Issue 2.6 **Nosokinetics News …** December 2005

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.

Nosokinetics seeking a better world

Hands across the world Adelaide HSCM 2006 University of Adelaide, 19 – 21 April 2006

Thanks to Mark Mackay and Elia ElDarzi arrangements are now well in hand for our first International Conference on Health and Social Care Modelling and Applications (HSCM 2006), at the University of Adelaide, Adelaide, South Australia, 19 – 21 April. The deadline for Abstract is now the 9th of December, Notification of acceptance 20th December, Early bird registration 31st January 2006. If you can come remember to register as a Nosokinetics News Reader.

What's in a word: Nosokinetics?

Although millions of people know that MRSA infections are acquired in hospitals, few would recognise this if they were told MRSA is a nosocomial infection. Two years after we launched Nosokinetics News we now have 115 hits on the web. Contrast that with the 2,160,00 hits for MRSA and you can see that we have a long way to go.

Should we have started from here? At the end of our second year, I think of the car-driver lost in an Irish village who asked an old man sitting on a seat "How do I get to Dublin from here?" Only to be told, "I wouldn't start from here if I were you."

Hospital acquired infections, drug errors, bed shortages, bed borrowing, bed blocking, outliers, trolley waits, ambulance by passes, cancelled operations, delayed discharges and constant managerial changes plague modern hospitals. The rationale for what we do is clear – "It's an interesting problem, which for everyone's benefit needs to be solved."

Moreover, in the United Kingdom, bi-annually, government Ministers have been changing the way the NHS is organised, thus giving the illusion of progress while causing the maximum confusion and dismay. Will we solve that? It's a tall order, yet, "If the flapping of a butterfly's wings in the Amazonian jungle can cause a hurricane in the Pacific Ocean" who knows what can be achieved.

As the New Year approaches may I take this opportunity to thank you for your support and to wish you good fortune and good health in 2006 and beyond.

Nosokinetics on the web: last but not least

MRSA 2,160,000 (Google hits)

Nos'o'co´mi`al (940,000)
1. Of or pertaining to a hospital; as nosocomial atmosphere
2. Acquired in a hospital; as a nosocomial infection

No`sol´o`gy (78,800)
A systematic arrangement, or classification, of diseases

Nos`o`log´ic`al (36,100)
Of or pertaining to nosology

No`sog´ra`phy (9,600)
A description or classification of a disease

Nos`o`po`et´ic (2,330)
Producing diseases

Nos`o`pho´bi`a (716)
A morbid dread of disease

Nos'o'ki'ne'tics (115)

The science/subject of measuring and modelling flow in health and social care systems

Footnote: "A Sting in the Tale" A reader writes: It's an uphill struggle. At a Strategic Health Authority meeting on capacity planning, the organiser stated that (Episodes) * (80th percentile of LOS) was the ONLY way to calculate bed requirements. When he argued that whilst the 80th percentile was better than the average, there are considerably better ways of estimating bed requirements. He was told to shut up because "*The NHS is not ready for your way of thinking*".

Simulating Accident and Emergency Services with a generic process model.

Anthony Codrington Virtue RKW Ltd & PhD student University of Westminster, London
email webversion

Editor's comment. Patients enter and leave hospitals 24 hours a day throughout the year. As well as purpose, structure and function model makers need to consider time, day and method of arrival, degrees of difficulty, age, alternative placement and staff availability. Here research developing a generic process of accident and emergency services is described. Data analysis is important. Look and see how the four-hour (political) waiting list target distorts the pattern of length of stay.

Bridging the gap: Challenges and opportunities for modellers The potential benefit to be gained by simulation modelling of health care systems is huge. Nevertheless, compared to other industries, modelling has a relatively poor adoption in health care. Model builders need to lead the effort to develop models, by improving their understanding of health care needs and challenges (model building) and communication of user-friendly models, to help provide answers and insights into complex health care issues.

Model building The continued advancement of computing power and visually interactive software opens-up the potential use of user-friendly models. This creates both opportunities and challenges for model builders. Table 1 shows that high abstraction levels are flexible enough to model any system or scenario.

Table 1. Model Building (adapted from Sinreich and Marmor, 2004*)

Generic Activities	Generic Processes	Fixed Processes
High abstraction	Medium abstraction	Low abstraction
Flexible: models any system and scenario	Flexible: models systems using similar processes	Specific: only models the system it was designed for
Difficult: user requires knowledge and experience		Simple: easy to use after a quick explanation

*A simple and intuitive simulation tool for analysing emergency department operations, from the proceedings of the 2004 Winter Simulation Conference in Washington, D.C.

However, high abstraction levels require high levels of knowledge, experience (and often time), to develop models that are sometimes difficult for non-expert users to interrogate. In contrast, low abstraction levels are simple and easy to use, but their use is limited to the system for which they are designed. The challenge is to develop models at medium abstraction levels, which both capture appropriate system complexity and ease of use.

Modelling Accident and Emergency A framework for the development of a generic processes model using discrete-event simulation and visually interactive software (Simul8) is being created. The framework allows users to input ambulance and walk-in arrivals hourly, over a 24-hour period, over a 7-day week via Excel spreadsheet interfaces. It also allows the user to direct arrivals through a number of different pathways (into minor, major and resuscitation work areas) and to set bed/cubicle/bay resources within the modelled department.

During the simulation run, users can see patients arriving in real simulation time, observing monitor their travel through the different work areas as defined by their assigned pathways. The simulation also allows enables users to see resource use and queue activity throughout the run. A snap shot of the simulation model is shown in Figure 1.

The generic framework also facilitates the testing of new scenarios e.g., resources can be changed and outputs compared by re-running the model. Similarly, process times can be changed and the model re-run to assess impact. Furthermore, the generic framework could be used to assign other attributes to patients for modelling. Initial studies have shown comparable results for mean length of stay between the model and major injury activities in a real A&E department.

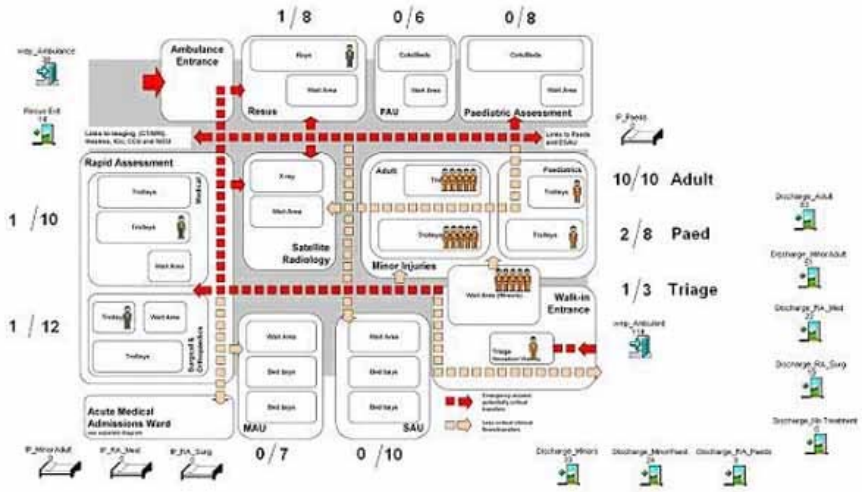


Figure 1. Snap shot of Simulation Mode showing number of patients in different parts of the Accident & Emergency department.

The model is being developed in close cooperation with staff in a UK A&E department. Analysis of one year's data shows contrasting patterns of ambulance and walk-in arrivals. The histogram in Figure 2 shows the busy time for walk-in arrivals is between 9.00 am and 9.00 pm, whereas ambulance arrivals continue to come in at approximately the same rate between 10.00 am and 1.00 a.m. The box-and-whisker plot in Figure 3, as one would expect, shows that the duration of stay of ambulance arrivals is greater that for walk-in patients. Notice however that outliers occur in both groups.

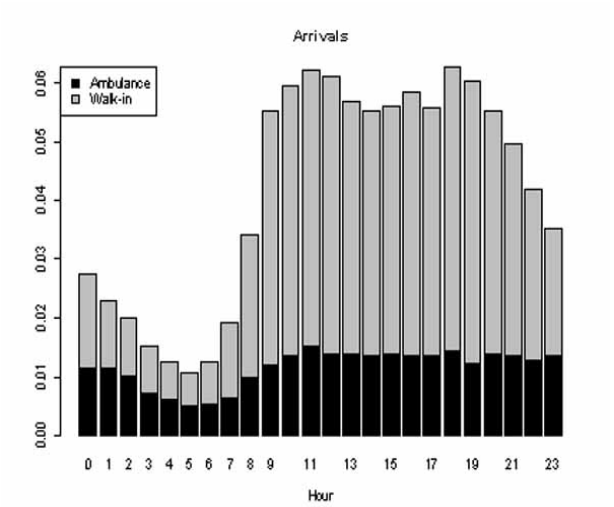


Figure 2. Pattern of arrival of A&E patients on an average day. Black represents shows the ambulance arrivals, grey the walk-ins.

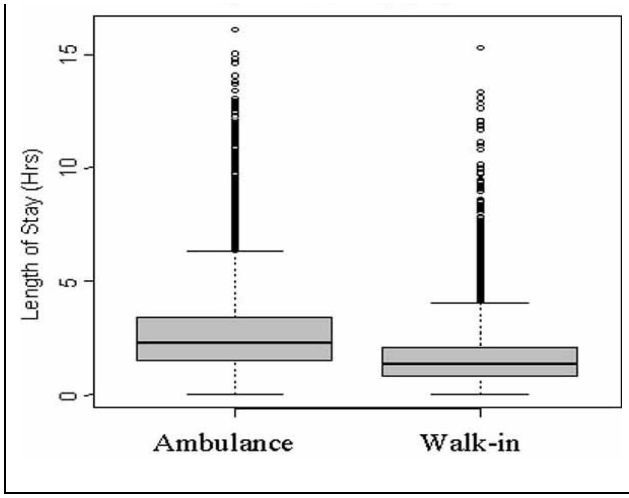


Figure 3. Box and whisker plot showing differences in duration of stay in A & E of ambulance arrivals and walk-in patients.

N.B. In box and whisker plots the box shows the interquartile range, i.e. the distance between the 25th and 75th percentiles and the line in the box is the median stay (50%). The 'hinges' on the whiskers are set at one and a half times the size of the box. Outliers are shown as points outside this range. For a full explanation see Eric W. Weisstein. "Box-and-Whisker Plot." From *MathWorld*--A Wolfram Web Resource. http://mathworld.wolfram.com/Box-and-WhiskerPlot.html

Figure 4 and 5 show the distribution of duration of stay of ambulance and walk-in arrivals. See how the expected pattern, in both cases, is distorted as staff struggle to achieve the UK governments 4 hour waiting time target.

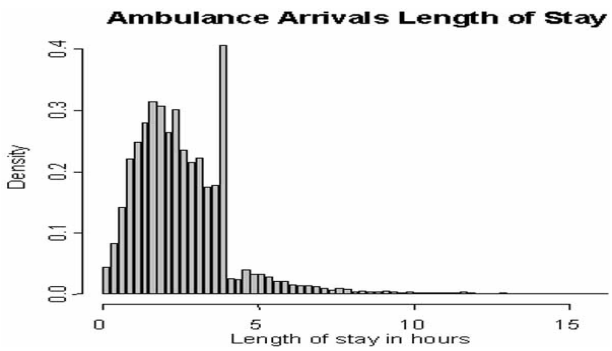


Figure 4. Distribution of duration of stay of ambulance arrivals in the A & E department.

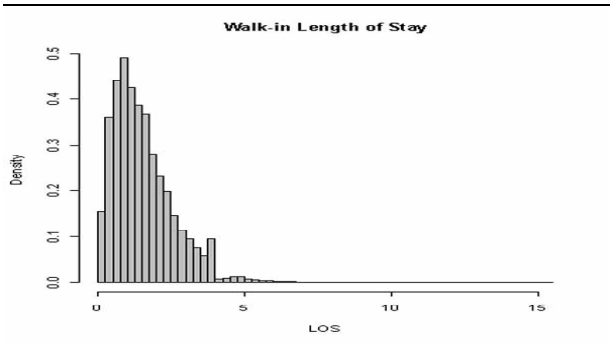


Figure 5. Distribution of duration of stay of walk-in patients in the A & E department.

Figure 7 shows that walk-ins by the 14 - 43 age group make up the bulk of the workload in the A & E department. In that age group most ambulance arrivals will truly have had an accident. In contrast the over 65's and over 75's arrive mainly in ambulances. Their needs are different. Many have combined medical and social problems and this lack of homogeneity in both need and pattern of arrival, means that old people challenge the 4-hour A&E target.

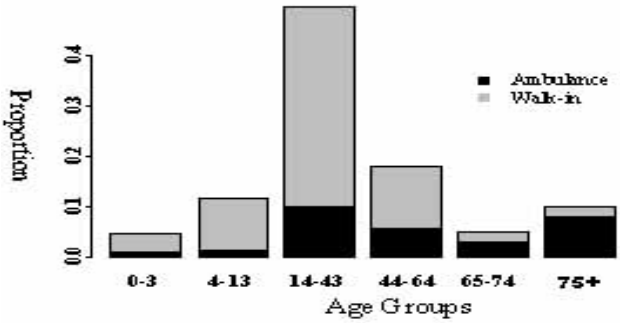


Figure 7 Proportion of ambulance arrivals (black) and walk-in arrivals (grey) by age group.

Locker & Mason's (2005) analysis of duration of stay in 83 UK A & E departments shows that patients who require hospital admission are more likely to stay longer and to be admitted in the final minutes before the 4 hour deadline ends. Taken together with our results, surely, different targets should be used for walk-in patients and for ambulance arrivals. From Figures 4 and 5, four hours seems to be appropriate for walk-in patients and six hours for admissions.

The model of accident and emergency services is being developed in conjunction with health care strategist RKW Ltd and Thierry Chaussalet's Health and Social Care Modelling Group at the University of Westminster. Combining simulation and service time allows end users to interact visually with the non-homogenous nature of accident and emergency services, and helps provide answers and insights to health care issues. For example, we might further investigate medical, social and or treatment factors that affect A&E length of stay with age.

Reference. T.E. Locker and S.M. Mason, Analysis of the distribution of time that patients spend in emergency departments, British Medical Journal 330 (2005) 1188-1189.

Leaving emergency departments without being seen.

Modelling emergency department capacity, Polevoi S. et al. (2005) Academic Emergency Medicine 12, 232-236 report that emergency department capacity of 100% may not be a sensitive measure for overcrowding. Physician factors, especially emergency medicine training, also appear to be important. Greater than 100% occupancy is associated with patients who leave and this is most significant at 140% capacity. Physician factors, especially emergency medicine training also appear to be important when using Leave Without Being Seen as a performance indicator.

Outpatient Models for a Diagnosis and Treatment Centre

John Bowers and Gillian Mould, University of Stirling, Scotland. Full version on the Web

Editor's comment. Staff from the University of Stirling have been working with Hospital Trusts to produce tools to support the modernisation of health services. Previous studies explored day surgery and inpatient care. This project focuses on outpatients, developing models to assist in the design of a Diagnosis and Treatment Centre. A planning tool has been constructed which allows managers to select the specialties for inclusion in the new centre and explore the consequences. A full version of the paper with tables and figures is on the web. Here key points are described and illustrated.

The model combines forecasts of activity demand in a range of scenarios, with changes in care pathways to estimate the requirements for radiology, pathology, therapies, endoscopies, ambulances, clinic space and staffing in new Diagnosis and Treatment Centres. Data were obtained from centralised IT systems, local systems, special manual data collection exercises, observation and interview. Considerable effort was dedicated to validating the data and comparing them to staff's personal experiences; this provided an essential check and also helped establish confidence in the basis of the analysis.

Changing practice. Discussion with clinical staff, therapists and managers established the current pattern of treatment for a number of common conditions. Cardiology, colorectal, elective orthopaedics and respiratory medicine services were examined in detail. Possible alternative treatment pathways were identified by examining practice in other hospitals and from the Department of Health Action website. Staff, from the Acute hospital and Primary Care considered the options, their feasibility and the implications for the design of the new centre.

New Initiatives. A recent local initiative in primary care of triaging referrals and offering non-surgical management to less urgent cases has delivered a high conversion to surgery rate (63%) for new outpatient appointments. In time, this should reduce the number of inappropriate referrals. Also, as recommended by the British Orthopaedic Association, a three-appointment one-year follow up plan was introduced. Consultants are keen to follow up patients over a 10 year time period to gain feedback on the long-term results of their treatment, however this feedback can still be obtained by following up just a sample of patients over 10 years. A physiotherapist ESP is also undertaking routine follow-ups. The implications of these changes on resource use are shown in Table 1.

Table 1 Implications of changes in the hip and knee pathway (567 procedures p.a.)

Practice	Current Practice 10 year, 5 follow ups			DTC Practice 1 year, 3 follow ups		
% of follow ups (FU) by physio	0%	33%	66%	0%	33%	66%
Consultant FUs	2835	1899	936	1701	1140	561
% reduction in consultant FUs	0%	33%	67%	40%	60%	80%
Physio.FUs	0	936	1899	0	561	1140
OPD X-rays	2268	2268	2268	1134	1134	1134

Figures 1 and 2 (overleaf) show the Hip and Knee pathways before and after revisions. Other pathways, by allowing diagnostics and consultations during the same number of visits, increase the convenience for the patient and reduce administrative overheads. Experience gained developing the new pathways was used in conjunction with benchmarking analyses to determine key parameters, such as the follow-up rates, for input into the capacity planning exercise.

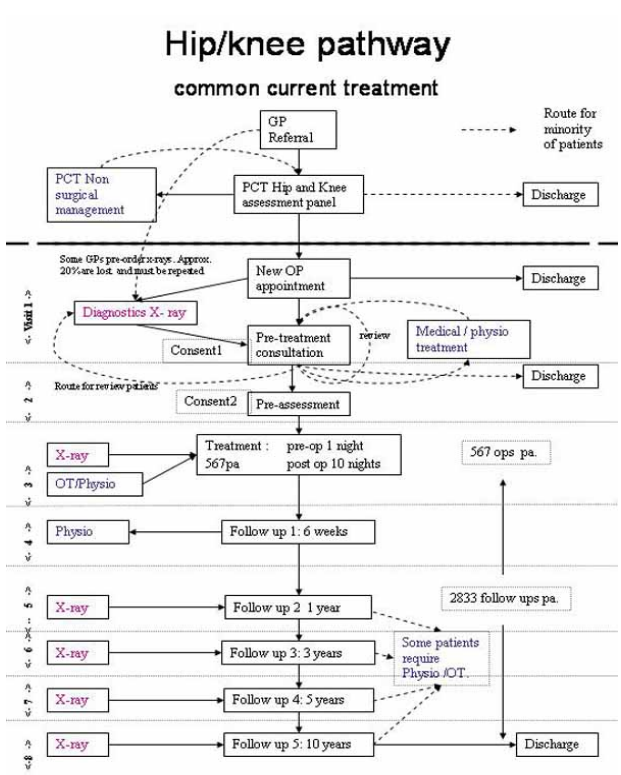


Figure 1. The hip / knee pathway identified in discussion with the staff.

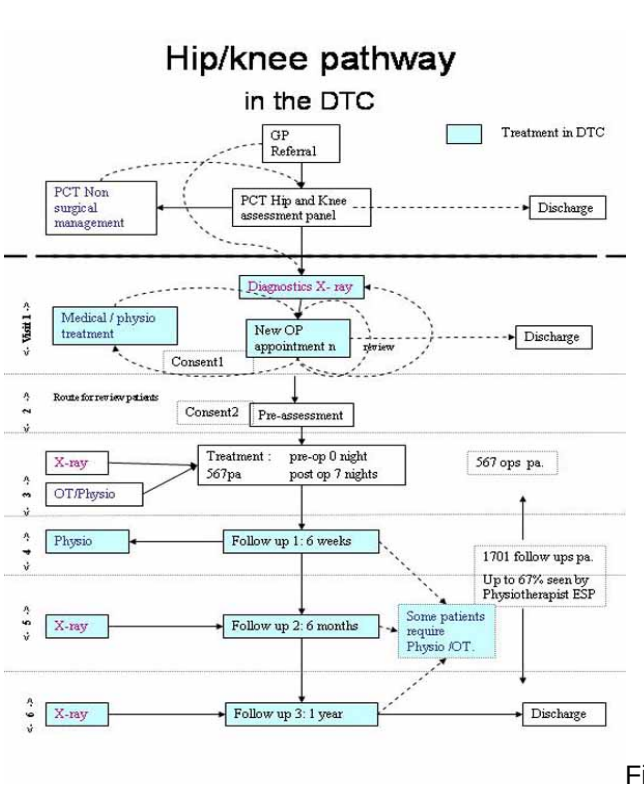


Figure 2. The Hip / knee pathway recommended for the new Diagnosis and Treatment Centre.

Possible future demand was estimated using the trends in referrals in each directorate, A number of different forecasts were considered, including an assumption of the demand remaining at the current level and another assuming national trends. Additional scenarios were explored with varying assumptions about the impact of changing practice on follow-up, did not attend rate and the potential for transfer of activity into primary care.

Detailed descriptions of resource requirements for each scenario were modelled. See table 3 on the website for the estimated resource requirements for different types of radiology, therapy and pathology in the Diagnosis and Treatment Centre. The overall implications for outpatient attendances, clinics and services from different scenarios are compared in Table 4 on the web and table 2 below.

Table 2 Selected scenarios & estimates of outpatient attendances for 2007/8

scen-ario	DTC			existing hospital (EH)			primary care	all	clinics	
	new	f/u	total	new	f/u	total		total	DTC	EH
1	57918	135585	193503	61534	151536	213070	0	406573	368	345
4	59658	113935	173593	69129	138368	207497	28165	409255	338	352
7	68054	132558	200612	72302	148154	220456	30756	451824	385	358

Conclusion

The study combined a diverse range of data into a set of models that aimed to provide a more complete picture of the present and possible future organisation of outpatient care. The study was more than a cold, quantitative capacity planning analysis: it incorporated visions of future patterns of care and involved a range of staff from both the acute hospital and primary care, helping to establish a better basis for designing Diagnosis and Treatment Centres.

Published paper

Bowers J, Lyons D, Mould G, Symonds T, (2005) Modelling outpatient capacity for a Diagnosis and Treatment Centre , Healthcare Management Science, Volume 8, Number 3, pp 205 - 211

MASH NET Launch report

MASHnet - The Network in Healthcare Modelling and Simulation was established on January 4th 2005 after receiving grant funding from the Engineering and Physical Science Research Council for £60 thousand pounds for three years.

Mashnet Aims To improve the application of modelling and simulation techniques within healthcare decision

Slides of presentations and notes of group discussions at the MASH net Launch event 'MODELLING HEALTH CARE - making it work' held on Tuesday 20th Sept 2005 at Warwick University are on the web. Follow the link for the speakers' contributions in pdf.

Modelling and Simulation in Health - Potential, Achievement and Challenge.

Dr Geoff Royston, Head of Operational Research, Department of Health, gives background information on recent major developments in UK health care and a short overview on modelling, and simulation in the UK health sector, including some from the work of OR analysts in the DH. Finally, he highlights some key issues for the UK health sector in the early 21st century and the challenges and opportunities these present for members of MASHnet.

OR, Academics and the Health Service

Professor Ruth Davies, Head of the Operational Research and Information Systems Group at Warwick Business School considers the relationship between OR and the Health Service using a hospital and a disease based case study. Demonstrating that academic research needs to take a broad view, both developing and exploiting new techniques and also taking account of the objectives of a range of stakeholders. Whilst academics are also concerned with implementation and change, they and the "users" will benefit from closer links with practitioners and software developers. We anticipate that MASHnet will facilitate this.

Developing Models of Health.

Dr Mark Elder, CEO of SIMUL8 Corporation, founded the company in 1994 because a radiology manager could not find simulation software that could answer his simple question: "Should I build an additional radiology room, or hire an additional nurse?" Using recent examples of healthcare simulation models Mark highlight some do's and don'ts in simulation modeling, before considering the numerical and non-numerical benefits of spending time on modelling

Designing win-win-win solutions for improved healthcare performance - it is possible!

Dr Simon Dodds, Consultant Vascular Surgeon at Good Hope Hospital, Birmingham, combines his experience in medicine, research and computer science to improve vascular surgery services at Good Hope. Simon argues that the current challenges in delivering high quality, cost effective, healthcare is not lack of medical knowledge but ineffective delivery of existing knowledge. Applied OR has great potential to dramatically improve existing services. Using Discrete Event Simulation a possible increase of 40% in maximum clinic capacity using existing resources was predicited. Implementing the best model in practice - resulted in a win-win-win outcome for patients, staff and the hospital.

Caution is needed, however, for the principles and methods of OR/OM require specific knowledge, skills and experience to apply safely. Active diffusion of innovation requires - support for further innovation, appropriate software tools, end-user training, and a programme of training successive waves of early adopters. The goal is the tipping point where the momentum generated is sufficient to complete the paradigm shift to a culture of evidence-based healthcare management.

Further details about the aims of MASHnet can be found on the website or by emailing mashnet@PenTAG.nhs.uk.

Statistical methods for length of stay

E Kulinskaya, D Kornbrot, H Gao: **Length of stay as a performance indicator: robust statistical methodology**. *IMA Journal of Management Mathematics* 2005, **16**:369-381.

Robust statistical methods are required because outliers bedevil the statistical analysis: they influence the mean (average stay) so their presence in the calculation has unfortunate consequences for 95% of patients who are not outliers. To determine the most appropriate statistical analysis for LOS data, using health care statistics from the UK NHS for 1997/98, standard general linear models were compared with an advanced robust method called truncated maximum likelihood.

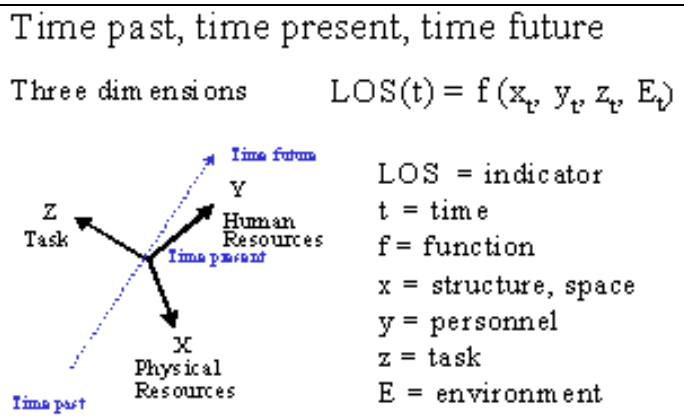
New findings were that admission method, discharge destination, provider (hospital) type, specialty and NHS region all influence length of stay, e.g., LOS is 25% longer for patient transferred from other hospitals rather than those admitted as an emergency. Also, death occurs early and transfer occurs late. Since the new NHS case mix funding ignores transfers and destination at discharge, while encouraging shorter length of stay, trusts with higher mortality may be doing the best under the new system. Which is certainly not desirable from the patient's point of view. *Editor's comment. The results are clinically not incorrect, the paper charts a new way forward and needs wider dissemination.*

Nosology on the web

PP Lévy: **The case view, a generic method of visualization of the case mix.** *Int J Med Inf* 2004, 73:713-718.

Hundreds of DRG's are described in tables, how do you sort them? Pierre Levy's method has developed a fascinating nosological way. Sort the DRG's by their cost into three groups – low, medium and high. Allocate a pixel to each DRG according to their cost group. Then sort the pixels by their colour group and visually display the results using ten columns each corresponding to a major category of diseases or to clusters of major categories. The display shows immediatiely that most of the DRG's are medium costs, that the costly DRG's are mainly surgical, and that the "ambulatory" zone contains a certain number of medium cost DRG's and that there exists low cost DRG's in the non ambulatory zone. Editor's comment: Have a look at this one it's fascinating.

IT's the FESTIVE SEASON - XYZ.



This is the nosokinetics challenge. Thierry Chaussalet developed it for our paper at the Hawaii conference. Everything we do stands on a moment of time. In that moment we are influenced by what happened in the past, where we are now, and what will happen in the future. Solve resource allocation with a random allocation clinical trial and you really are a magician. Far from being the gold standard, such trials are fool's gold. Read Pygmalion in the Classroom, an educational classic, and you will understand why random control clinical trials are fundamentally flawed, because prophecies have their own fulfillment. Medically it's the placebo effect – as the wise doctor once said "Give new drugs while they have the power to work.'

R Rosenthal, L Jacobson: Pygmalion in the classroom: Rinehart and Winston Inc.; 1968.

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

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