

## MODELLING DEMAND



**This is the first of two articles, which aim to take the reader through some basic concepts of health care modelling by discussing recent research in this field. The articles are based on the recent lecture course in health care modelling by Professor Millard.**

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# Health care modelling - why should we try?

**By Simone Ivatts and Peter Millard**

The population is ageing and scientists are forecasting that life expectation in wealthier countries will continue to increase (Guardian May 10th 2002). A fifth of the population is now aged over 60; the number of people over the age of 80 is forecast to increase between 1995 and 2025 by almost a half; and the number of people over 90 will double (NSF for Older People 2001). How will we cope? Will current plans stand the test of time?

Without scientific evidence, (DoH 1981), the Department of Health ran down the hospital-based, consultant-led, geriatric medical services that could have coped with the problem of an ageing population.

As consultants in geriatric medicine were perceived to have no role in long-term care, general practitioner care in private and voluntary nursing homes was fostered instead.

The unforeseen consequence was that 'rehabilitation' was (metaphorically) thrown out with the bath-water. Today there are too few acute beds to meet demand, and concerns about the care of individual cases are being highlighted nationally at Prime Minister's question time with angry claims and counter claims by prominent politicians, relatives, doctors, managers and the press (Bratby 2002).

Once again, the NHS is being reorganised. Key components of the current plan are:

- The acute hospitals will concentrate on speedy short term care,
- The nursing homes will deal with long term care, and
- Rehabilitation will take place, some-

where in between, preferably in the patient's own home or in general practitioner supervised intermediate care beds.

As older people need to be "fit for discharge" before they can safely return home no-one should be surprised, that emergency readmissions among the over 75's have shot up from 26,523 in the last quarter of 1999 to 31,427 for the same quarter in 2001 (Sunday Telegraph May 19th).

The NHS, Rehabilitation and Operational Research were health care legacies of the Second World War (Timm 1967). A basic principle of Operational Research is that scientifically valid models should be used to pre-test the outcome of different decisions (Feldstein 1963).

Drug therapy improved when the scientific principles that underpinned the absorption, distribution, metabolism and clearance of drugs were clearly defined.

Analogous to pharmacokinetics (Harrison and Millard 1991), the stop-go planning cycle that plagues the National Health Service will only be resolved when scientifically valid models that make clear the interactions between hospital and community are developed, validated, tested and introduced.

In this first of two consecutive, articles we aim to take the reader from Level Zero in Seymour's hierarchy of understanding of modelling methods where "Bed occupancy is regarded as an inexplicable natural phenomenon, driven by outside (predominantly malign) forces such as pattern of disease, the weather, and political policy" to Level A where a few general "rules



of thumb” or “heuristics” are understood due to general reading of the modelling literature (Seymour 2001).

The paper is based on a self-directed study course given by Professor Millard as part of the MSC in Health Informatics Course at St.Thomas’s Hospital, London.

### Health care modelling

Health care modelling studies the journey individual patients make through health care systems by analysing data from many patients collectively moving through the system.

From this data of pooled events explanatory models can be created; departments can be compared, trends identified and short and long-term implications of intended changes in health care management can be assessed.

By focusing attention on the internal and external factors that influence the day-to-day process of care decision makers are better able to understand the interactions between different components of the health and social care system.

However, different people involved in running a service have different needs from the available data on patients moving through the system.

### Measuring activity

All measures of inpatient activity are currently taken after the process of care is finished. This data concerns the management of individual patients. The Hospital Episode Statistics database underpins the financial aspects of the contract culture.

Health Authorities have used this data to compare services and to plan, without realising the inherent flaws within the methods used to enter, analyse and report

length of stay data. The difficulty is to determine the minimum amount of data that is needed to measure the process of care, bearing in mind that key players have different needs.

### THE GENERAL MANAGER (DILLON 1994)

General managers need a baseline of analysis that is consistent with scientific practice and acceptable to the doctors. Accurate, up-to-date, information about actual patient numbers and available resources is required.

Managers also need to understand the processes that occur around admission, utilisation and discharge as well as ensuring good co-operation with social services.

To be acceptable, any new methodology must be analytically sound, understood by key players, portable between specialties and have a track record.

### THE DIRECTOR OF SOCIAL SERVICES (KNOWLES 1994)

Social service directors need high quality data not just about the number of people in the system, but, also about individual characteristics of patients, which in the light of further studies might guide future decision making.

For example, which patients might benefit from an intensive short term package of care at home to enable them to eventually live independently again and which patients are likely to remain highly dependent despite all appropriate measures from the time of referral.

### CLINICIANS (MILLARD 1994)

Clinicians require patient and organisational details. Low-level detail about bed

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availability and individual patients is required to admit, diagnose and treat different types of illnesses and to monitor the course of disease.

Organisational details such as identification of empty beds, location of outliers, waiting lists and reporting actual activity are also needed. Data on all patients is also required to assess progress in rehabilitation, to plan discharge, to compare workloads, to assess the need for further resources and to undertake research.

### CURRENT MEASURES AND THEIR DEFECTS (MILLARD 1994)

The current system has evolved with time. Bed occupancy is counted at midnight, probably as a hangover from the occupancy function of the workhouse. Hospitals are not hotels, yet the workload of hospitals is counted in nights of bed occupancy, not days of bed usage.

Masses of data are electronically stored in NHS hospitals, but little of the data is used. Several different measurements of bed usage can be used to

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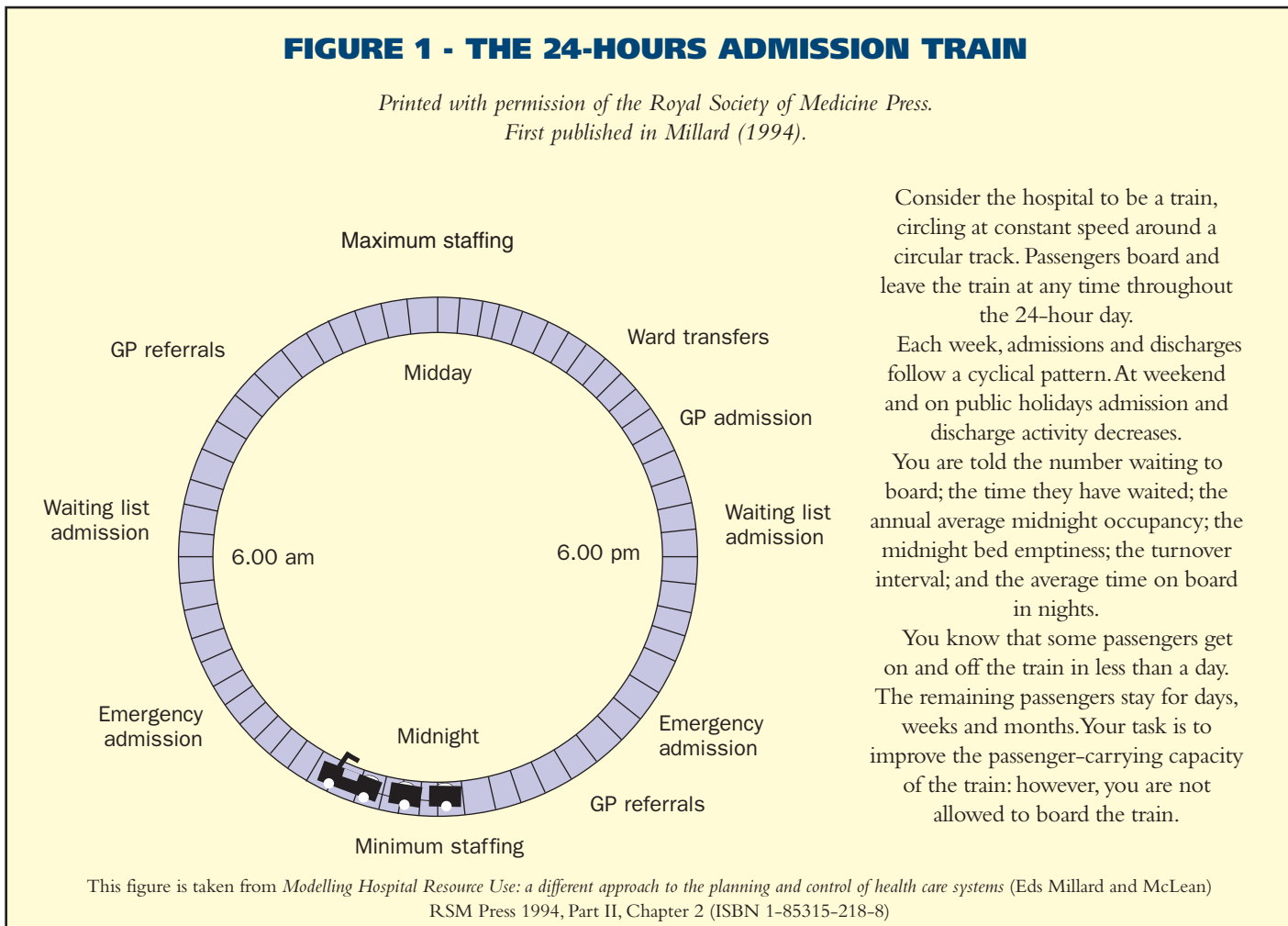
describe activity but there are limitations with each one. Listed below are a few of the countless problems that bedevil the planning of NHS hospital care.

- Surveys of bed usage are highly influenced by existing provision for services and the views of the group that set them.
- Bed norms are no longer used to set targets, so clinicians and managers plan in an aimless void.
- Bed occupancy is measured at midnight, but the work function occurs during the day.
- Similar rates of bed occupancy mask entirely different workloads.
- Average midnight bed emptiness is a poor method of measurement; hospitals need empty beds twenty-four hours a day.
- In today's busy hospitals, bed emptiness is a tiny fraction of beds at any one time.
- Individual length of stay is measured in nights of bed occupancy, not days of bed use. To count the days of bed use, plus one needs to be added to each patient's length of stay.
- Patients admitted and discharged on the same day are counted as having zero days' bed occupancy i.e., as far as workload planning is concerned these patients do not exist.
- The average length of stay can be difficult to interpret, particularly, when a minority of individuals have a length of stay that far outlasts the length of stay of the majority.
- Plans are based on shortening average length of stay and decreasing emptiness, yet, shortening length of stay – *a priori* – increases midnight emptiness.
- Performance comparison using average length of stay ignores the fact that factors outside hospitals influence length of stay.
- Speed of discharge is considered success, irrespective of the destination at discharge and the outcome of treatment.
- Early discharge is not a success, if patients come back, sicker and quicker.
- When beds are blocked, turnover occurs in only a proportion of the beds.
- Current NHS performance activity data concerns "Finished Consultant Episodes" rather than completed patient stays so it can be very difficult to interpret the available data.
- Etc., etc.

It is perhaps easier to see the complex interaction of many different variables effecting bed allocation and use by considering the hospital to be a train, travelling around a circular track, picking up and putting down passengers throughout

**FIGURE 1 - THE 24-HOURS ADMISSION TRAIN**

*Printed with permission of the Royal Society of Medicine Press.  
First published in Millard (1994).*



the 24-hour day. You are told:

- The number of carriages.
- The number of seats in each carriage.
- The average midnight occupancy and emptiness.
- The number of people waiting and the time they have been waiting.
- The average time passengers stay on board, in nights.
- That some passengers get on and off during the day, while others stay for days, weeks and even months.

Your job is to optimise the performance of the train. This problem can only be solved if you know the process of care in every carriage on the train.

### Measuring the process of care

A recent analysis of length of stay of 7,681 surgical patients discharged in 1977 from a hospital in Adelaide, Australia (which is not governed by completed consultant episodes) shows how emergency and non-emergency patients interact to effect bed occupancy (Millard et al 2000).

The survey's key points are:

- Surgical admissions and discharges follow a regular, weekly, cyclical pattern.
- Public holidays, especially Christmas, effect surgical planned admissions.
- The average stay in days was 5.7 days, but the distribution was skewed.
- The surgical beds contained two streams of flow; longer stay patients occupied 29% of the beds
- Most surgical admissions (91%) were short stay; their average stay was 4.8 days: 50% left within 2.9 days of admission
- The longer stay patient has an average stay of 22.8 days: 50% left within 13.8 days of admission
- Patients being discharged home had a shorter stay than those who were transferred elsewhere
- Improving inpatient management of complex patients would bring long-term gains

### Interactions between health and social care

The long-term solution to 'bed shortages' and 'bed-blocking' in hospitals may, or may not, require extra investment in

social care. Hypothetically, a better long-term, option would be to improve the prevention and management of complex illness in acute hospitals and to introduce a specialist-led, hospital-based, service between acute care and long stay care to minimise the need for permanent institutional care (Millard 1991).

The collapse of Britain's National Health Service is a classic example of the detrimental effect of the failure to recognise the interactions between hospital and community care.

Between 1981 and 1993, the UK government ran down the hospital-based geriatric medical services by fostering open access to board and lodging allowances in residential and nursing home care.

As the number of private and voluntary beds increased in non-NHS long-term care, more and more old people went to residential and nursing homes. Most were referred directly from hospitals, many of them by the geriatric medical services.

Within a decade, expenditure on board and lodging was out of control, and many more old people were in care than needed to be. Using flow models, Millard and Lee (1998) explain how the NHS collapsed.

The changes in the flow of patients occurred irrespective of the ageing of the population, specialist training and the science of patient care.

### Conclusion

The measures used to report, compare and plan hospital inpatient activity are seriously flawed. 'Black-box' models are used to justify change in NHS patient management. In black-box models all measures of performance are made from without the system under study (Figure 2).

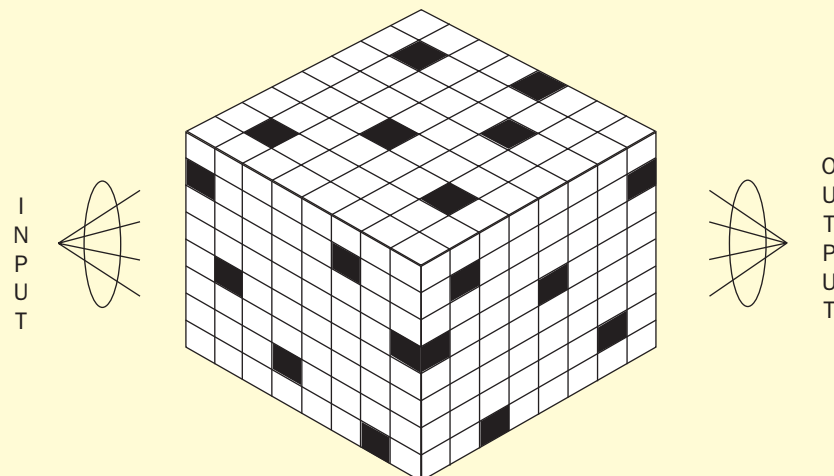
In the 1980s, the concept of planning NHS care using bed norms was discarded. Ever since, successive Health Secretaries have been attempting to meet the increasing need for hospital care using concepts associated with pressure and force. 'Name-and-shame' is now the

### FIGURE 2 - OPENING THE BLACK BOX

Mistakes are being made in the planning, provision, allocation and use of hospital beds because decision makers use black box models to plan changes in activity. In black box models all measures are made outside the system.

In specialties where beds are 'blocked' or different types of patients are being treated, turnover occurs at different rates within the occupied beds. To overcome this problem decision makers need to be able to measure the process of care.

To plan efficiently, statistically valid models are needed which show how beds are used.



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### KEY POINTS

- Data on patients has a wide range of uses to different health care professionals
- There are problems interpreting the raw data collected
- Admissions and discharges follow a cyclical pattern
- Factors within and without the hospital influence the outcome of care
- Four types of patients – planned and emergency: simple and complex – are managed in surgical wards
- To plan effectively, one has to understand the process of care

order of the game.

To escape from the vicious cycle of continual management change, new and scientifically valid tools are needed to enable decision makers to measure and model the process of care.

In the next issue, we will explain how bed occupancy analysis opens the way for the creation of dynamic models of care.

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