Newsletter of the UK Nosokinetics Group

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Past issues at http://www.nosokinetics.org/

Nosokinetics
HEALTH & SOCIAL CARE MODELLING

Farewell Iceberg, Hello Logo. Thanks to Mark Mackay in Adelaide and Andrew Gibki's design, the logo brings together symbiosis, working together, and nosokinetics in our mission, creating the science base to underpin decision making in health and social care systems to meet the needs of all citizens.

Nosokinetics
HEALTH & SOCIAL CARE MODELLING

Successful IMA conference: note call for papers

Since our February Newsletter much has happened. Not least of which is the successful IMA Modelling Conference, 'Quantitative Modelling in the Management of Health Care which attracted a keen group of delegates. Witness the fact that there was a near full house on the last morning to listen to Kate Silvester, championing the cause of a systems approach to health and social care modelling.

Kate has unique insights in that she brings together a medical degree, experience in eye surgery and a degree in engineering. With this in mind, a recent publication of Royal College of Physicians of London Journal (Clinical Medicine 2010; 10 (1) ; 13-15 Allder, Silvester & Walley consider concepts associated with 'Managing capacity and demand across 'the patient journey'.

PhD success.
We congratulate Md Asaduzzaman from Thierry Chaussalet's Health and Social Care Group at the University of Westminster on the successful defence of his PhD on Capacity Planning in Perinatal Networks.

And feature in pages 2 and 3 Laliit Garg's successful thesis Unified Modelling for Care of the Elderly from Sally McClean's Group in the School of Computing and Information Engineering at the University of Ulster, NI.

Asad

Lalit

Looking back, going forward.– reaching the tipping point

Looking back strains the neck and makes one fall over one's feet. Nevertheless, we planted the flowering cherry tree in our garden 40 years ago; the statue and pond (now housing 5 conifers) was possibly placed there before the First World War. As hundred and five years ago the whole place was a field.

'What's that got to do with Nosokinetics?' you may well ask. Every picture tells a story. If there were six conifers in the pond, which would not aesthetically seem right, we have the six line hexagrams that underpinned reasoning in — Chapter 3 New Concepts Based on Throughput and Occupancy pages 82-106 in my 1988 MD thesis. Available on line http://www.nosokinetivs.org/
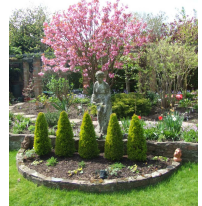
The model developed explains why admission numbers change, even though staff behaviour with regard to treatment is a constant. A constant style of staff behaviour, operating within different patterns of resource allocation, would also explain why different departments, with different internal mixes of beds, yet equal enthusiasm, get different results, when actually doing the same thing.

Sometime soon, due to the seminal work, twenty years ago, of two mathematicians, Prof Gary Harrison, College of Charleston, SC USA, who created the first mathematical solution to a two compartment model of flow and Prof Sally McClean at the University of Ulster, Coleraine, NI who validated the model and its stochastic equivalent, the world will wake up and recognise the inappropriate use of mechanical, linear, cause and effect models in the planning of health and social care systems. And the sooner that comes the better it will be for everyone.

Lalit Garg PhD   Unified Modelling for Care of the Elderly

School of Computing and Information Engineering, Faculty of Computing and Engineering, University of Ulster

Editor's comment. Accepted without changes, Lalit's thesis, in Sally McClean's group, heralds a new dawn n the mathematical modelling of clinical services.

The overall objective of this thesis was to develop and validate mathematical and statistical methods to aid informed healthcare decision making by providing useful information readily available to help hospital staff, managers and policy makers to ensure the quality of elderly care while at the same time reducing the cost. As the result of the work of this thesis, holistic methods are proposed to facilitate understanding of the healthcare process dynamics and management, monitoring and performance measurement of healthcare systems (See Fig. 1).

These models are illustrated and validated using three different datasets: a historical dataset on geriatric patients from an administrative database of a London hospital, a nationwide dataset available from the English Hospital Episode Statistics database on stroke-related patients, and a 5 years' retrospective dataset of stroke-related patients admitted to the Belfast City Hospital.

A novel mixture distribution is proposed for modelling hospital length of stay comprising of components of Gaussian mixture distributions and Coxian phase type distributions to overcome the limitations of these two distributions. It provides a significantly improved fit to length of stay data over both of above distributions.

Fig. 1: Diagrammatic representation of main contributions of the thesis

Two novel techniques based on survival trees have been proposed for clustering patients into clinically meaningful patient groups with respect to their length of stay; where partitioning is based on covariates such as gender, age at the time of admission and disease diagnosed. Each node in phase-type survival trees is modelled by a Coxian phase type distribution.

In order to have improved within node homogeneity, different nodes in mixture distribution survival trees can be modelled by distinct types of mixture distributions. The phase type survival tree is further grown by partitioning the terminal nodes into subgroups with more homogeneous patient pathways based on covariates representing outcome measures such as discharge destination (See Fig. 2 overleaf).

A novel approach based on phase type survival tree analysis and their extended survival trees is proposed for patient pathway prognostication of survival data. They provide understanding of heterogeneity of patient pathways stratified by covariates representing patient characteristics and can also be used to estimate the length of stay of a patient based on his/her characteristics available at the time of admission. We critically investigated and assessed the effect of using different splitting criteria to develop more efficient clustering.
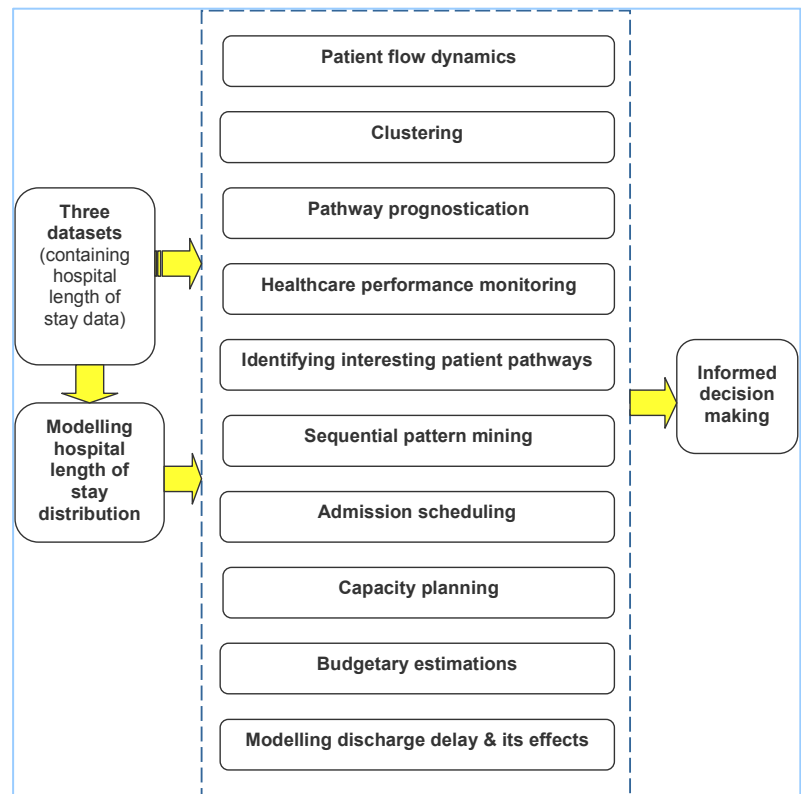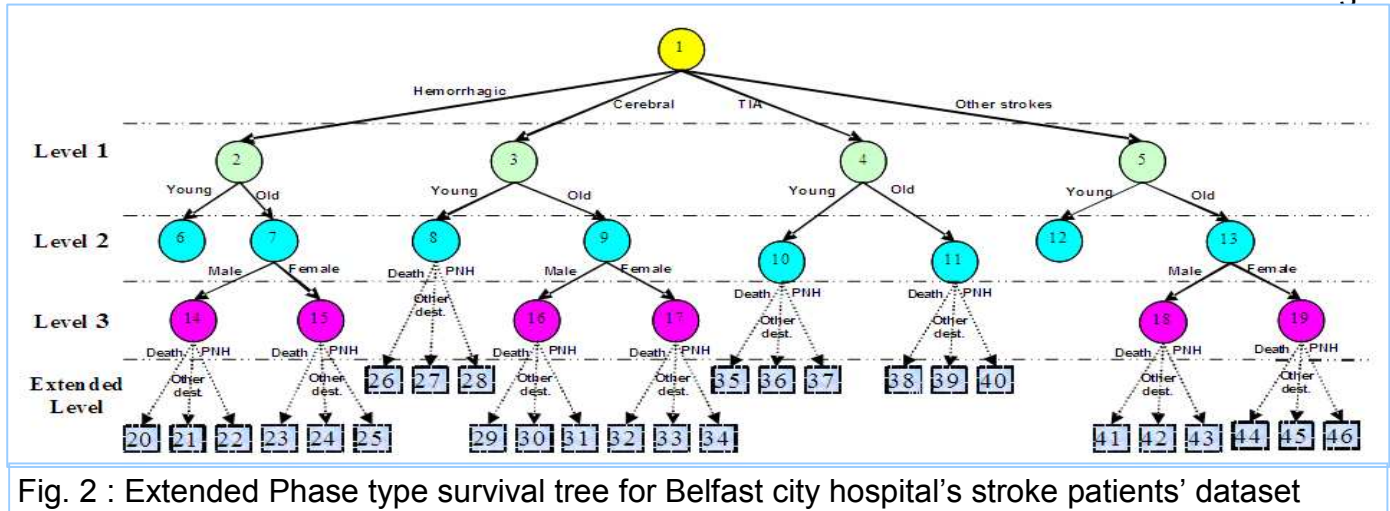
Fig. 2 : Extended Phase type survival tree for Belfast city hospital's stroke patients' dataset

We have proposed a non-homogeneous Markov model to compute key performance measures for the whole patient care system, including both hospital and community components. Two novel applications of the mathematical data mining techniques called interestingness and sequential pattern mining are proposed for healthcare data.

Sequential patterns are identified as patient pathways using a non-homogeneous Markov model. An algorithm is described to efficiently extract a number of such interesting or exceptional sequential patterns which require attention for efficiently managing scarce healthcare resources and developing effective healthcare management policies.

Two novel models are proposed for optimally scheduling patient admissions to satisfy resource restrictions, resource requirement forecasting, budgetary estimations, and/or comparing different admission scheduling strategies for a care system.

First, a model based on sequential pattern mining technique, which is simple, easy to implement, has better explainability and can be used for optimal control of admissions with fixed rate of change in the admissions to satisfy resource constraints in the future.

The second model is a more sophisticated non-homogeneous discrete time Markov model and cannot only be used in a scenario with fixed admissions each day but for more sophisticated admission scheduling as well such as a variable number of admissions each day to allocate resources to satisfy the fluctuating demand for care services or resource constraints.

A novel capacity planning model based on survival tree based analysis is also proposed which provides better estimations of resource requirements and cost of care as it considers the effects of individual cluster of patients, their interactions in the whole care unit and thus the effect of demographic changes in the patient population.

The approach is further extended to model blocking states, and the corresponding detrimental effect on length-of-stay and cost of care of patients whose discharge have been delayed.

In summary this thesis proposes models to make important information readily available to hospital staff, care managers and policy makers to aid strategic decision making the implementation of strategies for effective care management and improvement.

Nosokinetics News

Measuring and modelling the process of care: need for a new science
Peter Millard, Emeritus Professor, Geriatrics, St George's, University of London

"Either we must stop asking "Why" or we must seek to extend our intuition to new levels, to see that processes and events have shapes of their own'.

Structural Stability and Morphogenesis, Rene Thom 1923

Hospitals where too next?
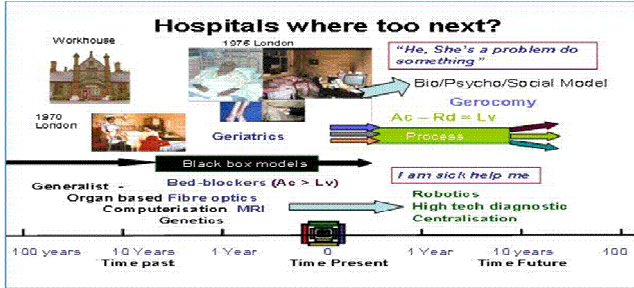
A famous riddle asked by the Sphinx:
"What goes on four legs in the morning, on two at noon, on three at night?" Oedipus guessed the right answer.

The pathway from birth to death varies for each and everyone of us. Look around you. Everything has been present for measurable amounts of time. Indeed the only thing we have in common is Time. How then should we model it?.

Compare and contrast general medicine and geriatrics; commonality and differences.

General Medicine
Contract: 'I am sick, help me'
  Bleeding, Pain Breathless, etc.,
Time in service
  Intensive   : Minutes and Hours
  Acute   : Hours and Days
  Recovery : Days and weeks
Streams: One to three
Bed allocation: Unconstrained
Bed borrowing : Yes; Outliers
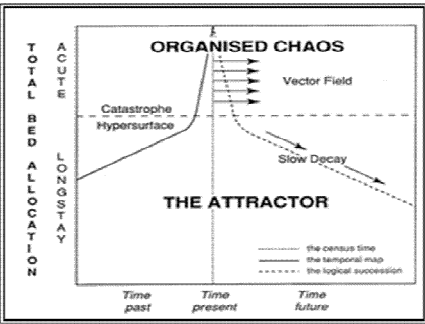
A topological model

Geriatric Medicine
Contract: 'He/ She is a problem, do something.' Bed-blocking, Falling, Confused, Incontinent,
Time in service
  Assessment : Days and weeks
  Enablement : Weeks and Months
  Long stay   : Months and Years
Streams: One to three
Bed allocation : Constrained
Bed Borrowing: No: Waiting lists   :
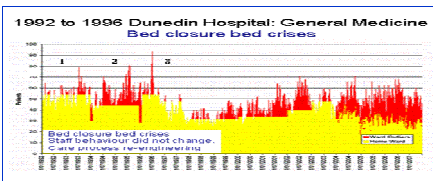
Medical outliers in a NZ Hospital.
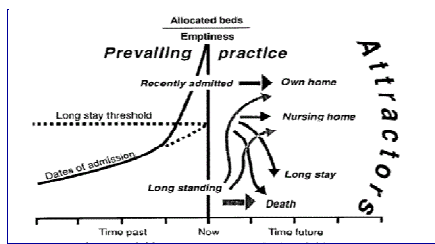
A clinical model of flow
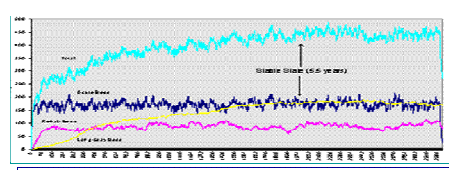
Six years to stable state: Simulation; Geriatrics – acute, rehab and long stay

Essential Measures of Process

1. Average Service Time per occupied and allocated bed:
Beds x Days (365) / Admissions
2. Percentile distribution of length of stay at discharge
Interquartile range, 95th and maximum stay
3. Direction at discharge:
Home, transfer, death
4. Plots of daily bed allocation and bed use
Midnight; 8.00 am; Midday; 6.00 pm

COMMONALITY

General and Geriatric Medicine are Human Activity Systems. Changing such system takes time..
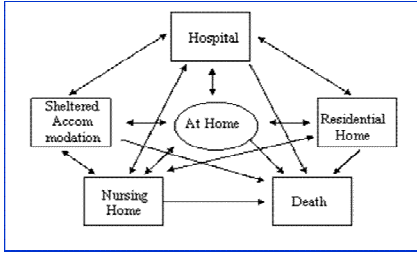
McClean and Bustard 1996

- Options 1, 2, 3
  – Long stay the same
- Options 4, 5, 6
  – Long stay Increase
- Options 7, 8, 9
  – Long stay decrease

Worst option

Best option

Geriatrics: Nine options for change.

NB Years to change, days to destroy

In putting together this poster, with a clinical view, I am conscious of all the people living and dead who have and are contributing to the Nosokinetics agenda. Without them but little could be achieved. phmillard@tiscali.co.uk

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Chand, S., Moskowitz, H., et al 2009. Health Care Manag Sci. 325-40

Impact of an observation unit and an emergency department-admitted patient transfer mandate in decreasing over-crowding in a pediatric emergency department: a discrete event simulation exercise Hung, G. R. and Kissoon, N. 2009. Pediatr Emerg Care. 160-3

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Tantau, C. 2009. J Ambul Care Manage. 32-43

Health care costs in the last week of life: associations with end-of-life conversations
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Modelling the size and skill-mix of hospital nursing teams
PR Harper, MH Powell and JE Williams JORS; 51 (5) May 2010 pages 768-779

The origin of bursts and heavy tails in human dynamics
Barabasi, A. L. 2005. Nature. 207-11

Somehow, and I don't know how this paper appeared in my EndNote data file. Serendipity. It opened my eyes. Linearity. Exponentials. Dynamic and stochastic models. Probabilities. Means and Poissons and Pareto Efficiency—80:20—the economic reason for markets, winners and losers: the rich get richer and the poor get poorer.

Bursts and heavy tails, took me back to a winter's night in 1960. As pre-reg houseman on my first surgical post, 5.00 p.m. to 9.00 am Thursday night I was on call for surgical emergencies. The day the labourers subbed their wages. Always busy—but this was an exception. 'Slash Bill … , bottled in a pub fight arrived and left with five policeman holding him down on a trolley. In between, without police in the room, he behaved impeccably. Circa 100 stitches later, to hands and face without anaesthetic, He asked for a 'fag' and could his girl come in. Together, we sat on the cubicle floor smoking. Then with a polite, thanks doc, I left and the police came back in— true to his reputation out he went struggling like mad, on the next stage of his nights journey to a police cell.

Why that tale, you may well ask. Its just written to remind me that however close we can get to measuring an model resource use, we need to bear in mind that there are exceptions to every rule. And my experience in 1968 was even then an exception to the rule. There is no certainty.

SIXTH IMA Conference 29-31 March 2010—Call for papers

We remind all those who attended the conference that selected papers will be published in the Springer journal Health Care Management Science or the IMA Journal of Management Mathematics - All participants wishing to be considered for publication must submit their manuscript to R.D.Baker@salford.ac.uk by the end of **MAY 2010** as an email attachment in MS Word or pdf. Indicate clearly which journal you would like your publication to be reviewed for. Follow the instructions for authors given for the journal you are considering.

JULY

Summer school (Biomedical and Health Informatics)
Samos Island, Greece19-24 July, 2010
http://www.ineag.gr/summerschool/index.php

24TH EUROPEAN CONFERENCE ON OPERATIONAL RESEARCH (EURO XXIV)
Lisbon, Portugal, July 11-14, 2010
www.euro2010lisbon.org Second call Abstracts Feb 28, 2010

SPAIN

WCCI 2010 IEEE World Congress on Computational Intelligence
Computational Intelligence and Cyberinfrastructure for Complex System Modelling and Knowledge Discovery in Medical Informatics and e-Health".
July 18-23 Barcelona, Spain Submission deadline extended until 7th February, 2010.
http://www.wcci2010.org/submission. Special Session "S122:

POLAND

MI&E'10 Workshop on Medical Informatics and Engineering
At International Multiconference on Computer Science and Information Technology (IMCSIT),Wisła, Poland, October 18-20,2010 http://mie2010.imcsit.org visit theMI&E'10 web site at http://www.imcsit.org/pg/319/259

UK Two week intensive course on:**"INTRODUCTION TO INFECTIOUS DISEASE MODELLING AND ITS APPLICATIONS"**organized jointly between the London School of Hygiene & Tropical Medicine and the Health Protection Agency Centre for Infections, UK **Venue:** London School of Hygiene & Tropical Medicine
Course dates: 5th-16th July 2010 **Cost:** £1,900

UK
'Optimization' stream at the OR52 Conference, to be held in the Royal Holloway University of London, UK, September 7-9, 2010: http://www.orsoc.org.uk/orshop/%28wi2vp345cmhoh5nqxidqgveq%29/orcontent.aspx?inc=or52_main.htm

UNDERSTANDING & EXPLORING PERFORMANCE MEASUREMENT – Wednesday 12th May 2010 - Birmingham contact hilary.wilkes@theorsociety.com

Nosokinetics News is the newsletter of the UK Nosokinetics Group

Nosokinetics is the science / subject of measuring and modelling 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.

Officers of the Nosokinetics Group:

Chair: Prof Sally McClean, *University of Ulster*
Secretary: Dr Adele Marshall, *Queen's University*
Treasurer: Dr Thierry Chaussalet, *University of Westminster*
Conference: Dr Elia El-Darzi, *University of Westminster*
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