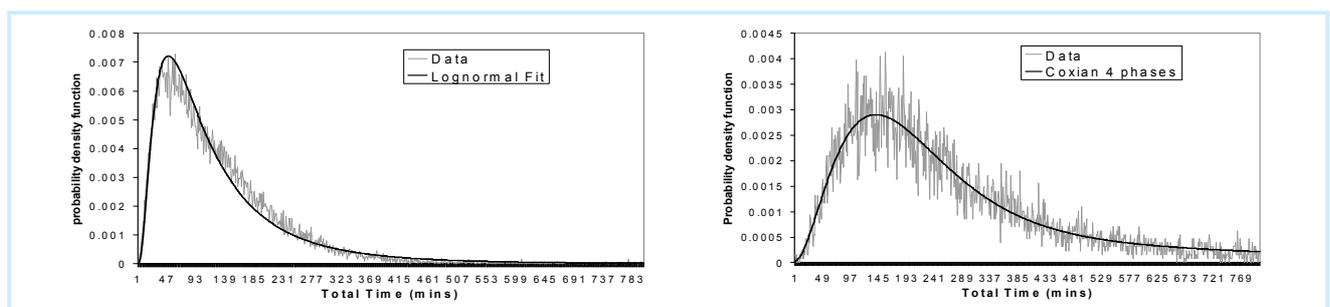


Figure 2: Results of fitting (a) a log normal model to the total time in A&E for no DTA patients and (b) a 4-stage Coxian phase-type model to the total time in A&E for DTA patients.

Nosokinetics News

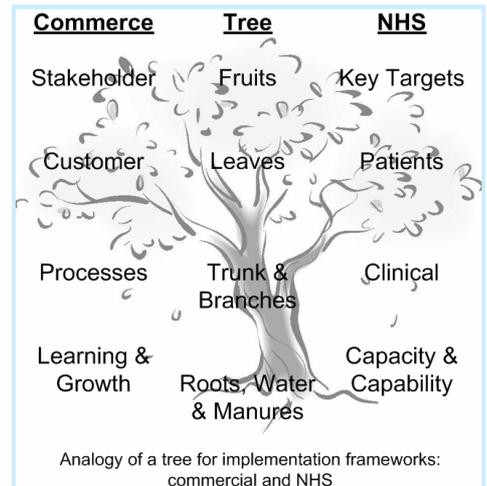
The NHS Plan and performance assessment frameworks

Editor's comment: *We congratulate Brijesh Patel from Thierry Chausselet's Group at the University of Westminster on his successful defence of his PhD submission. Here we consider the practical significance of his research, which reveals the links and traps in the Department of Health NHS Performance Ratings. (contact: brij21@hotmail.com)*



Performance management is a key component of success in commercial organisations. Companies invest in learning and growth, to improve the quality of products, to satisfy the customers, and to enrich the shareholders. Using the analogy of a tree, they water and manure the roots to strengthen the trunk to increase the yield of fruits (dividends) for the shareholders.

In July 2000, *The NHS Plan*, gave a blueprint for the modernisation and reform of the NHS over the next ten years. The planned change seeks to drive down costs and improve patient care, by changing the NHS from a professionally led clinical service based on planning norms, to a market driven service wherein patient choice, competitive tendering and targets drive down costs and improve care. Figure 1 shows how performance measurement in the modernised NHS differs from the commercial model.



A major problem that modellers' have to overcome is that models (imperfect as they are) seek first to describe the stable state, before determining the outcome of change. Since the 1980's, seeking instant success, every two or three years, politicians have been constantly changing the managerial structure of the NHS. Figure 2 shows the changes made in NHS performance measurement stems between 2001 and 2006. In 2001, CHI introduced a Balanced Score Card approach. Then star ratings were used to rank hospitals. Two years later, CHI was replaced by CHAI. Now the political goal has changed to 'Making and Sustaining Progress' and 'Getting the Basics Right'.

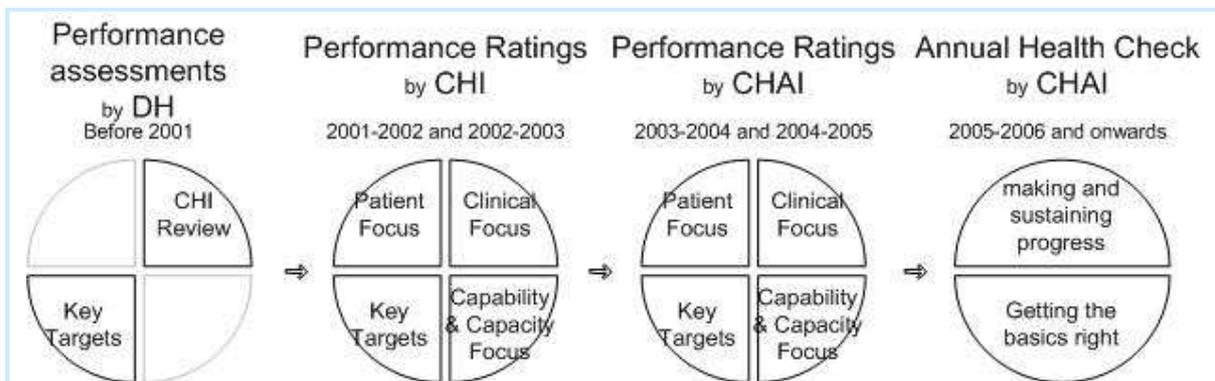


Figure 2. Changes in NHS Performance Measurement between 2001 and 2006. DH (Department of Health); CHI (Commission for Health Improvement); CHAI (the Commission for Healthcare Audit and Inspection).

Hospitals are human activity systems. Changing such systems takes time. Six months to consider what to do. Six months to employ new people to fulfil the task. One year to begin to implement change. Another year to consolidate the change and begin to establish a new stable state, which in years four and five will begin to reap the rewards of change. However, as a Chief Executive of a Primary Care Trust (who has been recycled three times in the last seven years) three jobs in six said " Politicians can't wait that long— they are on a four year cycle of elections and years two and three of comprehensive change are always chaotic. "Hence they blame others and reorganise, fostering chaos, rather than the excellence they seek.

Continued on Page 4.

Nosokinetics News

Pictures save a thousand words. The performance data for the financial years April 2001-March 2002 and 2002-03 came from the Department of Health website. After data cleansing, sixteen indicators in the returns of 148 Hospital Trusts, were suitable for analysis; 26 performance indicators were used in year one and 35 in year two.

Using the 26 performance indicators in the 2001-2 balanced score card, simple path analysis showed that patient satisfaction was linked to success in many aspects of care.

Performance Maps give a graphical view of the causal-effect relationships between indicators considered by a strategy map. Structural equation modelling was used to identify the relationships between the 16 common indicators for an average NHS Trust. One indicator, clinical negligence, was not related to any other factor in the strategy map. Simulating the impact of change, success in meeting the 'Emergency Readmission' target compromises 'Data Quality' and Delayed Transfer of Care'.

Patient Focus (PF)
6 months Inpatient Waits (P1)
Total Inpatient Waits - percentage of Plan (P2)
13 weeks Outpatients Waits (P3)
Cancelled Operations non-readmission (K5)
Breast Cancer Treatment (P7)
Delayed Transfer of Care (P8)
Clinical Focus (CF)
Clinical Negligence (C1)
Emergency Readmission - overall (C4)
Emergency Readmission for Children (C5)
Emergency Readmission for Fractured Hip (C6)
Emergency Readmission for Stroke (C7)
Capacity and Capability Focus (CC)
Data Quality (CC1)
Staff Satisfaction Survey (CC2)
Junior Doctors' Hours (CC3)
Sickness Absence Rate (CC4)
Information Governance (CC5)

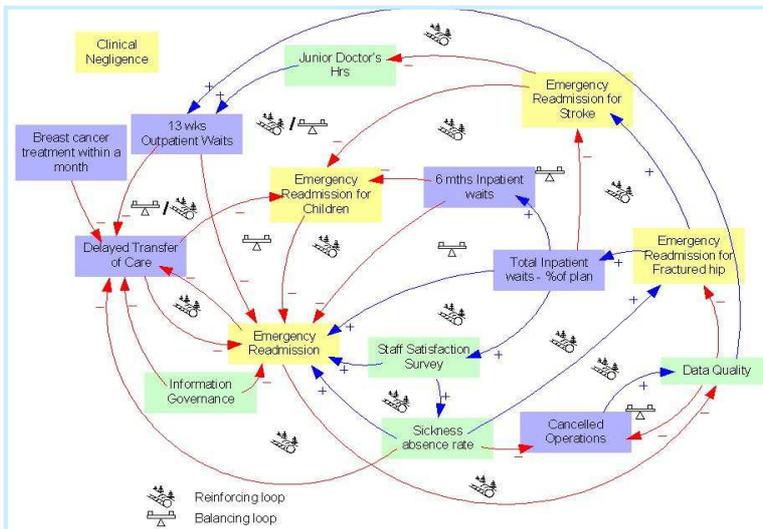


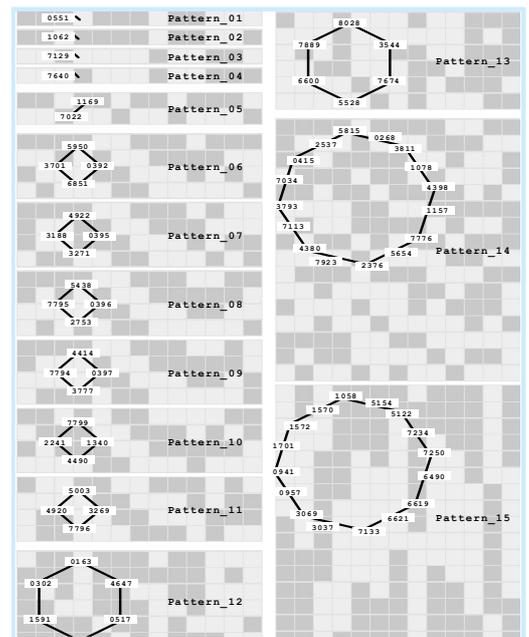
Figure 4. Performance map for the NHS Balanced Score Card (2001/02 to 2002/03) for an average NHS Trust. Purple Patient Focus, Yellow Clinical Focus, Green Capacity and Capability Focus.

Returning to the analogy of the 'Tree with its Fruits'. With the assistance of modelling research, such as that undertaken by Brijesh, we begin to understand the complex interactions between the different components of Health and Social Care Systems. Eventually, we will reach a stage where Administrative Efficiency and Maturity create virtuous cycles that improve the quality of care. Then we will know it's quality when the patients and their relatives see it.



Simulation using ten linked computers and difference equations based discrete dynamical systems to generate the status of change over 50 time periods and 8192 different states over 360 sets of assumptions. Eventually, from 2.9 million experiments 15 different patterns for the outcome of changes emerged.

Four single states. One double. Six four stage. Two eight stage. One fourteen and one fifteen. Thus the world goes round, much effort is expended and we return to where we are.



List of the fifteen distinct patterns revisited with over 2.9 million simulation experiments

Nosokinetics News

Lean thinking. Patients are not cars' write Ben Tovim and his co-workers from Flinders Medical centre. 'Providing good clinical care involves compassion and empathy as well as cognitive and organisational skills'. Nevertheless concepts used in manufacturing industry can be helpful in redesigning the pathways of care. In the *Australian Health Review* (2007, 31(1):10-15) they describe the progress they have made using Lean thinking to redesign care at the Flinders Medical Centre.

Value Streams. Also Ben Tovim and colleagues have used lean thinking to redesign patient flow through the Accident and Emergency service at Flinders Hospital.. A finding of their value stream change resonates with Louis Gibbs data analytical findings of two streams (page 2) —those to be admitted and those not to be admitted. Seeing the needs of admitted patients and non-admitted patients differ, it makes clinical as well as mathematical sense to provide specialist teams to meet their needs. See King, D. L., et al. (2006). "Redesigning emergency department patient flows: Application of lean thinking to health care." *Emergency Medicine Australasia* 18: 391-397.

Overcrowding in Australian Emergency Departments. Kamini Raj and his coworkers question the value of the National Emergency Overcrowding Study tool. However, their study of the agreement between objective and subjective scores was time limited (three weeks) and no overcrowding occurred, so further research is needed to validate their findings. See Raj, Ket, et al. (2006). "National emergency department overcrowding study tool is not useful in an Australian emergency department." *Emergency Medicine Australasia* 18: 282-288.

Disability increases length of stay. Take heed. A study of 1942 consecutive emergency admissions to Kent Hospitals, UK, reports the median difference between the observed and predicted HRG length of stay for patients with seven presenting conditions (one or more of stroke, fracture femur, myocardial infarction, acute respiratory infection, chronic obstructive airways and falls) was 1.2 days (25th percentile estimate 3.9 days, 75th 10.1 days) for patients with dependency. Hence these patients would have incurred £1.7 million in excess of their HRG based tariff. See Carpenter, I., J. Bobby, et al. (2007). *Age Ageing* 36(1): 73-78.

Fuzzy Logic and Interval Analysis. At a conference in Cairo, I learnt , in fuzzy logic an event can occur before or after a specific event. However, in interval logic they can only occur after the event. So a patient can arrive in a clinic before or after their specified time, but they can only be seen by the consultant after he or she has arrived. For a mathematical overview see: Moore, R. Lodwick, W. (2007). "Interval analysis and fuzzy set theory." *Fuzzy Sets and Systems* 135: 5-9.

Optimising hospital bed capacity. Increased demand and decreasing bed allocations make planning capacity a difficult problem for health care workers. Tackling this problem Akcali, E., M. J. Côté, et al. (2006) develop a mixed integer network flow model with capacity constraints, balancing the budget and waiting times. Different experiments are described. *Health Care Management Science* 9: 391-404.

Do nurse protocols diminish the capability of nurse practitioners? A study in the *Australian Health Review* by Jenny Carryer et al (2007, 31(1): 108-115) caught my eye because it questioned the use of tick box algorithms in clinical protocols. The academic nurse researchers from New Zealand and Australia question the wisdom of training nurse practitioners to take on a clinical supportive role while constraining their decision making by strict protocols. One of the father's of geriatric medicine Prof Ferguson Anderson said 'No self respecting old person comes into hospital without seven diseases!' I share their concern, often, the best thing to put on an old person's prescription in a line through the drugs that they are taking. No protocol tells you that.

Short term hospital occupancy prediction. Littig, S. J. and M. W. Isken (2007) develop a modelling approach using three basic flows, arrivals, internal transfers and discharges and four stages inpatient length of stay, total time spent in hospital and nursing unit and the current time. Time series models are used to predict emergency and direct arrivals. Multinomial regression models predict the unit of arrival and forecast three day discharges. The research is practical and a step towards the development of a complex model of flow. A weakness, , is the lack of recognition of Gary Harrison's approach to the problem of modelling bed census data. *Health Care Management Science* 10(1): 47-66.

Nosokinetics News

Warwick University Business School: Operational Research and Information Systems Group Post Research Fellow – A conceptual modelling tool for health care simulation projects

Salary: GRADE 6 £24,402 UP TO £29,138 PA Hours: Full-time Fixed Term Contract: 24 months

Reference Number 59499 - 037

Working on an EPSRC-funded research project in simulation in health care. Collaboration with surgeons and other clinical and non-clinical staff at two major hospitals in London and the south east of England. The overall purpose of this research is to improve implementation of the findings of health care simulation studies and the communication between modellers and stakeholders. You must have, or be about to obtain, a PhD in Operational Research or a related discipline and have experience of simulation modelling ideally in health care.

Closing Date: 21st May 2007 Further details for this post (including person specification and job description) may be found at <http://www.warwick.ac.uk/jobs>

Informal enquires: Dr Kathy Kotiadis Tel:02476 524275 (email: Kathy.Kotiadis@wbs.ac.uk) or Dr Christos Vasilakis Tel: 020 7911 5000 ext. 4029 (email: C.M.Vasilakis@wmin.ac.uk)

The US based Commonwealth Fund Website <http://www.cmwf.org/>

contains recent reports on the quality of care agenda and on performance measurement. Notably the ubiquitous average length of stay is still being used as a benchmark for success without regard to the impact of dependency and direction of discharge on length of stay. Incidentally, this is a grant funding organisation and may well be worth exploring for collaborative grants.

Electronic resources

Implementing Research - A guideline for health researchers

This recently updated 12-page booklet by The Health Research Council of New Zealand (HRC) is designed for researchers new to dissemination and implementation of research and working with mass media. The guide covers intellectual property, research and clinical practice, public health, changing policy, media advocacy and getting good media coverage.

<http://www.hrc.govt.nz/assets/pdfs/publications/HRC%20Implementing%20guidelines%20FINAL%20.pdf>

Australia: Health system review: Health Systems in Transition 2006

This document by the European Observatory on Health Systems and Policies takes an in-depth look at the Australian Health System. The report is divided into the following sections: organizational structure, financing, planning and regulation, physical and human resources, provision of services, principal health care reforms, assessment of the health system.

<http://www.euro.who.int/Document/E89731.pdf>

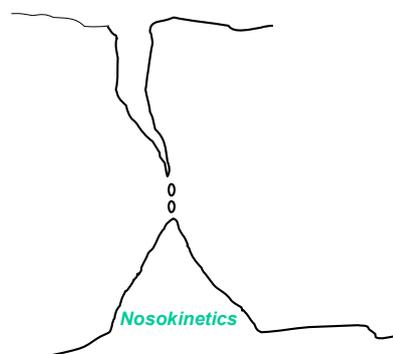
What about a new logo?

Mark sent me this.

Working towards building better health systems through facilitating improved understanding of patient flow by creating better information and modelling.

Better Decisions = Better Health Systems

Any offers?



Explanation:

1. Comes from a comment in our email discussions.
2. Stalactite = NK
3. Drips represent the slow progress
4. The stalagmite represents building the knowledge base

Working towards building better health systems through facilitating improved understanding of patient flow by creating better information and modelling.
Better Decisions = Better Health Systems

Nosokinetics News

SECOND INTERNATIONAL HEALTH AND SOCIAL CARE MODELLING CONFERENCE (HSCM 2008) Portrush, Northern Ireland 18 — 20 March, 2008

The first International Health and Social Care Modelling Conference of the Nosokinetics Group, at the University of Adelaide in April, 2006 provided a unique opportunity for researchers and practitioners 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.



The Second International Health and Social Care Modelling Conference (HSCM2008) organised by the University of Ulster will take place from 18th-20th April 2008 in Portrush, Northern Ireland. Portrush is a small seaside town on the North Coast of Ireland, with beautiful beaches, convivial restaurants and friendly pubs. It is close to the Bushmills Distillery and Giant's Causeway and part of the Causeway Coast Area of Outstanding Natural Beauty.

For further details contact Sally McClean (si.mcclean@ulster.ac.uk)

MODELLING IN HEALTHCARE STREAM OF THE OPERATIONAL RESEARCH SOCIETY CONFERENCE

Edinburgh on 4th - 6th September

http://www.orsoc.org.uk/conference/papersubmission/conference_submit.asp?cid=14

Stop Press

The Fifth IMA conference on Quantitative Modelling in the Management of Health Care was an outstanding success. 120 delegates from 16 countries. Six plenary sessions, over fifty papers, twenty posters. We thank Lucy Nye and her team from IMA, the organising committee led by Thierry Chausalet from the University of Westminster, his supporting doctoral students and the programme committee for the work that they did to make the conference enjoyable and instructive for all who attended.

A report of the conference contributions will be in the next issue. From the plenary papers we learnt that all models are myths, and all are not right. However, we also recognised that models like numbers can be too wrong. So the aim becomes seeking models that are not too wrong, and recognising that models 'like horses need to be fit for courses' and the results depend on the methods, the theories and the data.

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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