WORKING PAPER 387

A STRATEGIC PLANNING SIMULATION MODEL OF A DISTRICT HEALTH SERVICE SYSTEM : THE IN-PATIENT COMPONENT AND RESULTS

M. CLARKE, P. FORTE, M. SPOWAGE AND A.G. WILSON

WORKING PAPER
School of Geography
University of Leeds

WORKING PAPER 387

A STRATEGIC PLANNING SIMULATION MODEL OF A DISTRICT HEALTH SERVICE SYSTEM : THE IN-PATIENT COMPONENT AND RESULTS

M. CLARKE, P. FORTE, M. SPOWAGE AND A.G. WILSON

School of Geography
University of Leeds
LEEDS LS2 9JT.

March 1984

A strategic planning simulation model of a district health service system : the in-patient component and results

Introduction

In this paper we outline the framework of a strategic planning model we have constructed for District Health Authorities in England and Wales. We believe that the framework will be applicable to most health care planning systems in many different countries. The model consists of four main components, as outlined in Figure 1.

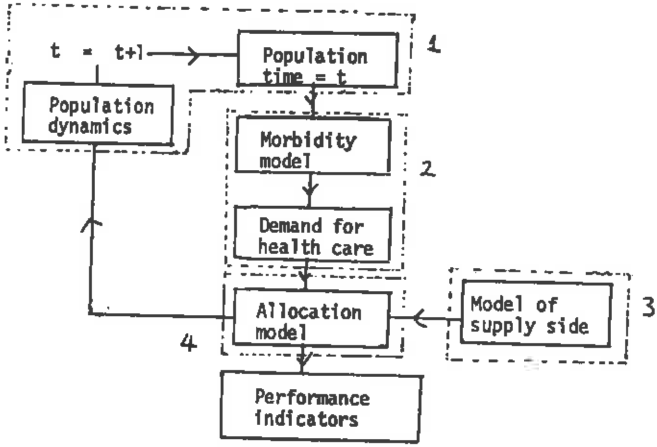

Figure 1. Model framework

First we have a model of population dynamics in which we annually update the characteristics of the health authority's population. Secondly, a morbidity model converts these characteristics into demand or need for hospital care of different types. Thirdly, there is a model of the supply side which represents the type and amount of care provided at various locations for different conditions and client groups. Finally there is an allocation model which allocates need to supply and generates a set of indicators both in terms of who receives care where and also the amount of resources consumed. We shall discuss each of these components in turn and present examples of the output the model can produce. For a more detailed description of the models we refer the reader to Clarke and Spowage (1984).

The methodology that underpins the set of models we have developed is known as micro-simulation. This approach is based on a "smallest-unit" representation - in our case households and individuals. Although we shall briefly comment on this technique a more detailed exposition can be found in Clarke, Keys and Williams (1981).

A final introductory comment is in order. There has, over the last decade or so, been a growing interest in the use of analytic methods in health care planning. This has involved many different disciplines : economics, operations research, geography, social policy and accountancy, to name but a few. But it still tends to remain *multi*-disciplinary rather than *inter*-disciplinary. We would argue that by integrating different methods and approaches from the various interested groups most progress will be made. This would also reflect our belief that most contemporary problems in health care planning are of a highly interdependent nature and it is important that correspondingly sophisticated methods must be developed if we are to understand and solve them.

Population model

Using a micro-simulation approach we require an initial population consisting of a sample of individual and household attributes stored as lists on the computers. The attributes specified will be specific to the application involved. In our model we have demographic, social and economic characteristics, such as age, sex, location, occupation, social group, ethnic group, household size and so on. The sample size will be chosen so that, in aggregate, the distribution of atrributes in the sample population will closely match those of the health authority being modelled.

The initial population may be specified from a suitable survey but this tends to be expensive and time consuming. Our own approach has been to synthesize an initial population from published aggregate information, such as the census, the Family Expenditure Survey and so on. This involves the use of contingency table analysis (Feinberg 1970) to generate the joint probability distribution of individual and household attributes from known marginal and conditional distributions and to use Monte-Carlo sampling methods to sample from the joint distribution to create lists of individual and household attributes. If a suitable sample size is used the synthesized population will have distributions of attributes in accord with the actual distributions in the real population.

It is this sample population which will be used as the basis of the morbidity model described in the next section. In addition however we need to update the characteristics of the population for each period (usually one year) of the simulation exercise. Changing demographic trends can, of course, markedly affect the demand or need for health care, as is being exemplified in Britain at the present time with the rapid increase in the number of elderly in the population.

We therefore test each individual and household to determine whether they undertake any demographic transitions in each period of the simulation. This is achieved by obtaining conditional probabilities for the following events: death, birth, marriage, divorce, and migration, and using Monte Carlo sampling once again to determine if the transition does occur. If a transition is deemed to occur the appropriate attributes are changed and any knock-on effects are accounted for. For example, if a married male does, his wife's marital status changes, the household size is reduced by one, household income changes and so on. Information on demographic transition rates are obtained from published sources such as the Registrar General's annual reports and 1981 census data.

The morbidity model

It is almost impossible to define 'the demand for health care' and this is reflected in attempts to construct models of morbidity. The majority of information that is routinely collected on morbidity is a measure of revealed demand, that is the number of persons who have received treatment of one form or another. Latent demand, the number of people with a certain condition, identified by the health service or not, who require treatment according to some predetermined criteria is a much more difficult phenomenon to measure. In addition, as Feldstein (1967) pointed out, there remains an intimate relationship between the revealed demand for health care and the supply of medical facilities.

In our model we have adopted a systems analytic approach to the modelling of morbidity. We have attempted to isolate the various channels by which an individual might make use of a health authority's services and model each of these components. Figure 2 outlines the main flows we consider.

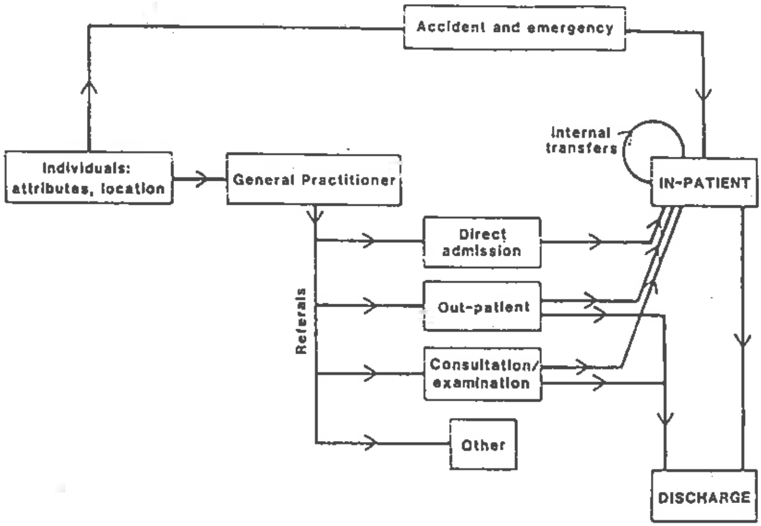

Figure 2. Examples of flows in the patient-hospital interface

First, the majority of individuals initially interface the medical system via their General Practitioner. If that individual is seriously ill, he or she may be directly admitted to a hospital. Alternatively they may need to make use of diagnostic facilities at an out-patients department. If the patient's condition is deemed to require specialised treatment or diagnoses the G.P. may refer the patient to a hospital consultant.

We model these flows in the following way. For each individual we obtain the probability of G.P. consultation on the basis of age and sex. There may, of course, be more than one consultation per year. This information is obtained from *Morbidity Statistics from General Practice*. On the basis of consultation we sample for morbidity condition given age and sex. We use the 26 standard conditions identified from the I.C.D. classification of disease. Both these stages are tested for, once again using Monte Carlo sample procedures. We allow for up to three conditions being identified as separate medical episodes each year.

Given that an individual has been identified as having a certain condition we now need to model the outcome of his G.P. consultation. Once again using

Monte Carlo sampling we test for the following outcomes : no referral, direct admission to hospital, referral to out-patients, referral to consultation/examination, and other outcome. This is done on the basis of age and condition. For each of the two referral channels we further test if the referral does lead to the individual requiring hospital in-patient services. Accident and emergency services are treated spearately, but in a similar manner.

This approach allows us to build up pools of the different types of demand for in-patient treatment. Each pool contains the appropriate individuals with their attributes. To these pools we add the waiting list that existed at the beginning of the simulation period together with other components of demand such as patient inflows from outside the authority and those patients already occupying a bed at the start of the simulation period. From the pool are subtracted those individuals who receive treatment outside the area, this too being determined on a probabilistic basis - using condition and age as the dependent variables.

The next important process to model is the transfer of morbidity conditions into the demand for treatment in a particular specialty or department of a hospital. An individual with a malignant neoplasm could be treated in, say, general medicine, general surgery or radiotherapy. There will also be a relationship between the supply of services in an authority and the types of treatment available. For example, a patient with a urinary complaint may receive treatment in a urology department if one exists or a general surgery department if one does not. Data on the probability of specialty given condition, age and sex is obtained from Hospital Activity Analysis (HAA) data for the appropriate authority.

Supply side model

In constructing a model of the supply side of the hospital system we are faced with a complicated task of determining how the various inputs into a hospital, in terms of manpower, and resources of different types, are transformed into the provision of medical care of various forms. Many direct analogies can be seen with an input-output framework. The 'final demand' may be the provision of bed-days for a given specialty. In effect, we have to articulate a complex production function. This relationship between supply and inputs is clearly not linear: sometimes a marginal increase in supply can be provided with few resources implications (when there is some slack in the system) but on other occasions a small increase in supply may imply a substantial increase in inputs (for example if a new consultant had to be appointed). In addition in certain situations an increase in one input (say beds provided) will only allow more care to be provided if the appropriate range of other inputs is increased (say operating theatre time available). This is why we often find in summary statistics specialties with low bed occupancy rates yet long waiting lists.

The costings of resource inputs, in terms of say the in-patient costs per bed day, by specialty and hospital, is an important task. Much work has been undertaken in recent years to develop methods for achieving specialty costings. For our own purposes we have developed an accounting framework that utilises all published information on district costings to derive bed day costs (the method is fully described in Forte and Wilson, 1983). For each in-patient we are then able to determine the total cost of in-patient treatment. In our current model we have not, as yet, built in a full representation of the supply side: we focus on bed days produced by specialty by hospital and we trace the underlying accounts linking these to resource inputs and costs. Work is underway in extending this approach to produce a more sophisticated model of the supply side.

Allocation model

In allocating demand to supply at the area or district level extensive use has been made of Hospital Activity Analysis data. In particular, the mapping of patients' conditions (and specialty) into a particular facility will depend very much on local factors. The demand component of the allocation procedure consists of the following main groups: (i) *Direct in-patients:* we assume that all this category have their demand satisfied; (ii) *Accident and emergency patients:* once again we assume that this category are directly admitted; (iii) *Out-patients who become in-patients:* the majority of this category are either placed on the waiting list or become 'booked and planned' patients; (iv) *Waiting list:* this consists of two separate components: the beginning of year list and those who get added to it during the year. We assume that those who have been waiting the longest with a given condition and specialty get treated first; (v) *In-flows from outside districts:* as the figures on these are an expression of revealed demand we assume that they all get treated; (vi) *Internal transfers:* the probability of an in-patient being transferred once admitted is taken from HAA data.

The allocation procedure is discussed in greater detail in Clarke and Spowage, (1984). Once a patient has been assigned a bed the probability of being admitted to a certain hospital is derived (from HAA data) and the length of stay determined on the basis of condition, age and sex. That number of bed days is subtracted from the total available supply. If no supply is available the patient is admitted to an alternative location, if available, or if not, put on the waiting list. For each in-patient the cost of treatment is calculated from our specialty costing data. When all potential demand has been processed a variety of summary statistics are output.

Examples of model output

Due to the nature of the list processing methodology we retain a large amount of information relating to the morbidity and allocation sub-models. In effect we can cross-classify any particular attribute with any other. Hence potentially a large number of indicators can be produced which can be used in a variety of planning situations. First, the model can be used to examine how future changes in demand will put pressure on the existing level of service supply. Secondly, the model can assess the impact of changes on the supply-side such as the opening or closure of hospitals. In particular the resource implications of these plans can be examined.

We can now present a set of example results produced by the model. Table 1 presents the key for the lists of conditions, specialties and surgical operations that we distinguish in the particular application we are studying. In addition there are six hospitals which we consider but these are not named for reasons of confidentiality. The rest of the tables should be self-explanatory. This type of information is produced at the end of each simulation and summary statistics, either in tabular or graphical form, and can be produced at the end of the simulation period.

Conclusions

We hope we have given the reader a glimpse of what we are trying to achieve. More details can be found in a series of papers - Clarke and Spowage (1982, 1984), Clarke and Wilson (1984), Forte and Wilson (1984). We see the major role of models as the providers of information to and decision making and not as the provider of solutions to planning problems. Viewed in this light we believe they have much to offer in the general debate concerning health care planning.

References

Clarke, M., Keys, P. and Williams, H.C.W.L. (1981) 'Microsimulation' in Wrigley, N. and Bennett, R.J. (eds.) *Quantitative Geography*, Routledge and Kegan Paul, London.

Clarke, M. and Spowage, M. (1982) Specification of a micro-simulation model of a District Health Authority, Working Paper 338, School of Geography, University of Leeds.

Clarke, M. and Spowage, M. (1984) Integrated models for public policy analysis : an example of the practical use of simulation models in health care planning, *Papers of the Regional Science Association*, Vol.54 (forthcoming).

Clarke, M. and Wilson, A.G. (1984) Modelling for Health Services Planning : an outline and an example, in Clarke, M. (ed.) *Planning and Analysis in Health Care Systems*, Pion, London.

Feinberg, S.E. (1970) An iterative procedure for estimation in contingency tables, Annals of Mathematical Statistics, 4, pp. 907-917.

Feldstein, M.S. (1967) Economic analysis for health service efficiency, *Contributions to Economic Analysis, 51*, North Holland, Amsterdam.

Forte, P. and Wilson, A.G. (1983) Models of hospital costs, Working Paper, School of Geography, University of Leeds.

CONDITIONS

1	INFECTIVE & PARASITIC DISEASES
2	ALL MALIGNANT NEOPLASMS
3	NEOPLASMS OF LYMPHATIC & HAEMATOPOIETIC TISSUES
4	BENIGN & UNSPECIFIED NEOPLASMS
5	ENDOCRINE, NUTRITIONAL & METABOLIC DISEASES
6	DISEASES OF BLOOD & BLOOD-FORMING ORGANS
7	MENTAL DISORDERS
8	DISEASES OF NERVOUS SYSTEM
9	DISEASES OF THE EYE
10	DISEASES OF THE EAR & MASTOID PROCESSES
11	RHEUMATIC FEVER, HYPERTENSIVE & HEART DISEASES
12	DISEASES OF PERIPHERAL CIRCULATORY SYSTEM
13	DISEASES OF RESPIRATORY SYSTEM
14	DISEASES OF DIGESTIVE SYSTEM
15	DISEASES OF URINARY SYSTEM
16	MALE GENITAL DISORDERS
17	DISEASES OF BREAST & FEMALE GENITAL SYSTEM
18	CONDITIONS OF PREGNANCY, CHILDBIRTH & PUERPERIUM
19	DISEASES OF SKIN & SUBCUTANEOUS TISSUE
20	DIS. OF MUSCULOSKEL. SYSTEM & CONNECTIVE TISSUE
21	CONGENITAL ANOMOLIES
22	CERTAIN CAUSES OF PERINATAL MORBIDITY
23	SYMPTOMS & ILL-DEFINED CONDITIONS
24	FRACTURES, DISLOCATIONS & SPRAINS
25	OTHER INJURIES & REACTIONS
26	PERSONS WITHOUT CURRENT COMPLAINT OR SICKNESS

SPECIALTIES

1	GENERAL MEDICINE
2	PAEDIATRICS
3	DERMATOLOGY
4	GERIATRICS
5	GENERAL SURGERY
6	EAR NOSE & THROAT
7	ORTHOPAEDIC SURGERY
8	OPTHALMOLOGY
9	GYNAECOLOGY
10	SPECIAL CARE
11	CORONARY CARE

SURGICAL OPERATIONS

1	NERVOUS SYSTEM
2	ENDOCRINE SYSTEM
3	EYE
4	EAR NOSE AND THROAT
5	UPPER ALIMENTARY TRACT
6	THORAX (WITH HEART & LUNGS)
7	BREAST
8	ABDOMEN
9	URINARY SYSTEM
10	MALE GENITAL ORGANS
11	FEMALE GENITAL ORGANS
12	OBSTETRICS
13	ORTHOPAEDIC
14	PERIPHERAL VESSELS
15	SKIN & SUBCUTANEOUS TISSUE
16	OTHER SURGICAL PROCEDURES
17	NON-OPERATIVE PROCEDURES

TABLE 1. Key to Conditions, Specialties and Operations

TOTAL OF ALL LOCATIONS

NUMBER OF HOUSEHOLDS = 3071.
NUMBER OF MALES = 3925 NUMBER OF FEMALES = 4035

	0-1	2-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75+
MALES	3.08	6.85	12.79	15.29	13.50	15.39	11.75	10.73	4.97	5.66
FEMALES	2.58	5.55	10.71	13.36	15.09	13.66	11.72	9.39	8.25	9.69

MARRIAGE RATES (PER 1000 POPULATION)

AGEGROUP

	16-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	>55	TOTAL
MALES	0.25	2.60	1.49	1.36	0.74	0.25	0.12	0.37	0.37	7.56
FEMALES	0.87	3.34	1.61	0.87	0.12	0.25	0.25	0.25	0.00	7.56

DIVORCE RATES (PER 1000 MARRIAGES)

AGEGROUP

	16-19	20-24	25-29	30-34	35-39	40-44	45-49	50-59	>60	TOTAL
MALES	0.00	2.50	1.50	5.00	3.00	1.00	1.50	1.50	0.00	16.01
FEMALES	0.50	2.00	4.50	3.50	1.50	1.50	0.50	2.00	0.00	16.01

OUT-MIGRATION RATE (PER 1000 HOUSEHOLDS) = 2.03

TABLE 2. Demographic Statistics (part 1)

DISTRIBUTION OF MARITAL STATUS BY AGE

0-1	2-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75+
0.00	0.00	0.00	33.01	61.98	74.55	83.08	80.00	59.66	42.41
100.00	100.00	100.00	65.23	34.24	20.35	9.85	9.38	7.39	9.79
0.00	0.00	0.00	0.18	0.79	1.21	4.50	8.75	31.63	46.66
0.00	0.00	0.00	1.58	2.99	3.90	2.57	1.87	1.33	1.14

DISTRIBUTION OF RACE BY AGE

0-1	2-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75+
2.71	6.27	11.66	14.39	14.24	14.65	11.66	9.95	6.73	7.74
2.04	10.20	6.12	10.20	12.24	22.45	4.08	10.20	14.29	8.16
6.29	3.43	12.57	12.57	18.86	9.14	14.29	12.57	6.86	3.43
0.00	28.57	14.29	0.00	28.57	0.00	0.00	0.00	14.29	14.29
4.35	4.35	17.39	10.14	10.87	10.14	17.39	11.59	2.17	11.59
3.57	4.46	10.71	19.64	16.07	16.07	9.82	11.61	1.79	6.25

HOUSEHOLD SIZE DISTRIBUTION

1	2	3	4	5	6	7
22.83	27.87	17.78	15.89	7.03	3.13	1.40

TENURE DISTRIBUTION

OWNER OCCUPIED	PUBLIC RENT	PRIVATE RENT
58.45	28.20	9.28

TABLE 3. Demographic Statistics (part 2)

INPATIENT DEMAND BY CONDITIONS

					MALES						
CONDITION	0-1	2-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75+	TOTALS
1	0	0	41	20	0	41	20	0	0	0	122
2	0	0	0	0	20	0	82	51	20	20	204
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	20	0	20	0	0	0	0	41
5	0	0	0	0	0	41	20	20	41	0	122
6	0	0	0	0	0	0	0	20	20	20	61
7	0	0	20	0	41	0	0	20	0	20	102
8	20	20	20	0	0	0	20	0	0	0	82
9	0	20	0	0	20	0	0	41	41	0	122
10	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	20	41	41	82	143	20	82	429
12	0	0	0	0	20	61	20	41	61	82	286
13	102	20	82	41	0	20	0	61	61	61	449
14	51	41	20	184	184	20	82	20	61	0	663
15	0	0	0	0	0	0	41	20	20	0	82
16	0	82	20	0	0	0	0	20	0	0	122
17	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0
19	20	20	20	0	0	41	20	20	20	0	163
20	20	0	0	41	102	82	143	51	0	0	449
21	20	0	20	0	0	0	0	0	0	0	41
22	255	0	0	0	0	0	0	0	0	0	255
23	61	82	61	82	61	20	102	61	20	0	551
24	0	20	0	20	0	0	0	0	20	0	61
25	20	82	61	153	41	20	20	102	0	0	510
25	20	0	0	0	0	41	0	0	0	0	61

TABLE 4(a). Inpatient Demand by Conditions (male)

CONDITION	0-1	2-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75-	TOTALS
					FEMALES						
1	20	0	20	0	20	41	0	0	0	0	102
2	20	0	0	20	41	41	82	0	0	102	306
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	20	20	41	20	41	0	0	143
5	0	0	82	0	41	20	41	0	0	0	194
6	20	20	20	0	20	20	20	20	20	41	204
7	41	0	0	41	41	0	20	0	41	0	184
8	0	61	41	20	0	0	20	20	0	20	184
9	0	0	0	20	20	0	0	20	0	0	61
10	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	20	0	20	41	82	143	306
12	0	0	20	20	61	41	41	41	61	184	469
13	82	61	41	41	41	82	20	82	102	41	592
14	0	20	20	122	184	82	61	61	61	82	694
15	0	0	20	0	0	20	20	61	41	82	245
16	0	0	0	0	0	0	0	0	0	0	0
17	0	0	41	285	245	224	82	61	0	0	939
18	0	0	0	82	286	0	0	0	0	0	367
19	20	0	0	41	20	20	41	0	0	0	163
20	0	0	0	0	20	82	143	41	61	163	510
21	20	20	0	0	0	0	20	0	0	0	61
22	408	0	0	0	0	0	0	0	0	0	408
23	82	0	82	61	61	41	20	61	82	102	592
24	0	0	0	0	0	0	0	20	61	82	163
25	0	0	61	163	41	82	41	41	82	20	531
26	20	0	0	41	0	20	20	0	0	0	102

TOTAL DEMAND FOR OP INPATIENTS = 12490

TABLE 4(b). Inpatient Demand by Conditions (female)

INPATIENT DEMAND BY SPECIALTIES

MALES

SPECIALTY	0-1	2-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75+
1	0	0	0	214	122	102	163	265	82	0
2	265	122	143	20	0	0	0	0	0	0
3	0	20	0	0	0	20	0	20	0	0
4	0	0	0	0	0	0	0	102	61	265
5	41	204	163	245	286	184	327	163	163	20
5	0	0	0	0	0	0	0	0	0	0
7	20	20	41	32	102	122	153	61	41	0
8	0	20	20	20	41	0	0	51	41	0
9	0	0	0	0	0	0	0	0	0	0
10	235	0	0	0	0	0	0	0	0	0
11	0	0	0	20	20	20	0	41	20	0

FEMALES

SPECIALTY	0-1	2-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75+
1	0	0	20	214	286	32	143	82	163	184
2	306	163	204	0	0	0	0	0	0	0
3	0	0	0	0	0	0	41	0	0	0
4	0	0	0	0	0	0	0	61	163	510
5	20	20	163	265	265	347	163	224	204	184
6	0	0	0	0	0	0	20	0	0	0
7	20	0	41	51	61	92	163	32	153	184
8	0	0	0	41	20	0	0	20	20	0
9	0	0	20	309	531	265	184	143	0	0
10	338	0	0	0	0	0	0	0	0	0
11	0	0	0	0	20	92	20	0	20	0

TABLE 5. Inpatient Demand by Specialties

DEMAND BY SPECIALTY AND SOURCE OF ADMISSION

SPECIALITY	ACCIDENT & EMERGENCY	DIRECT	INDIRECT	TRANSFER
1	775	837	459	0
2	131	429	612	0
3	0	61	41	0
4	112	347	573	20
5	735	735	2143	0
6	0	20	0	0
7	388	143	939	31
8	102	20	184	0
9	82	449	1020	0
10	0	573	0	0
11	143	122	0	0
TOTALS	2512	3636	6081	51

DEMAND BY CONDITION AND SOURCE OF ADMISSION

CONDITION	ACCIDENT & EMERGENCY	DIRECT	INDIRECT	TRANSFER
1	0	82	143	0
2	0	184	327	0
3	0	0	0	0
4	0	20	163	0
5	153	41	102	0
6	0	82	184	0
7	51	184	41	0
8	20	20	224	0
9	0	20	163	0
10	0	0	0	0
11	224	357	143	0
12	61	286	347	51
13	235	347	408	0
14	265	510	592	0
15	20	51	245	0
16	0	20	102	0
17	0	122	816	0
18	61	245	61	0
19	0	82	224	0
20	20	102	837	0
21	0	41	61	0
22	0	633	41	0
23	51	388	694	0
24	224	0	0	0
25	1041	0	0	0
26	0	0	153	0

TABLE 6. Source of Admission by Specialty and Condition

SPECIALTY BY CONDITION

SPECIALTY

CONDITION	1	2	3	4	5	6	7	8	9	10	11
1	41	61	0	0	51	0	0	20	41	0	0
2	61	20	0	61	306	0	0	20	41	0	0
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	41	0	41	0	102	0	0
5	92	82	0	20	61	0	0	0	20	0	41
6	41	61	0	82	82	0	0	0	0	0	0
7	122	61	0	61	0	0	0	0	0	0	41
8	0	143	0	20	0	0	102	0	0	0	0
9	0	0	0	0	20	0	0	163	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
11	469	20	0	143	0	0	0	0	0	0	102
12	143	0	0	306	204	0	61	0	20	0	20
13	367	347	0	224	41	20	0	0	0	0	41
14	224	82	0	20	1020	0	20	0	0	0	0
15	61	20	0	41	204	0	0	0	0	0	0
16	0	0	0	0	122	0	0	0	0	0	0
17	0	0	0	0	184	0	0	0	755	0	0
18	0	0	0	0	0	0	0	0	357	0	0
19	0	0	102	0	92	0	102	0	20	0	0
20	0	0	0	122	0	0	816	0	20	0	0
21	0	20	0	0	20	0	41	0	0	20	0
22	0	61	0	0	0	0	0	0	0	512	0
23	143	143	0	41	594	0	0	0	61	41	20
24	0	0	0	0	20	0	204	0	0	0	0
25	327	61	0	0	509	0	122	102	20	0	0
26	0	41	0	0	41	0	0	0	82	0	0
TOTALS	2032	1225	102	1143	3612	20	1510	305	1551	573	265

TOTAL DEMAND FOR OF INPATIENTS = 12490

TABLE 7. Specialty by Condition

OPERATIONS BY SPECIALTY

OPERATION	1	2	3	4	5	6	7	8	9	10	11
1	0	0	0	0	0	0	61	0	0	0	0
2	0	0	0	0	20	0	0	0	0	0	0
3	0	0	0	0	0	0	0	347	0	0	0
4	0	0	0	0	0	51	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	224	0	0	0	0	0	0
8	0	61	0	0	1163	0	0	0	122	0	0
9	0	0	0	0	122	0	0	0	0	0	0
10	0	0	0	0	245	0	0	0	0	0	0
11	41	0	0	0	0	0	0	0	1265	0	0
12	0	0	0	0	0	0	0	0	204	0	0
13	0	0	0	0	41	0	694	0	0	0	0
14	0	0	0	0	143	0	0	0	0	0	0
15	0	0	0	0	102	0	102	0	0	0	0
16	0	0	0	0	184	0	61	0	20	0	0
17	0	20	0	0	20	0	285	0	102	0	0
TOTALS	41	82	0	0	2265	51	1204	347	1714	0	0

TABLE 8. Operations by Specialty

LENGTHS OF STAY BY SPECIALTY

LENGTH OF STAY	1	2	3	4	5	6	7	8	9	10	11
1	510	224	0	61	918	0	245	20	245	347	20
2	204	286	20	20	592	0	102	102	469	82	0
3	143	163	20	20	469	0	61	0	102	41	41
4	122	143	0	20	347	20	61	0	20	41	41
5	102	102	0	20	61	0	143	61	102	20	41
6	143	41	0	0	163	0	82	0	41	0	20
7	265	0	0	0	265	0	61	20	20	0	41
8	61	0	0	41	122	0	20	20	51	20	0
9	122	61	0	20	41	0	0	41	92	0	0
10	41	0	0	41	122	0	61	0	82	0	0
11	20	0	20	82	82	0	143	0	143	20	0
12	61	20	0	61	92	0	0	20	51	0	0
13	61	0	20	0	0	0	0	20	41	20	20
14	41	41	0	41	0	0	0	0	0	41	0
15	0	20	0	0	20	0	82	0	0	0	0
16	41	0	0	20	0	0	20	0	20	0	41
17	20	20	0	41	41	0	82	0	20	0	0
18	0	0	20	0	20	0	0	0	0	0	0
19	20	20	0	0	20	0	61	0	0	0	0
20	0	0	0	61	0	0	61	0	0	0	0
21-30	41	61	0	204	184	0	61	0	41	41	0
31-50	41	20	0	204	20	0	82	0	0	0	0
51-100	0	0	0	82	20	0	82	0	0	0	0
101-500	20	0	0	82	20	0	0	0	0	0	0
501-1000	0	0	0	0	0	0	0	0	0	0	0
>1000	0	0	0	20	0	0	0	0	0	0	0

TABLE 9. Lengths of Stay by Specialty

TABLE 10. Admissions and Occupancy Rates by Hospital

ADMISSIONS BY SPECIALTY AND HOSPITAL

SPECIALTY	HOSPITAL 1	2	3	4	5	6
1	1225	857	0	0	0	0
2	0	1226	0	0	0	0
3	102	0	0	0	0	0
4	0	571	0	0	296	327
5	1367	2409	0	0	0	0
6	[illegible]	0	0	61	0	[illegible]
7	[illegible]	[illegible]	327	1327	0	0
8	409	0	0	0	0	[illegible]
9	592	1102	0	0	0	0
10	0	672	0	0	0	0
11	0	265	0	0	0	0
TOTALS	3694	7101	327	1388	285	327

PERCENTAGE OCCUPANCY RATES BY SPECIALTY AND HOSPITAL

SPECIALTY	HOSPITAL 1	2	3	4	5	6
1	46.5	37.1	0.0	0.0	0.0	0.0
2	0.0	71.3	0.0	0.0	0.0	0.0
3	23.9	0.0	0.0	0.0	0.0	0.0
4	0.0	58.2	0.0	0.0	54.1	53.2
5	94.9	76.1	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	8.4	0.0	0.0
7	0.0	0.0	76.9	51.0	0.0	0.0
8	44.1	0.0	0.0	0.0	0.0	0.0
9	57.2	82.0	0.0	0.0	0.0	0.0
10	0.0	41.0	0.0	0.0	0.0	0.0
11	0.0	41.2	0.0	0.0	0.0	0.0

OBSTETRICS

OVERALL DEMAND IN BED DAYS = 12613

OVERALL SUPPLY IN BED DAYS = 43800

COST OF OBSTETRICS IN THOUSANDS =1135.2

BIRTHS BY AGEGROUP

<20	20-24	25-29	30-34	35-39	40-44	45-
61	571	775	551	163	41	0

OVERALL BIRTH RATE (PER THOUSAND POPULATION) = 13.14

DEATHS BY AGEGROUP AND SEX

	0-1	2-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75+
MALES	20	0	0	0	0	41	41	163	[illegible]	531
FEMALES	51	0	0	[illegible]	0	0	61	143	245	592

OVERALL DEATH RATE (PER THOUSAND POPULATION) = 12.54

TABLE 11. Obstetrics Indicators and Death Rates from all Conditions

COST BY AGEGROUP, SEX & SPECIALTY

MALES

SPECIALTY	0-1	2-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75+
1	0.0	0.0	0.0	57.9	222.4	28.9	57.9	240.4	1867.3	101.4
2	140.5	62.0	190.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	21.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.6	17.1	104.3
5	6.8	32.3	19.2	14.7	199.5	132.6	49.6	105.9	109.3	156.6
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.7
7	0.0	77.2	0.0	50.1	85.4	50.1	206.1	5.9	103.1	219.8
8	2.2	0.0	0.0	0.0	20.1	0.0	0.0	0.0	0.0	33.6
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	95.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	49.6	20.7	111.6	0.0	4.1	0.0	0.0
TOTALS	244.5	171.5	209.3	172.2	548.1	344.2	313.6	394.0	2096.8	627.4

TOTAL COST FOR MALES 5121.4

FEMALES

SPECIALTY	0-1	2-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75+
1	0.0	0.0	0.0	39.8	78.5	249.1	2.6	37.9	264.5	2884.5
2	181.8	45.5	53.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	148.8	4984.6	769.0
5	0.0	27.4	25.5	60.1	44.3	183.7	66.9	509.1	100.3	197.2
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	111.9	2.4	48.9	14.7	17.7	29.5	217.9	254.4
8	2.2	6.7	0.0	6.7	0.0	22.4	24.6	24.6	26.8	35.8
9	0.0	0.0	8.3	258.5	183.3	102.2	10.9	116.8	85.3	136.4
10	181.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	99.2	28.9	20.7	20.7	0.0	0.0
TOTALS	365.9	79.6	199.4	367.5	454.3	601.0	143.3	887.4	5679.5	4277.4

TOTAL COST FOR FEMALES 13055.2

TABLE 12. Costs by Age and Sex

TOTAL COST 18176.6 (costs in £000's)

COST BY HOSPITAL AND SPECIALTY

	HOSPITAL					
SPECIALTY	1	2	3	4	5	6
1	2211.3	3921.8	0.0	0.0	0.0	0.0
2	0.0	673.6	0.0	0.0	0.0	0.0
3	21.0	0.0	0.0	0.0	0.0	0.0
4	0.0	5152.3	0.0	0.0	616.7	292.6
5	673.1	1367.9	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	11.7	0.0	0.0
7	0.0	0.0	152.2	1342.8	0.0	0.0
8	205.8	0.0	0.0	0.0	0.0	0.0
9	215.6	686.0	0.0	0.0	0.0	0.0
10	0.0	276.9	0.0	0.0	0.0	0.0
11	0.0	355.4	0.0	0.0	0.0	0.0
TOTALS	3326.9	12433.9	152.2	1354.5	616.7	292.6

COST BY LOCATION

THORNHILL	2669.4
DEWSBURY EAST	3489.5
DEWSBURY WEST	3967.1
BATLEY EAST	668.1
BATLEY WEST	246.3
BATLEY NORTH	2219.2
HIGHTOWN	458.0
CLECKHEATON	846.3
HECKMONDWIKE	1672.2
MIRFIELD	740.8
OUTSIDE AREA	1199.8

WAITING LIST BY SPECIALTY

1	2	3	4	5	6	7	8	9	10	11
5	0	0	53	238	0	126	99	87	0	0

TABLE 13. Further Cost Information and Waiting List by Specialty

Produced by
School of Geography
University of Leeds
Leeds LS2 9JT
From whom copies may be obtained