WORKING PAPER 444

THE USE OF PERFORMANCE INDICATORS AND INTERACTIVE PLANNING SYSTEMS TO EXAMINE IN-PATIENT PSYCHIATRIC CARE IN THE YORKSHIRE REGIONAL HEALTH AUTHORITY

S Harvey, M Clarke and A G Wilson

School of Geography
University of Leeds
Leeds LS2 9JT

"... should hospitals be sited outside cities where .... there is no risk of hospital miasmas being diffused among the population .... or, should a multiplicity of small hospitals be built at scattered points ....? In either case the hospital is intended to become a functional element in an urban space where its effects must be subject to measurement and control."

(Foucault, 1976
in Power/Knowledge, p. 180)

1. Introduction

The aim of this paper is to describe a set of interactive planning models and their application to the measurement of the performance of psychiatric services in the district of the Yorkshire Regional Health Authority. It is argued that modelling of the supply, demand and allocation of health services as described by Wilson and Clarke (1982) and Clarke and Wilson (1984; 1985) can provide the basis for investigating specialty planning and the monitoring of policy implementation. The models thus derived, can be used to explore the effects of changes in the variables of service supply consistent with existing policy trends or new initiatives. These effects are demonstrated through comparison of calculated performance indicators, which are the main outputs of the model.

In section 2 of the paper, the development of performance indicators in the context of NHS planning is outlined, followed by a discussion of the use of these indicators for demonstrating geographical variations in the standards and forms of psychiatric treatment across the region. Mention is also made of the specific aspects of services for the mentally ill which warrant particular attention. In section 3, we describe the model in more detail, the main inputs and variables, the outputs generated and its capacity to explore a series of planning issues. In section 4 the data set is discussed, the sources, problems and potential inaccuracies which the available information presents. In the fifth section we present some results from a series of runs of the model using both the data from existing services and with slight modifications to reflect possible policy developments. Finally in section 6 we assess the potential applications and limitations to using such models for specialty planning, and the functions which performance indicators may serve for the various actors involved in the provision and receipt of psychiatric services.

2.1 Performance indicators

Indicators of service performance were introduced into the NHS planning system in 1982, initially to enable the regional health authorities (RHA's) to assess their districts' operational strategies

and subsequently to aid the Secretary of State for Social Services in reviewing regional performance. The main objective of these indicators was the reconciliation of national strategic aims for certain types of services and service efficiency, with the achievements of managers and clinicians working within the operational tier of the district health authorities (DHA's). The introduction of performance indicators for the DHSS also represented a step towards improving the accountability of districts and their compliance with national policy objectives. A number of other developments at the national level are also consistent with these ends. The recommendations of the Körner Committee for improving district information bases and those of the NHS management enquiry (DHSS 1982; 1983) for example, are orientated towards improving performance assessments. The former will enable more detailed and accurate indicators to be computed whilst the latter proposes the definition of clearly stated managerial objectives with which output measures can be compared. Recent restrictions in the rate of growth of public expenditure on health and social services, in the face of increasing demands for improvements in the level and quality of health care, have resulted in a stronger focus on efficiency and performance indicators can be seen as consistent with such concerns.

The original indicators introduced by the DHSS in 1983 received considerable criticism not least for their inappropriateness for specialties such as mental handicap and mental illness in which policy was undergoing a substantial shift in emphasis. In response, the DHSS set up eight working groups to produce service-specific indicators based on existing available information, and a joint group who were to co-ordinate and balance the various proposals to produce a coherent package of performance indicators to be used at the district level.

Previous assessments of the performance of psychiatric services have tended to revolve around the qualitative aspects of institutional care, largely in the form of polemic debate, following a series of public enquiries into maltreatment in hospitals during the 1960's and 70's. In this respect these new indicators are to be welcomed as a means of assessing an individual district's psychiatric services whilst also providing a basis for inter-district comparisons. The mental illness services working group (DHSS, 1984) identified five issues

which were germane to good service performance as; efficiency; effectiveness; accessibility; comprehensiveness and acceptability. The criterion of comprehensivenesss refers to the whole range of psychiatric services including community health care and social services and related indicators tend to take the form of checklists. Accessibility and outcome measures of service ffectiveness are dependent on the impact which services have in terms of a patient's morbidity and his/her perception of services. Indicators orientated towards these assessments are not considered here due to limitations posed by the state of the art of individual outcome measurements and the availability of suitable information. The performance-indicators which are referred to in this paper then, are those which are directed towards the investigation of the accessibility, efficiency and effectiveness of psychiatric service provision. The indicators, which form the main output of the models, include some which were proposed by the mental illness working group (DHSS, 1984a) but also some which have been suggested by the acute services working group (DHSS, 1984b) because they take into account cross-boundary flows between districts and enable us to give a more detailed description of the geography of in-patient care in the Yorkshire region.

2.2

Little attention has been paid by geographers to the spatial distribution of psychiatric hospital facilities and their impact on treatment experiences other than general comments referring to the remote locations of former asylums as compared to the recent policy of providing self-contained district service in units attached to district general hospital premises. The present pattern of services in the Yorkshire RHA shown in figure 2.2, is a mixture of large isolated hospitals such as Storthes Hall and High Royds, and district general hospital units such as at St James's hospital or Grimsby New hospital. This patchy distribution results in substantial cross boundary flows between districts. These locations and flows suggest that there are likely to be considerable variations in the physical accessibility to treatment and also in the relative costs of a treatment episode according to where the individual lives. The policy of community based mental health care involving the planned closure of many of the older large psychiatric hospitals, the construction or adaptation of new units for

District Health Authorities (residential zones) in the Yorkshire Regional Health Authority

Psychiatric hospitals and units in the Yorkshire Regional Health Authority

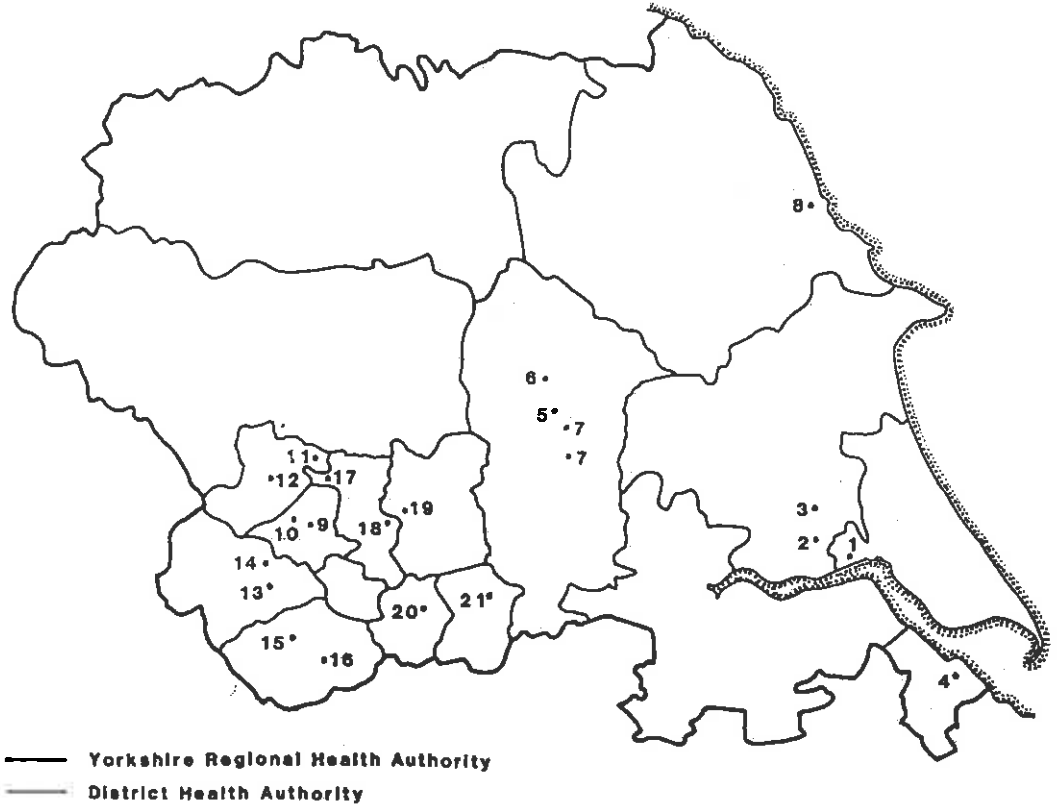

Table 2.1

List of residential districts (these also form the treatment disticts for the 17 x 17 zone case)

1) HULL
2) EAST YORKSHIRE (BEVERLEY)
3) GRIMSBY
4) SCUNTHORPE
5) NORTHALLERTON
6) YORK
7) SCARBOROUGH
8) HARROGATE
9) BRADFORD
10) AIREDALE
11) CALDERDALE
12) HUDDERSFIELD
13) DEWSBURY
14) LEEDS WEST
15) LEEDS EAST
16) WAKEFIELD
17) PONTEFRACT

Table 2.2

List of facility districts (hospitals)

1) KINGSTON GENERAL
2) DE LA POLE
3) BROADGATE
4) GRIMSBY NEW
5) CLIFTON
6) MOORLANDS
7) NABURN + BOOTHAM PARK
8) ST MARY'S
9) WADDILOVES
10) LYNFIELD MOUNT
11) SCALEBOR PARK
12) AIREDALE GENERAL
13) HALIFAX GENERAL
14) NORTHOWRAM
15) ST LUKE'S
16) STORTHES HALL
17) HIGH ROYDS
18) LEEDS GENERAL INFIRMARY
19) ST JAMES'S
20) STANLEY ROYD
21) PONTEFRACT GENERAL

brief hospital admissions and the development of community support services, is likely to result in changes in variables such as accessibility, efficiency and expenditure. It would be useful to be able to predict some of the impacts which planning decisions could have, particularly during the transition period from institutional hospital based care to community care. Although at this stage, we do not have sufficient information to be able to model the community sector of psychiatric service provision it is at least possible to demonstrate the impact of the policy on hospital services and change the supply variables to reflect assumptions in community service alternatives.

As well as indicators of service accessibility and efficiency, an important variable as far as mental illness is concerned is that of length of stay. The impact of long hospital stays in producing characteristics of institutionalisation has been noted by Goffman (1961; 1963). To some extent length of stay will depend on the type of hospital and obviously it will be related to the severity of condition. If is possible, however, bearing in mind the distribution of psychiatric in-patient facilities, that length of stay will be dependent on a patient's district of residence and the accessible facilities to which they are likely to be referred.

2.3

Yorkshire Regional Health Authority is subdivided into 17 District Health Authorities (see figure 2.1; table 2.1) which vary considerably in the size and distribution of their resident populations. Within the region there are twenty one mental hospitals or general hospitals which have a psychiatric specialty. Figure 2.2 shows however that these facilities are not evenly distributed between the districts so that DHA's such as Northallerton or Dewsbury have no in-patient facilities of their own, whereas districts such as York, Airedale, or Huddersfield have more than one treatment centre. No distinction is made in the data sets between psychiatric sub-specialties such as short stay acute facilities or those which provide long stay care for the chronic mentally ill. In general, however, the units attached to general hospitals tend to contain assessment or short stay beds. Excluded from the list of facilities are those which are specifically designated for the elderly

severely mentally infirm. The size of the facilities varies considerably from Kingston General hospital with an average daily number of beds of 9.4 to large hospitals such as High Royds with an average of 1166 available beds.

The overall strategic policy of Yorkshire RHA for psychiatric services is consistent with national policy objectives and gives first priority to providing district based services whilst working towards a reduction in the sizes of the larger psychiatric hospitals. The Regional Strategic Plan (Yorkshire RHA, 1977) clearly sets out by district whether a DHA is over or under provided for in terms of the number of available in-patient beds. Assuming the desirability of district self-sufficiency and the acceptability of a normative standard of 0.17 new long stay beds per 1000 residential population, districts such as Beverley are stated to have 1093 beds too many, whilst the district of Scunthorpe has 134 beds too few. The outline regional strategic plan published in 1984 (Yorkshire RHA, 1984a) suggested that the reduction of beds in overprovided districts would take place by the closure of the large old psychiatric hospitals accompanied by the development of alternative accommodation in district general hospital units offering in-patient services on a much smaller scale. Some of the indicators which we discuss below explicitly tackle the issue of distict self containment in services. We also make the distinction between provision per head of resident population in a district, and provision in relation to the catchment population of a district or facility. The calculation of catchment populations is discussed later but at this stage it is sufficient to mention that the catchment population is not equivalent to a spatially defined catchment but is a notional population which is assumed to be potentially referred for treatment at a particular place. Storthes Hall hospital in Huddersfield DHA, for example, has a large catchment population due to its availability to patients living in adjacent health authorities which have inadequate or no facilities within that district. There may also be a variety of social factors which might explain why patients are referred to services other than those in their district of residence.

3. Model system design

At its most basic, the system consists of a number of variables which represent the demand for and supply of psychiatric in-patient services. The initial data inputs represent the existing pattern of services which are referred to as the 'base-file'. The supply variables may be arranged to represent different plans or policy options in subsequent model runs. The altered data set is referred to as the 'current-file'. Each run of the model then consists of two sub-runs which represent the base situation and current plans respectively. Most of the base variables are contained in the base data file but some are actually calculated within the model (such as bed occupancy or the allocation of demand for hospital services by residential zone). The list of base-file variables is given in table 1.

The main ouputs of the model are the performance indicators. These are described in more detail below but fall into two main groups; residence based indicators and facility based indicators. The basic distinction between these groups is that the former relates to the delivery of services to residents living in a particular zone, whereas the latter are concerned with the efficiency of services at the point at which they are supplied. In the example used here, the residential zones are the district health authorities and take the algebraic notation (i). The facility or treatment zones (represented as j's) may be taken as either the district health authorities or the individual hospitals. The former would give a 17 x 17 case system when combined with the residentail districts and the latter would give a 17 x 21 case system as there are 21 hospitals with psychiatric in-patient services in the Yorkshire region.

Facility based indicators tend to be calculated using the catchment population as the denominator. Where DHA's have no treatment facilities of their own and where there are substantial inter-district patient flows, the catchment and residential populations are likely to vary considerably. Clearly the calculation of the catchment population is important if we are to get reliable estimates which can be used for planning purposes. Unfortunately there is no universally accepted method of calculating catchment populations as the acute services working group on performance indicators pointed out (DHSS, 1984b).

Two methods have been used here; the 'treatment intensity method' is used for the 17 x 17 case system, whereas the 'proportionate flow method' is used for calculating catchment populations in the 17 x 21 case system. This is primarily due to the assumptions and constraints involved in the different methods, particularly the fact that the treatment intensity method cannot be used for systems where the number of facilities exceeds the number of residential zones.

3.2 The Interactive Health Care Planning Model: model specification

The interactive planning model that we have used to generate the results found in section 4 of this paper has been designed to be applicable to a multi-district form of organisation within a region which has some responsibility for coordination of services or allocation of resources. It is particularly useful for situations where there are considerable cross-boundary flows, as is the case with mental illness in Yorkshire.

Details of the model can be found in Clarke and Wilson (1984) and examples of its use in acute care context for an Italian health region in Clarke and Wilson (1985). Here we briefly describe some of the components of the models at the heart of the system before presenting examples of its use in section 4.

The first part of the model system consists of setting up of a base and current file to represent the existing and a planned future situation. The system is described by 20 arrays which are listed in algebraic notation in table 3.1. Most of them, as noted above, are specified exogenously on an initial base data file. The demand variables can be updated as appropriate for both loose and current-plan files. The supply-side variables should be changed interactively on-line as part of a trial-and-error interactive planning procedure. The variables calculated endogenously include patient flows, catchment populations and performance indicators.

Patient flows are calculated using spatial interaction models and we can now briefly describe the family of models that are embedded in this system. There are four main types of spatial interaction

Table 3.1

POP(I,A,S) :	population in residential district I by age, A, and sex, S.
RMORB(K,I,A,S) :	morbidity rates by specialty K, district of residence I, age, A, and sex, S.
ASTAR(J) :	total beds in facility district J.
CSTAR(J) :	total budget (or expenditure) at J.
USTAR(J) :	aggregate occupancy rate at J.
HSTAR(J) :	aggregate average length of stay at J.
XSTAR(J) :	aggregate number of cases at J.
A(K,J) :	number of beds in specialty K at J.
C(K,J) :	budget (or expenditure) for specialty K at J.
U(K,J) :	occupancy rate for specialty K at J.
H(K,J) :	length of stay for specialty K at J.
X(K,J) :	number of cases for specialty K at J.
FCSU(1,K,J)) FCSU(2,K,J)) FCSU(3,K,J)) : FCSU(4,K,J)) FCSU(5,K,J))	resource inputs for different elements of (K,J) activity - eg. medical staffing, nursing staffing etc.
NSTAR(I,J) :	aggregate flow of patients from residence zone I to facilities in J.
TCOST(I,J) :	'cost' of travel from I to J.
NINT(K,I,J) :	flow of patients in specialty K from I to J.

model: unconstrained, production constrained, attraction constrained and doubly constrained. In addition we have developed a fifth - the marginal flow model which is described in Clarke and Wilson (1984). The variables used in spatial interaction modelling in the context of mental illness are as follows:

O_i - the demand or need for in-patient mental illness care in residence zone i.

W_j - the case capacity, cases treated or attractiveness of facility zone j.

S_{ij} - the flow of patients from residence zone i to facility zone j.

dij - the distance or cost of travel from zone i to zone j.

The unconstrained model is rarely used so we concentrate on the other three. The production constrained model takes the form

$$S_{ij} = A_i O_i W_j^{\alpha} e^{-\beta d_{ij}} \qquad 3.1$$

where α and β are parameters to be estimated and

$$A_i = (\sum_j W_j^{\alpha} e^{-\beta d_{ij}})^{-1} \qquad 3.2$$

to ensure that

$$\sum_j S_{ij} = O_i \qquad 3.3$$

It is termed a production constrained model because the A_i term ensures that all demand is allocated to a facility. In this case W_j is usually taken as a measure of attractiveness of facility j. This may be measured by the member of beds in j or something more sophisticated.

The attraction constrained model is of the form

$$S_{ij} = B_j O_i W_j e^{-\beta d_{ij}} \qquad 3.4$$

where

$$B_j = \left(\sum_j O_i e^{-\beta d_{ij}}\right)^{-1} \quad 3.5$$

to ensure that

$$\sum_i S_{ij} = W_j \quad 3.6$$

This is the opposite of the production constrained model because this time the model is constrained by the case capacities at each facility. A combination of these two models gives us the doubly constrained model

$$S_{ij} = A_i O_i B_j W_j e^{-\beta d_{ij}} \quad 3.7$$

and in this case

$$A_i = \left(\sum_j B_j W_j e^{-\beta d_{ij}}\right)^{-1} \quad 3.8$$

to ensure

$$\sum_j S_{ij} = O_i \quad 3.9$$

and

$$B_j = \left(\sum_i A_i O_i e^{-\beta d_{ij}}\right)^{-1} \quad 3.10$$

to ensure

$$\sum_i S_{ij} = W_j \quad 3.11$$

In each case the parameter β needs to be estimated. This is done by taking existing flow data and calibrating β to find the best maximum likelihood estimate which minimises the difference between observed and predicted mean migration length. However, for a variety of technical reasons that relate to differences in residence zone size and population density distribution it is often better to use an origin-specific β value - β_i - and the results presented in the next section have used such a term.

The practical use of spatial interaction models in health care modelling has a somewhat chequered history. The majority of applications have used the attraction constrained model which has the unusual property that as you reduce the number of beds in the system you effectively reduce the demand. For purposes of calibration we have used the doubly constrained model and in the model runs a variety of approaches have been tested.

Catchment populations can be calculated using patient flow data. For a base year this can be obtained from data, for a current plan, the flow matrix from the spatial interaction model can be used. As noted earlier, it is not a simple matter to provide an uncontroversial method for specifying and calculating catchment populations (Cottrell, 1985). The two methods we use are the treatment intensity method and the proportional flow method. The treatment intensity method is based on the assumption that the hospitalisation rate is constant over the catchment population of facility j and that each facility need not have the same rate. Thus the level of treatment given by district j is independent of the district of origin of the patient. The proportionate flow method assumes that the proportion of the resident population of district i served by facility j is given by the proportion of district i's patients treated in facility j. The two methods will give slightly different results.

Once the catchment populations have been calculated they can be fed into the performance indicators package which we now describe.

3.3 Performance indicators

Performance indicators are calculated for both the base year run and for the current file data. The indicators are based on either the base data or outputs from the spatial interaction model runs which estimate inter-zonal patient flows. The indicators as mentioned previously, fall into two groups; residential and facility indicators and are listed in tables 3.2 and 3.3 respectively.

Residential indicators 1 to 3 relate to the spatial pattern of treatment of residents in a given district health authority (residential zone i). The first of these, indicates the proportion of all cases

Table 3.3

Facility-based performance indicators

1) Proportion of j-facility patients who live in j.

2) Proportion who live in contiguous districts.

3) Proportion treated in j-facility who live in the rest of the system.

4) (Not used)

5) Beds/head of catchment population.

6) Budget (expenditure)/head of catchment population.

7) Treatment intensity rate: cases/head of catchment population.

8) Cases/bed.

9) Cases/budget (unit of expenditure).

10) Cases/head of catchment population (cases attracted).

11) Average distance travelled to that facility.

12) Cases attracted/case capacity.

Table 3.2

Residential performance indicators

1) Proportion of cases treated within the district in which they are resident.

2) Proportion of cases treated in the next 'ring' of contiguous districts.

3) Proportion treated in the rest of the system.

4) (Not used)

5) Hospitalisation rate; the number of cases generated in residential zone (I) divided by the total population of I.

6) Notional number of beds available to I residents from all districts per head of I - population.

7) Notional expenditure on I residents treated in any district per head of I population.

8) Average distance travelled to facilities by I residents.

9) Hospitalisation rate per 1000 residents in I.

10) Bed utilization rate

11) Notional beds available per head of resident resident in I.

from a district which are actually treated within that district, giving a measure of the self containment of a district in treating mental illness disorders. The second indicator includes the proportion of cases treated within adjacent districts, that is, those with contiguous boundaries. In figure 2.1, for example, it can be seen that Dewsbury DHA shares its boundaries with Leeds West, Huddersfield, Wakefield, Calderdale and Bradford. By implication, indicator three is the proportion of cases treated in the rest of the regional system. Indicators one, two, and three should therefore add up to 1.0. We would expect the self containment of residential districts to vary considerably because some districts have no facilities of their own whereas others are over provided for. The fourth residential indicator is not used for this model system.

The fifth residential based indicator is the hospitalisation rate defined as the number of cases generated in a residential zone divided by the total population of the zone. It is written algebraically as

$$H_i = \sum_j N_{ij}/P_i$$

where H_i = hospitalisation rate of the population in residence zone i; $\sum_j N_{ij}$ = total number of cases from zone i treated in all treatment zones (j); P_i = population resident in zone i.

Related to this indicator is indicator number nine which expresses the hospitalisation rate per 1000 residential population. So, with the above notation

$$H_i = (\sum_j N_{ij}/P_i) \times 1000$$

Variations in the hospitalisation rate might be interpreted in a number of ways. A low hospitalisation rate might be due to limited availability of services, low incidence or referral of mental illness conditions or to high average length of stay which has the effect of limiting the turnover of cases in the year. This illustrates the point that performance indicators can only highlight issues, which require careful interpretation in the light of existing knowledge of service organisation and delivery, or further investigation.

The sixth residential indicator is the notional number of beds available per head of residential population. A slightly different form of this gives us indicator number eleven, defined as the notional number of bed days per head of residential population.

$$\phi_i = \left\{ \frac{\sum_j N_{ij} a_j}{365} \right\} P_i$$

where ϕ_i = notional number of beds available to residents in zone (i); N_{ij} = flows of patients from residential zone i to all j's (treatment districts); a_j = average length of stay in treatment zone j in days; P_i = population resident in zone i.

The seventh indicator is similar being the notional expenditure per head of residential population. The term 'notional' in this context is used to describe allocations resulting from the practical operation of the referral process between and within districts which can then be examined in relation to specific residential districts. The notional number of beds, for example, takes into account where any patients living in a given residential zone are treated in the Yorkshire region and expresses the pattern as the bed availability of that district. Districts without any facilities of their own may conceivably have access to in-patient facilities in adjacent districts. The notional number of beds, however, reflects actual referral decisions rather than formal allocation of beds or wards to different health authorities. The notional number of beds is significant in helping to explain variations in the hospitalisation rate and the two should be interpreted together. The notional number of beds is also influenced by average length of stay which patients from a residential zone (i) experience. If we had a low notional number of beds available to a residential district but the patients treated in those beds had a short length of stay; we might conclude that the hospital is efficient but that the effectiveness of the service overall might be poor. The opposite case could be interpreted as an overprovided or inefficient service. These relationships are shown below in figure 3.1.

	High a_i	Low a_i
High ϕ_i	INEFFICIENT EFFECTIVE	EFFICIENT EFFECTIVE
Low ϕ_i	INEFFICIENT INEFFECTIVE	EFFICIENT INEFFECTIVE

Figure 3.1 The relationship between notional beds to zone (i) and average length of stay

where ϕ_i is the notional number of beds to residents in zone i; a_i is the average length of stay of patients from zone i calculated as

$$\sum_j N_{ij} a_j \Big/ \sum_j N_{ij}$$

The eighth residential indicator is the average distance travelled based on the calculation of intra-zonal distances. The distances used are proportional to one another but are not in standard distance units such as miles or kilometers. The distances are calculated as the straight line distance between residential zone centroids (weighted according to the population distribution) and the treatment location (either disticts or hospitals). The tenth residential indicator is the bed utilization rate and is written as

$$U_i = \left\{ \frac{\sum_j N_{ij} a_j}{P_i} \right\} \times 1000$$

where U_i is the utilization rate of residents in zone i; N_{ij} is the flow of patients from residential zone i to treatment zones (j); a_j is the average length of stay in days and P_i is the population resident in zone (i). As with the other indicators, U_i should be carefully interpreted and is designed to be examined in conjunction with the hospitalisation rate.

It should be clear from the above discussion that the various residential performance indicators are inter-related and should be interpreted as such.

Facility-based indicators, it will be recalled, are related to the provision of services by a hospital or district for its catchment population. As with the residential indicators the first four relate to the proportion of patients who actually live in the district in which they are treated. For the 17 x 21 system, however, these four indicators should be disregarded since the district of treatment (j) relates to the position of a hospital rather than a distict health authority. The fifth indicator is the number of beds available per head of catchment population.

$$B_j = \frac{X_j}{Z_j}$$

where B_j = beds available per head of catchment population; X_j = beds available in zone (j); Z_j = catchment population of facility zone j.

Calculation of the catchment populations is dependent on the level of provision of services not only in the district in question but also on the provision of services in adjacent districts. It follows that the level of B_j will also depend on the supply of services and will change whenever current file alterations are made in the number of beds available in any of the treatment districts. B_j will also be sensitive to the way in which catchment populations are calculated. Since B_j is an indicator of service provision we would expect the levels to vary considerably. Indicators six and seven are the budget and case capacities per 1000 catchment population

$$E_j = \frac{C_j}{Z_j} \times 1000$$

where E_j = budget (expenditure) per 1000 catchment population of zone j; C_j = expenditure in zone j; Z_j = catchment population of zone j. A cautionary note should be added here since expenditure data published by th RHA's tends to be at the level of the hospital unit rather than for individual specialties. This means that for hospital facility zones which contain specialties other than mental illness, the District General Hospital for example, both the total budget and the cost per in-patient day are substantially larger than for mental illness treatment alone. Although estimates for the specialty cost can be

obtained through the application of models such as that developed by Forte and Wilson (1985), it should be noted that only for the facility zones which cater for the single specialty of mental illness, are the budget figures reliable. If, however, we were only to look at the E_j values for these zones, the variations could still be considerable depending upon the efficiency and quality of service provision.

Indicators 8, 9 and 10 use the variable of cases attracted per bed, cases per unit of expenditure and cases per head of catchment population respectively. These indicators vary according to whether the system is run for the raw data or using the outputs of one of the models. If the raw data or the doubly-constrained model is used, then the figure for the cases attracted is simply the number of cases treated at a facility (j) during a year. This would mean that indicator ten is identical to indicator eight, both measuring the treatment intensity of a catchment population. If, however, a production constrained model is run, the model takes the availability of beds as an attractiveness factor and may allocate a greater or lesser number of patients to a facility on this basis. Indicator twelve (cases attracted/ case capacity) for the production-constrained model may on this basis be calculated to be over 100 per cent. Such cases simply imply that there is an underprovision of beds in that district. Similarly if indicator twelve is given a figure substantially below 100 per cent, this implies overprovision at that particular facility. Clearly indicator twelve is interesting as far as planning issues are concerned for it can highlight areas in which adjustments in the supply of services might be made.

As with the residential indicators, facility indicators have been designed to be interpreted in conjunction with one another.

3.5 Data

Three main sources of data have been used; the Mental Health Enquiry (MHE); the SH3 returns for mental illness specialty and the Health Service Costs for the Yorkshire region. In each case the most recently available data was used (1983-84). In addition the 1983 mid year population estimates (OPCS 1985) were used to give the regional population by district and age, sex subgroups. This population

data allows us to standardise districts by age and sex. Ideally we should also standardise by morbidity because of known variations in the incidence and type of mental illness according to age and gender. It is difficult to get accurate figures on morbidity because hospital admissions only indicate revealed demand rather than absolute incidence. In the acute services mortality is used as a surrogate indicator of morbidity allowing standardised mortality ratios to be calculated. For mental illness conditions which tend to be non-organic in nature, the condition is rarely fatal and it would not be acceptable to use mortality data. A cautionary note should therefore be added with regard to the interpretation of performance indicators such as the hospitalisation rate: whereas there is no reason to believe that there are marked variations in the incidence of psychiatric illness across the Yorkshire region, it is possible that some of the variations in the performance indicators could be accounted for by different rates of illness in the district populations. However, as we shall show later, the order of magnitude of differences in performance indicators, in many cases, is such that even taking into account possible variations in incidence, other mechanisms must also be at work. Until we have reliable estimates of the incidence of mental illness therefore, it will not be possible to standardise populations according to morbidity.

The use of two data sets to give information on the level and intensity of treatment in psychiatric hospitals although necessary did pose a number of problems which should be mentioned. Data from the MHE was used to give information on the flow of patients by district of residence and district of treatment (DHA or hospital). The SH3 returns were used for information on the average daily number of available and occupied beds and the annual number of deaths and discharges. The death and discharge figures are used as a measure of the number of cases treated but those contained in the MHE do not accurately match those of the SH3 returns. Some of these inconsistencies were eliminated by excluding cases in the MHE returns for whom no exact district of residence was recorded. Where the figures were still slightly different the MHE figures were used for consistency.

A further restriction posed by the data is that the returns treat mental illness as a single specialty and make no distinction between acute and chronic mental illness. In view of this no average length

of stay is given in these returns, the information being given in frequencies and different length of stay categories. For simplicity we have calculated the average length of stay on the understanding that variations in some of the performance indicators such as cases treated per bed, will be due as much to the type of patient as to the differences in a hospital's efficiency in treatment.

Clearly the data poses a number of limitations to the use of the models and the interpretation of the results which they yield. The implementation of the recommendations of the Körner Committee, however, should go a long way towards improving the situation, allowing some distinction between chronic and acute hospitals and cases and psychiatric sub specialties.

3.5 Model outputs and graphical facilities

The main form of output from the computer based model package is the set of performance indicators for both the base and currrent file. Clearly this is a very large amount of information that requires careful digestion. As we have pointed out performance indicators need to be viewed in conjunction, not simply in isolation. To aid this process we have developed an interactive graphics package that plots out the PI's in map form on the monitor of a personal computer. This enhances the interpretation of PI's that are produced in tabular form and enables situations that require close attention to be readily identified.

In addition to this information the output from the spatial interaction models is contained in a separate file. In this case the goodness of fit statistics and flow projections for the current file are of particular importance.

4. Some results from the model runs

4.1 Base file performance indicators

In this section we describe the performance indicators calculated from the raw data which constitutes the base file, for both the 17 x 17 zone and 17 x 21 zone cases. For simplicity the zones are referred to

Table 4.1

(a) Catchment poulations 17 x 17 zone case

ZONE	CATCHMENT POPULATION
1	25564
2	657185
3	153709
4	0
5	0
6	525444
7	92738
8	0
9	211712
10	333762
11	187457
12	378298
13	0
14	286578
15	283148
16	309882
17	159015

(b) Catchment populations 17 x 21 zone case

ZONE	CATCHMENT POPULATION
1	25419
2	433324
3	221602
4	153687
5	346731
6	568
7	178239
8	92737
9	15896
10	183372
11	226397
12	116950
13	118805
14	71995
15	236304
16	141897
17	255646
18	22890
19	282366
20	320844
21	158824

Total catchment population = 3604484 Total population = 3604487

by their type (either residential or facility) and their number. The names and locations of these zones were given in tables 2.1 and 2.2 and figures 2.1 and 2.2.

Perhaps the most basic calculation is that of the catchment populations, since these form the denominators of several of the facility based performance indicators. Table 4.1 lists the catchment populations for (a) the 17 x 17 zone case and (b) the 17 x 21 zone case. In the 17 x 17 case, a point to note is that four districts have catchment populations of zero. This is because these districts have no in-patient psychiatric facilities of their own. For the 17 x 21 case, the catchment populations relate to the hospitals and so there are no zero values. The populations for this example vary substantially from 568 to 433,324. This can be explained by examining both the size of those facilities and the availability of services in other areas. hospital 2, for example, has a large catchment population because it has a large number of beds, but also because Hull (the residential district adjacent to Beverley in which hospital 2 is located) is underprovided for in psychiatric in-patient services and therefore refers a large proportion of its patients for treatment in hospitals in Beverley DHA. Similarly, hospital 6 has a very low catchment population, since it has a relatively small number of beds, a very low discharge rate, and is located in a residential zone (6) which is well provided for in psychiatric in-patient care. Since these catchment populations depend on the supply of and demand for services, they will change if adjustments are made in the base file data for current file runs of the model.

Turning to the residential performance indicators for the 17 x 17 zone case, some of the most interesting figures are those showing the geography of patient care. Indicators 1 to 3 show the proportion of cases treated in their district of residence, in adjacent districts or in the rest of the system. The results are shown in table 4.2. None of the districts are entirely self contained in the treatment of psychiatric patients although district 12 treats 97 per cent of the cases generated from that zone. Districts 4, 5, 8 and 13 as noted before have no facilities of their own relying almost entirely on adjacent districts' services. Generally the figures for indicator 3 (patients

treated in the rest of the system) are low as we would expect. Residential zone 3, however, appears to send about 4 per cent of the patients to hospitals located some distance from their place of residence which would appear to be undesirable, particularly since this figure is significantly greater than the proportion of patients treated in adjacent zones (indicator 2). The patient flow data shows that some Grimsby patients are treated in Wakefield, Beverley and York, probably because the closer districts of Hull and Scarborough have low in-patient psychiatric service provision.

Indicator 5, the hospitalisation rate (table 4.3) shows some interesting variations from 0.000690 (zone 4) to 0.007543 (zone 11). To some extent zone 4 has an artificially low hospitalisation rate since it is known that some patients from Scunthorpe are treated in the adjacent Trent RHA. For simplicity we have assumed Yorkshire RHA to be a closed system since the inter-regional flows are relatively small in comparison to the total number of intra-regional flows and the appropriate data is difficult to obtain. Similarly, zone 5 is known to have some patients referred to the Northern RHA. A hospitalisation rate, as noted previously, needs to be carefully interpreted. The high figure for Calderdale (residential zone 11) is in part due to short lengths of stay or a high turnover of patients associated with general hospital psychiatric units generally. This is confirmed when we look at indicator number eleven (the notional number of bed-days per head of residential population) also in table 4.3. It appears that zone 11 has few notional bed-days despite the large number of cases. For zones such as Dewsbury it implies that once patients are admitted for psychiatric treatment they tend to stay in hospital for a long period of time. Whilst performance indicators were not explicitly designed with the objective of measuring clinical outcomes, indicators five and eleven clearly point to significant variations in clinical practice in the treatment of mental illness, and that treatment experiences depend upon where patients live. Considering the relationship between symptoms derived from institutionalisation, and length of stay, these variations are a cause for some concern.

The facility performance indicators from the 17 x 21 zone case

Table 4.2

Residential performance indicator 1-3

INDIC NO. / DISTRICT	1	2	3
1	0.039971	0.953488	0.001453
2	0.962199	0.030928	0.000000
3	0.950192	0.003831	0.038314
4	0.000000	0.969925	0.000000
5	0.000000	0.953271	0.000000
6	0.945578	0.019274	0.009070
7	0.630556	0.361111	0.000000
8	0.000000	0.990893	0.003643
9	0.586333	0.398414	0.008542
10	0.953020	0.025503	0.000000
11	0.924931	0.067493	0.002755
12	0.976072	0.010967	0.000997
13	0.000000	0.977186	0.003802
14	0.657848	0.332745	0.000588
15	0.685264	0.302001	0.003032
16	0.937132	0.025540	0.005894
17	0.873016	0.120370	0.001323

Table 4.3

Residential performance indicator 5. Hospitalisation rate

1	0.004319
2	0.004821
3	0.001631
4	0.000690
5	0.001021
6	0.003522
7	0.005125
8	0.004210
9	0.004877
10	0.004238
11	0.007543
12	0.004722
13	0.004782
14	0.004590
15	0.004613
16	0.003574
17	0.004352

Residential performance indicator 11. Notional bed days per head of residential population

1	0.001050
2	0.001204
3	0.000120
4	0.000178
5	0.000454
6	0.001743
7	0.001071
8	0.001897
9	0.000736
10	0.000605
11	0.000688
12	0.002008
13	0.002526
14	0.002911
15	0.001188
16	0.002115
17	0.000583

give a much finer level of detail than the 17 x 17 zone case though for treatment districts in the latter where there is only one hospital the figures will be the same as for the 17 x 21 facility indicators. Facility indicator 5 (beds/head of catchment population) is shown in Table 4.4 and reveals a large variation from the lowest in zone 4 to the highest in zone 6. In general the rates are related to the level of bed provision but vary by a factor of 70 if zone 6 is exluded. Hospital 6 is something of an anomaly in that it is a small hospital with a low rate of occupancy and treated only two cases during the year. The long average length of stay which by our method of calculation is in the order of fifteen years, together with these other factors means that for all indicators zone 6 appears as an extreme case and it would perhaps have been better to exclude it altogether. Indicator seven is the case capacity per 1000 catchment population (table 4.5) and again shows substantial variations between the zones. Zones which had a large number of beds per head of catchment population such as High Royds (zone 17) do not necessarily have a high case capacity since indicator 7 is also dependent on length of stay of patients. Zone 14, for example, which provided a relatively low level of beds per head of catchment population takes a high value in indicator number seven because the average length of stay is less than a month.

This description of some of the base file indicator results should demonstrate the need for careful interpretation of indicators conjointly. No mention has been made to this point of the resource indicators. This is in part due to the problems associated with the cost information discussed earlier. The resource data which has been used here was obtained directly from the regional hospital cost returns in the case of the single specialty mental illness hospitals. For the district general hospitals, the resources allocated for mental illness is estimated by multiplying the number of deaths and discharges by the average length of stay by the cost per in-patient day. When these figures were calculated for the mental illness hospitals they gave a close approximation to the hospital expenditure figure quoted in the returns suggesting that this measure gives us an acceptable estimate of expenditure on psychiatric cases in distric general or partly acute, hospitals. The values for indicator six (expenditure per head of catchment population) are given in table 4.6. One of the striking points to note, is that even excluding extreme figures such as that for

Moorlands hospital (facility district number 6) the variation between hospitals is startling. Of the single specialty mental illness hospitals, Storthes Hall is by far the most expensive; spending over twice as much per head of catchment population as Stanley Royd hospital (district 20) and almost three times as much as Broadgate hospital (district 3). The figures for costs per in-patient day depict Storthes Hall as having slightly below average costs and so it would seem likely that overall the hospital is being run relatively inefficiently. Obviously these figures need careful interpretation and it may be that larger expenditures represent the inefficiencies inevitable during the run down of a hospital's capacity. Just as very high levels are a cause for concern, low levels of expenditure may be reflecting poor qualitative standards of service. St Mary's (district 8) and Waddiloves (district 9) for example, have low expenditure per head of catchment population compared to the other psychiatric hospitals in the region.

We can compare these facility based expenditure figures with the residential indicator equivalent (notional available expenditure on residents in zone i per head of residential population). (Table 4.7). The figures show that Dewsbury and Huddersfield (zones 12 and 13) have high notional expenditure due to the influence of Storthes Hall hospital, but that Leeds West has a slightly higher notional expenditure probably due to greater self-containment of the district than is the case for Huddersfield. Zones with low notional expenditure (3, 4, 5 and 17) are particularly interesting but are in part explained by the fact that some of the patients from those districts are treated in adjacent regional health authorities, the figures for which are omitted from this analysis.

4.2 Calibration of the model

The description of the performance indicators in the previous section related to those calculated from the raw data for the base file. If, however, we want to use the model system to explore different policy options, we need to use one of the spatial interaction models to predict patient flows. The type and form of the models was described in section 3.2.

The first stage in running these models is to calibrate the distance deterrence parameter, β_i, for the particular model being tested. In this case it is obviously important to examine how good a fit is obtained between observed and predicted flow matrices. There are a number of relevant statistics that can be used for this purpose. Traditionally considerable importance is attached to the Pearson correlation coefficient - R^2. However, sometimes it is more relevant to use the sum of squared deviations or at least examine the residuals matrix.

Using the doubly constrained model and origin specific β_i values (table 4.8) we obtained an R^2 of 0.945 for the 17 x 17 zone model and 0.973 for the 17 x 21 zone model (the β_i values are given in table 4.8). In both cases the residuals were generally small although they were on average larger in the first case than in the latter. There are a range of technical problems associated with model calibration that will not be covered here but we refer the interested reader to Openshaw (1976) for further details.

One important point regarding the comparison of performance indicators which should be spelled out is that if we are running the current file data through say a doubly-constrained spatial interaction model, then for consistency that model should also be used for the base file rather than the raw data. Although the performance indicators thus calculated would be similar to those based on the raw data they are not identical and small variations in the current and base file indicators may be due to the spatial interaction predictions rather than to changes in the current file variables if raw data based indicators were used for comparison.

The performance indicators for the raw data were described in the previous section and those which are calculated using the doubly-constrained model on the base file data are essentially quite similar. The catchment populations for the 17 x 21 zone case, for example, are shown in table 4.9 so that they can be compared with the data based calculations. Some interesting results are obtained however if we use the production-constrained model. This model uses the beds available in treatment facilities as an attractiveness factor. Facility indicator

Table 4.4

Facility performance indicator 5
Beds per head of catchment population

1	0.000370
2	0.001152
3	0.001087
4	0.000128
5	0.001658
6	0.058053
7	0.002232
8	0.000485
9	0.000944
10	0.000654
11	0.000940
12	0.000531
13	0.000497
14	0.000613
15	0.000408
16	0.007960
17	0.004561
18	0.000699
19	0.000516
20	0.003062
21	0.000371

Table 4.5

Facility performance indicator 7
Case capacity/1000 catchment population

1	0.002872
2	0.003252
3	0.004043
4	0.001627
5	0.003242
6	0.003518
7	0.003484
8	0.005057
9	0.004529
10	0.004564
11	0.004364
12	0.004147
13	0.007104
14	0.007473
15	0.004752
16	0.004799
17	0.004706
18	0.004718
19	0.004600
20	0.004258
21	0.004344

Table 4.6

Facility performance indicator 6
Expenditure per head of catchment population

1	4.245952
2	12.728881
3	19.095932
4	3.035822
5	17.343292
6	263.892090
7	25.691437
8	4.737952
9	9.312842
10	10.871595
11	16.880737
12	7.723628
13	7.895059
14	50.881485
15	4.668358
16	59.257156
17	36.156296
18	14.927538
19	8.941576
20	25.111511
21	6.159615

Table 4.7

Residential indicator 7
Notional expenditure (£) on residents in zone i per head of residential population

1	17.817963
2	20.187622
3	3.268268
4	2.762952
5	5.309375
6	23.867447
7	13.080246
8	22.194122
9	13.814354
10	10.789738
11	26.471634
12	22.039734
13	27.508240
14	30.249863
15	15.074525
16	21.132004
17	8.697344

Table 4.8

	β_i values
1	5.18
2	3.09
3	4.39
4	2.97
5	4.20
6	1.85
7	4.16
8	2.79
9	4.51
10	3.09
11	4.72
12	3.50
13	7.14
14	4.39
15	4.20
16	3.55
17	4.45

number 12 as explained in section 3.3 may under these circumstances take values significantly above or below 100 per cent. The values for indicator 12 for the 17 x 21 zone case are given in table 4.10. The most striking value is that for zone 1 which suggests that there is substantial underprovision of services at Kingston General Hospital for the people resident in Hull District Health Authority. This is borne out in the flow data which shows that most psychiatric patients from that district are treated in the adjacent district of Beverley. Districts which are overproviding services in relation to demand include, Airedale General, Stanley Royd Hospital and Naburn and Bootham Park. This might suggest that we should try to redistribute bed-capacity in some of the policy runs of the model in which the current file data is altered.

4.3 Exploration of policy issues

One of the main advantages of the model system is that it allows us to explore and assess future intra-regional resource allocation strategies. There are a number of variables which we can change in the current file which are consistent with existing policy issues. In the case of mental health care, the general policy at all organisational levels of the NHS is to reduce the size of large psychiatric hospitals with the eventual aim of closing some altogether to provide community based service alternatives. Although at present we are not able to model community sector services, we can examine what the likely impacts of, say, changing the length of stay or reducing the number of beds and resources allocated to hospital facilities. We can then investigate the effect of such changes on the efficiency with which hospitals operate and perhaps identify appropriate changes in the balance of resources. We might also want to investigate changes in the flow of patients to reflect the referral policy of general practitioners.

One point to raise in connection with the capabilities of the model is that of the interdependence between variables. If, for example, we halved the number of beds in a particular hospital without making any other changes in the base file data, the model outputs would tend to show a massive increase in the occupancy rate.

In reality it would not only be the beds that would be reduced but also the number of cases treated during the year or the demand for beds or even the average length of stay. These variables must therefore be adjusted as appropriate in the current file.

In the rest of this section we describe two examples of the use of interactive planning models for exploring policy issues. The first of these is based on planning projections produced by High Royds hospital for the year 1988, and the second looks at the effect on Storthes Hall hospital of a substantial reduction in the average length of stay. In each case the performance indicators calculated are compared with those calculated for the base file data. Both cases use a doubly-constrained spatial interaction model. Since it is hospitals we are interested in, in this case, only the 17 x 21 zone case is discussed.

4.3.1. High Royds Hospital

A planning document published in 1982 highlighting plans for reduction of bed capacity at High Royds hospital predicted that the number of in-patient beds would be 575 by December 1988, and that on present trends the hospital could expect an increase in the annual number of cases (acute admissions) to 1600 in 1988. Since the model cannot make appropriate adjustments in length of stay we estimated the reduction in length of stay which would be needed to achieve a sensible occupancy rate (of about 100 per cent). In the current file then the following variables were changed.

DISTRICT	VARIABLE	BASEFILE	CURRENT FILE
Residential district 14	Morbidity (a measure of demand)	1764	2161
Facility district 17	Beds available	1166	575
Facility district 17	Average length of stay (days)	284.7	130.8
Facility district 17	Cases treated	1203	1600

One of the most fundamental changes made in the calculated indicators is to the catchment populations. Table 4.11 contains the new calculated catchment population. If we compare these values to those contained in table 4.7, district 17 shows an increase in its catchment population. Another point to notice is that although we have made no changes in the data relating to the other treatment districts, their catchment populations will alter slightly, particularly those contiguous with Leeds West DHA where High Royds is situated. This point was mentioned earlier but the example here illustrates the fact that calculation of catchment populations is based on the multi-district system and takes into account the relative supply and demand of and for services in all districts. The increase in hospital 17's catchment population is notable in that although the number of beds has been reduced, the number of cases has increased, together with demand which account for the change in catchment size.

The facility performance indicators will tend to be the more interesting ones where current file alterations have been made in service supply. Indicator 5 for example (table 4.12) shows a reduction in the beds per head of catchment population of about 55 per cent which would be expected bearing in mind the reduction of beds from 1166 to 575. If, however, we look at case capacity or cases attracted (table 4.13) it can be seen that compared to the base file situation, High Royds could treat far more patients per head of catchment population. This example clearly illustrates the deficiencies of measures of service provision which look simply at service provision per 1000 population in relation to some normative standard, for such measures fail to take into account the efficiency of service use or methods of treatment in different facilities. Performance indicators by contrast allow us to investigate different facets of service delivery in combination with one another. By reducing patients length of stay in hospital, High Royds can reduce the number of beds available and perhaps make overall expenditure savings. In this example no changes were made in the total budget of hospital or to the costs per in-patient day. Since the new current file represents the projected situation in 1988 it is difficult to make assumptions about the level of funding or the savings that would be made from reducing the number of beds. This would depend on factors such as

Table 4.9

Catchment populations calculated using Base file data and doubly-constrained model

1	16774
2	440162
3	203885
4	151389
5	312807
6	632
7	196336
8	91100
9	16045
10	186402
11	229756
12	124228
13	116437
14	75749
15	237780
16	147339
17	255881
18	22999
19	283577
20	333198
21	162019

Table 4.10

Facility indicator 12: cases attracted/case capacity x 100 using production constrained model (Base file)

1	744.845459
2	81.811981
3	74.557114
4	105.589066
5	85.569122
6	41.766022
7	41.578690
8	158.071442
9	152.738563
10	146.541214
11	68.319427
12	53.493271
13	118.002930
14	122.756393
15	90.503128
16	89.920624
17	129.070770
18	119.654831
19	122.104004
20	68.618164
21	99.404190

Table 4.11

Current file with High Royds projections catchment populations

1	16758
2	439297
3	203598
4	151324
5	312378
6	631
7	196008
8	91055
9	15996
10	186277
11	221680
12	124108
13	116547
14	75839
15	237834
16	147381
17	285537
18	19220
19	280012
20	321066
21	161947

Table 4.12

Indicator 5: beds/head of catchment population

	Base file		Current file
1	0.000560	1	0.000561
2	0.001134	2	0.001137
3	0.001182	3	0.001183
4	0.000130	4	0.000130
5	0.001838	5	0.001840
6	0.052239	6	0.052327
7	0.002027	7	0.002030
8	0.000494	8	0.000494
9	0.000935	9	0.000938
10	0.000644	10	0.000644
11	0.000926	11	0.000960
12	0.000500	12	0.000500
13	0.000508	13	0.000507
14	0.000582	14	0.000581
15	0.000406	15	0.000406
16	0.007666	16	0.007664
17	0.004557	17	0.002014
18	0.000696	18	0.000832
19	0.000514	19	0.000520
20	0.002948	20	0.003059
21	0.000364	21	0.000364

as the possibility of closing whole wards or units and on whether these units could be sold or would remain unused by the hospital. All the performance indicators suggest at present is that the expenditure per case will decrease, since the average length of stay per case has been reduced. This highlights one area in which the models could be improved and we discuss these in the final section of the paper. To summarise the projected increase in the number of acute cases treated at High Royds hospital could be easily accommodated if the number of beds were substantially reduced, if the turnover of patients were increased by reducing a patient's average length of stay. The resource implications which such developments might have would depend on the manner in which the changes are implemented and whether corresponding changes were to be made in the quality of in-patient care.

4.3.2 Storthes Hall

The example of Storthes Hall hospital provides an interesting contrast to the previous one in that Storthes Hall provides in-patient care for both Huddersfield and Dewsbury DHA's (residential zones 12 and 13) as well as treating some patients from Calderdale. Like High Royds, patients at Storthes Hall have very long lengths of stay. It is planned that Dewsbury DHA will, over the next few years, develop its own acute psychiatric care facilities and that in due course Storthes Hall hospital will close. Indicator 12 for the production constrained model (see Table 4.9) implied that Storthes Hall (treatment zone 16) was overproviding for the number of cases which it attracted. In this run then, we have reduced the number of beds in Storthes Hall hospital, reduced the number of cases treated in a year by 281 and made a slight alteration in the length of stay. This is to reflect the fact that unlike High Royds hospital Storthes Hall deals more with chronic mentally ill people and the acute cases are treated in St Lukes hospital. The alterations in the current file are as follows.

Table 4.13

High Royds projections
Facility indicator 7
Case capacity/head of catchment population

	Base file	Current file
1	0.004352	0.004356
2	0.003201	0.003207
3	0.004395	0.004401
4	0.001651	0.001652
5	0.003593	0.003598
6	0.003166	0.003171
7	0.003163	0.003168
8	0.005148	0.005151
9	0.004487	0.004501
10	0.004490	0.004493
11	0.004300	0.004457
12	0.003904	0.003908
13	0.007249	0.007242
14	0.007102	0.007094
15	0.004723	0.004722
16	0.004622	0.004621
17	0.004701	0.005603
18	0.004696	0.005619
19	0.004581	0.004639
20	0.004100	0.004255
21	0.004259	0.004261

Table 4.14

Current file for Storthes Hall projections
Facility indicator 5
Beds per head of catchment population

1	0.000560	1	0.000560
2	0.001134	2	0.001134
3	0.001182	3	0.001181
4	0.000130	4	0.000130
5	0.001838	5	0.001836
6	0.052239	6	0.052151
7	0.002027	7	0.002023
8	0.000494	8	0.000494
9	0.000935	9	0.000933
10	0.000644	10	0.000643
11	0.000926	11	0.000925
12	0.000500	12	0.000499
13	0.000508	13	0.000507
14	0.000582	14	0.000582
15	0.000406	15	0.000350
16	0.007666	16	0.003712
17	0.004557	17	0.004537
18	0.000696	18	0.000695
19	0.000514	19	0.000513
20	0.002948	20	0.002903
21	0.000364	21	0.000364

	VARIABLE	BASE FILE	CURRENT FILE
Res. Dist.			
12	morbidity	1003	873
13	morbidity	788	637
Facility Dist.			
16	beds	1129.4	375
16	cases	681	400
16	length of stay	422.5	300

The morbidity (demand) has been changed for the residential districts of Dewsbury and Huddersfield since we do not want the model re-allocating the cases from Storthes Hall's reduced total to other hospitals. In this way we are able to simulate the change in the mode of care from hospital to community based services.

The results for this run using a doubly constrained model for the current file data, show that the catchment populations for both psychiatric hospitals in Huddersfield DHA have changed. St Lukes increased from 237,780 in the base file (see table 4.7) to 275,699. By contrast Storthes Hall's catchment population declined, consistent with the reduction of beds and cases treated, from 147,339 to 101,026. Indicator 5, the beds per head of catchment population (see table 4.14), reveals that the value for Storthes Hall has been roughly halved for the current file data. This is a smaller change than might have been expected from the substantial reduction in beds and is due to the concurrent reduction in catchment population. The financial indicators for this run also present an interesting picture. Storthes Hall hospital, although it has a fairly low cost per in-patient day, has a very large annual expenditure figure which is not entirely explained by its size. It would appear that there may be cause for thinking that the hospital has high maintenance costs or operates relatively inefficiently.

Indicator 9 is listed in table 4.15 and shows the cases attracted per unit of expenditure for the base and current files. The point to note here is that in the first instance, the figure for Storthes Hall is the lowest of all the facility zones (excluding zone 6) and that this figure becomes even lower in the current file

run. This again reflects the reduction in the total number of cases and the fact that we have not changed the assumptions about the total expenditure. Another comment which can be made is that for the District General Hospital units (see table 2.2 for a list of hospitals) although the average cost per in-patient day is relatively high compared to the mental illness hospitals, they operate relatively efficiently by attracting a large number of cases per unit of expenditure, and by keeping the average length of stay low.

Facility indicator number 8 is the number of cases treated per bed and is used to demonstrate the degree of efficiency of a facilities operation. From table 4.16 it can be seen that the current file value of this indicator is 70 per cent higher than the base file value which is attributable to the reduction in length of stay and to proportionate changes made in the two variables. The occupancy rate is also associated with this indicator being higher for the current file situation (0.88) than for the base file (0.80).

The current file data was run again using the production constrained model to examine the effect which the changes may have had on facility indicator number 12. The use of this indicator in suggesting possible under or overprovision of services was discussed in section 3.3 above. The changes surprisingly had little effect on the value of indicator 12 being 89.92 for the base file (as shown in table 4.10) and 88.17 for the current file. As with the other indicators this might imply that we can reduce the number of beds further if we accept the proposed reduction in cases and length of stay.

For Storthes Hall hospital, the current file changes show some interesting results since they demonstrate the relationships between variables such as length of stay, the number of cases and beds and the degree of efficient operation of the hospital. This run highlights the fact that for small changes in the average length of stay, which are probably possible by simply improving the methods of assessment or the availability of community support services, we can reduce the number of beds substantially, potentially allowing efficiency savings to be made.

The two runs above illustrate the type of changes which can be

Table 4.15

Facility indicator 9
Cases attracted/Budget unit of expenditure

	BASE FILE		CURRENT FILE
1	0.000676	1	0.000676
2	0.000255	2	0.000255
3	0.000212	3	0.000212
4	0.000536	4	0.000536
5	0.000187	5	0.000187
6	0.000013	6	0.000013
7	0.000136	7	0.000136
8	0.001067	8	0.001067
9	0.000486	9	0.000486
10	0.000420	10	0.000420
11	0.000259	11	0.000259
12	0.000537	12	0.000537
13	0.000900	13	0.000900
14	0.000147	14	0.000147
15	0.001018	15	0.001018
16	0.000081	16	0.000048
17	0.000130	17	0.000130
18	0.000316	18	0.000316
19	0.000514	19	0.000514
20	0.000170	20	0.000170
21	0.000705	21	0.000705

Table 4.16

Facility indicator 8 Case attracted per bed

	BASE FILE		CURRENT FILE
1	7.765954	1	7.765947
2	2.821948	2	2.821947
3	3.719378	3	3.719378
4	12.690435	4	12.690431
5	1.955462	5	1.955463
6	0.060606	6	0.060606
7	1.560696	7	1.560696
8	10.422194	8	10.422184
9	4.799996	9	4.799997
10	6.974992	10	6.974998
11	4.642849	11	4.642851
12	7.809967	12	7.809967
13	14.280866	13	14.280866
14	12.199516	14	12.199516
15	11.637293	15	11.637298
16	0.602921	16	1.066665
17	1.031734	17	1.031733
18	6.750009	18	6.750010
19	8.915585	19	8.915586
20	1.390613	20	1.390613
21	11.694899	21	11.694902

made in current file data to replicate different policy options. In the case of High Royds the figures used were those contained in the projection plan for the hospital; for Storthes Hall we were investigating the effect of reducing beds and cases. A comparison of the two runs demonstrates the need for sensitive planning targets which recognise the interdependence between the various parameters of service delivery and the targets of efficiency and effectiveness. The run for Storthes Hall also revealed the likelihood that during the period in which psychiatric hospitals are being reduced in size or even closed, there are likely to be instances of inefficient or expensive delivery simply because of the indivisibility of hospital units. A further point which should be made is that whilst decisions to close a particular ward may be fairly straightforward, the possibility of achieving planned targets in, say, average length of stay or admissions depends on the cumulative decisions of a number of professional staff and on the severity or incidence of mental illness through time. Even if the latter are assumed to be consistent over a period of time, the likelihood of clinicians altering their referral patterns or discharging patients more rapidly may not be as simple as the realisation of formal planning objectives requires.

5. Conclusions and developments

5.1

In this section we summarise the limitations and potential achievements of the models in the planning of in-patient psychiatric services and suggest some developments which might be pursued to improve assessments of psychiatric service performance.

There are two ways in which the explanatory power of performance indicators may be restricted. The first of these relates to the calculation of performance measures, the limitations posed by the data set and errors derived from the model. The second of these and perhaps the more fundamental kind, relates to the way in which performance indicators are conceptualized and would include the theoretical and political assumptions and objectives on which the indicators are based.

5.2

Some of the problems involved in using the existing available data were discussed in section 3.5 and were borne out in both the raw data and calibrated performance indicator results. It is not possible for example, to draw any firm conclusions about the relative efficiencies in patient care from indicators based on average length of stay since there are likely to be substantial variations in the needs of patients and in the quality of services provided. It is important to realise however, that the outputs to the models are at best 'indicators' in that they are not intended to offer explanations of variations in the delivery of care between districts. Performance indicators can only draw attention to particular issues, the significance of which depends on the interpretation of the investigator, in the light of knowledge of local geographical and organisational variations in health care services. Errors to emerge in the model runs are limited, the close correlation between the observed patient flows and those predicted in the model, and the low values of the residuals suggest that the spatial interaction models can replicate fairly accurately changes in patient flows which result from changes in planning assumptions contained in the current file data (see section 4.2). The outputs of the model are however, dependent on the operator making realistic changes in the input data and the interdependence between variables suggests that we usually need to change more than one variable in the current file to replicate the constraints posed in the real world.

Major improvements in the calculation and formulation of performance indicators are to be gained from improvements in the form of the data set. Disaggregation of the information into chronic and acute cases together with their corresponding lengths of stay would enable us to consider psychiatric services as two sub-specialties with essentially different trends and patterns of treatment. Disaggregation of the population into age-sex groups with group specific morbidity rates could enable us to standardise the populations for more accurate inter-district performance comparisons. More detailed information on the various components of hospital budgets and their relation to different types of patient could clarify the issue of service quality and relative efficiency which might be particularly interesting in

comparisons of psychiatric units' and large psychiatric hospitals' performances.

One of the most important areas in which performance assessments could be developed is in the measurement of service outcomes. Although the relationship between morbidity and the form of treatment is by no means straightforward, some information relating to say, drug prescriptions or hospital re-admission episodes could indicate whether any residual morbidity exists following discharge from hospital. An interesting indicator might be developed by comparing the proportion of all patients admitted to pschiatric in-patient services which are first admissions with the proportion which are re-admissions. If this indicator was examined over a number of years the preventative component of community care services could be assessed.

5.3

Conceptual limitations to the use of performance indicators are more serious than those dependent on the form and detail of available information. Although there is not the space to go into these issues in much detail some outline comments can be made. Firstly, performance indicators are orientated towards improving the organisation and efficiency of service delivery and although they were intended to demonstrate the effectiveness of treatment, the existing indicators and the ones discussed in this paper offer little information upon which to assess service outcomes in terms of a patient's morbidity. This situation is in part the product of data availability but perhaps also to the challenge which this might represent to clinical autonomy. The lack of attention paid to service effectiveness in the case of mental illness is also consistent with the nineteenth-century emphasis on custodialism rather than the more contemporary theoretical tenets of prevention, treatment or rehabilitation. Outcome concerns raised by the working group on mental illness performance related almost entirely to the implementation of community care policy rather than to the actual effects of those services. Whilst it is acknowledged that there are many problems involved in measuring service outcomes and that to attribute the emphasis on efficiency purely to the fiscal constraints germane to most areas of public expenditure in Britain

would be simplistic; psychiatric service performance indicators are formulated such that they are consistent with the economic and ideological imperatives which underly the transition from institutional to community based care. Any challenge to the organisation and delivery of psychiatric care which performance indicators might precipitate is likely to be directed at issues such as resource allocation or structural organisation rather than those such as clinical judgement or the outcome of particular treatment types. As our introductory quotation suggested, performance indicators are directed at the measurement and control of the effects of hospitals as functional units. They are not, however, involved in the surveillance of individual practice and process. In this way performance indicators remain embedded within the matrix of professional power and its control of the form and organisation of mental health services.

Bibliography

Clarke, M. and Wilson, A.G. (1984) Models for health care planning: the case of the Piemonte region, Working Paper 38, IRES, Turin, Italy.

Clarke, M. and Wilson, A.G. (1985) Health services planning with an interactive model system: preliminary results from a case study, Working Paper, IRES, Turin, Italy.

Cottrell, K. (1983) Determining the population served by a health service, Mimeo, North Western Regional Health Authority.

DHSS (1982) Report of the Steering Group on Health Services Information, (Chairman: E. Korner), London.

DHSS (1983) NHS Management Enquiry Report, 'The Griffiths Report', London.

DHSS (1984a) Report of the Mental Illness Services Working Group of the Joint Group on Performance Indicators, DHSS, London.

DHSS (1984b) Interim Report of the Acute Service Working Group of the Joint Group on Performance Indicators, DHSS, London.

Forte, P. and Wilson, A.G. (1985) Speciality costs for Health Services Planning: model-based approaches to estimation, Working Paper 394, School of Geography, University of Leeds.

Foucault, M. (1976) The politics of health in the eighteenth century, in Power/Knowledge: selected interviews and other writings (1972-1977), Gordan, C. (ed.), Harvester Press, Brighton.

Goffman, E. (1961) Asylums, Doubleday Anchor Books, New York.

Goffman, E. (1963) Stigma: notes on the management of spoiled identity, Prentice Hall, Englewood Cliffs, New Jersey.

Openshaw, S. (1976) An empirical study of some spatial interaction models, Environment and Planning, A, 8, pp. 23-41.

Wilson, A.G. and Clarke, M. (1982) Frameworks for modelling in relation to strategic planning in a health service, Working Paper 334, School of Geography, University of Leeds.

Yorkshire RHA (1977) Regional Strategic Plan 1977 to 1986, Yorkshire RHA, Harrogate.

Yorkshire RHA (1984a) Outline Regional Strategy, Yorkshire RHA, Harrogate.

Yorkshire RHA (1984b) 1983 SH3 Statistics, Yorkshire RHA, Harrogate.

Yorkshire RHA (1984c) Health Service Costs in the Yorkshire Region, 1983-84, Yorkshire RHA, Harrogate.