Issue 7.1 **Nosokinetics News** February 2010

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

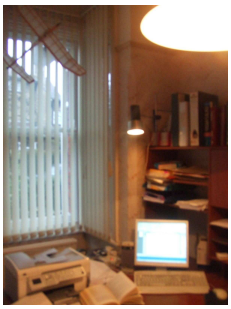
NK Seventh Year - where to next? Journey over, another begins

The beauty of the mathematical models of flow of patients through health and social care systems, which have followed the seminal work of Gary Harrison in Charleston, SC and Sally McClean in Coleraine, NI, is that they bring transparency to the process of inpatient care. No longer is it good enough to compare and contrast the process of hospital inpatient care, to plan and to set targets simply in terms of numbers of beds allocated and occupied, admissions and discharges, and length of stay at discharge. For the needs of an ageing population are much more complex than that.

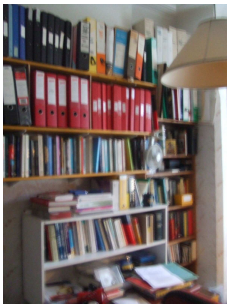
During the last twenty years, little by little and step by step, like a mushroom growing in the dark, others have joined in. Mathematically; Florin Gorunescu, Romania, Thierry Chaussalet, UK, Malcolm Faddy, Australia and Adele Marshall, Queens University Belfast. Computationally, Elia El-Darzi at Westminster. Organisationally, Mark Mackay in Adelaide; and Clinically, Brendon Rae, New Zealand have made major contributions.

So much so that we can safely say, we have the tools, and the know how to measure and model the time sequence of care in constantly moving systems. For example, by combining snap-shots in time present (bed census data) with past patterns of resource use (cohort data) Thierry Chaussalet's group at the University of Westminster are leading the field in providing a decision support tool, which enables purchasers of residential and nursing home, Local Government and Primary Care Trusts, to estimate their committed cost of care in publicly funded placements.

One stage is over, another begins. Early concepts of measuring and modelling time came from one of my heroes, PD Ouspensky, a Russian Mathematician Philosopher, author of a New Model of the Universe. Now mathematically, we can measure and model the time dimensions (phases) of health and social care, and clinically, using destination at discharge and percentile distributions of length of stay, we can explore and explain how and why staff learnt behaviour and discharge destination interact to explain differences in the outcome of care.

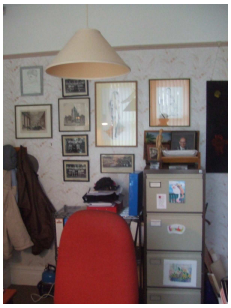


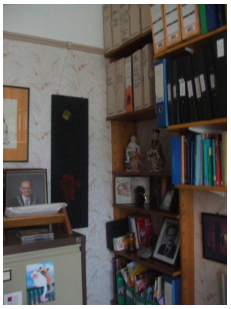
However, clinically and practically, without visiting the hospitals and homes, no-one knows why, where and when differences in outcome occur, while medically staff are doing the same thing. Witness to this I give you four snapshots of my study.



Basic statistics. The room height is 10 feet, width 8 feet, length 12 feet. The left picture, is a view to the street. Focusing on the computer, you may or may not see the glider in the upper left hand corner. And even if you did, and more importantly, you would not know why it flies there.

Looking behind me, the picture on the right, the red folders contain all publications 1969- 2009. Clearly, I am not there. Which doesn't indicate that I am not there. Indeed, bottom left, if this shows the back of the chair and not the front, someone with a black hat on could be sitting in the chair.





Finally, bottom right, there is a filing cabinet, two Chinese figures and a black painting, by Joseph, one of our 12 grandchildren, when he was eight. It's the moon and an astronaut. No knowledge there about me, but guesses of what might be. Moreover, no knowledge of the nature of the rest of the house. But, I'll let you into a secret - it doesn't look at all like this - much more tidy, but that's Gill's territory.

'Why this?' you may ask. Well For twenty years, Gary and Sally, the lead mathematicians, have developed step-by-step, alone and with others a science base to underpin the planning of sustainable health and social care systems to meet the needs of an ageing population. Bringing transparency to the importance of symbiotic relationship between health and social care. Collaboration not competition.

The beauty of the mathematical and computational solutions is that they enable 'What If'' optimisation of competing solutions of the outcome of change. However, there is a caveat, for, like the pictures in my study, they give information but no knowledge about the contents and purpose. Which is why the Nosokinetic, mathematical science base of medicine, now needs to be co-developed in association with the Art of care.

Insight from Australia

Short-term forecasting of emergency inpatient flow

Abraham, G., et al. IEEE Trans Inf Technol Biomed, 2009. **13**(3): p. 380-8.

Modelling three years daily data emergency admissions are largely random, hence unpredictable, whereas emergency occupancy can be forecasted, up to one week ahead, using a model combining regression and autoregressive integrated moving average (ARIMA) model, or a seasonal ARIMA model, Faced with variable admissions and occupancy, hospitals must prepare a reserve capacity of beds and staff. Their approach allows estimation of the required reserve capacity.

Myths of ideal hospital occupancy

Bain, C.A., et al., . Med J Aust. **192**(1): p. 42-3

Where did 85% come from? Horrocks (Age and Ageing 1986;15:321-342) from experience in geriatrics recommended it. And Bagust (BMJ 1993;319:155-8), using a simulation model and acute medical data, concluded that departments with more than 85% occupancy would experience difficulties. Since then 85% has become a management mantra. Yet, elementary queueing theory shows that a finite-capacity system with variable demand cannot sustain both full utilisation and full availability. So a single level of ideal or save occupancy is too simplistic an interpretation and application of the underlying science. Authors argue that a specific study and action are necessary to understand and deal with the problems of long waiting lists and access block in any given health care facility. Editor Think about it—general medicine has an unconstrained bed allocation, with seasonal demand (need) and the shorter the length of stay is the greater the need for empty beds. More beds in winter fewer in summer.

Modelling the process of inpatient care and planning for the future

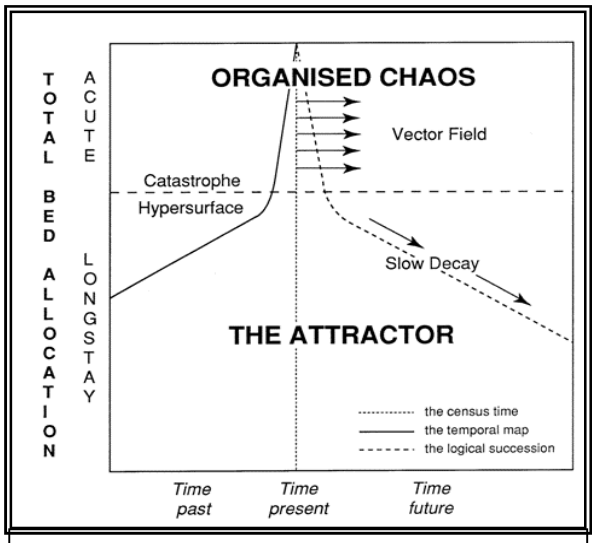


Figure 25: Theoretical model of a department of geriatric medicine in stable state. The total bed allocation is constant. There is organised chaos in the acute sector with a constant force of behaviour in the vector field. The temporal map - a plot of time that has passed since the first consecutive admission, i.e. the district spell - shows the prevailing practise with regard to the balance of acute and long stay patients. The catastrophe hypersurface derived by backward projection of the long stay separates the two states. The mirror image of the temporal map shows the logical succession.

See http//www.nosokinetics.org MD publication

Reflecting on the way forward, my mind went backwards, to the days in the 80's when we were struggling to understand the basic concepts underpinning the process of inpatient care. And I recalled a lunch time discussion with Dr (now Prof) Brian Livesley , who directed our thoughts to Catastrophe Theory and the work of Prof Rene Thom. The Figures come fro theory and the work

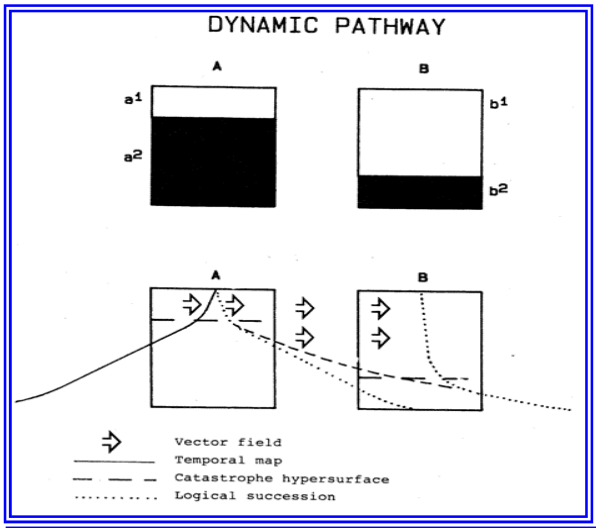


Figure 26: The dynamic pathway between state A and state B represents a combination of the exponential decay in long stay patient numbers present in state a and the expected decay in patient numbers in state B. Change from state A to state B therefore requires time, because the rate of change between state A and state B depends on the rate of decline in state a^2 with time, coupled with the rate of decline in state b^2 .

Recent References relating to the use of modelling in clinical care.

At the December meeting of the UK Nosokinetics Group, to ease the task, it was decided that a more frequent publication, with notices of conferences and titles of publications in the literature would be helpful. Hence titles and details only.

Bernstein, S.L., et al., *The effect of emergency department crowding on clinically oriented outcomes.* Acad Emerg Med, 2009. **16**(1): p. 1-10.

Damiani, G., et al., *An ecological study on the relationship between supply of beds in long-term care institutions in Italy and potential care needs for the elderly.* BMC Health Serv Res, 2009. **9**: p. 174.

Dexter, F., et al., *Automatic updating of times remaining in surgical cases using bayesian analysis of historical case duration data and "instant messaging" updates from anesthesia providers.* Anesth Analg, 2009. **108**(3): p. 929-40.

Hoot, N.R., et al., *Forecasting emergency department crowding: an external, multicenter evaluation.* Ann Emerg Med, 2009. **54**(4): p. 514-522 e19.

Jones, R., *Cycles in emergency admissions* British Journal of Health Care Management, 2009. **15**(5): p. 239-246.

Karnon, J., M. Mackay, and T.M. Mills. *Mathematical modelling in health care* in *18th* World *IMACS / MODSIM Congress,* . 2009. Cairns, Australia 13-17 July.

Kolker, A., *Process modeling of ICU patient flow: effect of daily load leveling of elective surgeries on ICU diversion.* J Med Syst, 2009. **33**(1): p. 27-40.

Lovell, C.A., A. Rodriguez-Alvarez, and A. Wall, *The effects of stochastic demand and* expense *preference behaviour on public hospital costs and excess capacity*. Health Econ, 2009. **18**(2): p. 227-35.

Marrie, R.A., N.V. Dawson, and A. Garland, *Quantile regression and restricted cubic splines are useful for exploring relationships between continuous variables.* J Clin Epidemiol, 2009. **62**(5): p. 511-7 e1.

Nager, A.L. and K. Khanna, *Emergency department surge: models and practical* implications. J Trauma, 2009. **67**(2 Suppl): p. S96-9.

Pidd, M. and M. Gunal, *Ending the wait.* Nurs Manag (Harrow), 2009. **15**(9): p. 14-7.

Schoenmeyr, T., et al., *A model for understanding the impacts of demand and capacity on waiting time to enter a congested recovery room.* Anesthesiology, 2009. **110**(6): p. 1293-304.

Schweigler, L.M., et al., *Forecasting models of emergency department crowding.* Acad Emerg Med, 2009. **16** (4): p. 301-8.

Thomsen, M.S. and O. Norrevang, *A model for managing patient booking in a* radiotherapy *department with differentiated waiting times.* Acta Oncol, 2009. **48**(2): p. 251-8.

Troy, P.M. and L. Rosenberg, *Using simulation to determine the need for ICU beds for* surgery *patients.* Surgery, 2009. **146**(4): p. 608-17; discussion 617-20.

Vasilevskis, E.E., et al., *Mortality probability model III and simplified acute* physiology *score II: assessing their value in predicting length of stay and comparison to APACHE IV.* Chest, 2009. **136**(1): p. 89-101.

Zai, A.H., et al., *Queuing theory to guide the implementation* of *a heart failure inpatient registry program.* J Am Med Inform Assoc, 2009. **16**(4): p. 516-23.

Editors comment—if you would like attention to be drawn to your publications email

phmillard at tiscali.co.uk

Sixth IMA International Conference on
Quantitative Modelling in the Management of Health Care
Mary Ward House, London on 29 - 31 March 2010
Early-Bird registration deadline is 22 February.
Register online at http://online.ima.org.uk

APRIL

2nd International Conference on Computer Supported Education
CSEDU 2010, to be held in Valencia, Spain (7 - 10 April, 2010) (http://www.csedu.org)

JUNE

7th Annual ICMCC Event Personal Health – Intelligent solutions to serve empowered patients 8-11 June, 2010 http://2010.icmcc.org
University of Westminster, London, UK
Abstract deadline 14 February 2010
http://2010.icmcc.org/2010-call-for-papers/

ALIOS INFORMS 2010 Joint International Meeting
June 6-9, Law School, University of Buenos Aires, Argentina.
http://meetings.informs.org/buenosaires2010
Abstract extended to February 12

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

GREECE (a trio three in one)

CSOFT 2010 5th International Conference on Software and Data Technologies -
Website: http://www.icsoft.org July 22 - 24, 2010 Athens, Greece Abstract March 05, 2010

ENASE 2010 5th International Conference on Evaluation of Novel Approaches to Software Engineering

Website: http://www.enase.org July 22 - 24, 2010. Athens, Greece.

Paper submission March 2010,

ICETE 2010 7th International Joint Conference on e-Business and Telecommunications
July 26 - 28, 2010 Athens, Greece Website: http://www.icete.org
Regular Paper submission: February 24, 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, Po-

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.