Department of Health

MASHnet (Modelling and Simulation in Health network) launch , Warwick. September 20 2005

Modelling and Simulation in Health - Potential, Achievement and Challenge

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GORS
Government Operational Research Service

Roadmap

- **Some background on UK health care**
- **A few points on modelling**
- **Recent modelling achievements in health care**
- **Future issues and challenges in UK health care**
- **Future challenges and opportunities in health care modelling and simulation**

Some background on UK health care

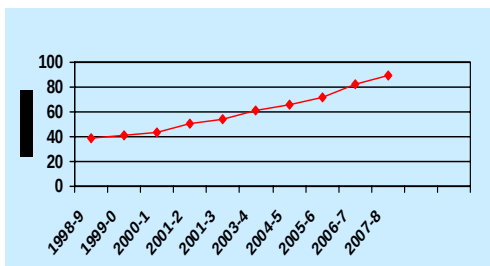
Health care in the UK is a huge business

- NHS annual spend around £60,000m, hourly spend over £6m
- about 1 million staff including 90k doctors, 300k nurses, 150k health care assistants
- daily 1m visits to GPs, 33k trips to A&E, 25k operations

The NHS is getting bigger

- over 100 new hospital building schemes
- 40% increase in medical school students 1997 -2005
- over 20 new diagnostic and treatment centres treating half a million patients a year
- over 40 new one-stop primary care walk-in centres

Unprecedented growth in planned spending

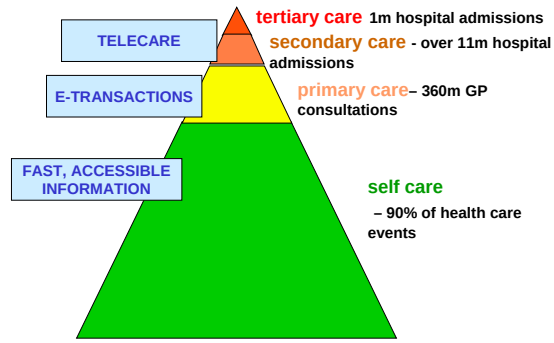


Growth in NHS Spending at over 7% a year – 42% in real terms between 2002-3 and 2007-8

The NHS is changing

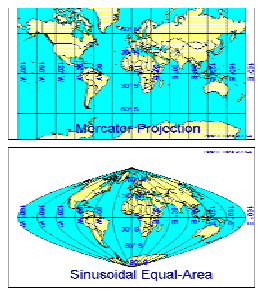
- changing **structures** e.g. strategic health authorities, primary care trusts, foundation trusts
- changing **settings** e.g. specialised treatment centres, walk-in centres, care at home
- changing **processes** e.g. national service frameworks, telecare
- changing **roles** e.g nurse consultants, expert patients
- Changing **focii** e.g patient choice, long term conditions, health promotion

Health care in the information age



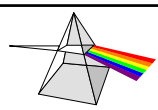
A few points on modelling

The map is not the territory!



Models are false because they simplify; they are useful for the same reason

Modelling covers a broad spectrum of approaches



accepting uncertainty

GROUP

- behavioural simulation
- scenario analysis
- soft systems modelling

QUALITATIVE

QUANTITATIVE

- systems dynamics
- discrete event simulation
- statistical modelling

INDIVIDUAL

seeking certainty

Recent achievements of modelling in health care

Growth of simulation in healthcare

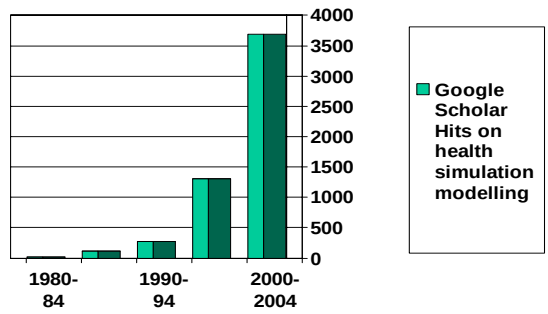
For example a review* (not just UK) of studies of simulation of health clinics found

1973-1977 : 8 studies

1993-1997 : 28 studies

* J B Jun, S H Jacobson and J R Swisher, Application of discrete-event simulation in healthcare clinics: a survey, JORS, **50**,109-123, 1999)

Growth of simulation in health care (ctd)



Simulation Modelling by Sector

"Simulation Modelling" AND	Google Hits (thousand)
Environment	136
Health	87
Transport	57
Agriculture	56
Defence	33

Recent applications of modelling and simulation in health

Some examples from the special health issue of Journal of the OR Society (February 2005)

- **"Modelling the requirement for supplementary nurses in an intensive care unit"**
- **"Geographical simulation modelling for the regional planning of oral and maxillofacial surgery across London"**
- **"A simulation-based study of a NHS Walk-in Centre"**
- **" Assessing the risk of vCJD transmission via surgery – models for uncertainty and complexity"**

Recent applications of modelling and simulation in health (ctd)

Some examples from the special issue of Health Care Management Science (August 2005) on quantitative modelling

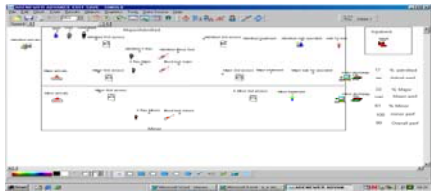
- "Modelling outpatient capacity for a Diagnosis and Treatment Centre"
- " Length of Stay-Based Patient Flow Models"
- " Choice of models for the analysis and forecasting of hospital beds"

Some examples from the DH of recent applications of health care modelling

- **Blood safety and vCJD risk strategy**
- **Setting targets for waiting times**
- **Chlamydia screening strategy**
- **Peak load capacity planning** (hospitals, walk-in centres, NHS Direct)
- **Reducing waiting times** (elective care and emergency care)

Role of simulation modelling in DH work on A&E

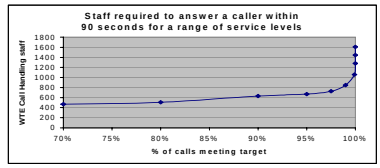
DH OR analysts built a discrete event simulation model to show visually and numerically the flow of patients through a typical A&E department on a typical day, showing the impact of variability in demand, and process capability.



Key questions answered were:
- What if x% of A&E demand was diverted?
- What if more staff were available or if diagnostics tests were speeded up?
- What if there was no wait for beds?

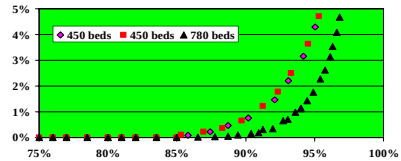
The A&E model was also used locally in particularly struggling trusts to identify key bottlenecks.

A little modelling can go a long way!



NHS Direct response times/staffing

Hospital admission refusals/bed occupancy



Future issues and challenges in health care

Some key shifts in the balance of health care

- When provided? Treatment -> Prevention
- Who receives? Acute -> Chronic
- Where delivered? Institution -> Community
- What validates? Habit -> Learning
- Who decides? Professional -> Patient

Three key issues for the UK health sector in the early 21st Century

- Who and What is the focus of care?
  - Increase in aged population and associated long term conditions
- How and Why is care provided?
  - Changes in availability and use of resources – skills, information
- When and Where is care given?
  - Shifts to prevention and to care outside hospitals

Four key performance challenges in health care

- Better quality and safety
- Better access - speed and convenience
- Better personalisation and more participation
- Better value for money

Improving quality and safety

New NHS agencies

- National Institute of Clinical Excellence
- National Patient Safety Agency
- Health Protection Agency

Adverse events in hospitals

- Estimated at 10% of admissions
- 10,000 severe drug reactions
- 400 deaths or serious injury
- £2bn in additional length of stay
- £400m in negligence payouts

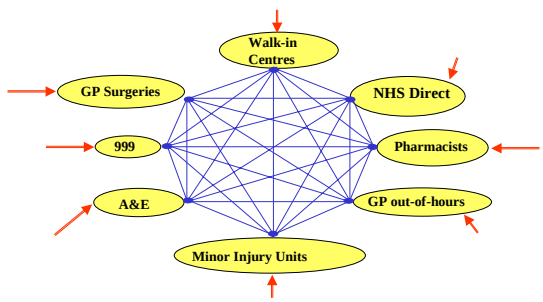
"An organisation with a memory"
DoH 2000

Improving speed and convenience - care closer to home

New fast access routes

- NHS Direct
- Walk-in Centres
- Minor Injury Units

Multiple access to NHS primary care



NHS becoming a network organisation

Improving personalisation and participation

New modes of patient engagement

- patient choice
- patient advice and liaison services
- self care support
- expert patients

Self care and professional care

The average diabetic has some 3 hours contact a year with a health care professional, and self cares for the other 8757 hours

Future challenges and opportunities in health care modelling and simulation

Some helpful shifts in the balance of modelling approaches?

- Tactical -> Strategic?
- Back-room -> Participatory?
- Arcane/Complex -> User friendly/simple?
- Reductionistic -> Systemic?
- Optimising -> Satisficing?

Challenge #1 – for the industry and research sectors

Advances in simulation modelling - visual simulation, object programming - have made simulation easier and quicker to use.

Challenge: to extend and accelerate technical and methodological developments in modelling and simulation to assist in tackling health and healthcare problems of the future.

E.g how can computer simulation be linked more to behavioural simulations? How can modelling be integrated with lean thinking and theory of constraints approaches ? How can systems thinking and modelling be joined with scenario analysis and other futures thinking approaches?

Modelling vs experiment?

Attribute	Experiment (e.g RCT)	Modelling (e.g DES)
Veracity	Often high, within its domain	Contingent on logic, elements and data
Timescale	Often long	Can be quick
Cost	Often high	Can be low
Risk	Can be high	Generally low
Extendablity	Limited	High

See Royston G, Trials versus modelling in appraising screening programmes , BMJ, 1999, 318, pp360-361

Modelling vs experiment (ctd) ?

articles in BMJ search	"Control trial"	"Simulation model"
1995-99	29	14
2000-04	41	13

PubMed search	**"Control trial"**	**"Simulation model"**	**"Control trial" + "Simulation model"**
Articles	880	1716	1 (veterinary medicine!)

Challenge #2- for the healthcare sector

Developments in the health sector, as in the rest of the public sector , are charged with being more "evidence-based" .

Challenge: for modelling to be seen as an essential part of evidence-based design, implementation and evaluation of health policies, programmes and processes.

This entails modelling being seen as a powerful partner to experimentation.

Implementation of simulation in health care

1981 review of 200 simulation projects in health care found only 16 (8%) reported successful implementation

JCT Wilson, Implementation of computer simulation projects in hea;th care, JORS, 32, 825-832, 1981

2003 review found 182 papers (1980-99) but only a few reported on implementation so their "value could not be assessed".

Fone D et al, Systematic review of the use and value of computer simulation modelling in population health and health care delivery, J Public Health Med, 2003, 25(4) 325-335

Challenge #3 - for the research and the healthcare sectors

Implementation and application of modelling and simulation to improve health and health care must be a key goal yet is rarely given much coverage in publications

Challenge: for modelling and simulation work in health care to be focused on application , for reports to show if and how the work was applied, and to discuss reasons for implementation successes and failures

A warning tale – the New Orleans Hurricane

In 2002 a chillingly prescient piece of reporting appeared on the science pages of the New York Times.

It described the potential impact of a direct strike by a category 5 hurricane on New Orleans (estimated at less than 100-1 chance per year) . Worst-case computer predictions showed death tolls in the tens of thousands with many more people trapped by high water that would turn into a toxic sludge.

In July last year, federal and state officials ran a simulation exercise to work out what would happen if a category 3 hurricane hit New Orleans. The prognosis was not good: it would result in billions of dollars' worth of damage.

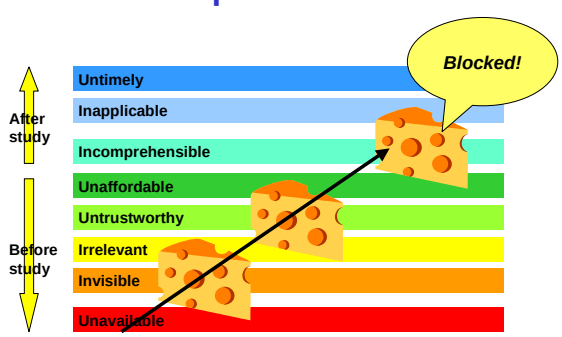
Yet, far from gearing up for a potential catastrophe on a massive scale, America swept the problem of New Orleans under the carpet.
The Observer 4 Sept 2005

New Orleans Hurricane

Some explanations of failure to act on simulation results

- **the simulation did not cover the worst case scenario** (arguable)
- **some people did not believe the severity of the simulation results** (the Army Corps of Engineers commander, admitted that "there was a collective mindset - that New Orleans would not be hit.")
- **medium- term precautionary action was very expensive** (and budgets were under stress from Iraq)
- **many people did not have the means to take effective emergency action immediately prior to the event**
- **many major system failures e.g. of communications and control after the event**

Modellers' obstacles - A Swiss Cheese Model of Implementation Failure



A concluding challenge - for everybody

Technical and methodological advance important but not the fundamental issue; which is to be *problem focussed*:

Focus modelling and simulation on key health and health care issues and contribute to making things better!

- Better quality and safety
- Better access - speed and convenience
- Better personalisation and more participation
- Better value for money