W.P. 37

THE POTENTIAL FOR DAY HOSPITALS IN PIEMONTE.
A FEASIBILITY STUDY.

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ires ISTITUTO RICERCHE ECONOMICO - SOCIALI DEL PIEMONTE

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SUMMARY

This report describes the findings of a feasibility study carried out on behalf of IRES. The objectives of the study were:

- to evaluate the potential demand for day hospital provision
- to develop a prototype spatial model to estimate the size and optimal location of day hospitals, subject to resource and logistic constraints.

The types of facility that have been established in other countries, particularly the UK, and the clinical procedures carried out there, are described. Considerable cost savings may be achieved when day hospitals are substituted for inpatient facilities.

The model has been applied to the region of Piemonte. The potential demand for day hospital treatment in all acute specialties has been estimated at 130,000 cases per annum. This could be serviced with about 650 beds and 300 dedicated nursing staff. The illustrative runs of the model suggest that initial growth in provision should be concentrated in Torino, later expanding to the other main towns of Piemonte.

Acknowledgements

We would like to thank Professor Mussa and Professor Pileri for their advice on the potential for day hospitals in Piemonte. We further acknowledge the assistance of IRES, and in particular of T. Gallino, in the preparation of the data used in this study.

CONTENTS

SECTION 1 INTRODUCTION

1.1 A day hospital is a facility in which patients are admitted, treated and sent home in the same day. It is now recognised in many countries that the treatment of patients on a day basis may be both cheaper and more satisfactory to the patient than admission to an inpatient ward.

1.2 In February 1984, the authors were commissioned by the Istituto Ricerche Economico-Sociali del Piemonte (IRES) to carry out a feasibility study on the introduction of day hospital facilities in Piemonte, Italy. The specific outputs of the study were to include:

- a broad evaluation of different types of day hospital in relation to their efficiency and effectiveness as compared with alternative facilities;
- estimates (subject to data availability) of the potential demand by area for day treatment;
- a broad evaluation of the resource implications (in terms of manpower, hospital beds, operating theatres, community health services, etc);
- the preferred locations of day hospitals taking into account demand and the ease of access between different areas;
- a prototype spatial model to evaluate the demand for day treatment in different locations, taking into account accessibility and social factors.

1.3 Day hospitals may serve either acute or chronic patients. Acute hospital services are those predominantly concerned with treating urgent and severe conditions which, if left untreated, could result in death or considerable impairment of normal functioning and of the ability to pursue a productive and independent life. Day hospitals may also be provided for the long term care and rehabilitation of patients with chronic conditions. This will particularly be the case in the pyschiatric and geriatric specialties.

1.4 After discussion with IRES, the scope of the study was narrowed to concentrate on acute patients. The growth of day hospitals for acute patients is made possible and desirable by a number of factors:

- improvements in medical practice allow rapid treatment and recovery;

- improvements over the years in patients' home environments make rapid discharge feasible;

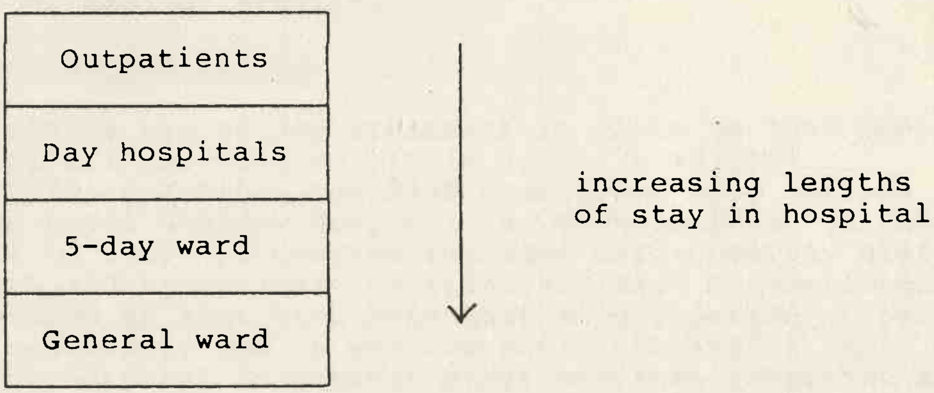
- there is less disruption of patients' normal lives - especially children;

- day hospitals can reduce waiting lists for treatment;

- nursing and hotel costs are saved by the hospital authorities.

1.5 It is important to distinguish day hospitals from outpatient clinics, which are not involved in substantial treatment or observation. Sometimes however day hospitals will be used as an alternative to outpatients, which is unlikely to be a cost-effective use of resources.

1.6 More generally, day hospital provisión may be seen as part of a spectrum of facilities within a hospital, that can be classified according to the expected time that patients remain in hospital.



We would normally see the day hospital as a facility for treating patients who would otherwise be admitted as in-patients. If however the level of provision in a particular locality was particularly high, or the management of the facility was poor, it is probable that the day hospital would tend to act as an alternative to outpatient treatment.

1.7 The next section of this report reviews recent literature (in English language publications) on day hospital provision in the acute sector. In section 3, we examine some data from the U.K., where day hospitals are fairly widespread, and in section 4 develop a simple model to estimate the potential demand for such provision in Piemonte. Section 5 discusses the supply factors and sets out some assumptions which are incorporated in the location model, the formulation of which is fully described in section 6. Some illustrative results of the location model are given in section 7, and the practical implications are discussed. The possibilities for further development and implementation form our concluding remarks in section 8.

SECTION 2 THE DEVELOPMENT OF DAY HOSPITALS

> "Look at a patient lying long in bed. What a pathetic picture he makes! The blood clotting in his veins, the lime draining from his bones, the scybala stacking up in his colon, the flesh rotting from his seat, the urine leaking from his distended bladder, and the spirit evaporating from his soul."
>
> (R.A.J. Asher, British Medical Journal, 1947)

2.1 Beliefs about what is appropriate in medical care are deeply ingrained. Both patients and doctors will frequently assume that an operation, however trivial, will require admission to hospital as in in-patient. It is however increasingly possible to carry out minor procedures and tests on patients on a day basis. The literature on this topic is extensive, particularly in the English language, and clearly demonstrates the high potential for this form of medical practice.

History of Day Facilities

2.2 Extensive use of day treatment is known to have been adopted in certain hospitals as early as 1907. Simpson (1976) describes how 2400 operations were carried out at the Royal Glasgow Hospital for Sick Children in the nine years to 1908: procedures included herniotomies, cleft lip repairs and operations for spina bifida. Conventional medical wisdom at that time held that a long period of bed rest was necessary, and it was not until the 1950's that first short hospital in-patient stays and then treatment as a day patient spread to any significant extent to other specialties. Such changes in medical practice were greatly encouraged by improved anaesthesia techniques, which allowed rapid recovery after an operation (Ogg, 1976; Loder, 1982).

Current Practices

2.3 In the UK, day hospitals are now used in all the major specialties for the treatment of a wide range of conditions. Table 2.1 summarizes some of the procedures commonly carried out in the surgical specialties. As Marcovitch et al, 1975, comment, little has been written on day hospital care for <u>medical</u> problems: increasingly medical specialties carry diagnostic testing on a day basis. In other cases, where the patient's condition may not be amenable to a rapid cure regular attendance at a day hospital may provide an alternative to long-term admissions as an inpatient. This type of provision is particularly

Table 2.1 Some Procedures commonly carried out in Day Hospitals

Specialty	Procedure
General surgery	Herniorrhaphy - inguinal and femoral Stripping of varicose veins Anal stretch for haemorrhoids Excision biopsy of skin, node and other superficial lesions
Urology	Cystoscopy, diathermy, urethroscopy Vasectomy
Paediatric surgery	Circumcision Herniorrhaphy - inguinal and umbilical Endoscopies Orchidopexy
Gynaecology	Diagnostic D&C Abortion 6-10 weeks Laparoscopy
Ear, nose and throat	Antral washout Turbinal diathermy Myringotomy
Orthopaedics	Carpal tunnel syndrome De Quervain's syndrome Excision of ganglia Removal of pins
Other	ECT Sternal marrow aspiration and other investigations Paracentesis and chemotherapy Plastic procedures to face, nose, eyes and scalp Endoscopy Dental extraction and restoration

used by the oncology and gastroenterology specialties (Northfield et al, 1983). Vance, 1975, reports on the establishment of a day transfusion centre for children with thalassaemia major.

Selection of Patients

2.4 The efficacy of day hospital treatment is dependent on a satisfactory selection of patients. Marshall Barr, 1982, describes many of the criteria which need to be taken into account, for example:

- the procedure to be carried out should allow rapid recovery,

- the period of general anaesthesia should not exceed 20 minutes,

- transport (not necessarily ambulance) should be available to and from home,

- the home environment should be supportive.

Scobie et al, 1979, comment that although the clinical condition is the first criterion for identifying a potential paediatric day case, selection is determined by the adequacy of the home environment. Kemp, 1975, carried out a survey of patients' travel times to return home: only 13% took longer than 45 minutes, half of these travelling by ambulance.

2.5 Age is not necessarily a bar to becoming a day patient although some authors (eg Kemp, 1975) comment on the unsuitability of elderly patients for the more intensive treatments.

Cost-effectiveness

2.6 Although day hospitals are generally thought of as providing an alternative to in-patient care, they may often be used as an alternative to out-patient provision, particularly in the paediatric specialty, and it is felt that this substitution may offer certain medical advantages (Valman et al, 1979). Such provision cannot show the cost savings of, for example, surgical day units mainly treating hernias and varicose veins (Oosterlee et al, 1979).

2.7 Oosterlee et al also comment on the fact that the introduction of day units may increase total costs in a hospital if in-patient provision is not correspondingly reduced. In practice, day provision in the UK has risen in response to lengthening waiting lists and increasing demands on hospital services by the elderly (Ruckley, 1980). The Oxford region now have a policy of absorbing all additional demand in this way (Oxford Regional Health Authority, 1984).

2.8 Day treatment does set extra demands on community health services (Simpson, 1976; Dilnot, 1979). Overall however treatment costs are reduced eg Prescott et al, 1978, show substantial savings in the treatment of hernia and varicose veins patients.

Day Hospitals in Different Health Care Systems

2.9 Despite these savings, extensive use of day hospitals seems less prevalent in countries with private or insurance based systems. Thus, in the US, where both state and private insurance schemes supposedly demand the cheapest appropriate care, day treatment is rare despite its demonstrated savings (Grossman, 1979; Evans et al, 1980). Rosoff, 1976, points out that a national health service will have government-imposed restraints on the total resources available. Loffer, 1981, suggests that the major behavioural constraints on the expansion of day facilities are that:

- hospital administrators wish to generate income by keeping their beds full;

- clinicians wish to "play safe" by keeping the patient in hospital as long as possible;

- there has been no requirement on anaesthetists to improve techniques.

2.10 In addition to the above obstacles to the successful implementation of a day hospital strategy, there are a number of practical factors to be considered:

- the day hospital must be located in or adjacent to an existing hospital, in order for it to be accessible to medical staff and close enough to the key support services if required (Dilnot, 1979);

- for logistic reasons, the day hospital is best organised as a separate unit, rather than sharing the facilities of, say, a general ward (Dilnot, 1979);

- X-ray and operating theatres may be included within the day hospital unit (Smith, 1976);

- staffing of the unit can be organised in a different way to in-patient facilities: in particular, since the day hospital will be open only during the working day, married women with children may find the hours convenient (Ruckley, 1980).

Day Hospital Potential

2.11 Few published studies consider in detail the total potential for day hospital treatment. Marcovitch et al, 1975, suggest that 30% of paediatric cases (most of them surgical) would be suitable for day hospital treatment. Burn, 1983, reports on a special survey which indicated that 48% of operations carried out in the main surgical specialties could be on a day basis, provided that the patient's home environment was adequate and access was not a problem. In the UK, the Oxford Regional Health Authority (RHA) are planning services on the basis that 25% of all acute cases will be cared for on a day basis by 1994 (Oxford RHA, 1984).

SECTION 3 DATA ON DAY HOSPITAL TREATMENT

3.1 At the time the study was carried out, no data on day hospital treatment in Piemonte were available to us. We have therefore examined data for 1981 from England, where day hospital treatment is more common than in Piemonte. This was necessary to establish a proper comparative foundation for examining day hospital potential.

3.2 In England, data on day hospital treatment by specialty are routinely collected. These data have been mapped onto the 28 specialty categories developed by IRES. It should be noted that five categories have been excluded from all analyses, four (long stay, geriatric, infantile neuropsychiatry, psychiatry) because they are not acute specialties, and the other (infectious diseases) because patients treated in this specialty will not be suitable for day hospital treatment. Pneumology and phthisiology are combined in England in a single specialty, chest diseases. From discussions with Italian clinicians we understand that the label "general medicine" covers a wider range of physician activity in England, thus the figures will not be exactly comparable. Nevertheless the total number of patients (including the day patients in England) treated per thousand population are broadly comparable in England and Piemonte, with the hospitalisation rate slightly higher in Piemonte (see Table 3.1).

3.3 Table 3.2 shows the total number of cases (inpatient and day patient) in England in 1981 and the proportions treated on a day basis. Overall, 12.5% of cases are day patients. Generally the surgical specialties have a higher than average proportion (general surgery 17.8%, urology 27.6%), while the medical specialties are lower than average (general medecine 9.6%, paediatrics 5.3%). Note however that large specialties with a small proportion of day cases are still major potential users of day hospitals (eg general medicine). Conversely the specialties with the highest proportions (gastroenterology, oncology, haematology) treat only relatively few of the total day case population.

3.4 Piemonte has a population roughly one-tenth that of England; thus similar practices transferred to that region would imply a total day hospital patient volume of some 7,000, with the largest specialties:

General surgery	21,000
Obstetrics & gynaecology	8,600
General medicine	8,600
Trauma & orthopaedics	8,100
'Other' surgical specialties	4,900
Urology	4,600
Ear, nose & throat	3,000

Table 3.2 Numbers of Day Cases in England (1981)

IRES No	Specialty	Total cases	Day cases Number	%
1	General medicine	893,161	85,880	9.6%
2	General surgery	1,189,282	211,846	17.8%
3	Obs. & Gynaecology	1,321,904	86,241	6.5%
4	Paediatrics	302,604	15,888	5.3%
6	Trauma & Orthopaedics	594,039	80,608	13.6%
7	Ear, nose & throat	291,960	30,380	10.4%
8	Neurology	44,935	2,012	4.5%
9	Ophthalmology	156,646	23,171	14.8%
10	Urology	166,820	45,991	27.6%
11	Cardiology	43,201	408	0.9%
12	Dermatology	25,407	4,105	16.2%
13	Haematology	24,430	12,295	50.3%
14	Endocrinology	2,254	219	9.7%
15	Gastroenterology	13,127	9,195	70.0%
19	Nephrology	11,317	472	4.2%
21	Oncology	24,727	14,492	58.6%
22 25	(Pneumology (+Phthisiology	72,017	6,756	9.4%
24	Rheumatology	28,345	1,165	4.1%
26	Surgical specialties	280,190	49,134	17.5%
27	Intensive therapies	8,447	0	–
28	Others	119,044	19,082	16.0%
	TOTAL	5,613,857	699,340	12.5%

3.5 Practices in the 190 "health districts" (average population 250,000) in England vary widely however. Some districts make very little use of day hospitals, others have extensive facilities. District-level patient data reflect this variance, as shown in Figure 3.1. For general surgery, the upper quartile value is about 25% (average 17.8%). For general medicine, the upper quartile is about 14% (average 9.6%). The shape of the distribution for general medicine suggests that districts with very high proportions of day cases (over 30%) may be using day hospitals where outpatient facilities would be more cost-effective.

3.6 Overall however the high variability shown in Figure 3.1 suggests a potential for day treatment greater than that experienced in England in 1981, as less developed districts attain the levels of provision of their counterparts. Uneven development will lead to a steady upward trend - and Figure 3.2 shows that this has indeed been the case for general medecine and general surgery over the last ten years. We would expect to see a similar evolution in Piemonte as day hospital facilities are successively established in centres of population, with some areas receiving less coverage than others in the initial stages.

Figure 3.1 Proportions of Cases Treated as Day Patients
(England 1981 - 190 districts)

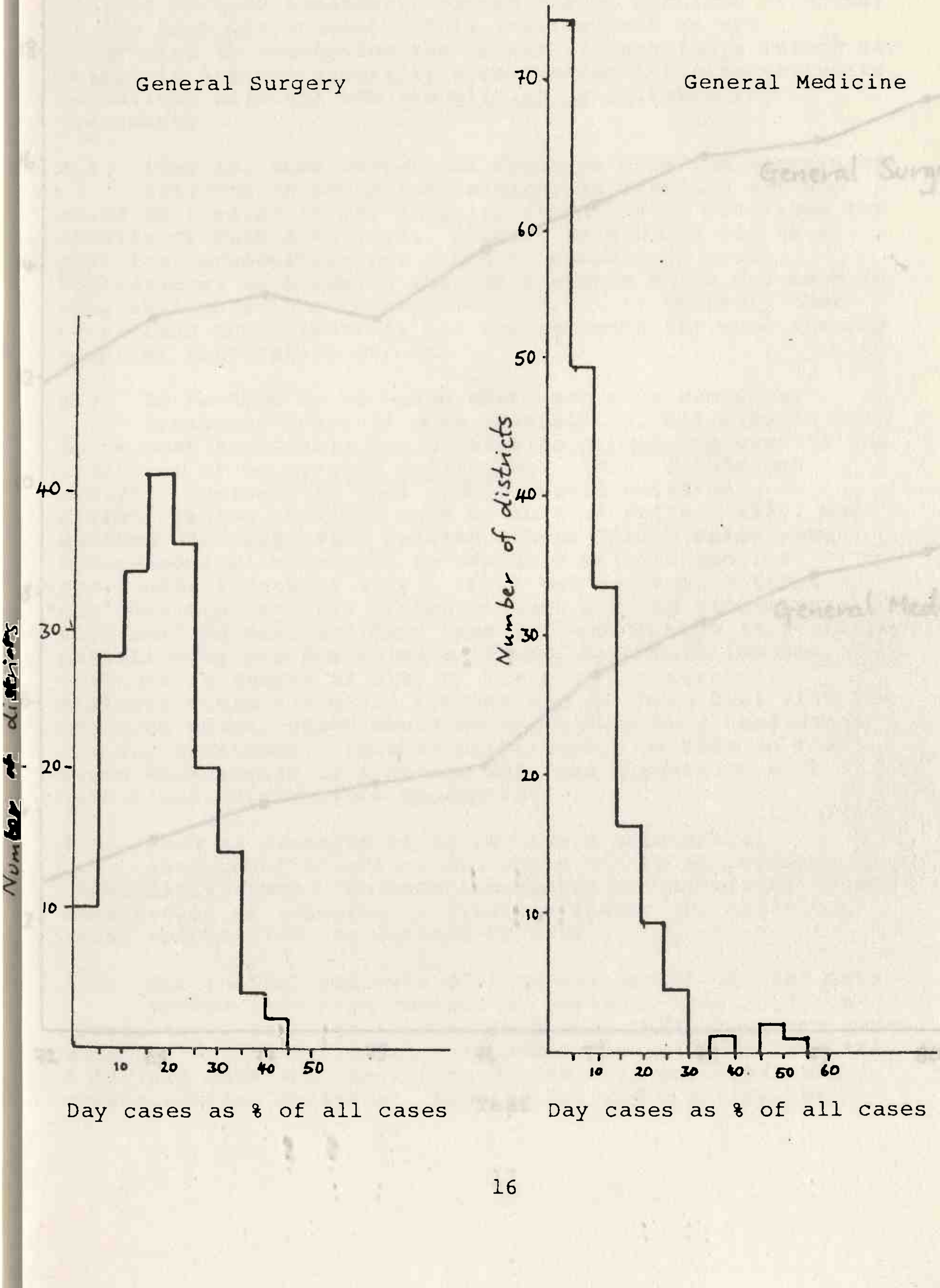
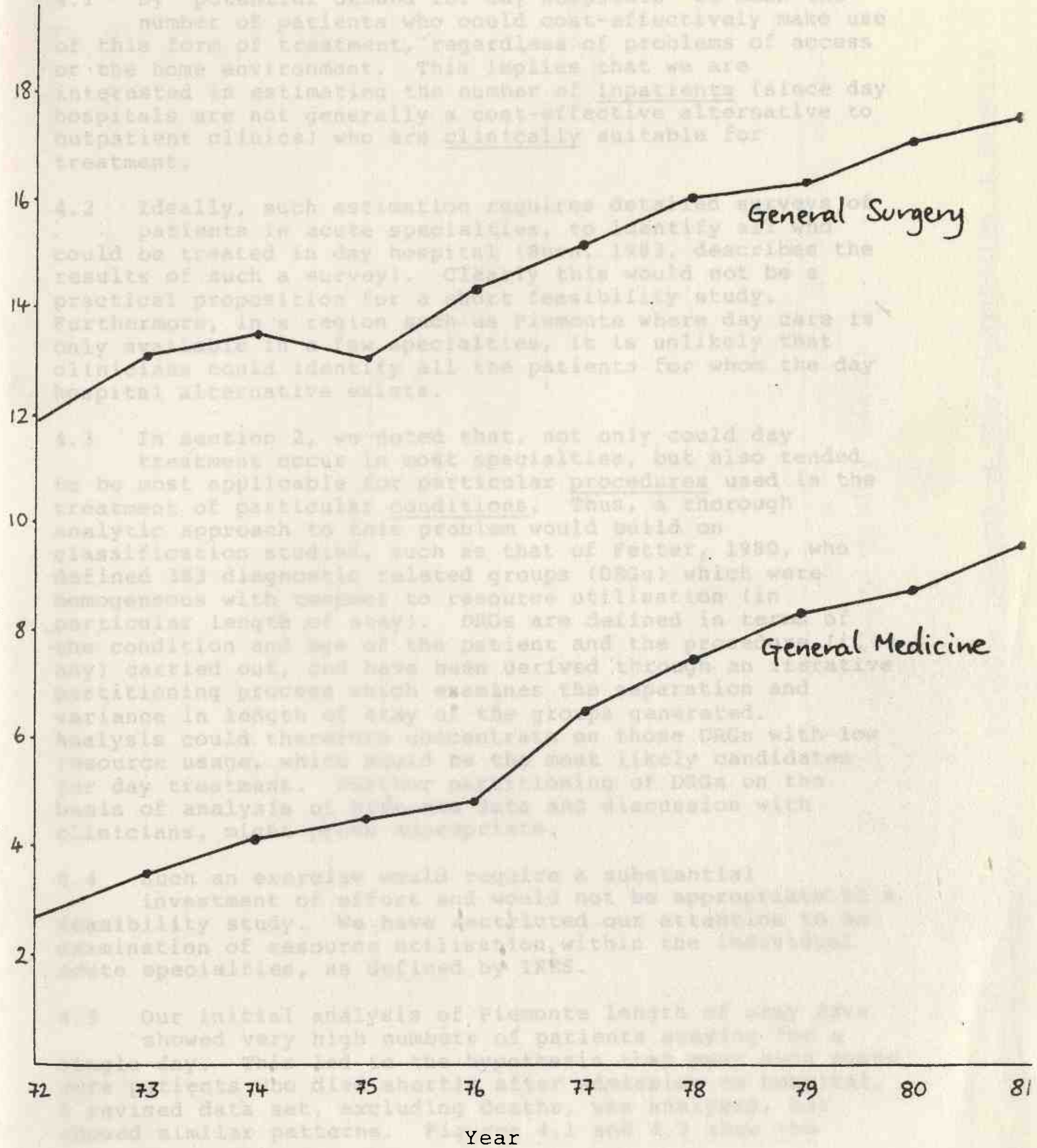


Figure 3.2 Percentage of Cases Treated as Day Patients
(England 1972 - 1981)



SECTION 4 ESTIMATES OF POTENTIAL DEMAND

4.1 By "potential demand for day hospitals" we mean the number of patients who could cost-effectively make use of this form of treatment, regardless of problems of access or the home environment. This implies that we are interested in estimating the number of inpatients (since day hospitals are not generally a cost-effective alternative to outpatient clinics) who are clinically suitable for treatment.

4.2 Ideally, such estimation requires detailed surveys of patients in acute specialties, to identify all who could be treated in day hospital (Burn, 1983, describes the results of such a survey). Clearly this would not be a practical proposition for a short feasibility study. Furthermore, in a region such as Piemonte where day care is only available in a few specialties, it is unlikely that clinicians could identify all the patients for whom the day hospital alternative exists.

4.3 In section 2, we noted that, not only could day treatment occur in most specialties, but also tended to be most applicable for particular procedures used in the treatment of particular conditions. Thus, a thorough analytic approach to this problem would build on classification studies, such as that of Fetter, 1980, who defined 383 diagnostic related groups (DRGs) which were homogeneous with respect to resource utilisation (in particular length of stay). DRGs are defined in terms of the condition and age of the patient and the procedure (if any) carried out, and have been derived through an iterative partitioning process which examines the separation and variance in length of stay of the groups generated. Analysis could therefore concentrate on those DRGs with low resource usage, which would be the most likely candidates for day treatment. Further partitioning of DRGs on the basis of analysis of Piemonte data and discussion with clinicians, might prove appropriate.

4.4 Such an exercise would require a substantial investment of effort and would not be appropriate to a feasibility study. We have restricted our attention to an examination of resource utilisation within the individual acute specialties, as defined by IRES.

4.5 Our initial analysis of Piemonte length of stay data showed very high numbers of patients staying for a single day. This led to the hypothesis that many such cases were patients who died shortly after admission to hospital. A revised data set, excluding deaths, was analysed, but showed similar patterns. Figures 4.1 and 4.2 show the

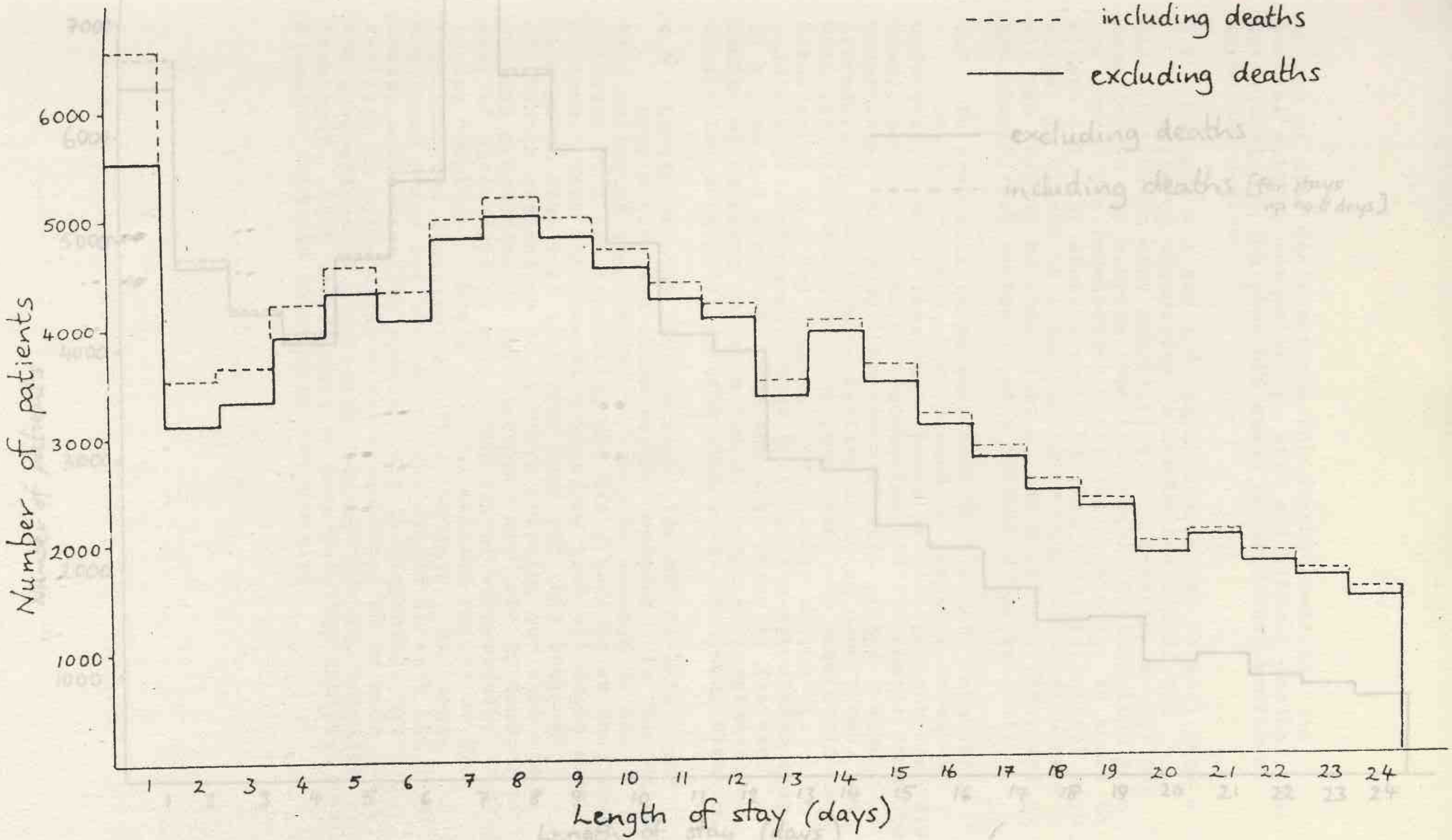


Figure 4.1: General Medicine : Length of Stay Distribution in Piemonte

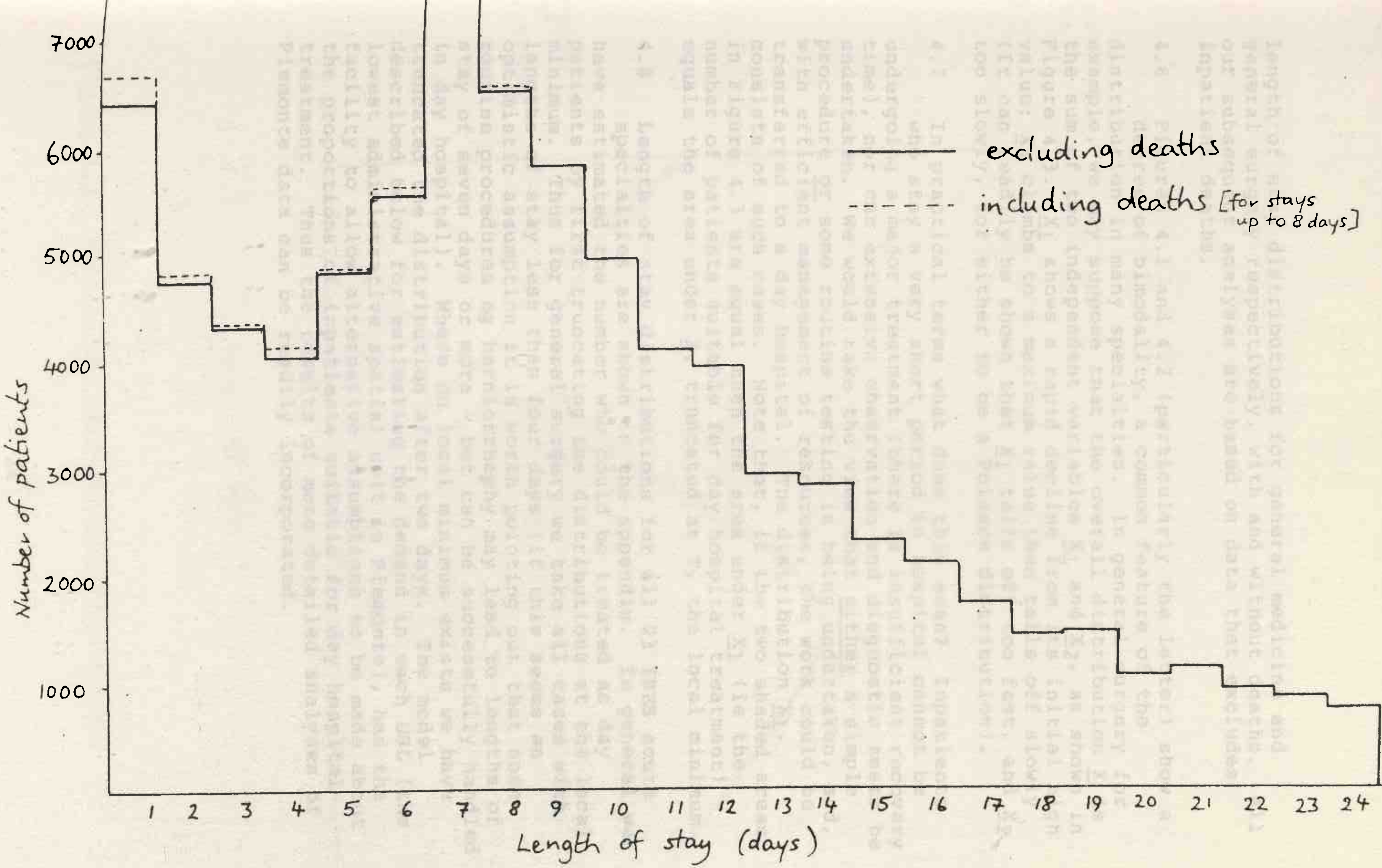


Figure 4.2: General Surgery : Length of Stay Distribution in Piemonte

length of stay distributions for general medicine and general surgery respectively, with and without deaths. All our subsequent analyses are based on data that excludes inpatient deaths.

4.6 Figures 4.1 and 4.2 (particularly the latter) show a degree of bimodality, a common feature of the distribution in many specialties. In general surgery for example, we may suppose that the overall distribution $\underline{X}$ is the sum of two independent variables $\underline{X}_1$ and $\underline{X}_2$, as shown in Figure 4.3. $\underline{X}_1$ shows a rapid decline from its initial high value; $\underline{X}_2$ climbs to a maximum value then tails off slowly (It can readily be shown that $\underline{X}_1$ tails off too fast, and $\underline{X}_2$ too slowly, for either to be a Poisson distribution).

4.7 In practical terms what does this mean? Inpatients who stay a very short period in hospital cannot be undergoing a major treatment (there is insufficient recovery time), nor can extensive observation and diagnostic tests be undertaken. We would take the view that either a simple procedure or some routine testing is being undertaken, and, with efficient management of resources, the work could be transferred to a day hospital. The distribution $\underline{X}_1$, consists of such cases. Note that, if the two shaded areas in Figure 4.3 are equal then the area under $\underline{X}_1$ (ie the number of patients suitable for day hospital treatment) equals the area under $\underline{X}$, truncated at T, the local minimum.

4.8 Length of stay distributions for all 23 IRES acute specialties are shown in the appendix. In general we have estimated the number who could be treated as day patients by first truncating the distributions at the local minimum. Thus for general surgery we take all cases with lengths of stay less than four days (if this seems an optimistic assumption it is worth pointing out that some routine procedures eg herniorrhaphy may lead to lengths of stay of seven days or more - but can be successfully handled in day hospital). Where no local minimum exists we have truncated the distribution after two days. The model described below for estimating the demand in each USL (the lowest administrative spatial unit in Piemonte), has the facility to allow alternative assumptions to be made about the proportions of inpatients suitable for day hospital treatment. Thus the results of more detailed analyses of Piemonte data can be readily incorporated.

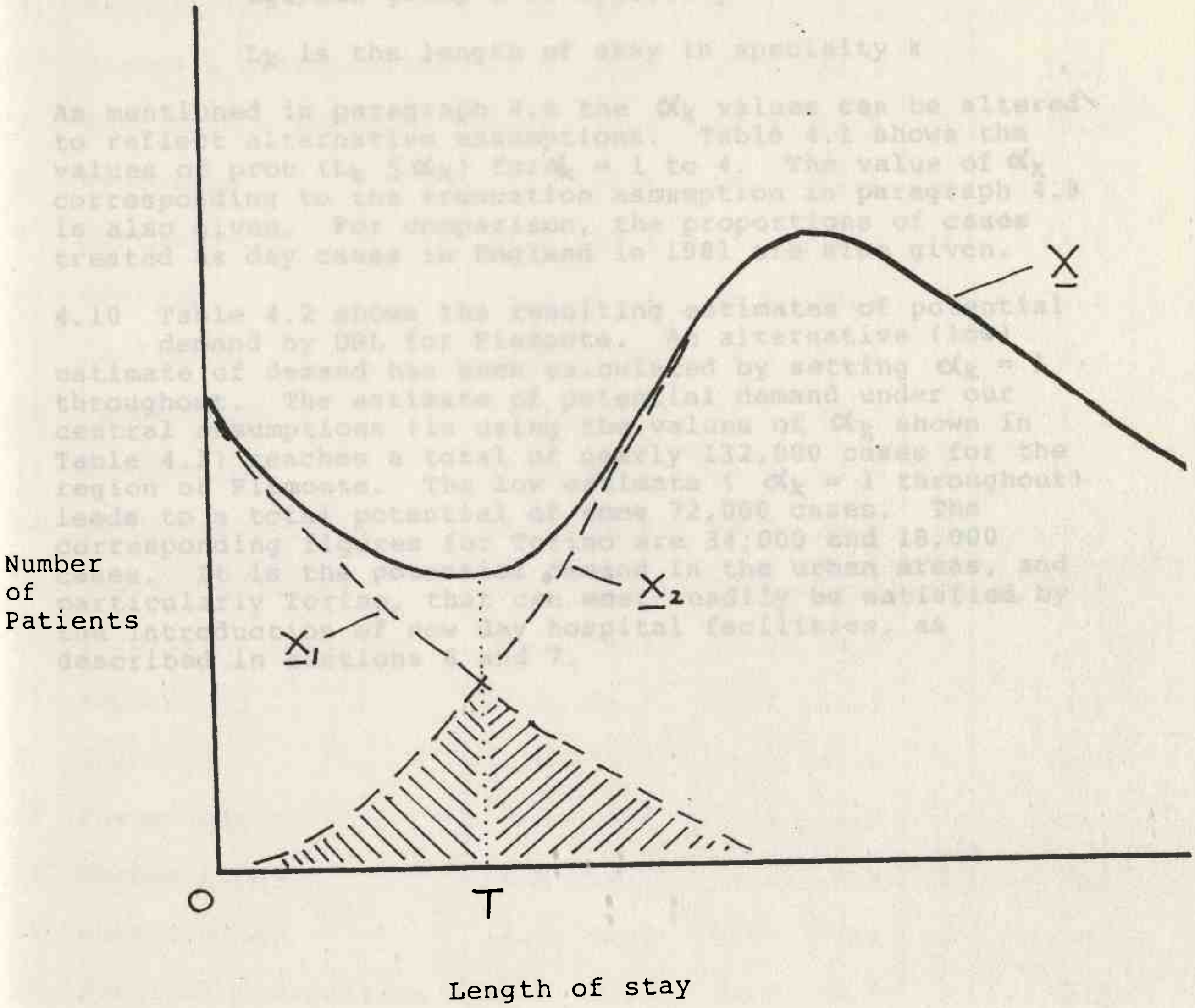


Figure 4.3: Subdivision of a Bimodal Distribution

Model of Local Demand

4.9 Let W_i be the potential demand for day case treatment in locality i. We estimated W_i by

$$W_i = \sum_{l,k} P_{il} \cdot u_{lk} . \text{prob} \left(L_k \leq \alpha_k \right)$$

where

P_{il} is the population in age/sex group l in locality i

u_{lk} is the current admission rate in Piemonte for age/sex group l in specialty k

L_k is the length of stay in specialty k

As mentioned in paragraph 4.8 the α_k values can be altered to reflect alternative assumptions. Table 4.1 shows the values of prob ($L_k \leq \alpha_k$) for α_k = 1 to 4. The value of α_k corresponding to the truncation assumption in paragraph 4.8 is also given. For comparison, the proportions of cases treated as day cases in England in 1981 are also given.

4.10 Table 4.2 shows the resulting estimates of potential demand by USL for Piemonte. An alternative (low) estimate of demand has been calculated by setting α_k = 1 throughout. The estimate of potential demand under our central assumptions (ie using the values of α_k shown in Table 4.1) reaches a total of nearly 132,000 cases for the region of Piemonte. The low estimate (α_k = 1 throughout) leads to a total potential of some 72,000 cases. The corresponding figures for Torino are 34,000 and 18,000 cases. It is the potential demand in the urban areas, and particularly Torino, that can most readily be satisfied by the introduction of new day hospital facilities, as described in sections 6 and 7.

Table 4.1 Length of Stay Probabilities and the Truncation Assumption

IRES No	Specialty	Prob $(L_k \leq \alpha_k)$ expressed as % $\alpha_k=1$	$\alpha_k=2$	$\alpha_k=3$	$\alpha_k=4$	Truncation point	England % day cases
1	General medicine	5.7	8.8	12.3	16.3	2	9.6
2	General surgery	7.0	12.1	16.8	21.2	4	17.8
3	Obs. & Gynaecology	13.3	25.6	34.3	44.9	3	6.5
4	Paediatrics	31.0	39.7	47.1	53.9	1	5.3
6	Trauma & Orthopaedics	11.0	20.2	27.8	34.5	1	14.1
7	Ear, nose & throat	13.6	36.8	52.4	61.5	2	10.4
8	Neurology	9.2	14.0	19.0	24.1	2	4.5
9	Ophthalmology	6.1	10.3	15.3	20.7	2	14.8
10	Urology	5.2	11.4	18.0	24.4	2	27.6
11	Cardiology	2.8	5.2	7.8	10.8	2	0.9
12	Dermatology	3.9	7.6	13.1	20.2	2	16.2
13	Haematology	59.3	61.1	62.8	64.8	3	50.3
14	Endocrinology	13.7	18.8	24.7	29.9	2	9.7
15	Gastroenterology	9.6	11.0	12.5	14.3	2	70.0
18	Industrial medicine	6.3	8.7	11.2	13.8	2	-
19	Nephrology	19.3	23.1	27.1	31.5	2	4.2
21	Oncology	31.6	35.0	38.9	43.5	2	58.6
22	Pneumology	3.7	5.8	7.8	9.8	3	na
24	Rheumatology	1.0	1.7	2.2	3.6	3	4.1
25	Phthisiology	4.0	23.3	31.7	34.1	2	na
26	Surgical specialties	13.0	23.2	30.6	38.0	3	9.8
27	Intensive therapies	9.0	15.6	20.2	25.6	3	14.3
28	Others	12.5	17.3	21.1	25.0	3	26.3

Table 4.2 Estimates of Potential Demand (W_i)

USL	Central assumptions	$\alpha_k = 1$ throughout	USL	Central assumptions	$\alpha_k = 1$ throughout
1	1769	976	39	2124	1159
2	1440	801	40	2765	1497
3	1499	807	41	1014	552
4	1180	638	42	615	332
5	1600	864	43	625	339
6	1779	963	44	2392	1305
7	1531	831	45	2328	1259
8	1301	700	46	1095	595
9	1137	616	47	3732	2027
10	1858	1013	48	1948	1059
11	2235	1211	49	1428	778
12	1686	920	50	967	525
13	2110	1150	51	3808	2057
14	1763	956	52	1460	798
15	1572	855	53	1775	976
16	1370	746	54	1807	989
17	1486	808	55	2113	1147
18	1762	961	56	2124	1165
19	924	505	57	1271	697
20	969	520	58	2042	1106
21	516	279	59	1021	556
22	786	426	60	1239	676
23	1444	777	61	1389	760
sub total			62	1009	552
(1-23)	33717	18323	63	2224	1215
			64	1570	861
24	2355	1293	65	2839	1545
25	1633	894	66	1842	1004
26	1800	985	67	818	445
27	2206	1208	68	4277	2327
28	2065	1134	69	1779	966
29	911	492	70	4021	2177
30	2407	1315	71	907	493
31	1315	720	72	2008	1087
32	2291	1251	73	2209	1198
33	1920	1050	74	806	436
34	2248	1241	75	1386	748
35	582	316	76	2925	1584
36	2240	1217			
37	776	421	TOTAL	131941	71820
38	1773	969			

SECTION 5 SUPPLY FACTORS FOR INCORPORATION IN THE MODEL

5.1 Before developing a model for optimally locating day hospitals we also need to consider

- what existing facilities there are in Piemonte
- how many patients a day hospital bed can throughput in a year
- how many staff are needed to run a day hospital
- what is the minimum economic size for a day hospital
- what resource implications there are for other sectors of the health services.

We discuss these issues below, and state the assumptions we have made in the illustrative runs of the location model described in section 7.

Existing Facilities

5.2 The inpatient data for Piemonte that we have analysed is for the year 1980: there was some day hospital provision in this year, but we have no information on the caseloads involved. By 1982, collected data showed a total of 31,525 day patients. These were mostly in the oncology, haematology and gastroenterology specialties; thus a substantial part of the total will be accounted for by regular day patients (as opposed to those who come only once eg for a herniorrhaphy). All the day patients attended hospitals in Torino, 95% in USL number 9 where the Molinette and other hospitals are located.

5.3 Since we have insufficient data, we have not taken existing supply into account in either the potential demand or location models. This does not substantially affect the model results described in section 7 since most of the potential demand identified in section 4 will be in specialties other than those which already have day provision.

Day Hospital Throughput

5.4 After allowing for weekends and holidays there are 220 working days in the year in Piemonte. If we assume that beds are occupied on 85% of all days, with one patient per bed, this would imply some 187 patients per bed each year. Normally we would not expect more than one patient to occupy a single bed on a particular day, but occasionally this may be possible for treatments where the recuperation is very short. We have therefore assumed in all model runs that 200 cases per bed per annum is achievable.

Staffing Levels

5.5 The number of dedicated staff required will be partly dependent on the case-mix of patients attending the day hospital. We are assuming that doctors and anaesthetists will not be devoted full-time to day hospital work, but rather will utilise these facilities as appropriate. The principle need for additional staff is in the nursing and administration sectors. On the basis of published data of staffing arrangements (see, for example, Kemp, 1975) and discussions with doctors in Piemonte, we have identified, for an 18-bed day hospital facility, a staffing requirement of 8.5 whole-time bed equivalents (WTEs) consisting of:

1 general administrator
1 reception
3 nurses
2.5 nursing auxiliaries

The general administration and reception functions might also be carried out by nursing staff.

5.6 On the basis of 200 cases/bed, an 18 bed unit will handle 3,600 cases per year, with an additional staff of 8.5 WTE. This amounts to 2.36 staff per 1,000 cases, and in the model we have assumed a value of 2.5 WTE per 1,000 cases.

Minimum Size

5.7 A day hospital of whatever size will incur unavoidable overhead costs (eg for administration). Below a certain size the cost advantages of preventing inpatient admissions will be outweighed by these overheads. We have taken the view that, as is generally the case, a day hospital should have at least ten beds. This is reflected by the threshold assumption in the runs of the location model shown in section 7: the number of day patients treated in a USL either should be over 2,000 [i.e. 10 beds], or should be zero. Note that in general this implies that several specialties will share the facilities of a day hospital.

Other Health Services

5.8 We have not considered in any detail the extra demands that the substitution of day hospitals for inpatient treatment places on community health services. However, given modern anaesthesia and surgical techniques, it is nowadays thought unlikely that any major resource implications will occur (Burn, 1983).

5.9 There are of course demands made on existing hospital support services eg some laboratory facilities. For this reason, and to allow easy access for medical staff, it is always necessary to locate a day hospital in or adjacent to an inpatient facility (see for example, Dilnot, 1979). This has been incorporated in the location model by constraining to zero the potential day hospital capacity of any USL with no inpatient beds.

5.10 Finally, the demands that day hospital patients place on the ambulance service must be mentioned. In a survey described by Kemp, 1975, over 35% of patients used an ambulance to take them home after treatment. Whilst it might be possible to reduce this percentage (eg by using taxis more), there will clearly be major constraints of the feasibility of patients using day hospitals who live a substantial distance away.

SECTION 6 DESCRIPTION OF THE MODEL

6.1 This section describes the basis for the model used to determine the most appropriate locations for day hospital facilities and their respective caseload capacities. It is important to note that the model can provide more than one set of planning options depending on the likely development of demand in each area, the resources available for day treatment and other planning considerations. The results presented are, therefore, simply illustrative examples of a much wider set of possibilities. It is taken for granted that in a realistic planning situation, these possibilities would need to be thoroughly explored in conjunction with administrators and doctors.

6.2 In developing the model, it was essential to include in the technical specification the appropriate mechanisms for allocating resources and for evaluating each option in turn. These mechanisms took into account the following criteria, discussed in more detail in earlier sections:

(a) Accessibility

- The need to facilitate daily access and to allow sufficient time for treatment and post-treatment recovery
- The need to ensure that sufficient utilization will be generated so that the facility can be run economically and effectively

(b) The availability of resources

- The requirement not to spread the available resources too thinly across the region as this could render day services ineffective
- The need to take full advantage of existing inpatient facilities in order to reduce the cost overheads of day provision

(c) The problems of over-concentration

- The requirement that supply in each area should be controlled in line with expected demand
- The need to control the expansion of successful day hospital facilities in an area where the number of cases resident locally is already close to expected demand

Model Variables

6.3 The above criteria are taken into account in the model in various ways. The idea is that, by altering the variables under their control, the health authorities can influence the development of day hospitals in a systematic manner:

- to ensure an efficient distribution of available resources;
- to provide services which are as accessible as possible to potential patients.

The model generates a variety of output measures for determining whether one particular pattern of provision is superior, in some sense, to another. The technical details depend on an optimisation procedure in which the preferences of patients for treatment in different areas are maximised. These preferences are derived from the current geographical pattern of hospital utilization based on accessibility. This represents an important further assumption in our approach because, in the absence of any significant day treatment provision in Piemonte, it becomes necessary to base assumptions about choice behaviour on a closely allied set of services. The full list and description of the main input and output variables is as follows:

Inputs

W_i : the potential demand for day treatment by USL or area of residence based on the population size weighted by age, sex and case severity, where i varies from 1 to 76, the total number of USLs in Piemonte

P_i : the resident population in area i

c_{ij} : the accessibility costs between each area of residence i and place of treatment j [j = 1,76]

A : the minimum economic caseload (or threshold) below which it would be uneconomic to establish day treatment facilities (here 2000 cases per year)

D_j^{max} : the maximum annual caseload in j above which either existing inpatient facilities would be over-loaded or generated demand would exceed expected demand

D_j^{min} : the minimum level of provision in j for ensuring a non-zero allocation of resources

Q : the total quantity of resources measured in caseload units for allocation within the region (alternatively known as the budget level)

β : the model parameter

σ : the staffing factor for converting beds into staffing requirements

ω : the bed factor for converting cases into day beds

Outputs

D_j : the caseload capacity allocated by the model to j

T_{ij} : the predicted volume of day patients originating in i and treated in j

H_i : the day hospital treatment rate per ten thousand resident population

C_j : the catchment population of a day facility located in j

b_j : the beds allocated to j for day hospital treatment

n_j : the nursing staff in nurse-equivalents allocated to j

6.4 In addition, the model produces a number of location-specific and region-wide performance indicators which provide a more detailed picture of the predicted service pattern. They include:

$\bar{c}_i$: The average travel cost to day hospitals of patients resident in area i

$\bar{c}$: Average travel costs overall

$P(c_{ij} \leq X)$: The proportion of all patients for whom travel costs are less than or equal to X, where X, say, is one hour's travel

R_i : The ratio the predicted number of patients originating in i to the expected number of patients (expressed as a percentage).

6.5 These indicators allow the user to evaluate allocation decisions in finer detail. For example, if R_i has a value greater than 100, it would mean that area i was generating more patients than expected on the basis of its potential demand. This is equivalent to saying,

$$\frac{\sum_j T_{ij}}{W_i} > 1 \qquad (6.1)$$

This is an important statistic because it shows that i is receiving a higher level of service than is justifiable on grounds of demand alone. The most likely cause would be an over-allocation of resources to nearby day hospitals. Such effects can be counteracted by selecting the appropriate upper limit (D_j^{max}) for the day facilities concerned. Some examples of this procedure are shown later. Table 6.1 is a technical summary of the main model output indicators.

TABLE 6.1 : Technical summary of main model indicators

VARIABLE	DEFINITION
T_{ij}	See section 6.
H_i	$\frac{\sum_j T_{ij}}{P_i} \times 10000$
C_j	$\sum_i E_{ij} P_j$ where $E_{ij} = \frac{T_{ij}}{\sum_j T_{ij}}$
$\bar{c}_i$	$\frac{\sum_j T_{ij} c_{ij}}{\sum_j T_{ij}}$
$\bar{c}$	$\frac{\sum_i \sum_j T_{ij} c_{ij}}{\sum_i \sum_j T_{ij}}$
R_i	$\frac{\sum_j T_{ij}}{W_i} \times 1000$
b_j	$\omega . D_j$
n_j	$\sigma . b_j$

The Gravity Mechanism

6.6 Missing from the above description is a statement of the way the model inputs are combined to produce T_{ij}, the predicted flow of patients between i and j. The method of calculation is based on a gravity hypothesis as described by Mayhew and Taket, 1980. This states that the flow of patients between i and j is proportional to the treatment resources available in j and the potential demand in i, but is in inverse proportion to the accessibility costs of getting from i to j. The resultant model assumes in addition that <u>all resources allocated to each place of treatment are fully used.</u> This assumption reflects the tendency, discussed earlier, that facilities will be fully utilized within the anticipated budget provision, Q. The model is written formally as follows:

$$T_{ij} = B_j D_j W_i f(c_{ij}) \tag{6.2}$$

where $f(c_{ij})$ = the deterrence function j usually $\exp(-\beta c_{ij})$ which is later abbreviated to f_{ij}

β = the model parameter.

$$B_j = \left[\sum_i W_i f(c_{ij}) \right]^{-1} \tag{6.3}$$

B_j ensures that

$$\sum_i T_{ij} = D_j$$

that is all available caseload resources in j are used. It is noteworthy that the inverse of the term in square brackets also has a further interpretation. It is also interpreted as the potential demand incident on location j from all locations i, discounted by the accessibility of getting from i to j. As is shown below, the potential demand is a key influence in the resource allocation process. It is defined as,

$$\phi_j = \sum_i W_i f_{ij}$$

Allocating Resources by Area

6.7 The above model, known also as RAMOS (Resource Allocation Model Over Space) is a standard representation of the interaction between supply and demand in a health care system and has been applied in many regions, including Piemonte (see also Mayhew and Rising, 1984; Hall et al, 1982; and Tadei et al, 1983; Bertuglia and Tadei, 1984). The model is behavioural in the sense that it describes the way patients select treatment facilities given the geographical distribution of demand and supply. However, it does not necessarily represent an optimal allocation of resources in the sense of maximizing the locational preferences of patients.

6.8 This problem then is the key to deciding on the appropriate allocation of day treatment facilities. It is very similar to the one analysed in detail by Mayhew and Leonardi (1982), whose analytical approach was based on the maximization of a utility function. It may be shown that the utility function they chose is formally related to the concept of consumer surplus (eg Neuburger, 1971; Leonardi, 1978). Depending on how it is formulated the function can be used to derive either the basic "gravity" model given in equation (6.2) or the associated resource allocation problem. This is important because it implies that the model predicting patient flows and the model which allocates resources are closely related and can be derived using similar assumptions.

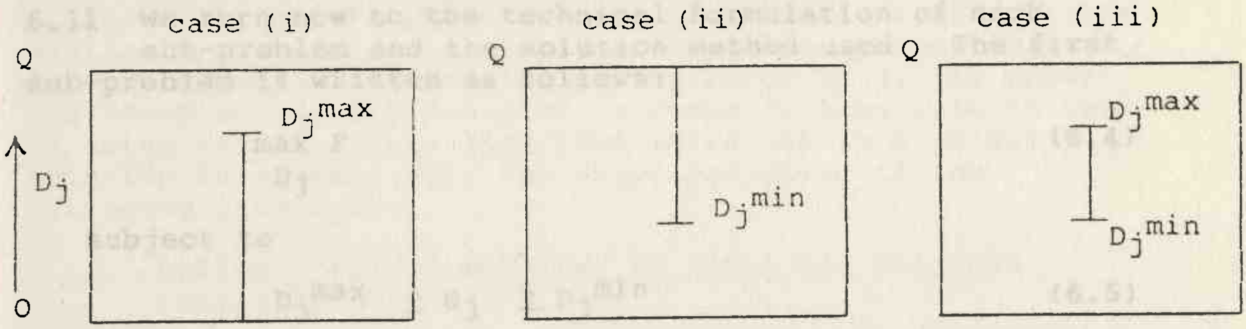
The Allocation Methods

6.9 In this section the key equations for allocating resources are derived. The allocation problem is split into three sub-problems which each assume varying degrees of flexibility on the part of health authorities. Sub-problem one considers the case when there are upper and lower restrictions ("bounds") on allocations corresponding to D_j^{max} and D_j^{min} in the input variable list. Sub-problem two considers the case where there exists a threshold allocation of resources (variable A in the input list) based on potential demand which must first be satisfied before any facilities are provided (see also Mayhew and Leonardi, 1984). Sub-problem three considers the case where there are both upper bounds and a threshold (D_j^{max} and A).

It is noteworthy that there also exists a fourth possible sub-problem which includes both upper and lower bounds and a threshold. This, of course, allows most flexibility, but it is also, in a certain sense, conceptually the most difficult to deal with. Currently, it is not fully implemented within the model. Paragraphs 6.16 to 6.19 below sketch out the reasons why.

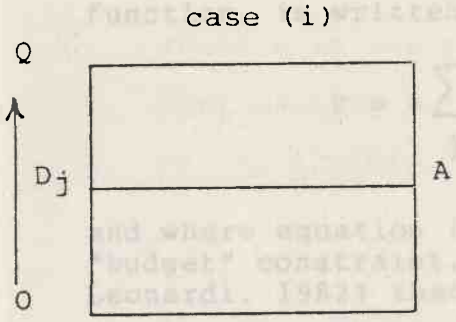
6.10 Figure 6.1 summarizes in diagrammatic form the essential differences between the three sub-problems. An equivalent diagram for the fourth sub-problem is presented in Figure 6.2 alongside the relevant discussion. In Figure 6.1, the solution space is shown for particular cases within each sub-problem. The vertical axis, in caseload units, shows the maximum feasible range (zero to Q) for a particular D_j. This range reduces when either D_j^{min} or D_j^{max} are greater than zero or less than Q, or when A is greater than zero. Whereas in sub-problem one all locations receive a positive quantity of resources, in sub-problem two there are actually two completely different types of possible solution depending on the value of A, the threshold, and Q, the total budget. Either D_j satisfies the threshold, in which event D_j must be greater than or equal to A, or it is less than the threshold, in which case D_j is zero. Of course, if A is greater than Q, none of the resources is allocated. In the third sub-problem, with upper bounds and a threshold there are two cases of interest. If D_j^{max} is greater than or equal to A then two outcomes are possible (either $A \leq D_j \leq D_j^{max}$ or D_j equals zero); if D_j^{max} is less than A, then D_j is automatically zero.

Sub-problem 1 : Upper and lower bounds



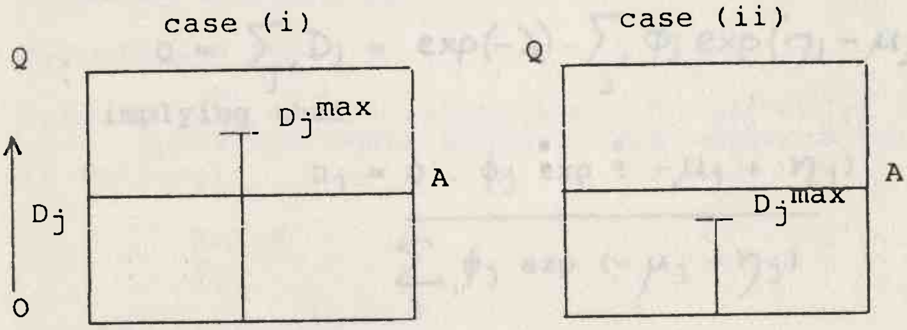
Solution: $D_j^{max} \geq D_j > O$ $\quad$ $Q \geq D_j \geq D_j^{min}$ $\quad$ $D_j^{max} \geq D_j \geq D_j^{min}$

Sub-problem 2 : Threshold only



Solution: either $Q \geq D_j \geq A$
or $D_j = O$

Sub-problem 3 : Threshold and upper bound



Solution: $D_j^{max} \geq D_j \geq A$ $\quad$ $D_j = O$

Figure 6.1 : Solution space for allocating resources according to the three sub-problems

Sub-problem one

6.11 We turn now to the technical formulation of each sub-problem and the solution method used. The first sub-problem is written as follows:

$$\max_{D_j} F \tag{6.4}$$

subject to

$$D_j^{max} \geq D_j \geq D_j^{min} \tag{6.5}$$

and
$$\sum_j D_j = Q \tag{6.6}$$

where F, the utility or consumer surplus maximising function, is written,

$$F = -\sum_j D_j \left[\ln \left(\frac{D_j}{\phi_j} \right) - 1 \right] \tag{6.7}$$

and where equation (6.6) represents the resource or "budget" constraint. It is easily shown (Mayhew and Leonardi, 1982) that F is optimal when

$$D_j = \phi_j \exp (\eta_j - \mu_j - \lambda) \tag{6.8}$$

where η_j and μ_j are the Lagrange multipliers associated respectively with the lower and upper bounds in (6.5) and λ is the multiplier associated with (6.6). From equation (6.6) we note that

$$Q = \sum_j D_j = \exp(-\lambda) \cdot \sum_j \phi_j \exp(\eta_j - \mu_j) \tag{6.9}$$

implying that

$$D_j = Q \cdot \frac{\phi_j \exp (-\mu_j + \eta_j)}{\sum_j \phi_j \exp (-\mu_j + \eta_j)} \tag{6.10}$$

In the case where there are no effective bounds on D_j, $\mu_j = \eta_j = 0$ and equation (6.10) reduces to

$$D_j = Q \cdot \frac{\phi_j}{\sum_j \phi_j} \tag{6.11}$$

6.12 Equation (6.11) is the basic allocation formula matching the resources in j with the patients' preferences for treatment in that location. In effect, the available resources are simply allocated in proportion to ϕ_j, the potential demand for day services in j. If upper and lower bounds are declared, a computer algorithm is used to solve for D_j. This algorithm converges to a unique solution in a relatively few steps according to the following procedure:

1. Define a set of weights, X_j ($\forall j$) and set them initially to one

2. Compute $D_j = \dfrac{Q \phi_j X_j^{(n)}}{\sum_j \phi_j X_j^{(n)}}$

   where n is the number of iterations (0,1....)

3. Test whether $D_j^{max} \geq D_j \geq D_j^{min}$

4. If $D_j \leq D_j^{min}$, set $X_j^{(n+1)} = \dfrac{X_j^{(n)} D_j^{min}}{D_j}$

   If $D_j \geq D_j^{max}$, set $X_j^{(n+1)} = \dfrac{X_j^{(n)} D_j^{max}}{D_j}$

5. Go to 2 and repeat until a convergence criterion is satisfied

Sub-problem two

6.13 In the second sub-problem the threshold replaces the upper and lower bounds. The required formulation is as follows:

$$\max_{D_j} F \quad (6.4)$$

where either

$$D_j \geq A \quad (6.12)$$

or

$$D_j = 0 \quad (6.13)$$

and where

$$\sum_j D_j = Q \quad (6.6)$$

In this case, if predicted allocations to some locations are below the threshold minimum those allocations are reduced to zero and the model redistributes the freed resources among the remaining locations. The optimality conditions for this problem are as follows:

$$0 = -\ln\left(\frac{D_j}{\Phi_j}\right) - \lambda + \nu_j \qquad (6.14)$$

where ν_j is now the multiplier associated with (6.12).

Plainly ν_j will be active (ie non-zero) whenever

$$\lambda > -\ln\left(\frac{A}{\phi_j}\right) \qquad (6.15)$$

6.14 If this situation arises condition (6.13) is invoked and j's resources are redistributed. The method of redistribution is achieved by deleting j from the list of facilities and re-optimizing over the reduced sub-set of locations. This process continues until all allocations satisfy the threshold. This process always converges providing $A \leq Q$. In some situations a solution could be obtained in which the location with the smallest allocation is well above the threshold. Here it is worth testing the sensitivity of whether, either by relaxing the threshold slightly or by increasing Q, more facilities cannot be opened. This is consistent with the logic of the procedure which is to open as many facilities as possible.

Sub-problem three

6.15 The third sub-problem considers the case with upper bounds and a threshold. It is written as follows:

$$\max_{D_j} F \qquad (6.4)$$

subject to

$$D_j \leq D_j^{max} \qquad (6.16)$$

and $\sum_j D_j = Q$

and either $D_j^{max} \geq D_j \geq A$ (6.12)

or $D_j = 0$ (6.13)

The optimality conditions for this problem are

$$0 = -\ln\left(\frac{D_j}{\phi_j}\right) - \lambda + \nu_j - \mu_j \qquad (6.17)$$

In this case the threshold will be active whenever

$$\lambda + \mu_j > -\ln\left(\frac{A}{\phi_j}\right) \quad (6.15)$$

Discussion

6.16 Currently the only sub-problem which is not fully implemented within the model program is the most flexible case containing both upper and lower bounds and a threshold. Figure 6.2 shows the solution space for this sub-problem and indicates some possible difficulties which need resolving.

6.17 In cases one to four there are no contradictions and the solutions are simply variants of the previous sub-problems. In cases five to seven, however two particular situations arise: either D_j^{min} is less than the threshold, or D_j^{min} and D_j^{max} are less than the threshold. Herein lies a possible contradiction since, according to the way the problem is structured, it is not feasible to receive a mandatory allocation of resources (based on the D_j^{min} requirement) that is also below the threshold.

6.18 To ignore the threshold in such cases would be analogous to giving location j preferential consideration. If this is so, one way of proceeding is to provide the locations concerned a guaranteed minimum level of provision equivalent D_j^{min} before distributing the remaining resources. That is if $D_j^{min} < A$, set D_j equal to D_j^{min}. If, as a result of the subsequent allocation by the model, j receives further resources which, when added to D_j^{min}, bring its quota equal to or above A, then entitlement to those resources is granted in the normal way. Note that if this approach is adopted, then D_j^{max} in case six becomes redundant as it is never needed: D_j will always equal D_j^{min}.

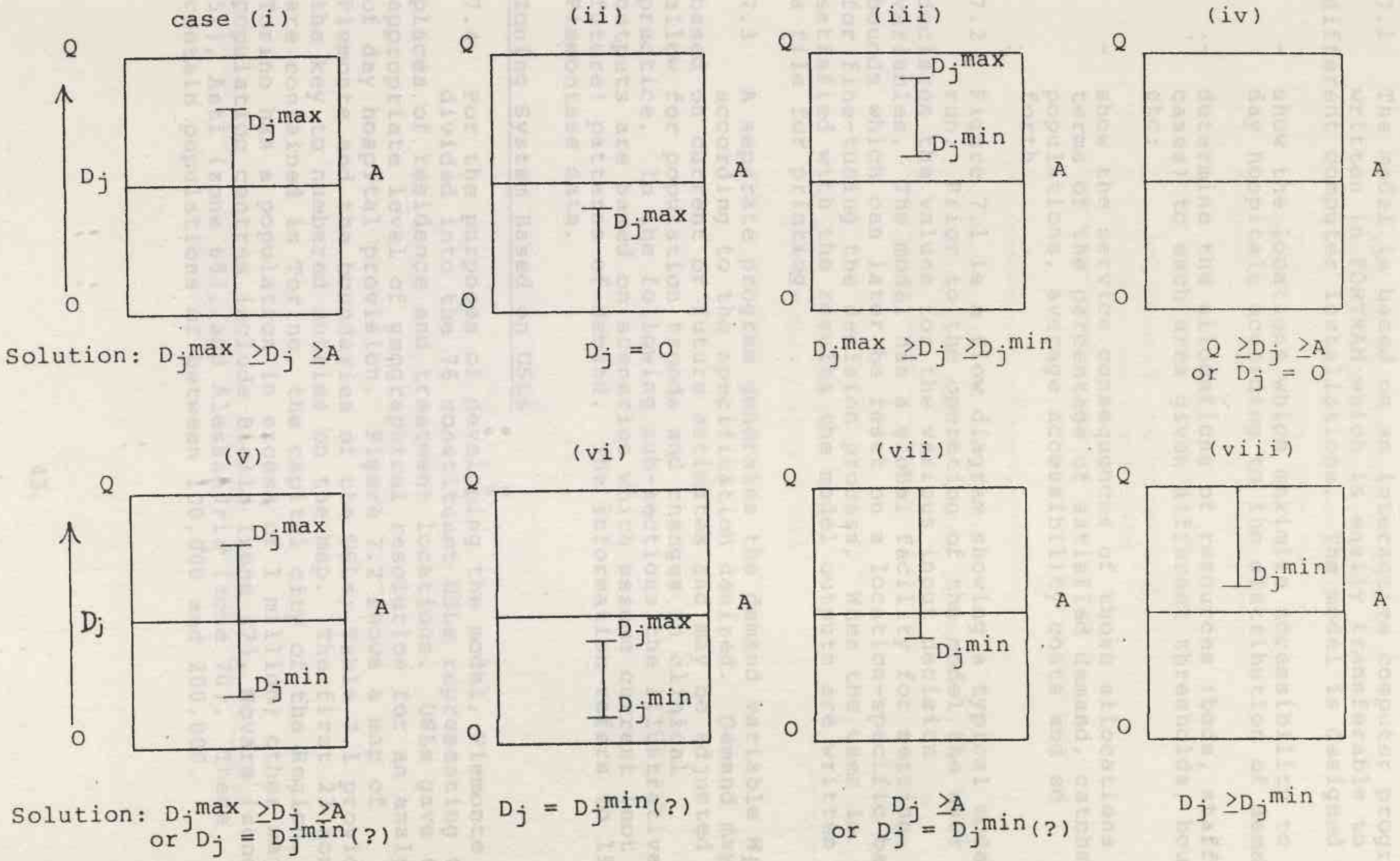


Figure 6.2: Solution space for allocating resources in the unresolved case

SECTION 7 USE OF THE MODEL IN PRACTICE AND FIRST RESULTS

7.1 The model is based on an interactive computer program written in FORTRAN which is easily transferable to different computer installations. The model is designed to

- show the locations which maximize accessibility to day hospitals according to the distribution of demand;
- determine the allocations of resources (beds, staff, cases) to each area given different thresholds, bounds etc;
- show the service consequences of those allocations in terms of the percentage of satisfied demand, catchment populations, average accessibility costs and so forth.

7.2 Figure 7.1 is a flow diagram showing a typical model run. Prior to the operation of the model the user declares the values for the various input decision variables. The model has a global facility for setting bounds which can later be reset on a location-specific basis for fine-tuning the decision process. When the user is satisfied with the results the model outputs are written to a file for printing.

7.3 A separate program generates the demand variable W_i according to the specification desired. Demand may be based on current or future estimates and may be adjusted to allow for population trends and changes in clinical practice. In the following sub-sections the illustrative outputs are based on scenarios which assume current (not future) patterns of demand. The information refers to 1980 Piemontese data.

Zoning System Based on USLs

7.4 For the purposes of developing the model, Piemonte was divided into the 76 constituent USLs representing the places of residence and treatment locations. USLs gave the appropriate level of geographical resolution for an analysis of day hospital provision. Figure 7.2 shows a map of Piemonte and the boundaries of the USLs; Table 7.1 provides the key to numbered entries on the map. The first 23 zones are contained in Torino, the capital city of the Region. Torino has a population in excess of 1 million; other major population centres include Biella (zone 47), Novara (zone 51), Asti (zone 68), and Alessandria (zone 70). These contain populations of between 100,000 and 200,000.

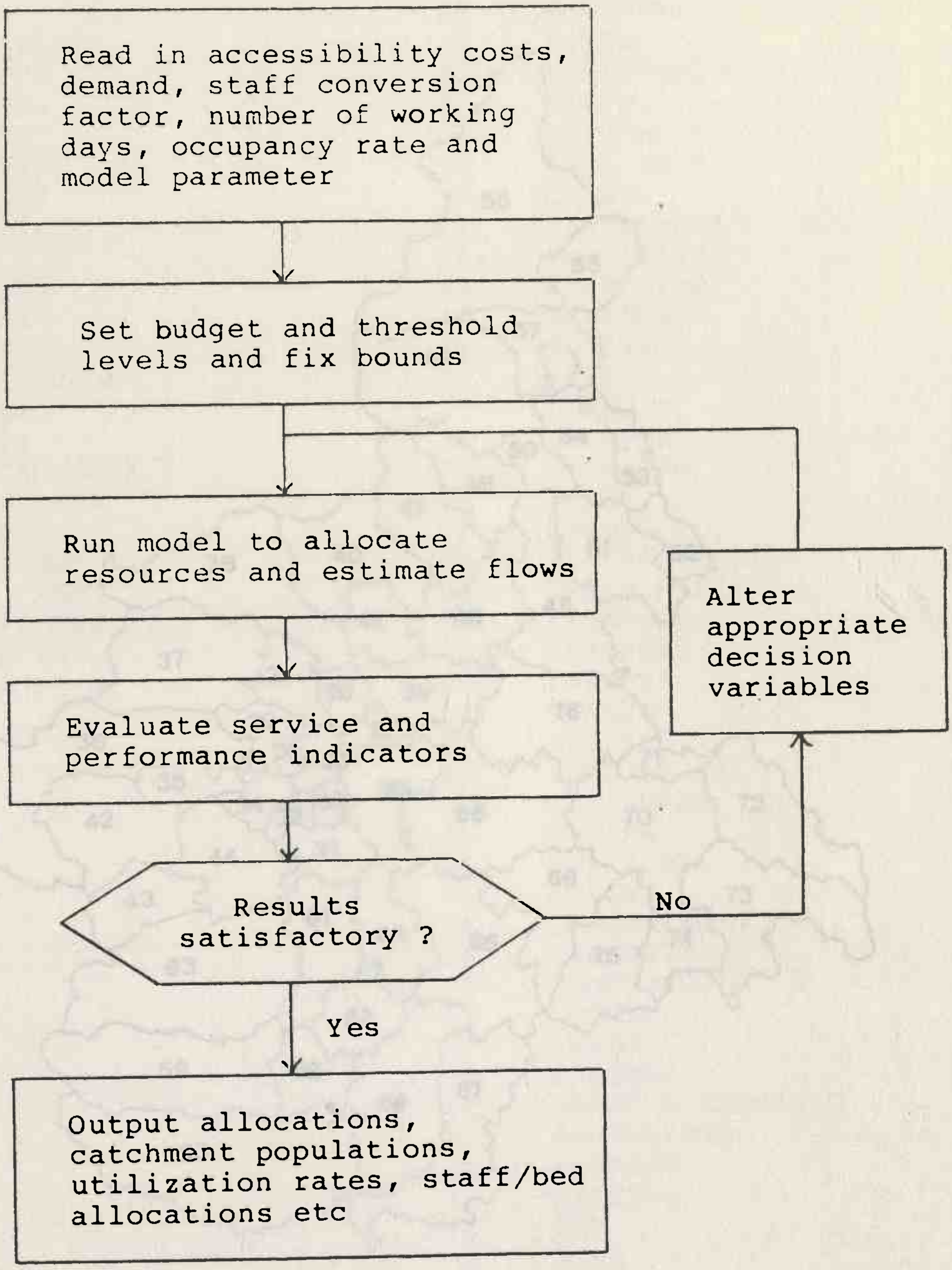


Figure 7.1: Flow diagram showing procedure for using the model

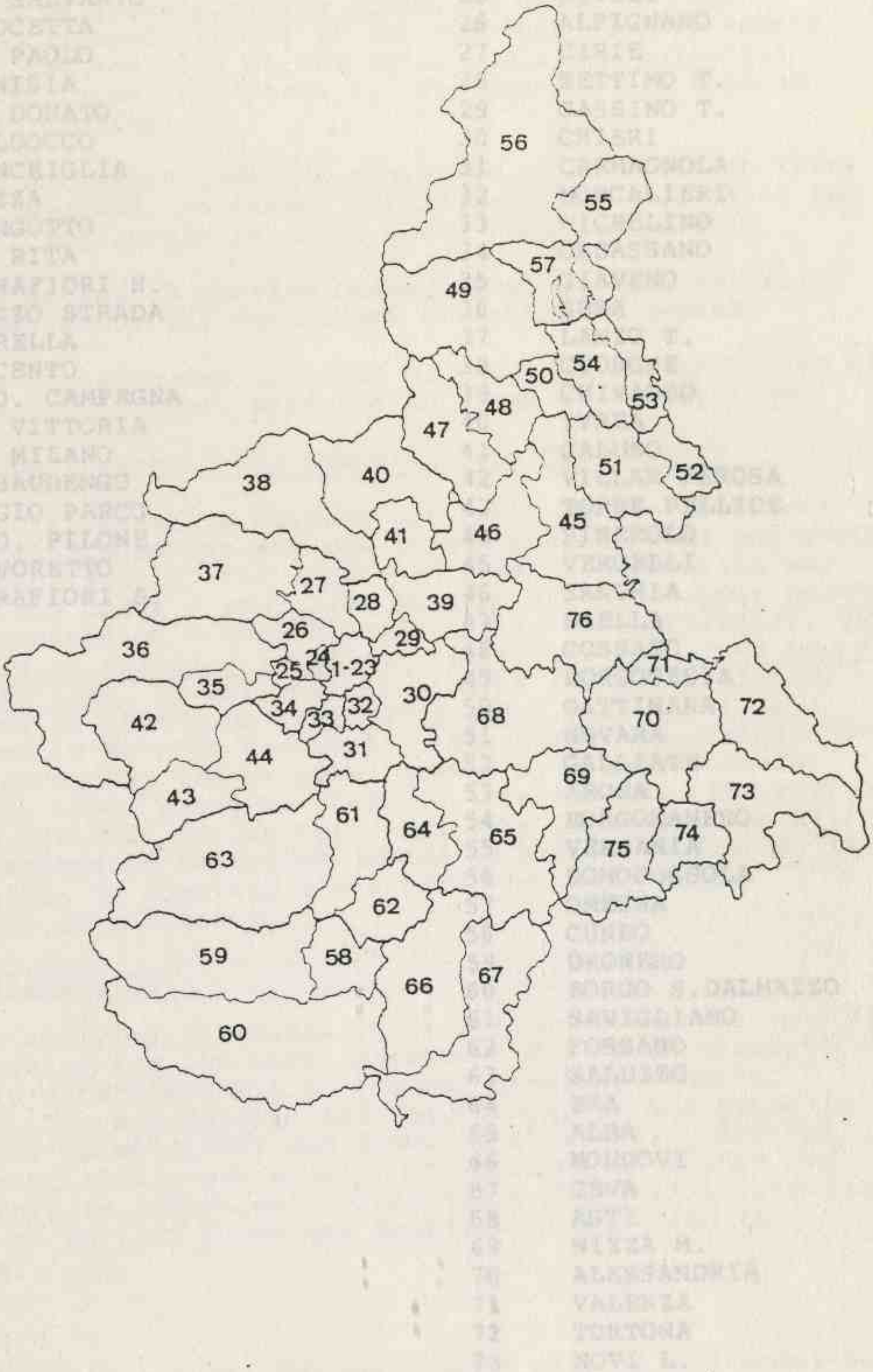


Figure 7.2: Map of Piemonte showing USLs (for key see Table 7.1)

Table 7.1 : Key to the names of the USLs shown in the results

Torino		Other Piemonte	
1	CENTRO	24	COLLEGNO
2	S. SALVARIO	25	RIVOLI
3	CROCETTA	26	ALPIGNANO
4	S. PAOLO	27	CIRIE
5	CENISIA	28	SETTIMO T.
6	S. DONATO	29	GASSINO T.
7	VALDOCCO	30	CHIERI
8	VANCHIGLIA	31	CARMAGNOLA
9	NIZZA	32	MONCALIERI
10	LINGOTTO	33	NICHELINO
11	S. RITA	34	ORBASSANO
12	MIRAFIORI N.	35	GIAVENO
13	POZZO STRADA	36	SUSA
14	PARELLA	37	LANZO T.
15	LUCENTO	38	CUORGNE
16	MAD. CAMPAGNA	39	CHIVASSO
17	B. VITTORIA	40	IVREA
18	B. MILANO	41	CALUSO
19	REBAUDENGO	42	VILLAR PEROSA
20	REGIO PARCO	43	TORRE PELLICE
21	MAD. PILONE	44	PINEROLO
22	CAVORETTO	45	VERCELLI
23	MIRAFIORI S.	46	SANTHIA
		47	BIELLA
		48	COSSATO
		49	BORGOSESIA
		50	GATTINARA
		51	NOVARA
		52	GALLIATE
		53	ARONA
		54	BORGOMANERO
		55	VERBANIA
		56	DOMODOSSOLA
		57	OMEGNA
		58	CUNEO
		59	DRONERO
		60	BORGO S.DALMAZZO
		61	SAVIGLIANO
		62	FOSSANO
		63	SALUZZO
		64	BRA
		65	ALBA
		66	MONDOVI
		67	CEVA
		68	ASTI
		69	NIZZA M.
		70	ALESSANDRIA
		71	VALENZA
		72	TORTONA
		73	NOVI L.
		74	OVADA
		75	ACQUI T.
		76	CASALE M.

Scenarios

7.5 To illustrate the results of the model we have chosen four relatively simple scenarios based on four different (assumed) levels of day hospital supply, namely 10%, 25%, 50% and 100% of the total estimated potential demand calculated in section 4. The results are grouped under four headings:

- the estimated level of provision to each USL in terms of caseload, catchment population, bed allocation and staffing levels in nurse whole time equivalents.

- the estimated service consequences in each USL as measured by the percentage of satisfied demand.

- the consequences in terms of expected accessibility of demand to supply measured in terms of travel time.

Setting the Threshold and Operating the Constraints

7.6 The illustrative outputs are based on the technical model procedures set out in sub-problem 3 of paragraph 6.15. Specifically, the threshold level of provision was set to 2,000 cases a year (see section 5). The upper bounds were determined on a zone by zone basis. In particular, if there were no existing inpatient facilities the upper bound was set to zero, effectively precluding any allocation of day places to that area (see paragraph 6.2(b)). If an allocation to an area resulted in the demand generated locally exceeding the expected demand by a considerable amount the upper bound was reduced accordingly. The key decision variable for carrying out this procedure was R_i, the percentage of satisfied demand in area i. Usually, it was possible to complete a scenario with only a few iterations of the model.

Model Calibration

7.7 In applying the model it is also necessary to specify a value for the model parameter β. This parameter is currently determined within the day hospital computer program. The conventions for determining β are given in Mayhew and Taket (1980) and Tadei et al (1983). For the purposes of this study a value of β equal to 0.1069 was used. This is equivalent to the value obtained in previous studies of patient flows and hospital utilization in Piemonte.

Results

7.8 The main results for the supply side of the model are set out in Figures 7.3 to 7.6. The black columns are proportioned to the sizes of the allocations. Because of the threshold criterion no zone provided with resources receives an allocation of less than a 2,000 cases per year capacity. According to the model the most appropriate location for developing day hospital services is Torino. Torino not only accounts for the bulk of potential demand (approximately 26%) but it is also highly accessible to populations living in surrounding areas. Increasing, the level of resources results in further allocations to the Torino area, up to a maximum of between 24,000 and 25,000 day cases a year. Areas surrounding Torino are next to benefit (Figure 7.4) followed by locations to the north-east of Torino. In the 100% scenario most locations benefit to some degree except for those lying on the periphery of the region. At this stage, there are three general points to note:

- The broad effect of the threshold is to give locations outside Torino allocations in the range of 2,000 to 3,000 cases a year. This is equivalent to an allocation of between 10 and 15 beds and between five and eight full-time nursing staff

- Some locations that might be expected to receive allocations such as Alessandria (zone 70) and Novara (zone 51) are excluded from all but the 100% scenario. This is partly a reflection of their relatively peripheral locations within the region. If patients from the neighbouring region are treated in Novara and Alessandria it might be possible to satisfy the 2,000 a year threshold. We have not investigated this possibility

- Within Torino the allocations reflect the existing contribution of inpatient facilities. However, the area with the largest existing hospital, the Molinette, is allocated less than some other areas in the city. For Molinette to be allocated more, the bounds must be adjusted accordingly.

7.9 Table 7.2 summarises the main details of each scenario for the supply-side.

The Percentage of Satisfied Demand by Area of Residence

7.10 Table 7.3 is a breakdown by USL of the potential demand for day hospital treatment in Piemonte according to the central assumption (as shown in Table 4.2). For each supply scenario only a proportion (usually less than 100%) of this demand will actually be met. This proportion is called the level of satisfied demand and is represented in the model by the statistic R_i (see paragraph 6.5). Figures 7.7 to 7.10 show the percentage of satisfied

10% Scenario

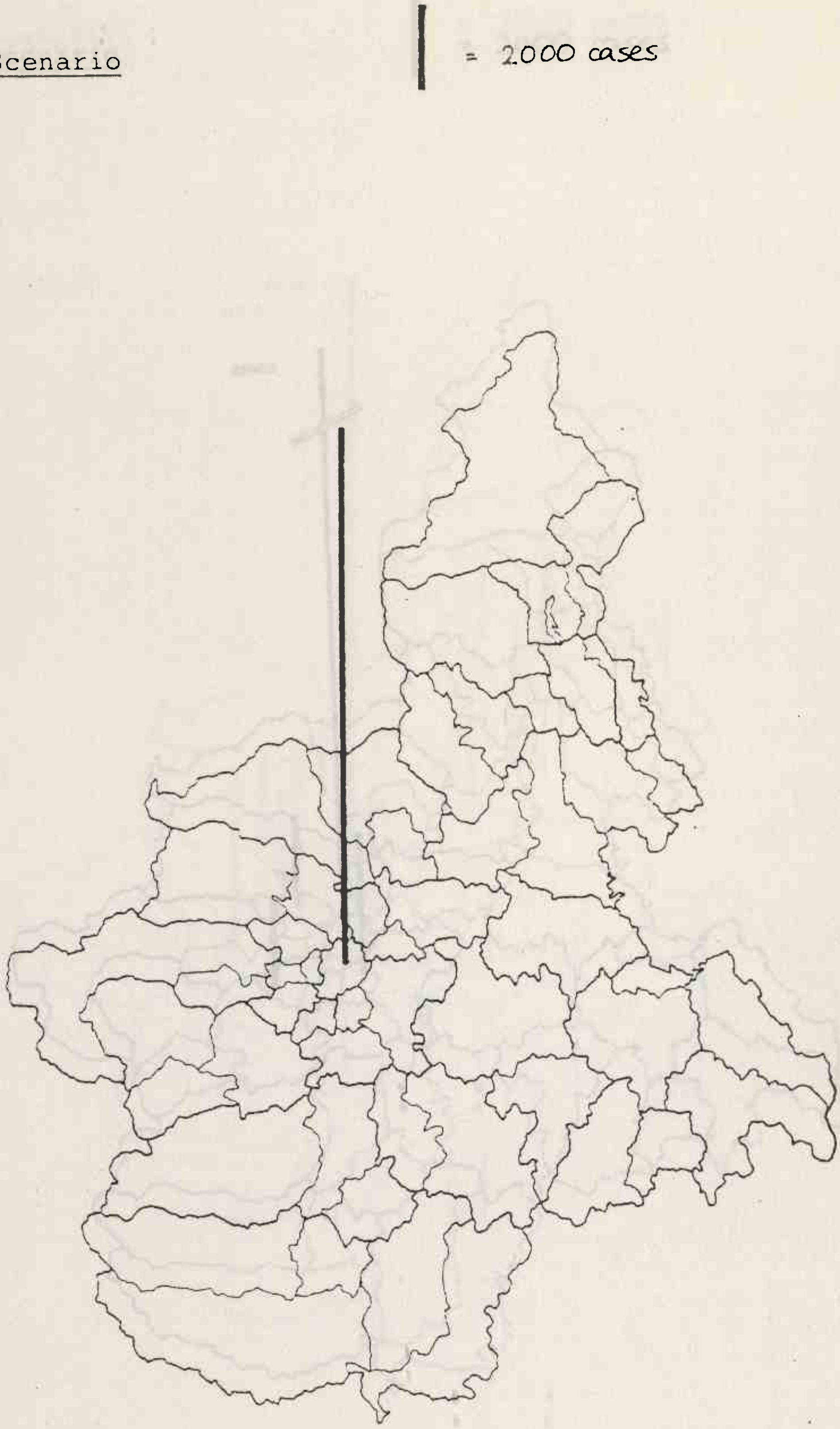


Figure 7.3: Allocations of day caseloads under the 10% scenario

25% Scenario

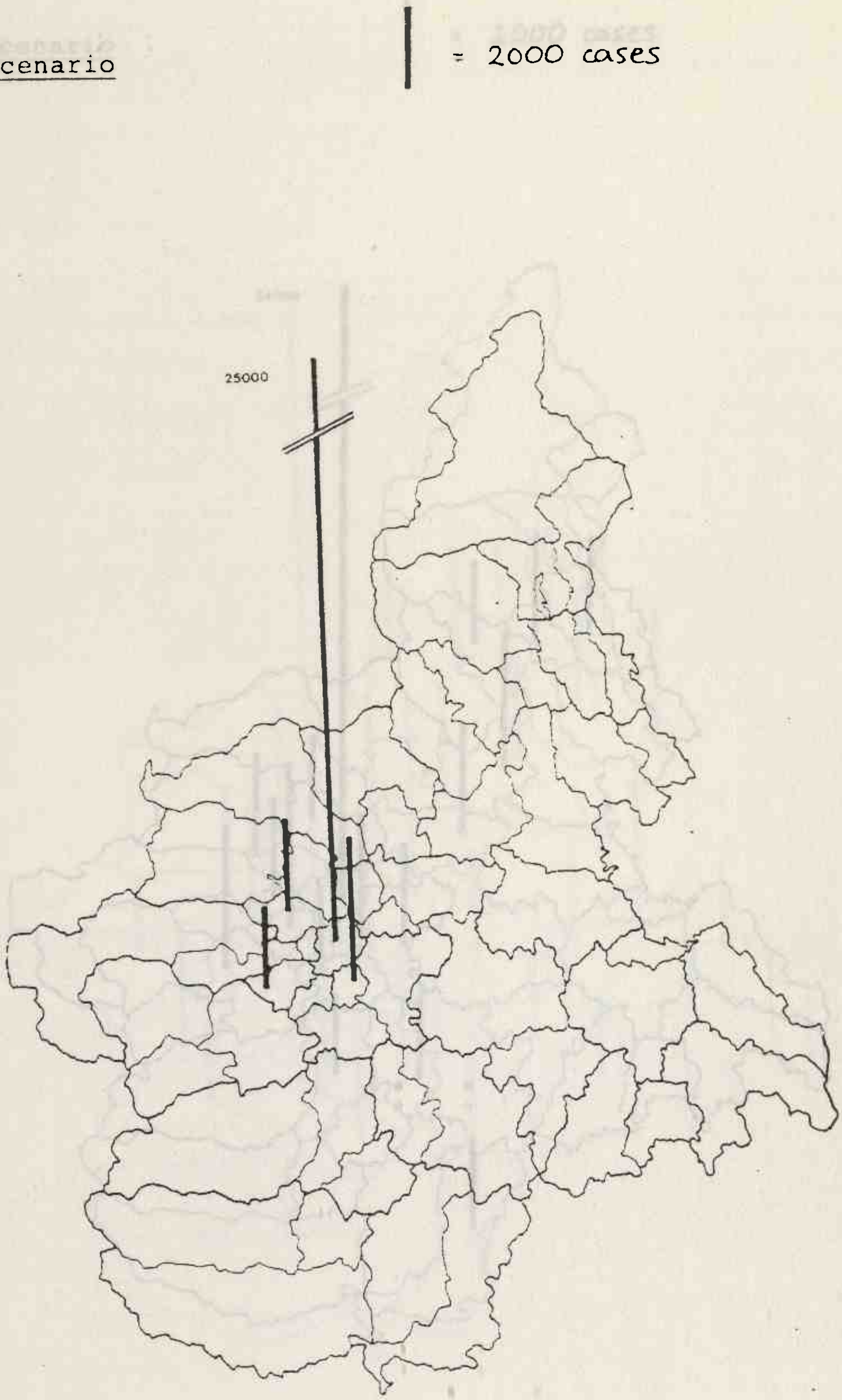


Figure 7.4: Allocations of day caseloads under the 25% scenario

50% Scenario

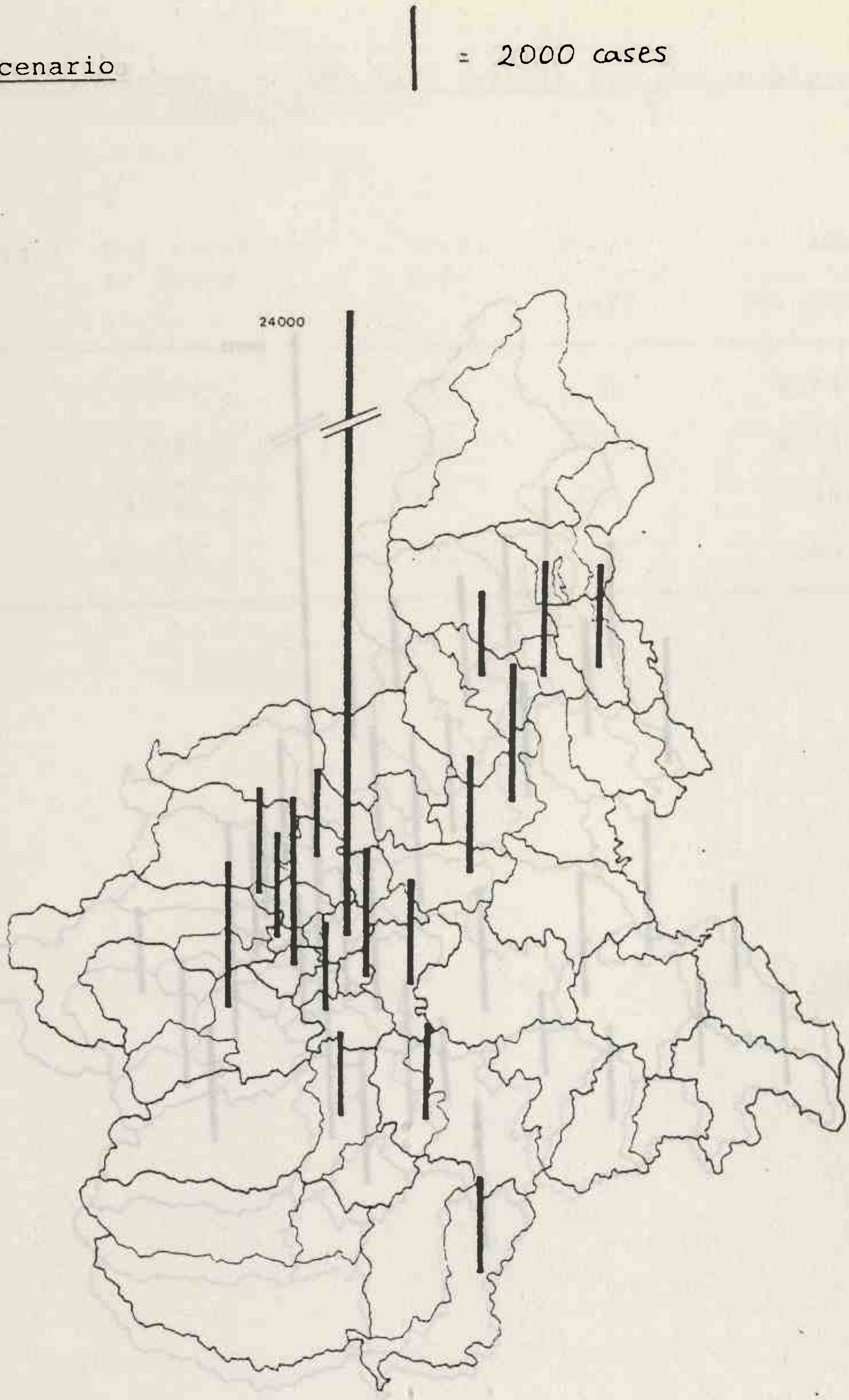


Figure 7.5: Allocations of day caseloads under the 50% scenario

100% Scenario

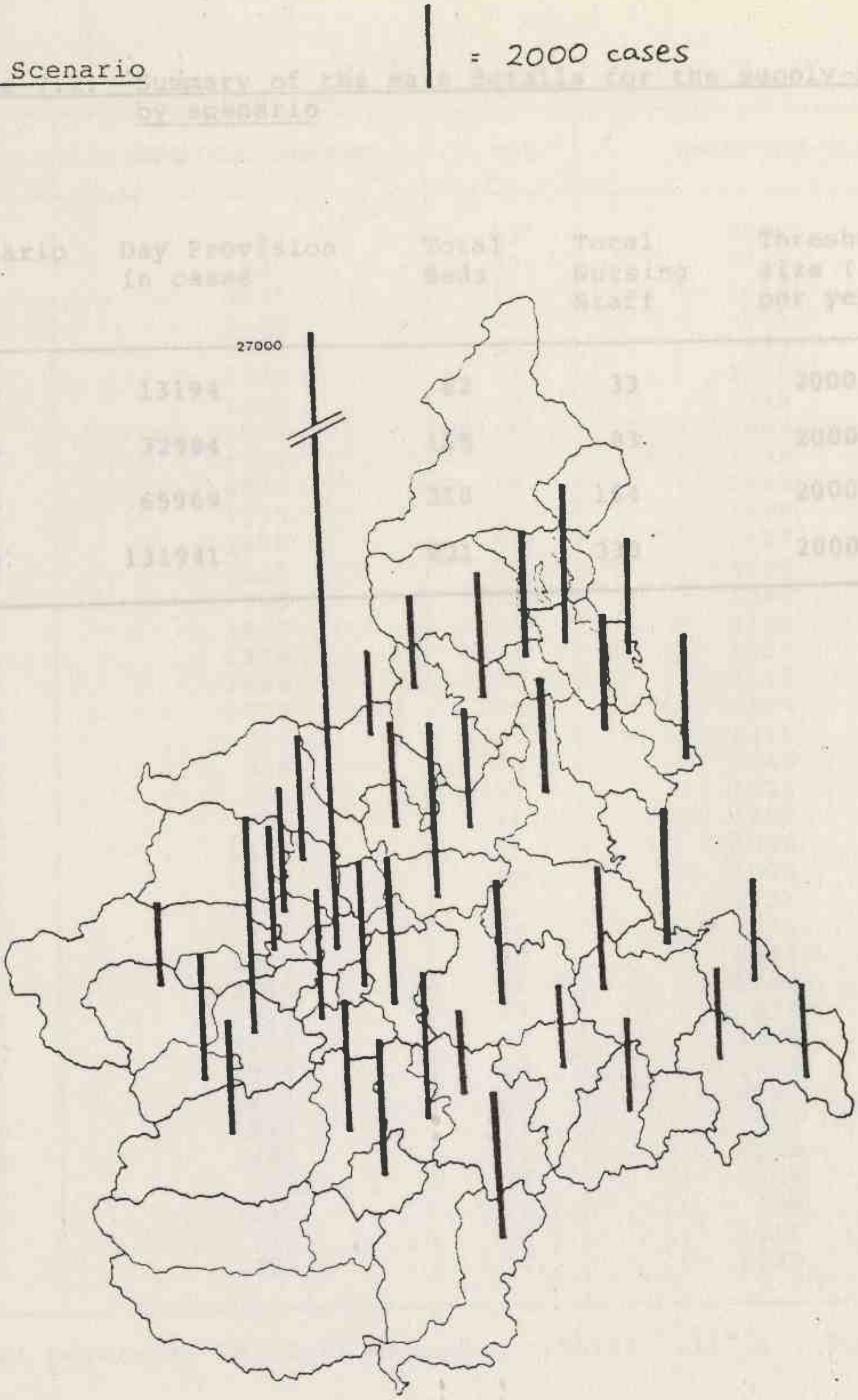


Figure 7.6: Allocations of day caseloads under the 100% scenario

Table 7.2: Summary of the main details for the supply-side by scenario

Scenario	Day Provision in cases	Total Beds	Total Nursing Staff	Threshold size (cases per year)
10%	13194	62	33	2000
25%	32984	155	83	2000
50%	65969	310	164	2000
100%	131941	621	330	2000

USL	EXPECTED DEMAND	USL	EXPECTED DEMAND
1	1769	39	2124
2	1440	40	2765
3	1499	41	1014
4	1180	42	615
5	1600	43	625
6	1779	44	2392
7	1531	45	2328
8	1301	46	1095
9	1137	47	3732
10	1858	48	1948
11	2235	49	1428
12	1686	50	967
13	2110	51	3808
14	1763	52	1460
15	1572	53	1775
16	1370	54	1807
17	1486	55	2113
18	1762	56	2124
19	924	57	1271
20	969	58	2042
21	516	59	1021
22	786	60	1239
23	1444	61	1389
24	2355	62	1009
25	1633	63	2224
26	1800	64	1570
27	2206	65	2839
28	2065	66	1842
29	911	67	818
30	2407	68	4277
31	1315	69	1779
32	2291	70	4021
33	1920	71	907
34	2248	72	2008
35	582	73	2209
36	2240	74	806
37	776	75	1386
38	1773	76	2925

Total potential Regional demand : 131941 (33717 : Torino)

Table 7.3 : The regional demand for day hospital provision by USL

demand by USL according to each scenario. The pattern shows that the optimal location policy is initially to satisfy demand in Torino followed by demand in the USLs in the surrounding area and in the north-east of the region. Relatively little demand in the peripheral areas of the region would ever be satisfied on the basis of these scenarios. For this, the appropriate adjustments to the bounds would have to be included in the model. However, the penalty for abandoning the optimal location policy would be to reduce the level of overall accessibility.

Accessibility by Area

7.11 As noted, the model optimally allocates resources on the basis of their accessibility potential. As is seen, by concentrating resources in Torino initially, a large proportion of potential demand is easily satisfied. There, the patients are guaranteed a reasonable daily access to and from hospital. For the four scenarios the average accessibility costs were 15.1, 16.8, 19.6, 22.0 minutes. Thus, as the resources are spread to other areas average accessibility is gradually reduced. This effect is underlined in the four histograms shown in Figure 7.11. These show the percentage of patients predicted to be generated as a result of the scenarios who are within a particular travel time from a day hospital. The results show that in each case the majority of patients are able to access day facilities within one hour's travel time.

10% Scenario

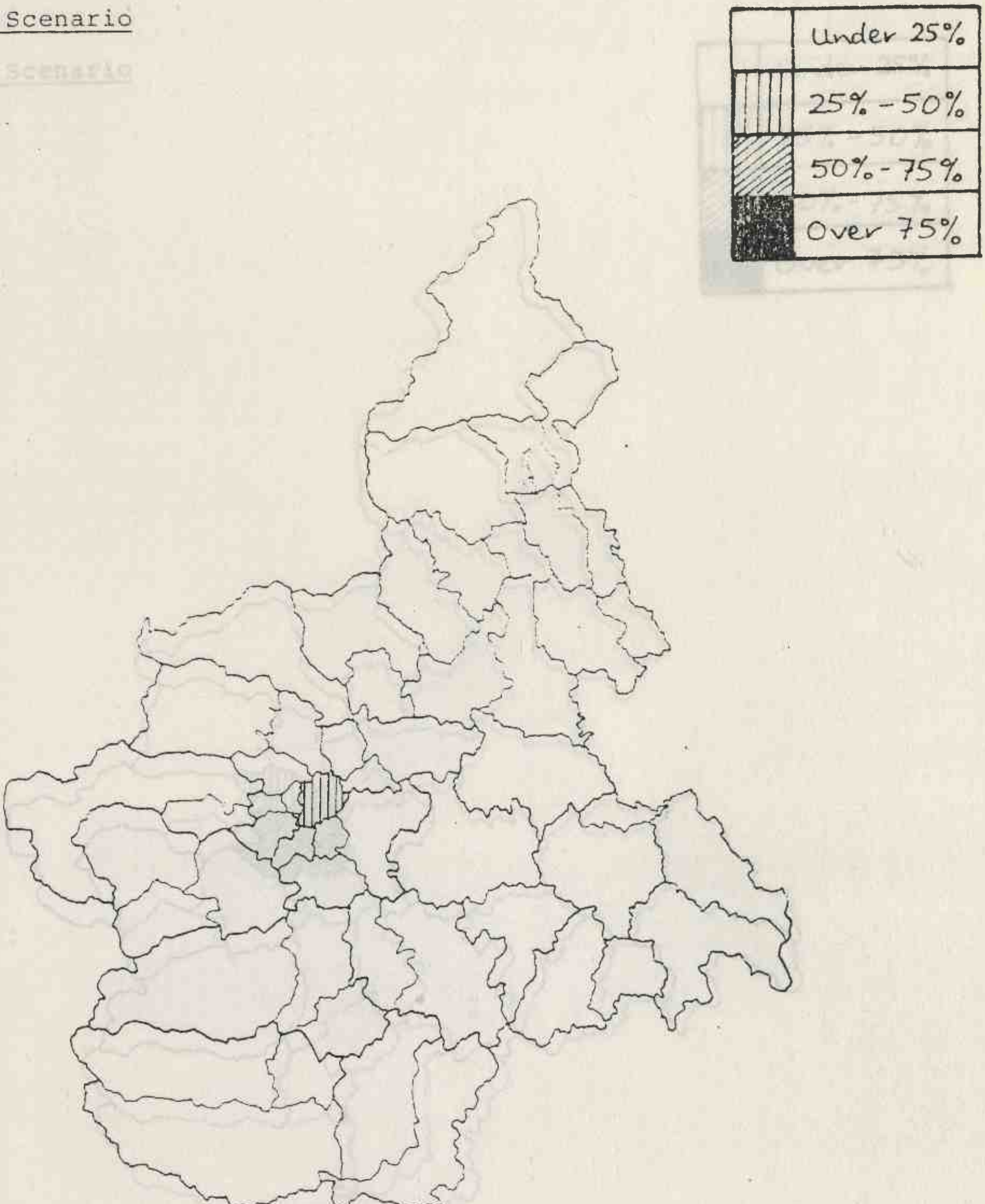


Figure 7.7: The distribution of satisfied demand according to the model: the 10% scenario

25% Scenario

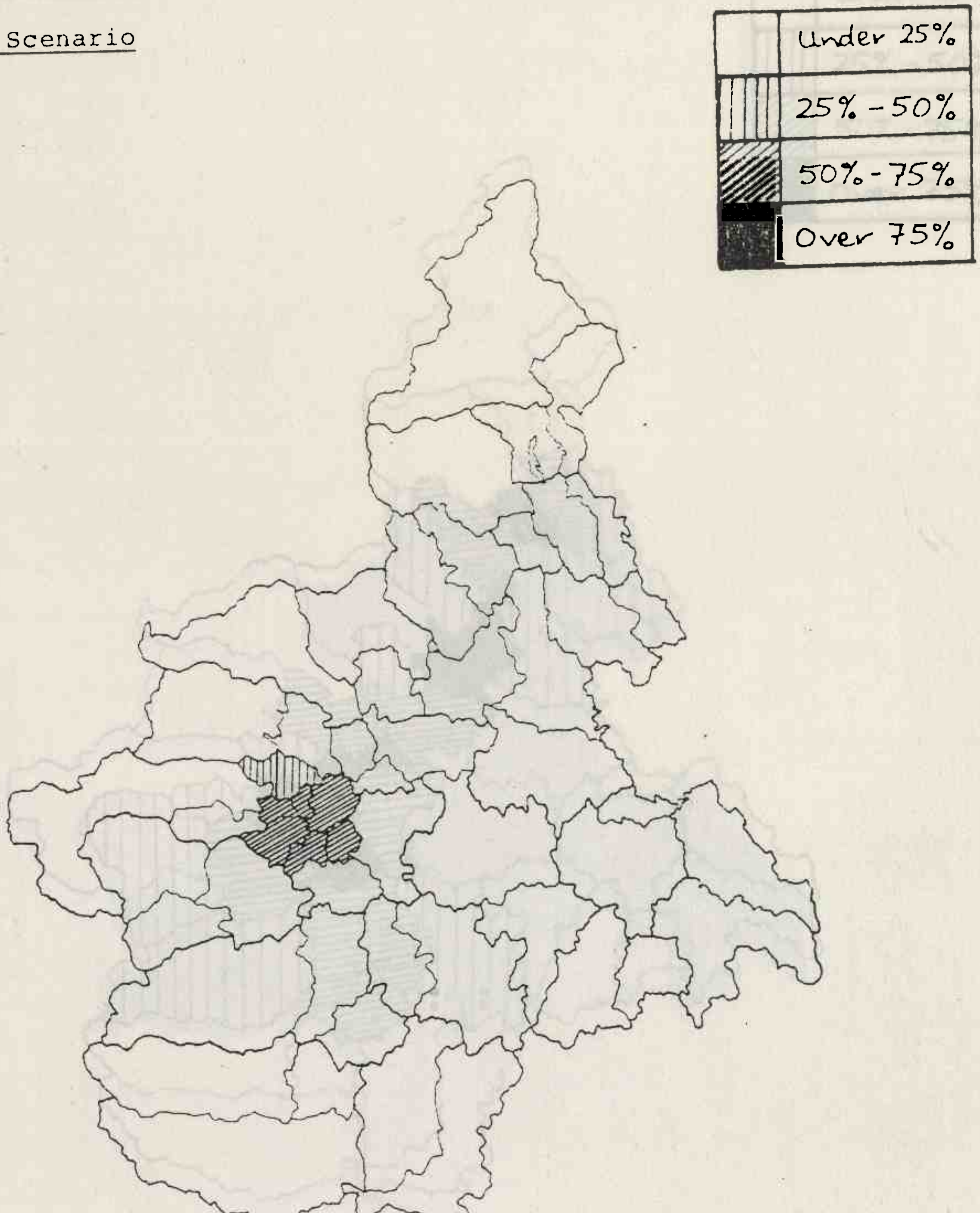


Figure 7.8: The distribution of satisfied demand according to the model: the 25% scenario

50% Scenario

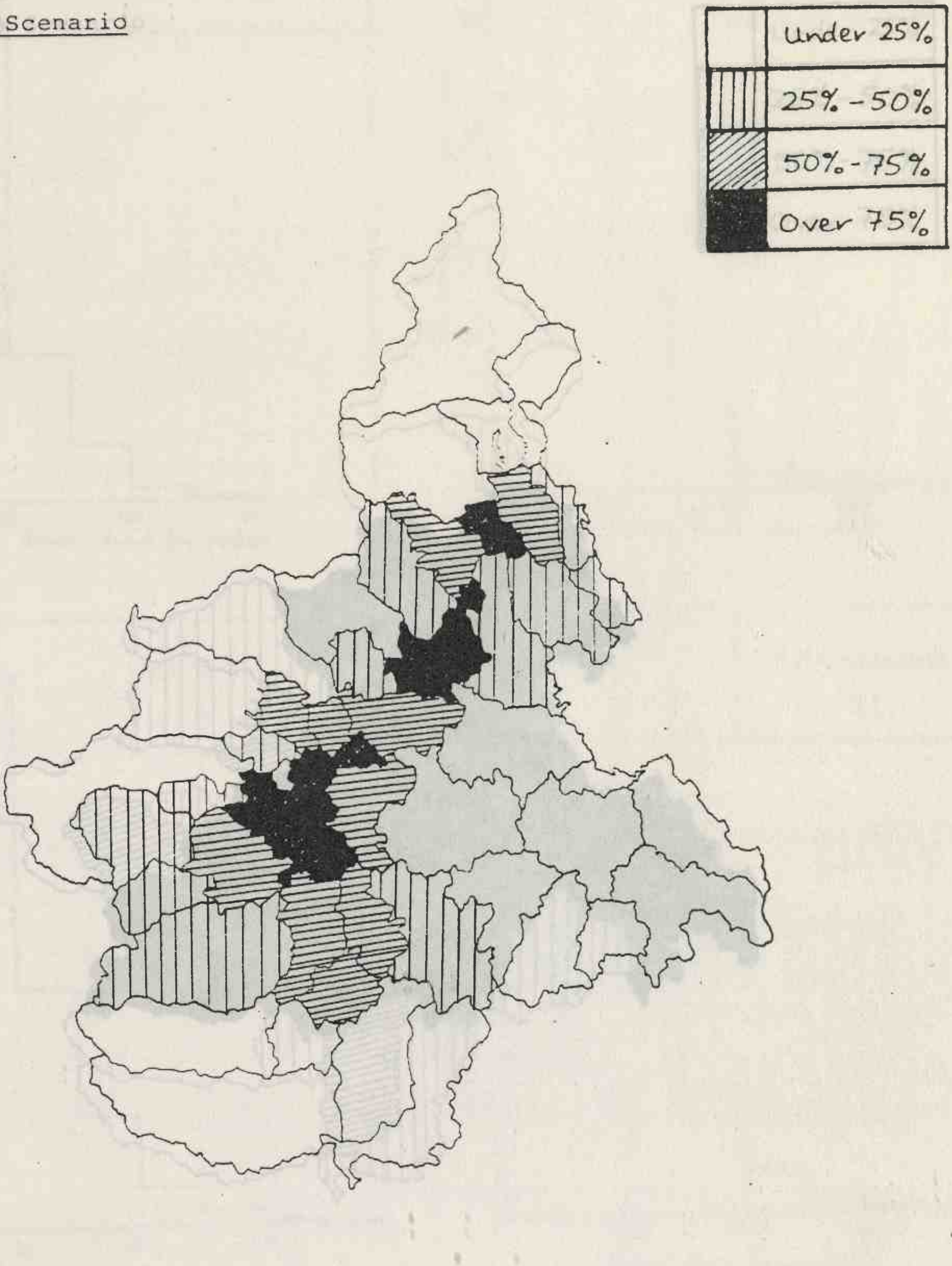


Figure 7.9: The distribution of satisfied demand according to the model: the 50% scenario

100% Scenario

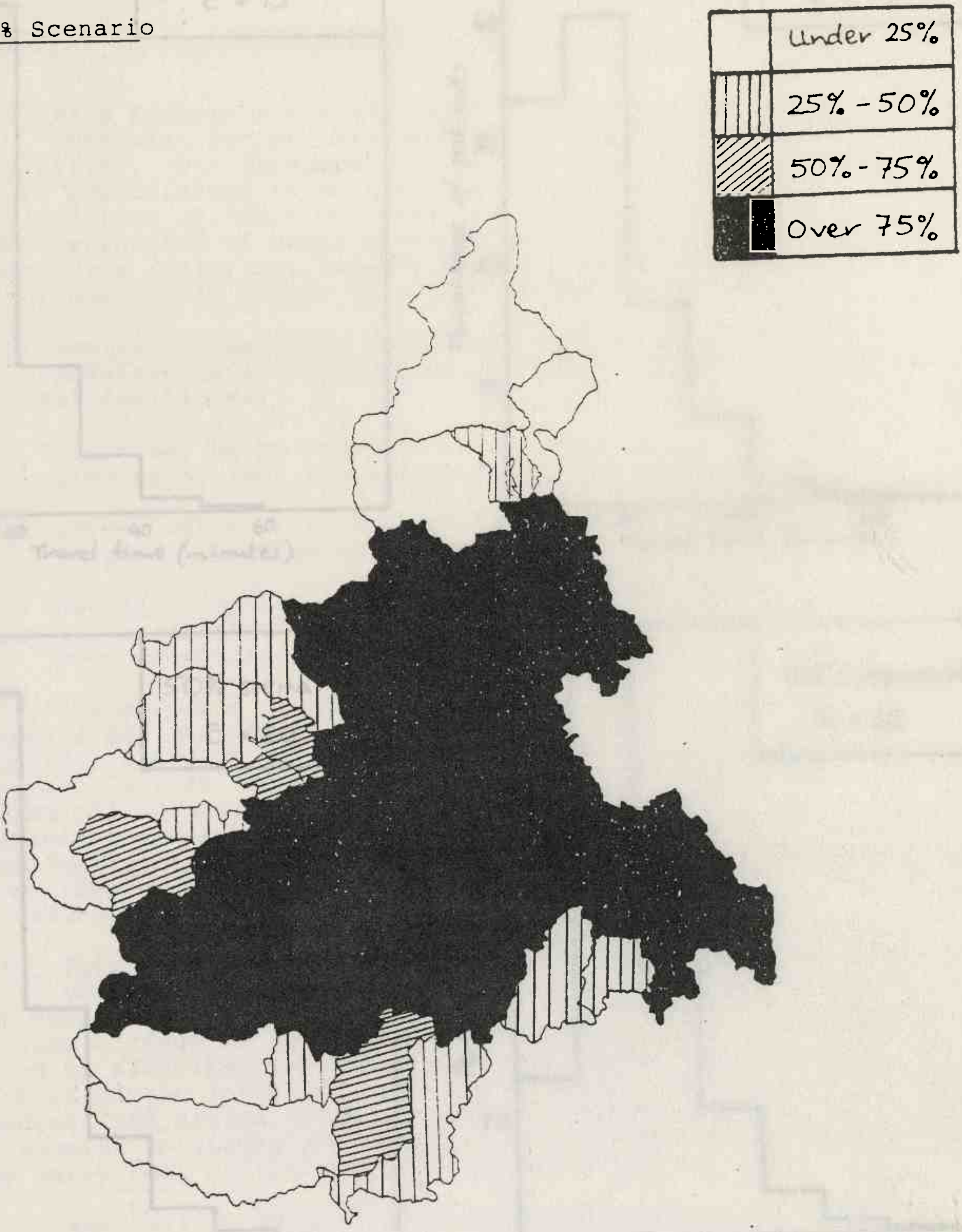


Figure 7.10: The distribution of satisfied demand according to the model: the 100% scenario

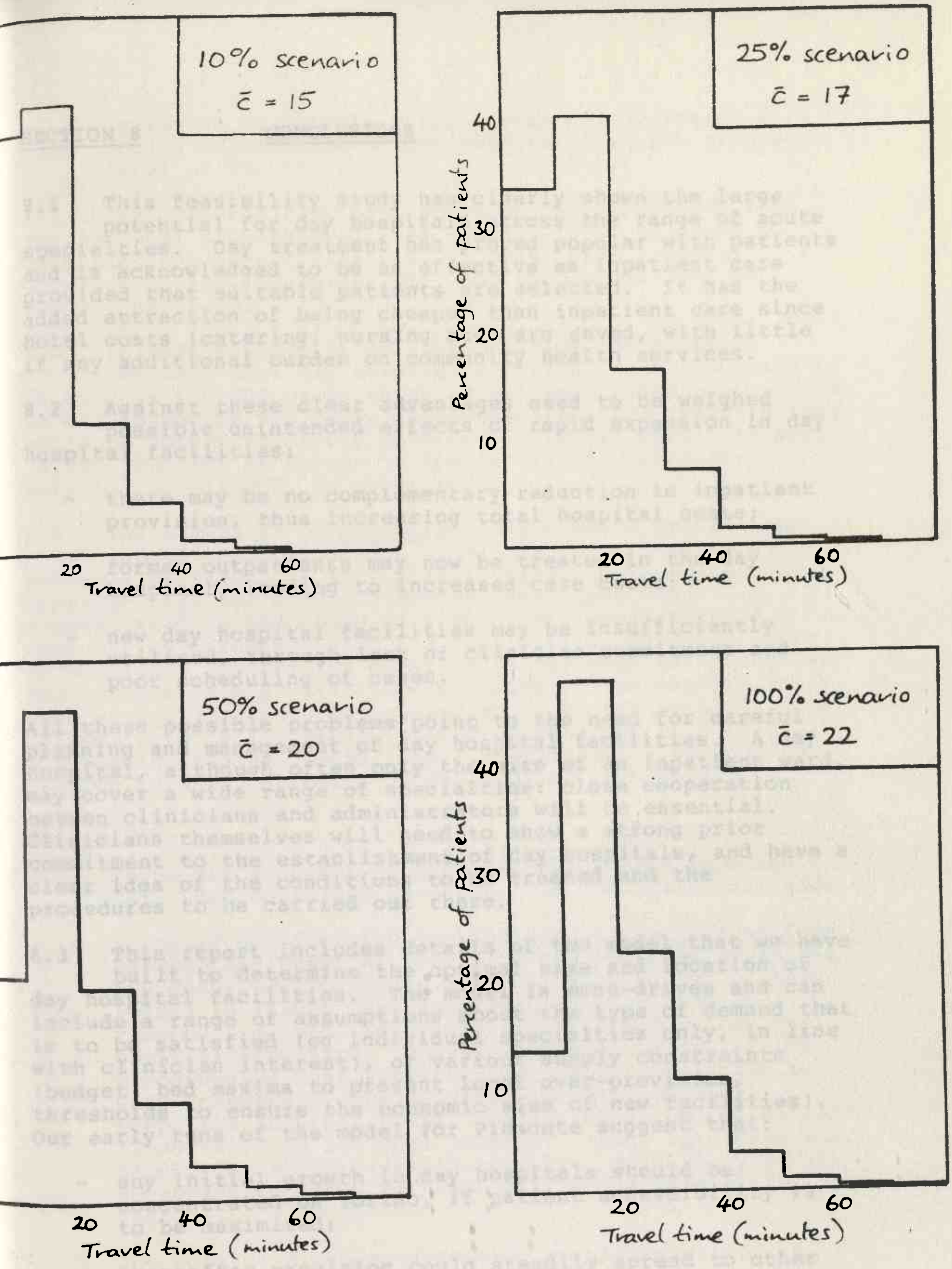


Figure 7.11: The distribution of travel times

SECTION 8 CONCLUSIONS

8.1 This feasibility study has clearly shown the large potential for day hospitals across the range of acute specialties. Day treatment has proved popular with patients and is acknowledged to be as effective as inpatient care provided that suitable patients are selected. It has the added attraction of being cheaper than inpatient care since hotel costs (catering, nursing etc) are saved, with little if any additional burden on community health services.

8.2 Against these clear advantages need to be weighed possible unintended effects of rapid expansion in day hospital facilities:

- there may be no complementary reduction in inpatient provision, thus increasing total hospital costs;
- former outpatients may now be treated in the day hospital, leading to increased case costs;
- new day hospital facilities may be insufficiently utilised, through lack of clinician commitment and poor scheduling of cases.

All these possible problems point to the need for careful planning and management of day hospital facilities. A day hospital, although often only the size of an inpatient ward, may cover a wide range of specialties: close cooperation betwen clinicians and administrators will be essential. Clinicians themselves will need to show a strong prior commitment to the establishment of day hospitals, and have a clear idea of the conditions to be treated and the procedures to be carried out there.

8.3 This report includes details of the model that we have built to determine the optimal size and location of day hospital facilities. The model is menu-driven and can include a range of assumptions about the type of demand that is to be satisfied (eg individual specialties only, in line with clinician interest), or various supply constraints (budget, bed maxima to prevent local over-provision, thresholds to ensure the economic size of new facilities). Our early runs of the model for Piemonte suggest that:

- any initial growth in day hospitals should be concentrated on Torino, if patient accessibility is to be maximized;
- thereafter provision could steadily spread to other major towns in Piemonte;

- residents of certain fringe areas of the region will not be major users of day hospitals, at any economic level of provision.

All these analyses have been based on the assumption that day hospital provision will be located in or adjacent to existing inpatient facilities, in order that support services (X-ray, anaesthetists, ambulances etc) can be readily utilised.

8.4 In quantitative terms, the analyses for Piemonte indicate that day hospital provision could increase by as much as 130,000 cases which, given good management, could be throughput by 650 beds. The potential case capacity that could be cost-effectively absorbed in Torino itself is about 30,000, subject of course to the levels of provision, existing or planned, in other towns.

8.5 The estimates of <u>potential</u> demand which provide the inputs to the location model have been derived by analysis of length of stay distributions in Piemonte. We consider that the wide differences that have been demonstrated in the <u>shape</u> of these distributions could usefully be discussed with the specialists concerned, both to highlight further the question of day hospital potential and to develop a greater understanding of the casemix in each specialty. Such understanding is an essential prerequisite to the establishment of relevant diagnostic-related groups (DRGs) - which could be used to develop refined estimates of day hospital potential.

<u>Next Steps</u>

8.6 There are a number of possible directions in which this work could now progress. On the analytical side:

A. We could consider the implication of the <u>interactions</u> between day hospital provision and existing inpatient and outpatient services. In the work so far we have tended to assume that inpatient numbers will be reduced and outpatient levels unaffected by new day hospital provision. However, in the context of the overcrowding that afflicts many hospitals in Torino and, conversely, the under-utilisation of the hospitals in other towns, the consequences for patient flows could be far more complex. There is a case for developing a "congestion-sensitive" model of throughput, encompassing resource trade-offs and accessibility factors.

B. The work on diagnostic-related groups described in section 4 could be applied to Piemonte data to refine our estimates of potential demand.

Both the above studies would require substantial analytic development. We consider however that substantial practical progress could be made with the tools already to hand. We would in particular point out that, since the growth of day hospitals will inevitably take several years to reach the potential levels that we have identified, more detailed estimates of demand may not be immediately required for every specialty.

8.7 There are two immediate applications in Piemonte for our modelling approach:

C. The use of the model in Piemonte to agree planning targets for day hospital provision with administrators and doctors. This would require discussion of the estimates of potential demand with clinicians, and further refinement of the model scenarios on the basis of administrative and clinical objectives and constraints. Such work could exploit the interactive, menu-driven construction of the computer model. It may prove desirable to carry out specialty specific analyses of demand and location (remembering that threshold constraints of the type that we have introduced will not apply to individual specialties).

D. The planning targets thus established could lead naturally to an implementation planning study in which specific plans for day hospitals on named sites could be developed. The regional administration and the clinicians intending to use the facilities (whose interest may have been aroused by study C!) will need to be closely involved. The model could be used to ensure that the size and location of the facilities planned were appropriate to the demand that could be generated.

Both studies C and D would be enhanced by further analytical work such as that of studies A and B, and there is no reason why the practical and theoretical should not proceed in tandem.

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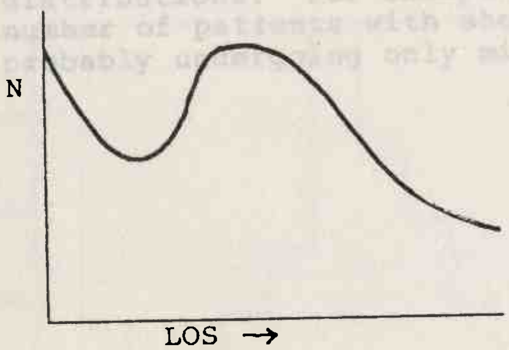
SPECIALTY SPECIFIC LENGTH OF STAY DISTRIBUTIONS IN PIEMONTE (1980)

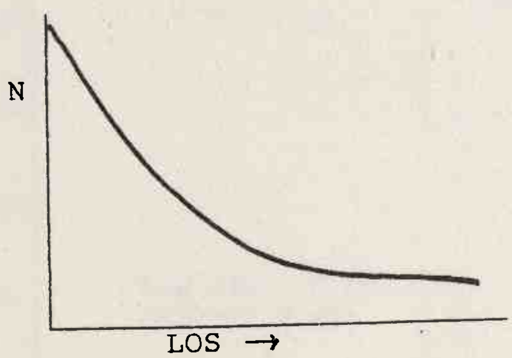
Length of stay distributions were examined for Piemonte in each of the 23 acute specialty categories, as defined by IRES. The data are shown of the following histograms. Note that:

- data are only shown up to lengths of stay of 24 days, since we are particularly interested in the very short stays;
- the total number of cases and the percentage staying less than 24 days are also given;
- to make the shapes of the distributions comparable the y-axis scale varies between specialties;
- in many specialties (eg Trauma & Orthopaedics, IRES no. 6), slight discontinuities occur at 7, 14 and 21 days: this reflects a slight tendency amongst clinicians to admit and discharge patients on the same day of the week.

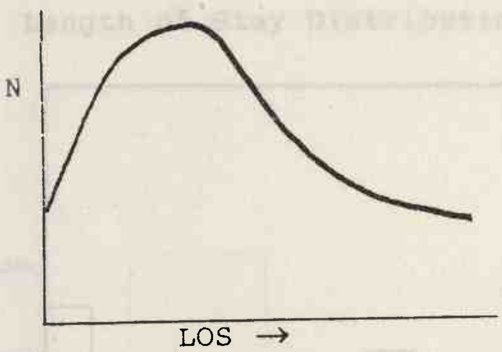
The distributions fall into four main types:



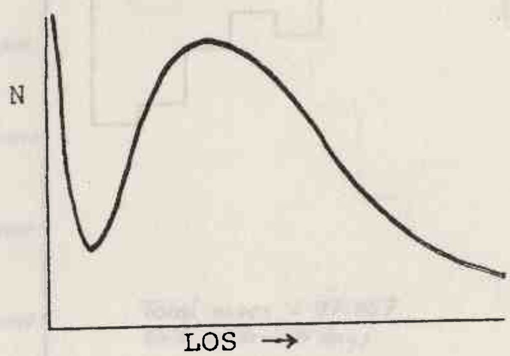
(1) bimodal, with a local minimum at 3 to 4 days (eg specialty nos. 2, 3, 26, 27)



(2) unimodal, with monotonic decline (eg specialty nos. 6, 14) : some unimodal distributions have a very high number of one day stays (eg specialty nos. 4, 13)

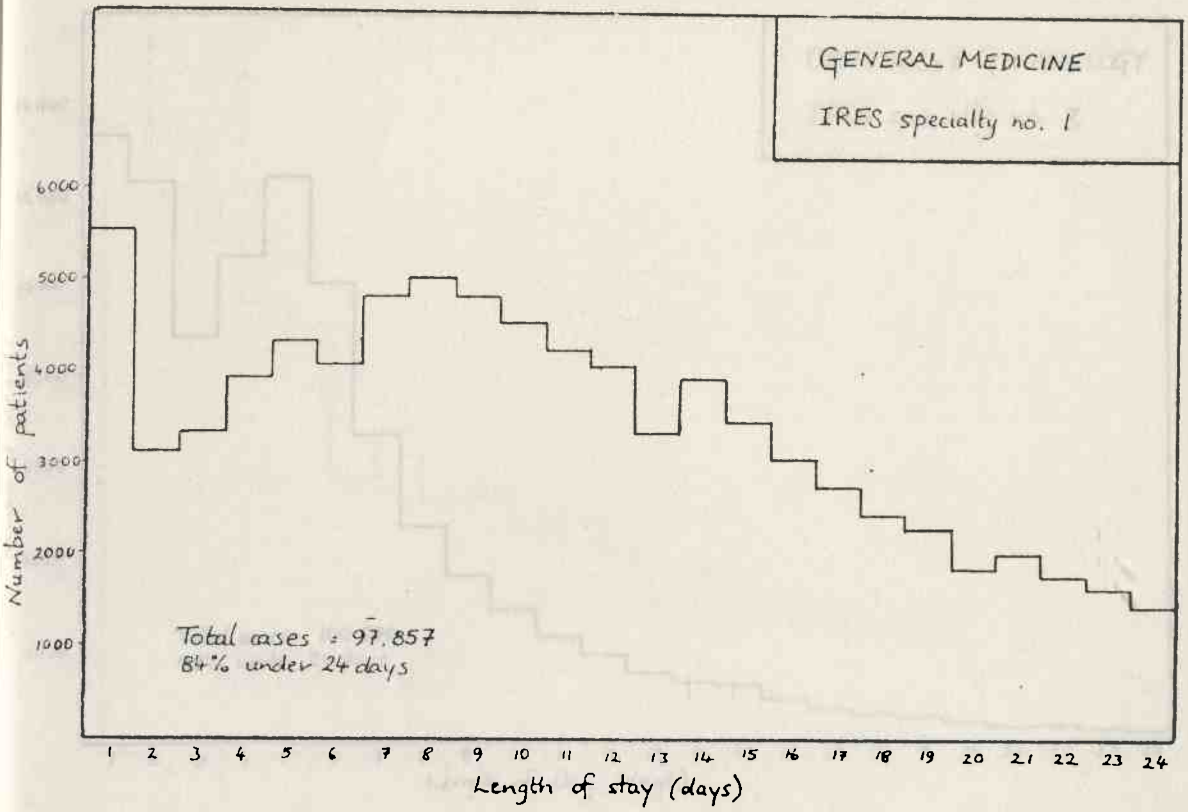


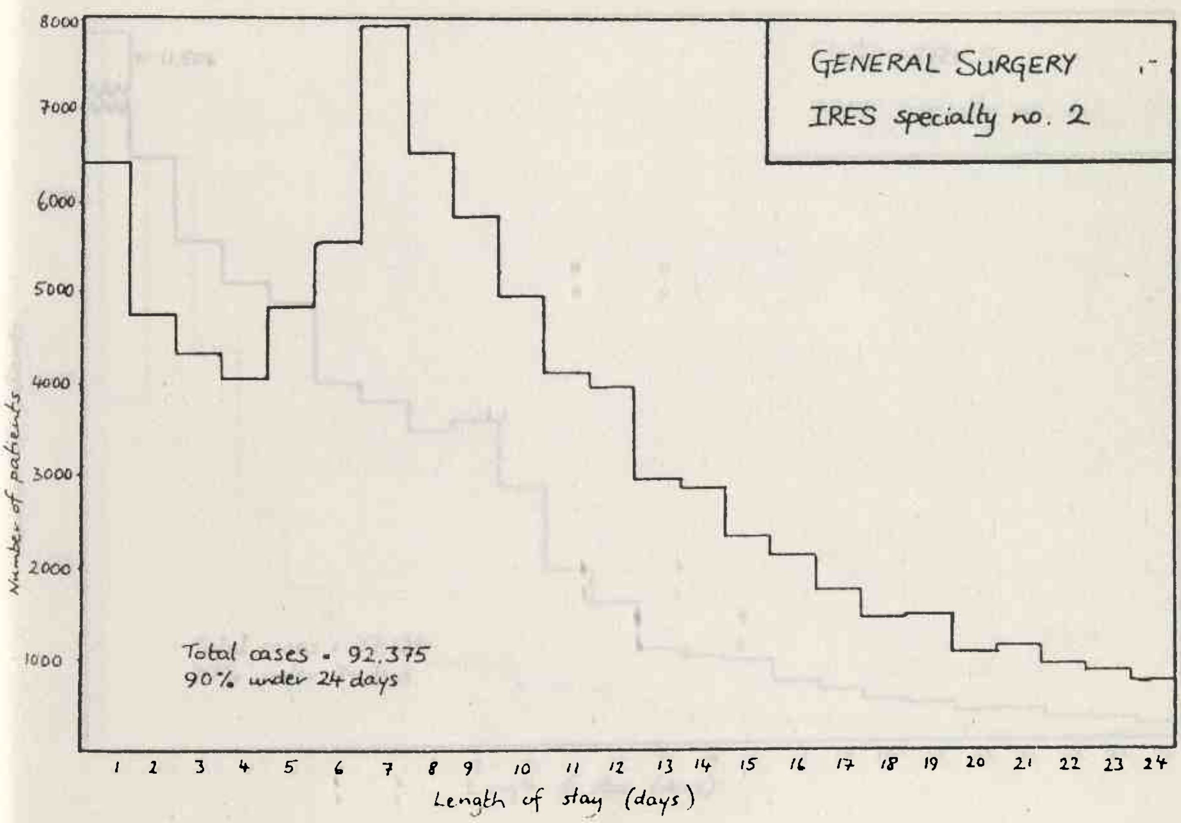
(3) unimodal, with a maximum value greater than one day (eg specialty nos. 7, 10, 11)

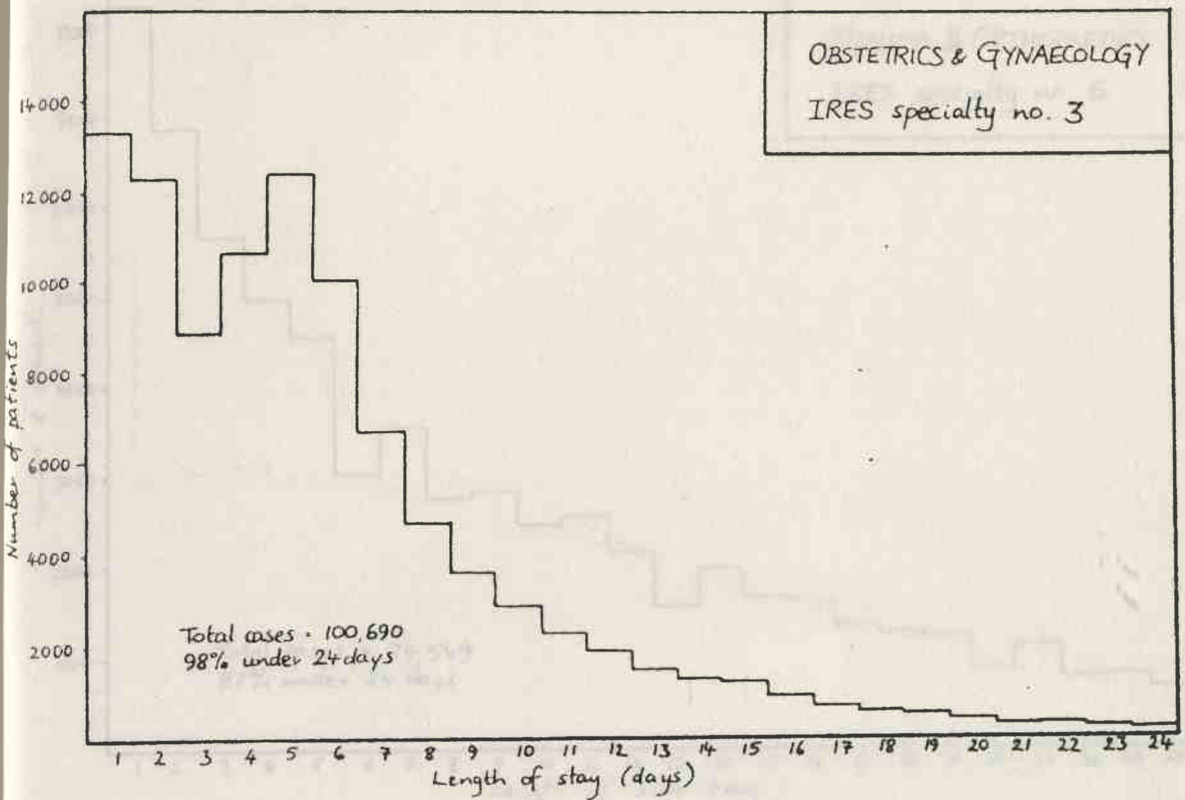


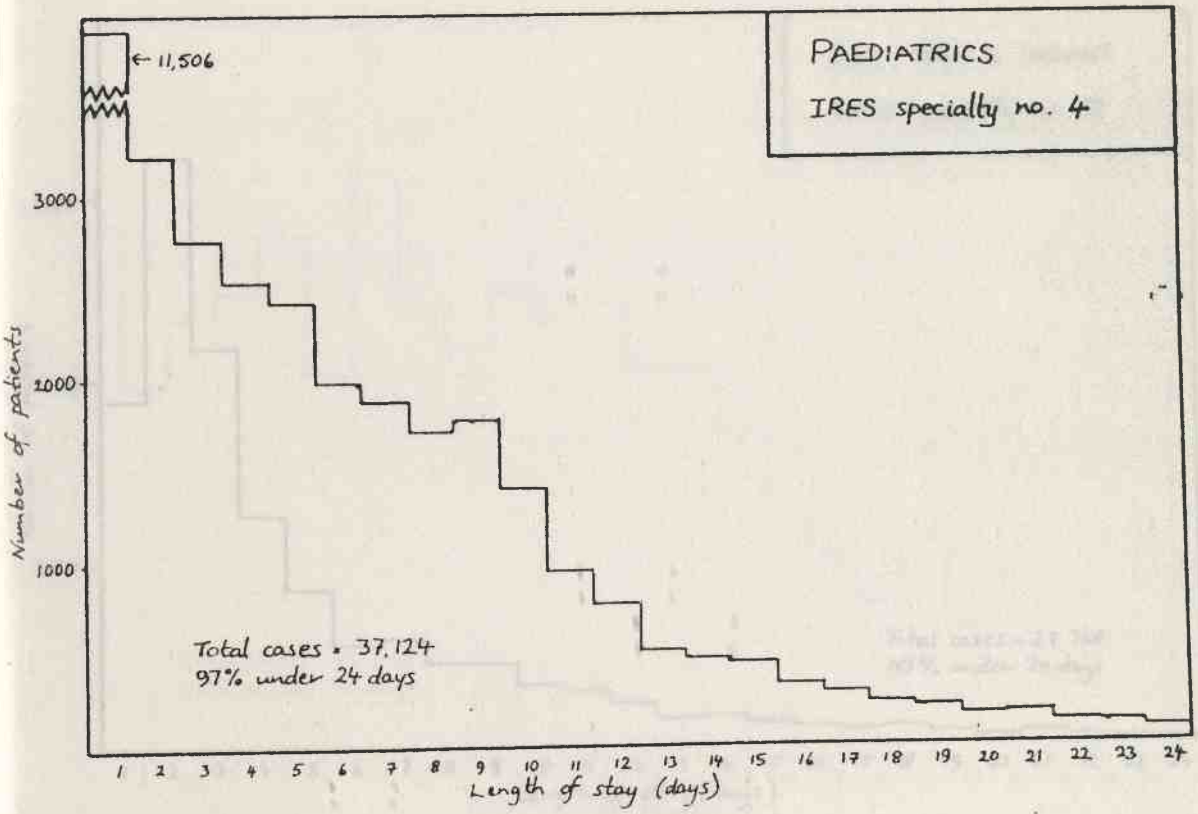
(4) Distributions as in (3), but with a high number of cases with stays of one day (eg specialty nos. 1, 9, 15).

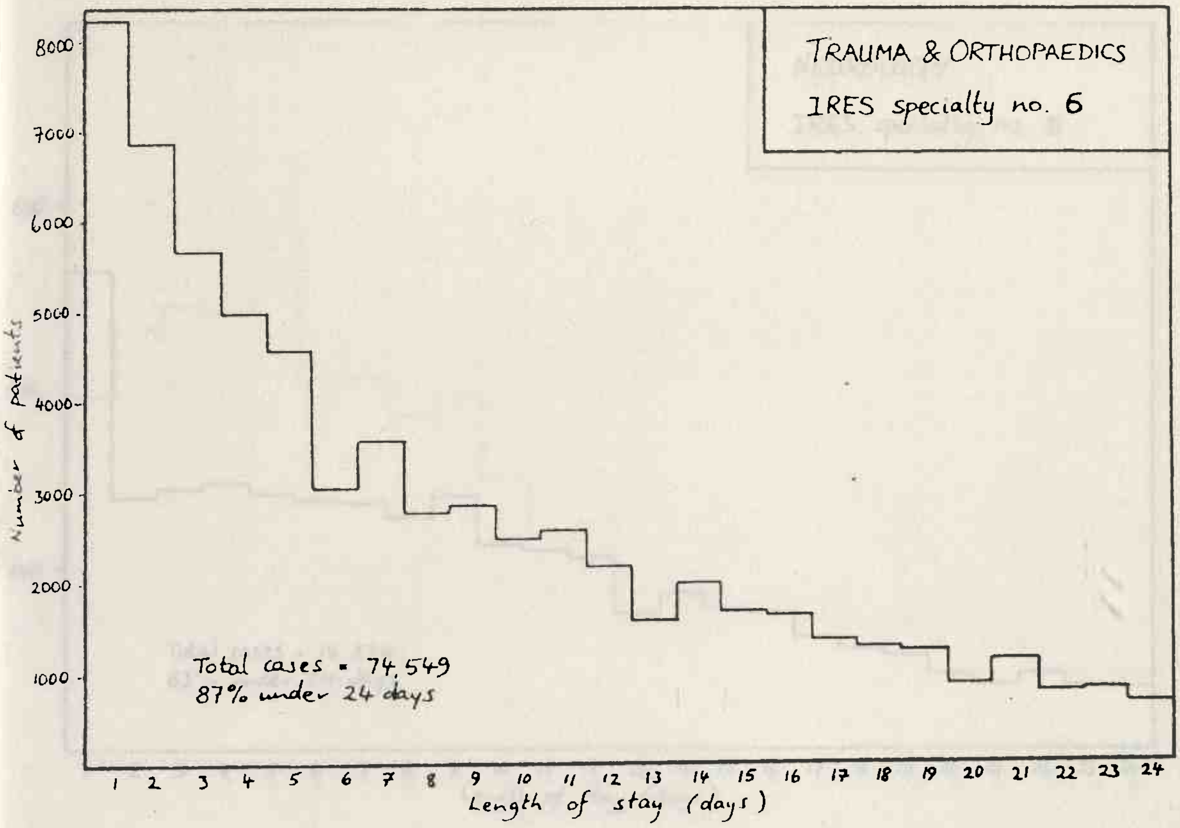
We expect that clinicians in the specialties concerned would be able to indicate the case mixes that have led to these distributions. For example, in general surgery, the high number of patients with short stays (under four days) are probably undergoing only minor procedures.

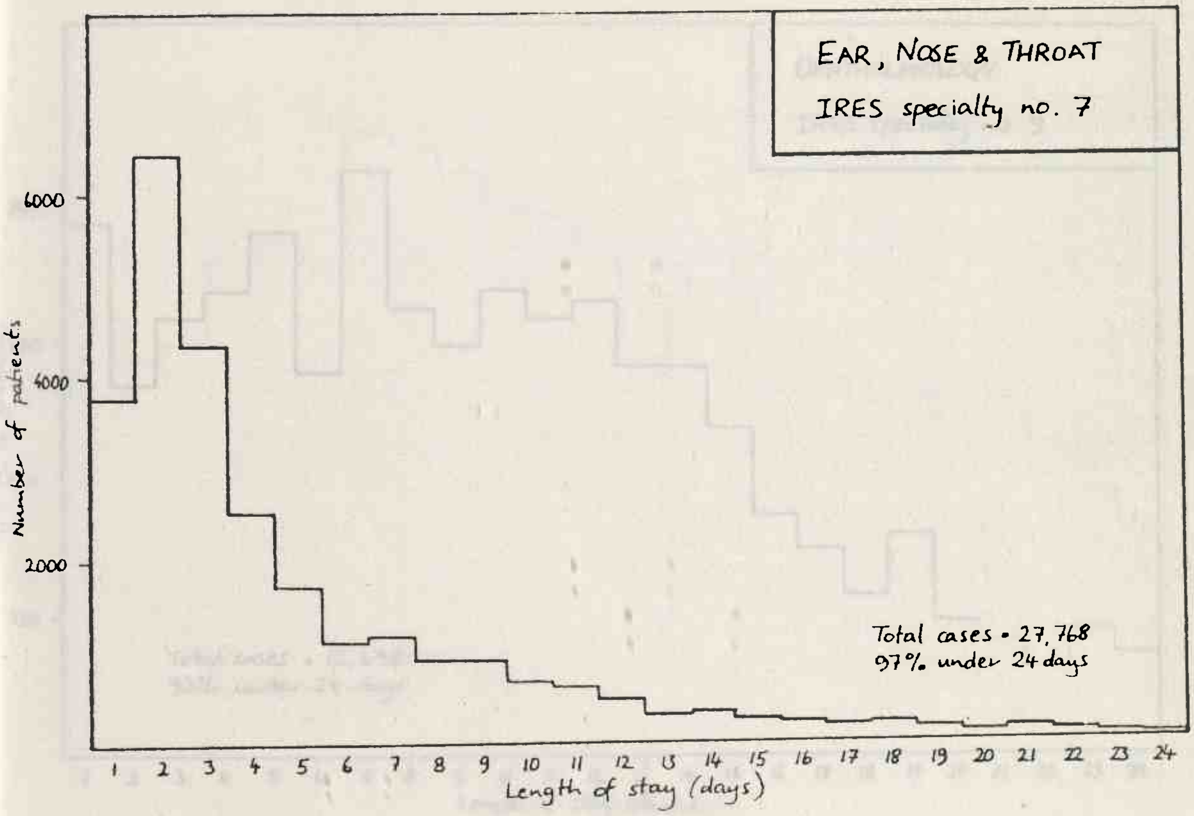

GENERAL MEDICINE
IRES specialty no. 1
Number of patients
6000
5000
4000
3000
2000
1000
Total cases : 97.857
84% under 24 days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)

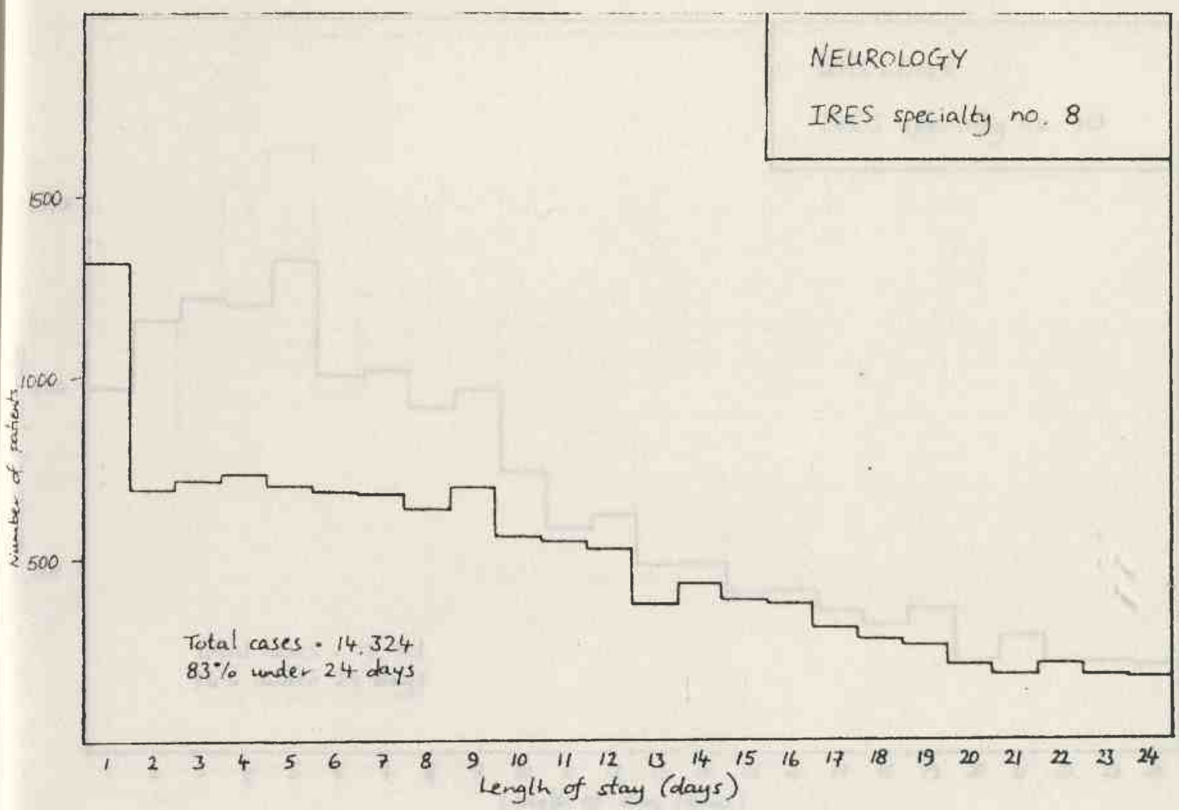

GENERAL SURGERY
IRES specialty no. 2
Number of patients
8000
7000
6000
5000
4000
3000
2000
1000
Total cases - 92.375
90% under 24 days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)

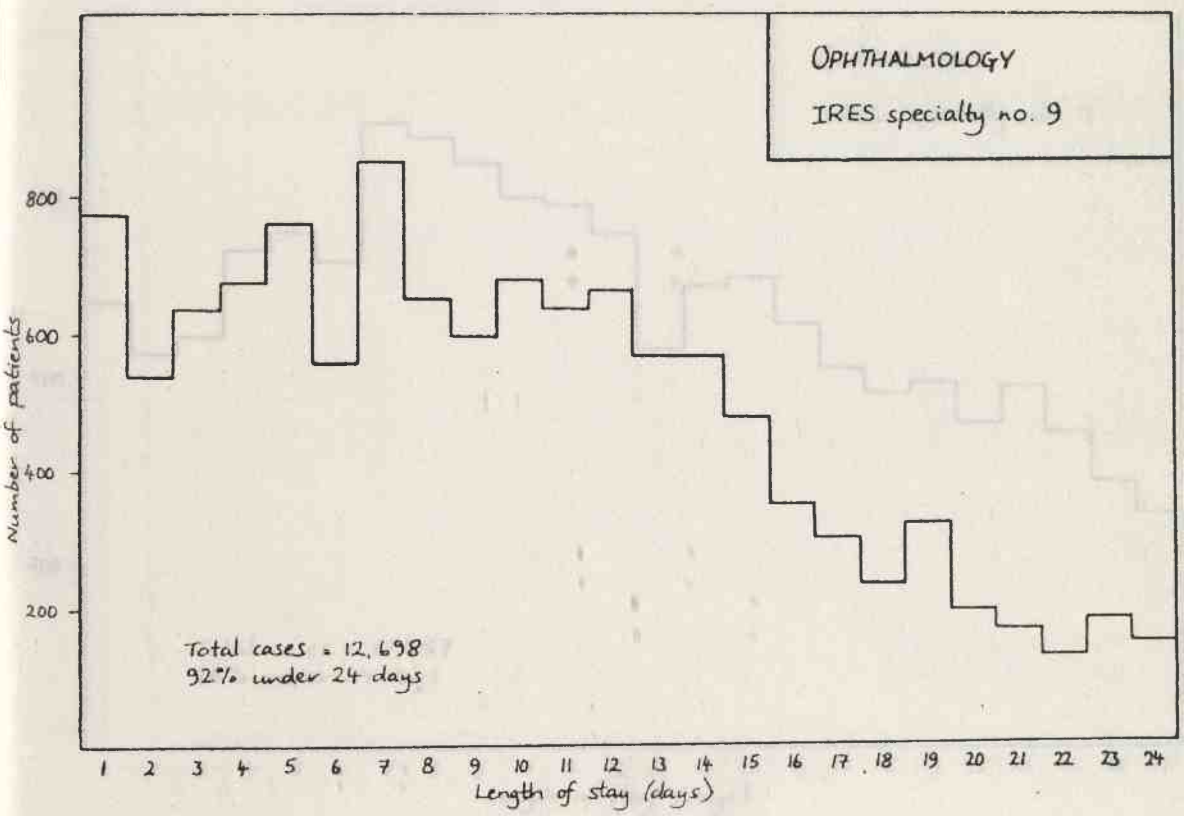

OBSTETRICS & GYNAECOLOGY
IRES specialty no. 3
Number of patients
14000
12000
10000
8000
6000
4000
2000
Total cases = 100,690
98% under 24 days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)

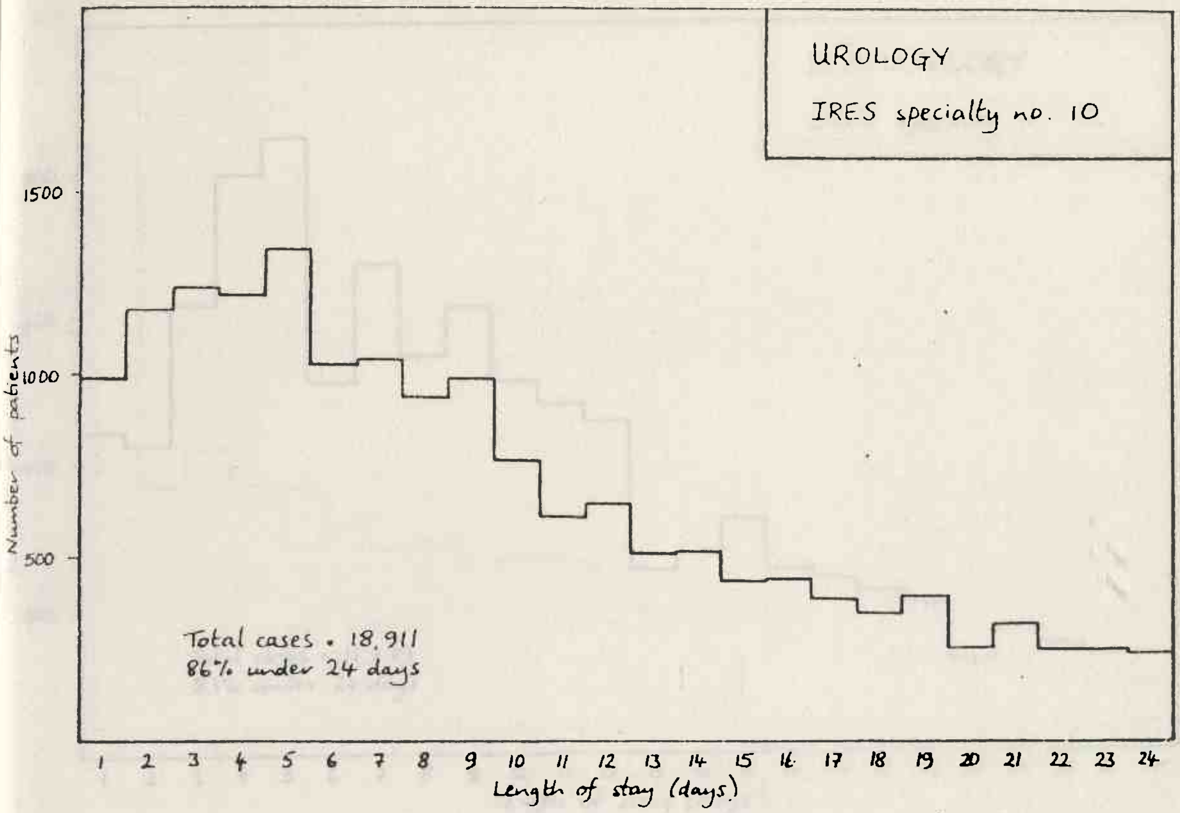

PAEDIATRICS
IRES specialty no. 4
← 11,506
Number of patients
3000
2000
1000
Total cases = 37,124
97% under 24 days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)

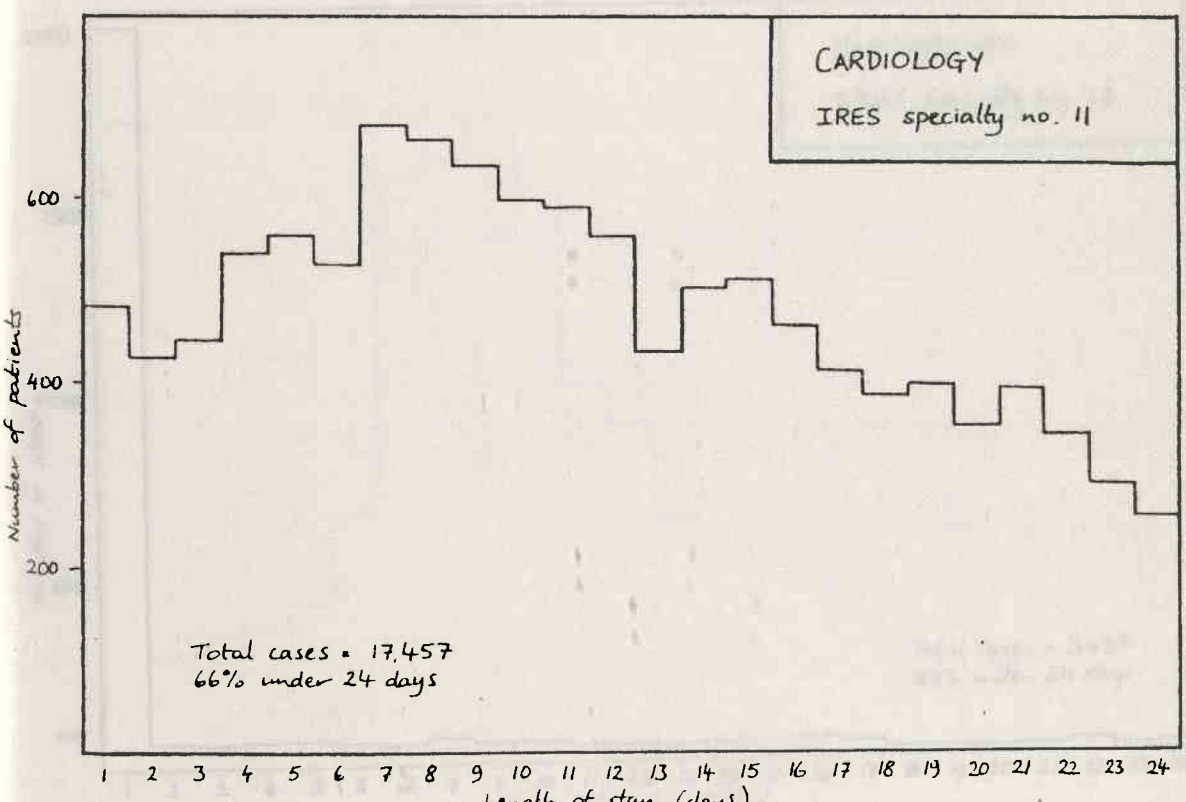

TRAUMA & ORTHOPAEDICS
IRES specialty no. 6
8000
7000
6000
5000
4000
3000
2000
1000
Number of patients
Total cases = 74,549
87% under 24 days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)

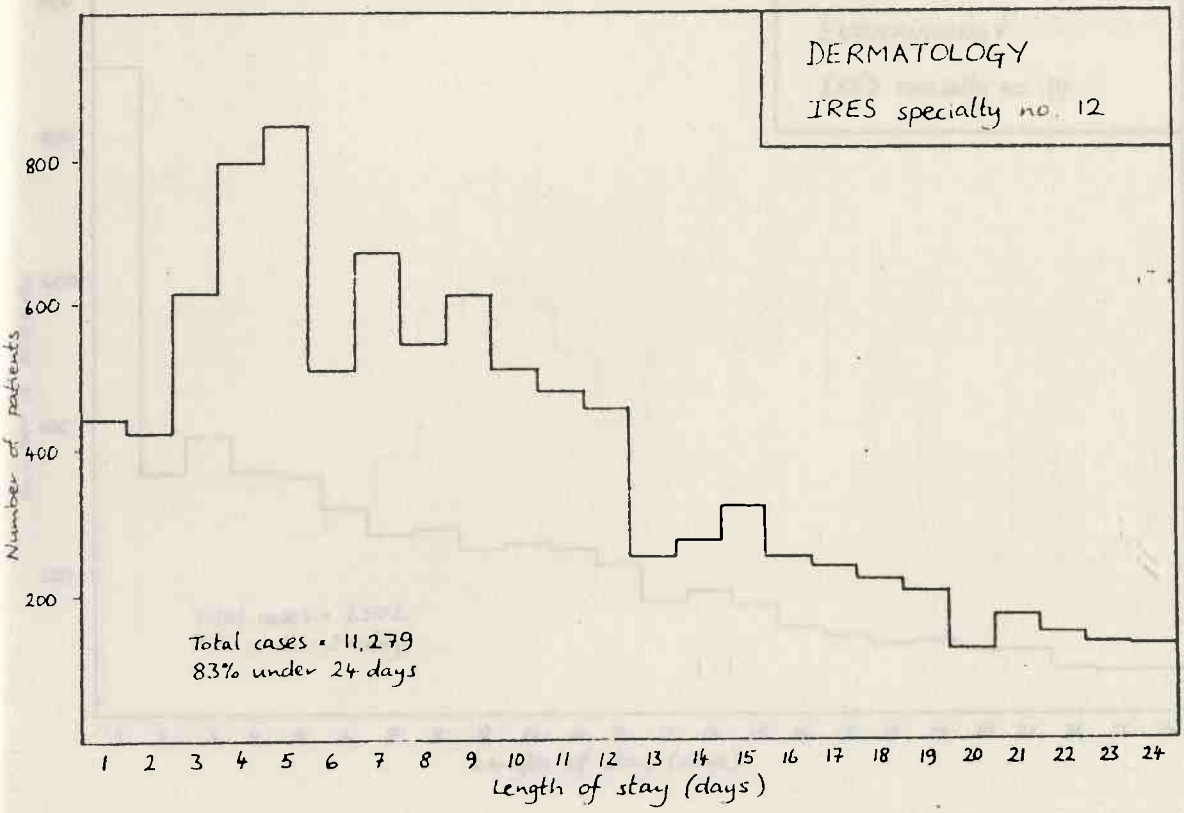

EAR, NOSE & THROAT
IRES specialty no. 7
6000
4000
2000
Number of patients
Total cases = 27,768
97% under 24 days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)

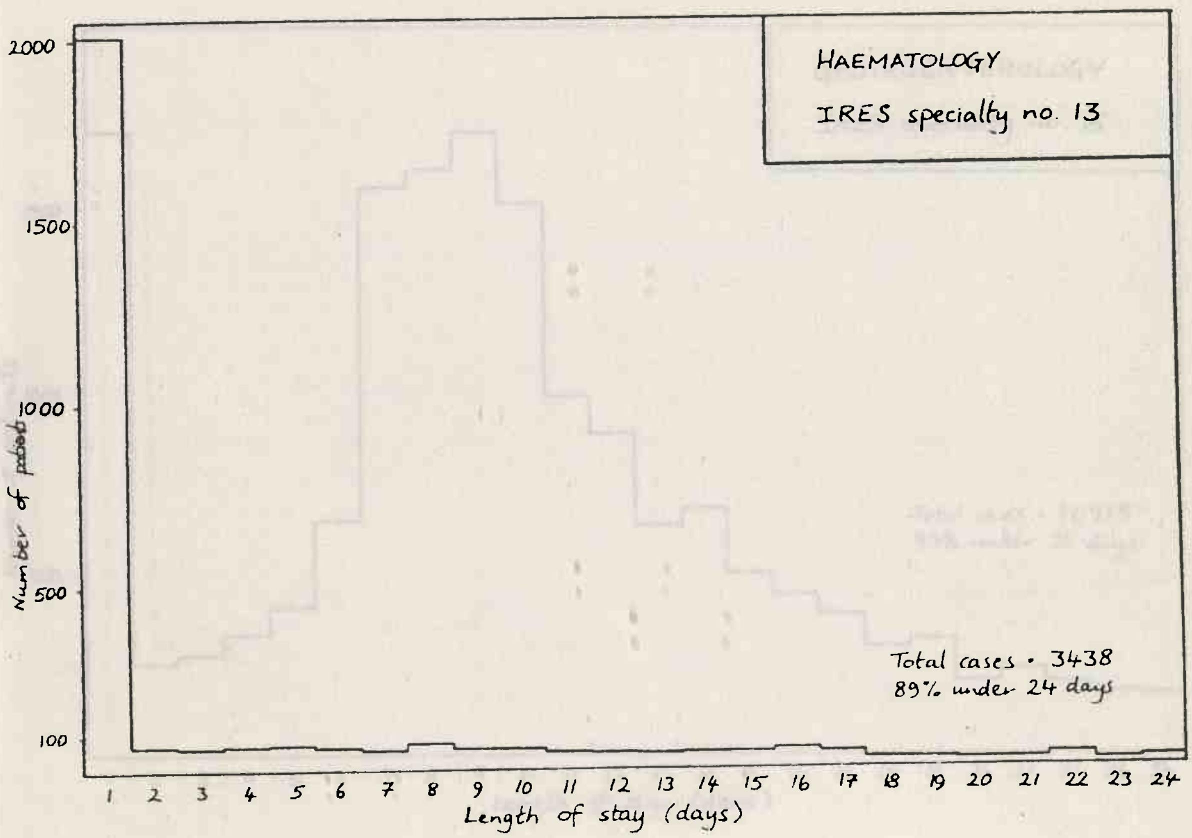

NEUROLOGY
IRES specialty no. 8
1500
1000
500
Number of patients
Total cases = 14,324
83% under 24 days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)

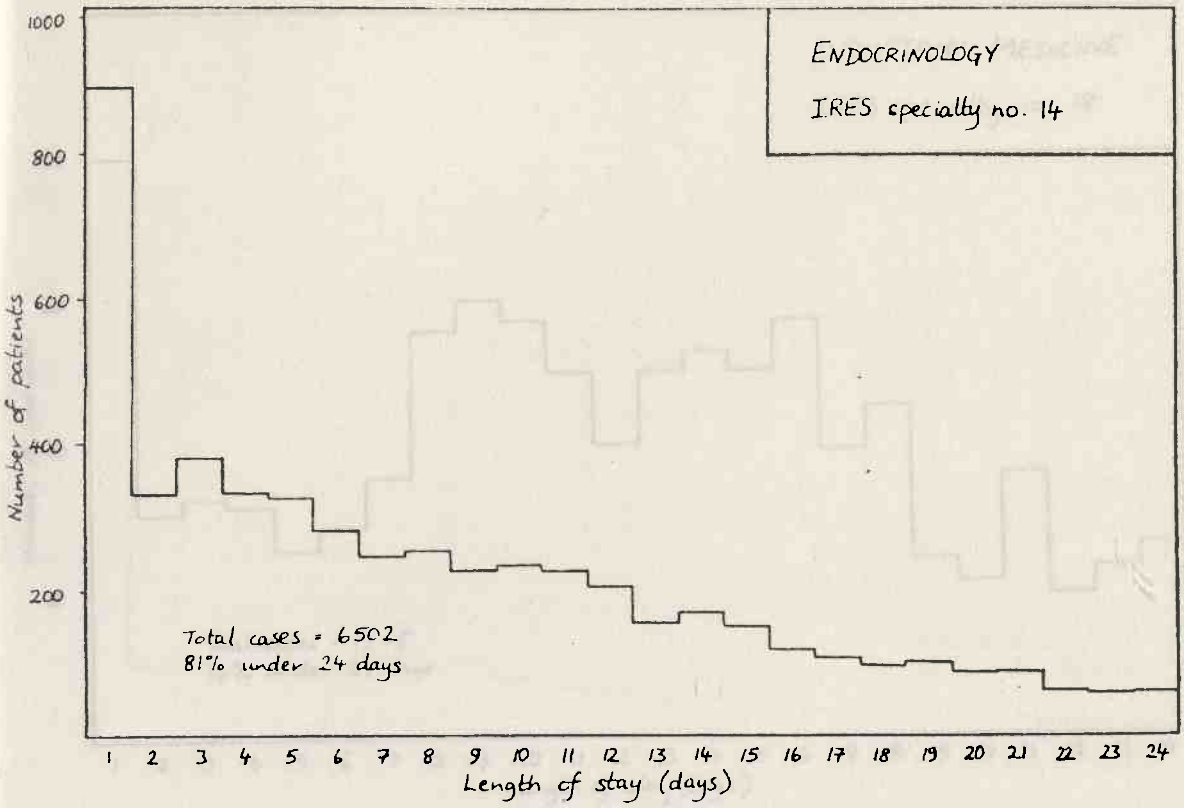

OPHTHALMOLOGY
IRES specialty no. 9
800
600
400
200
Number of patients
Total cases = 12,698
92% under 24 days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)

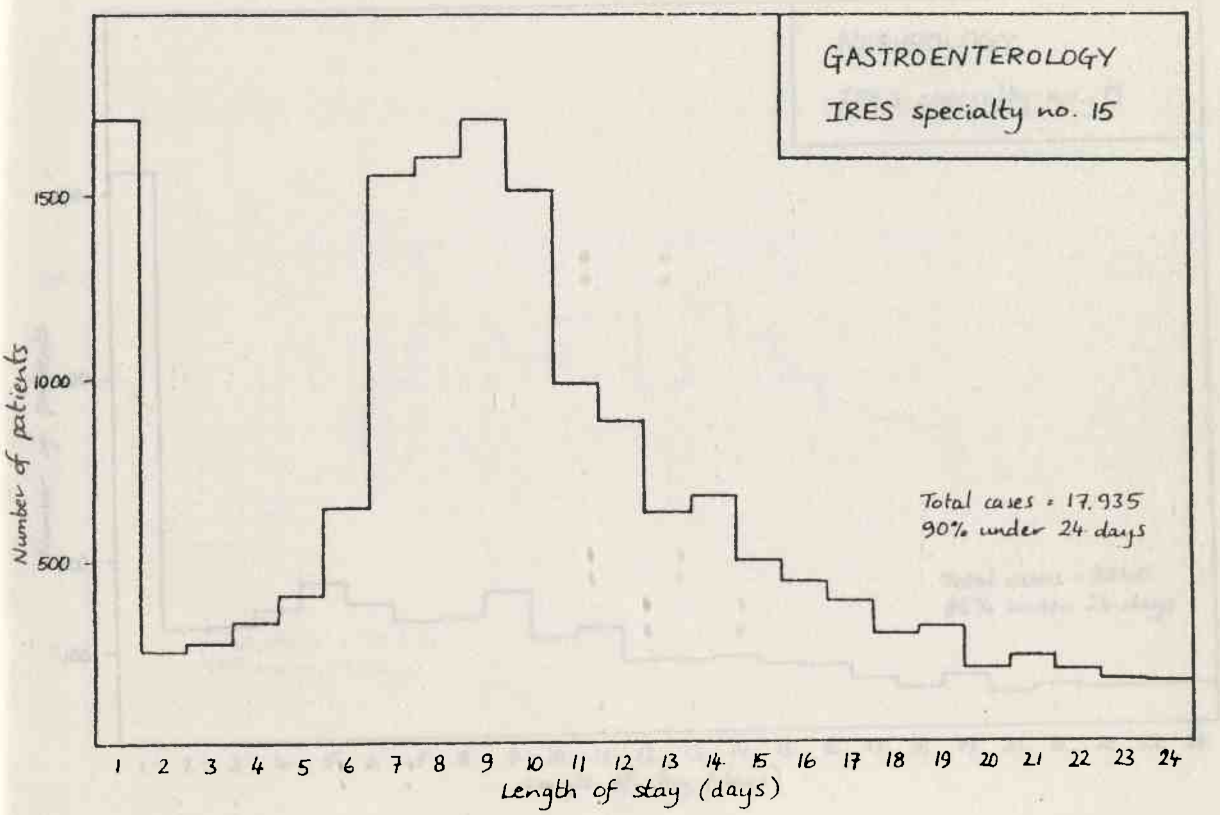

UROLOGY
IRES specialty no. 10
1500
1000
500
Number of patients
Total cases = 18,911
86% under 24 days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)

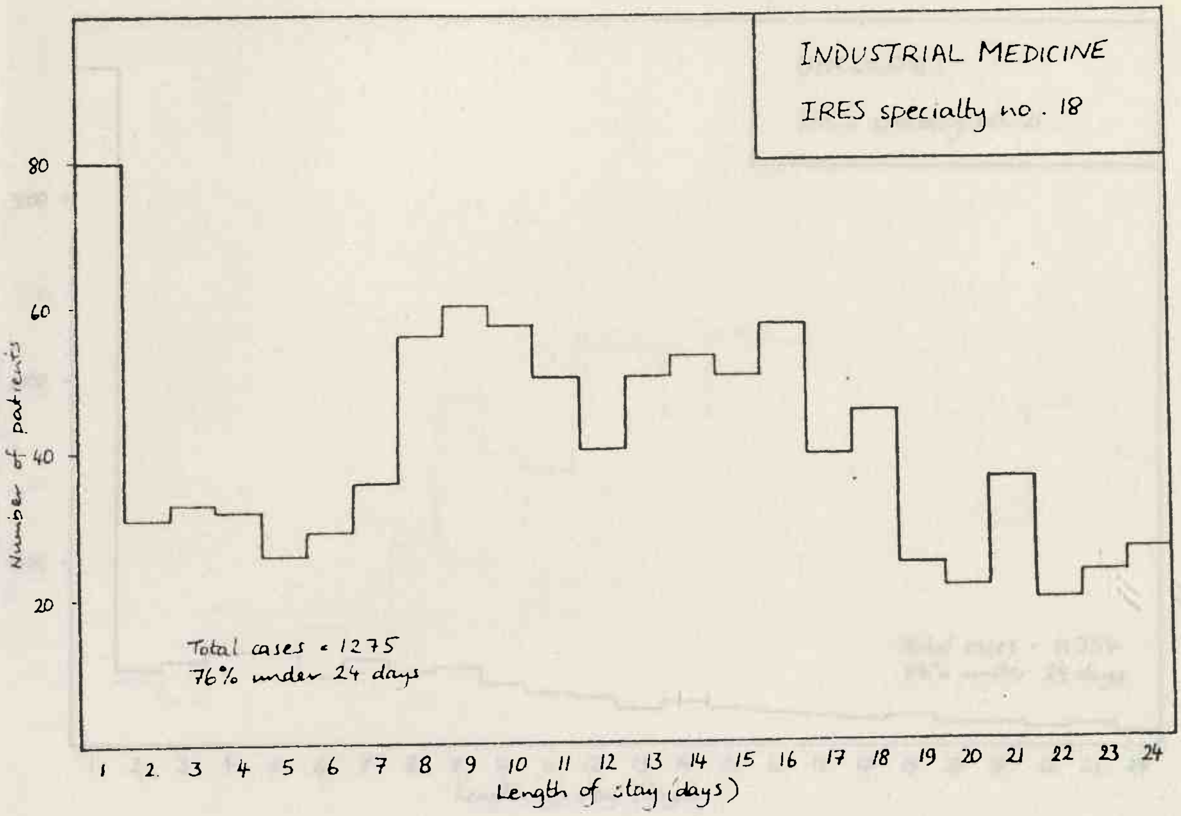

CARDIOLOGY
IRES specialty no. 11
600
400
200
Number of patients
Total cases = 17,457
66% under 24 days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)

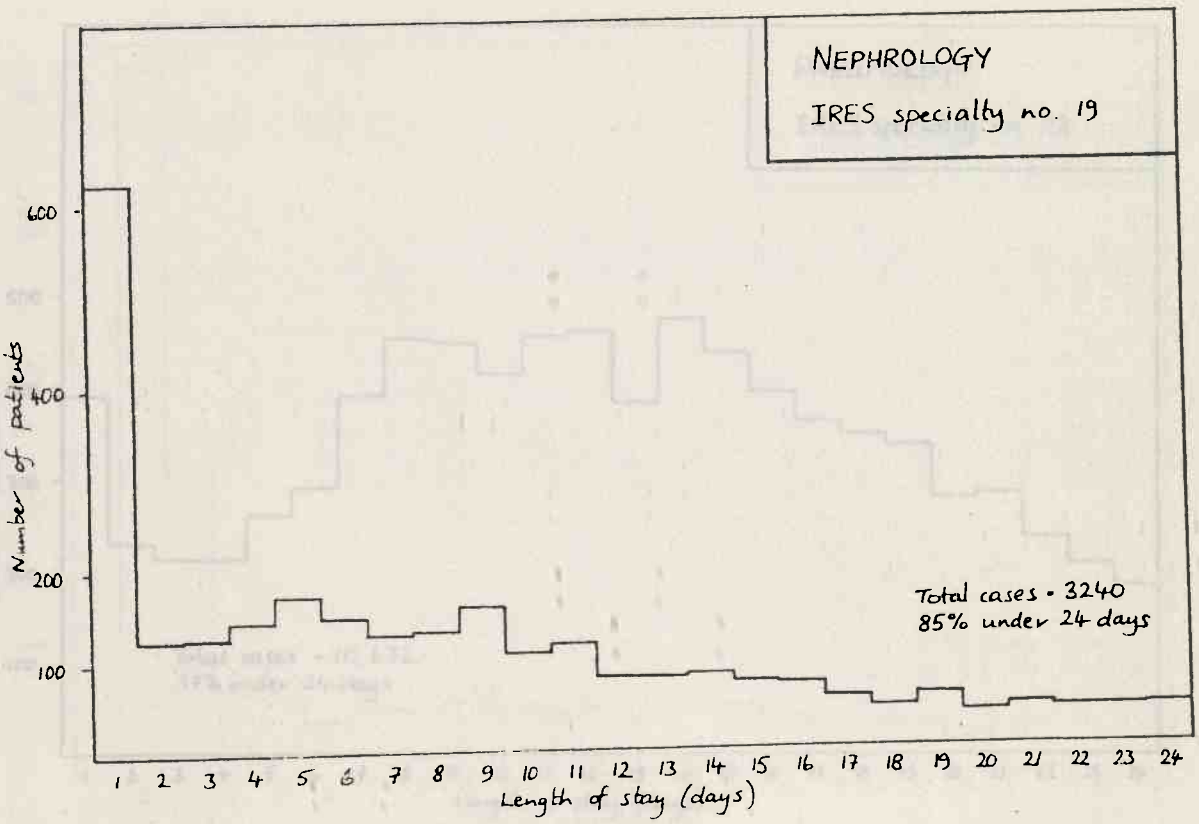

DERMATOLOGY
IRES specialty no. 12
Number of patients
800
600
400
200
Total cases = 11,279
83% under 24 days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)

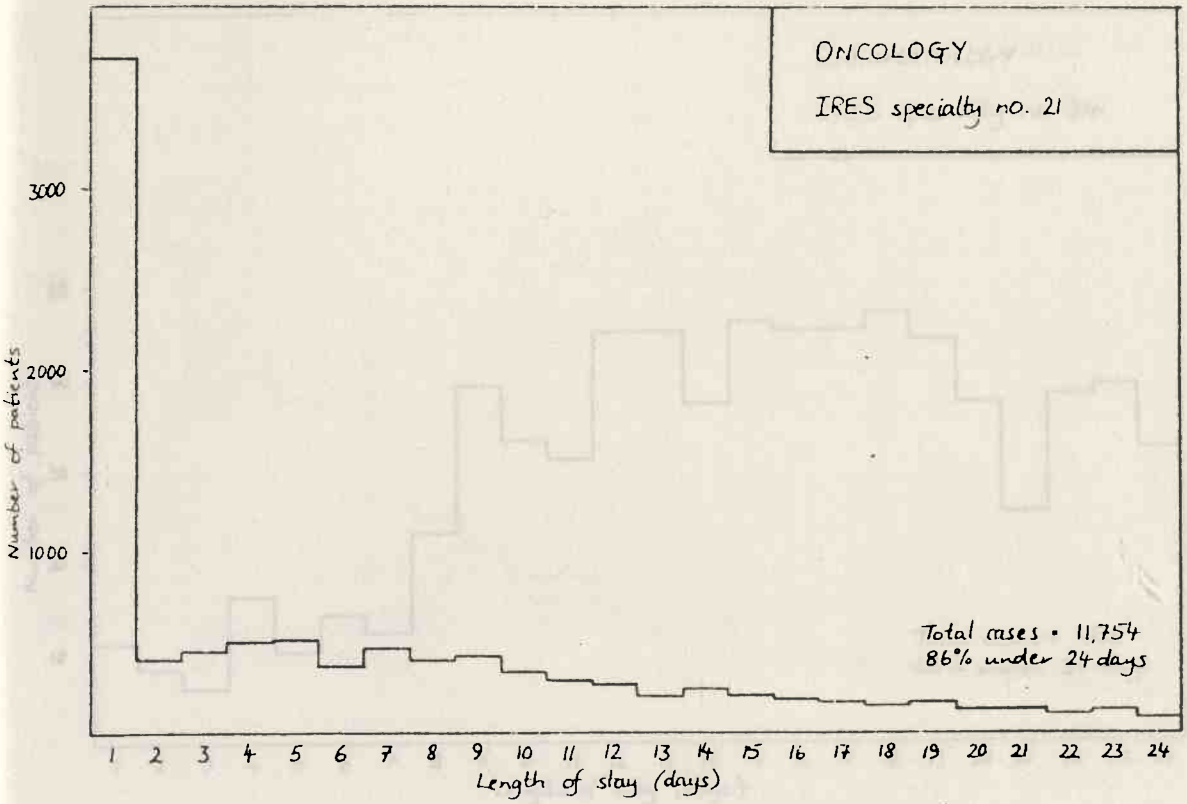

HAEMATOLOGY
IRES specialty no. 13
Number of patients
2000
1500
1000
500
100
Total cases = 3438
89% under 24 days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)

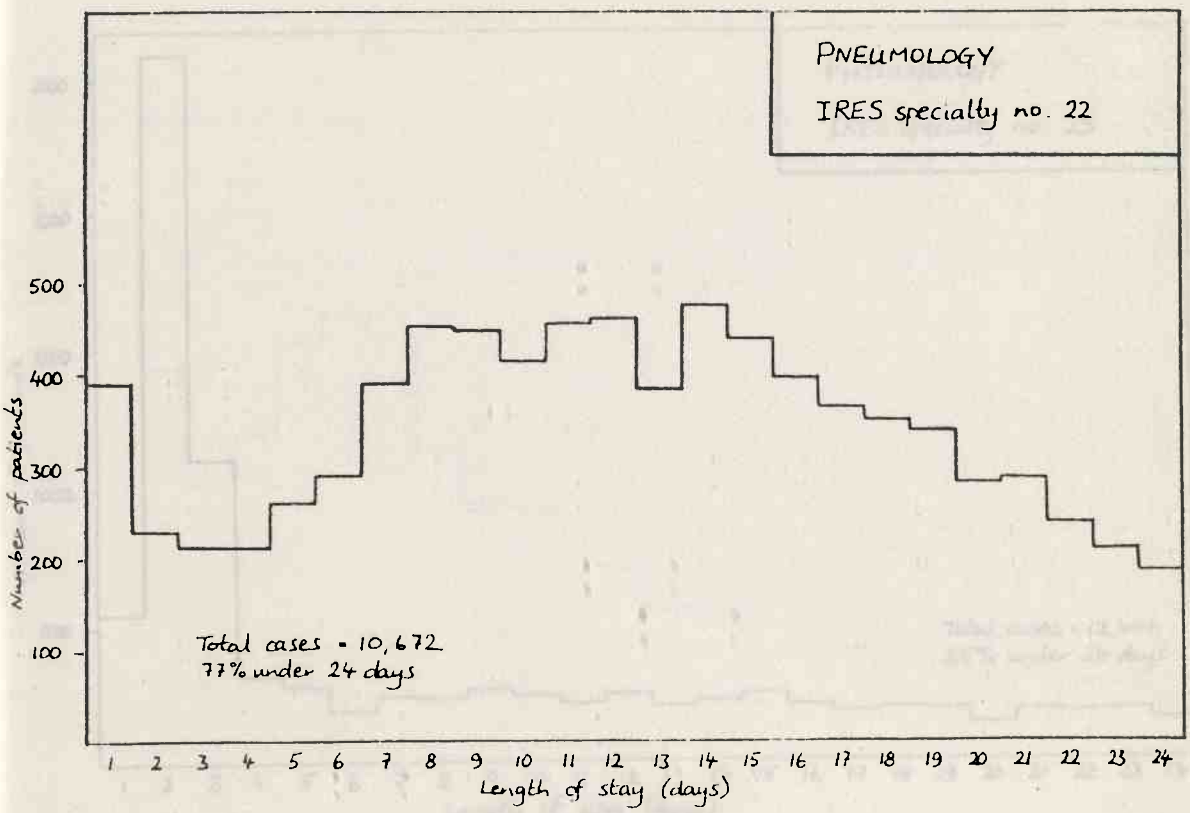

ENDOCRINOLOGY
IRES specialty no. 14
Total cases = 6502
81% under 24 days
Number of patients
1000
800
600
400
200
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)

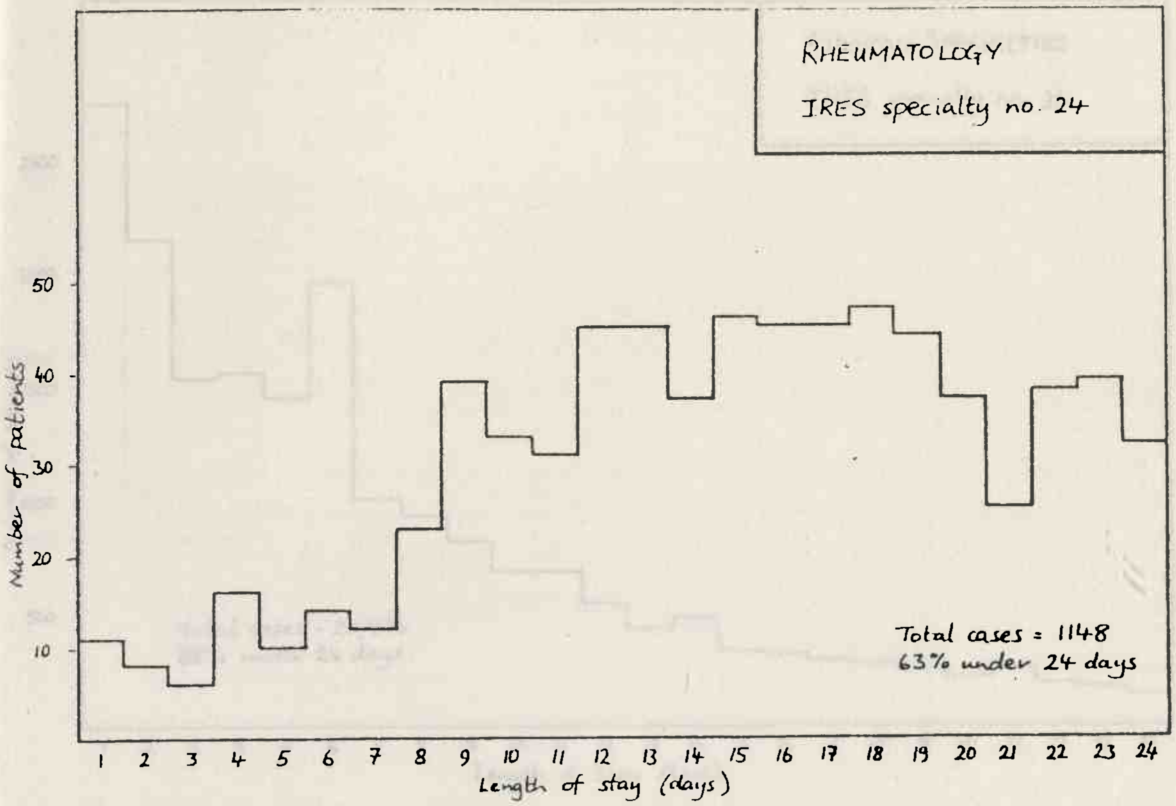

GASTROENTEROLOGY
IRES specialty no. 15
Total cases = 17.935
90% under 24 days
Number of patients
1500
1000
500
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)

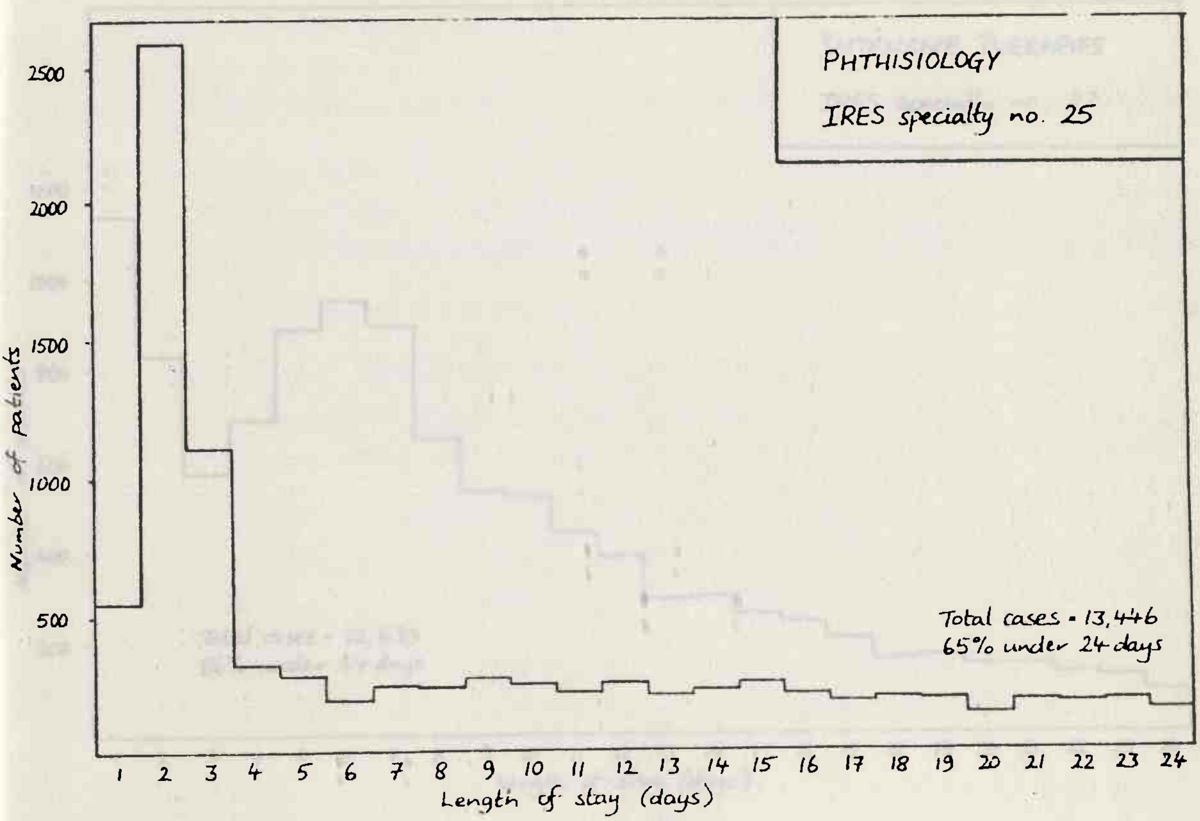

INDUSTRIAL MEDICINE
IRES specialty no. 18
80
60
40
20
Number of patients
Total cases = 1275
76% under 24 days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)

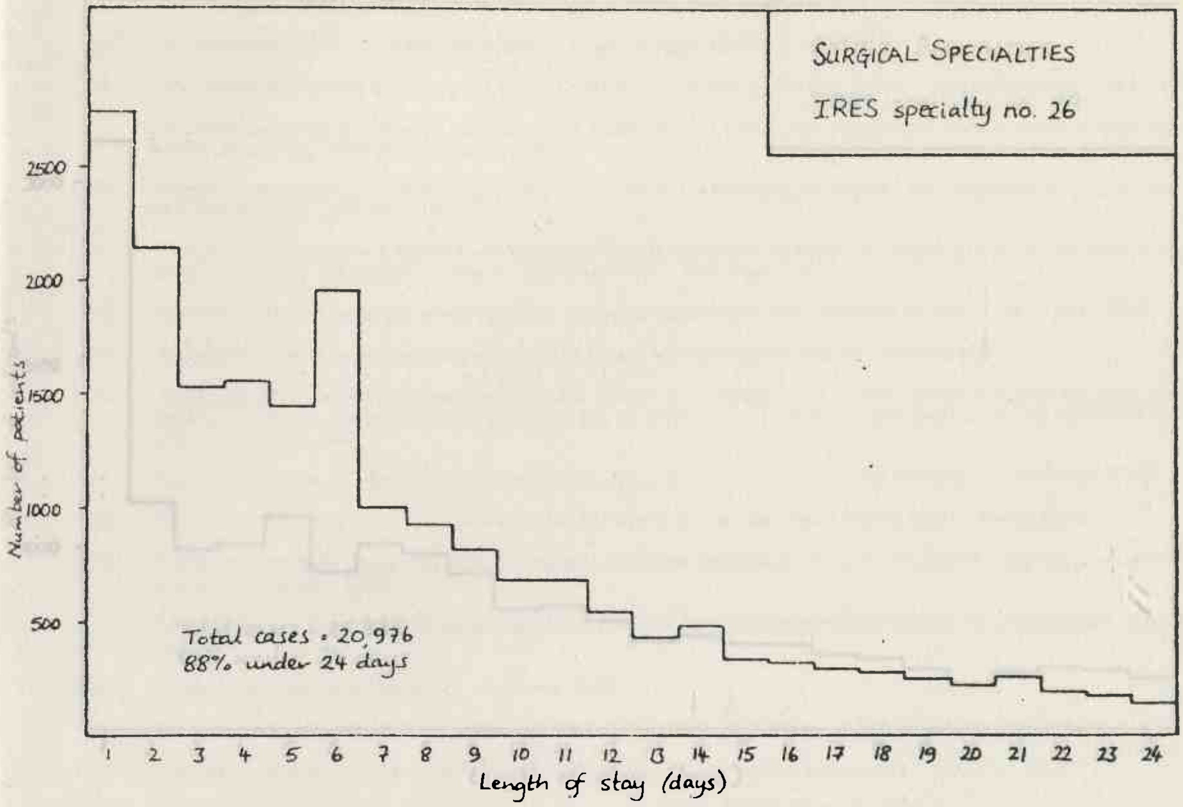

NEPHROLOGY
IRES specialty no. 19
600
400
200
100
Number of patients
Total cases = 3240
85% under 24 days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)

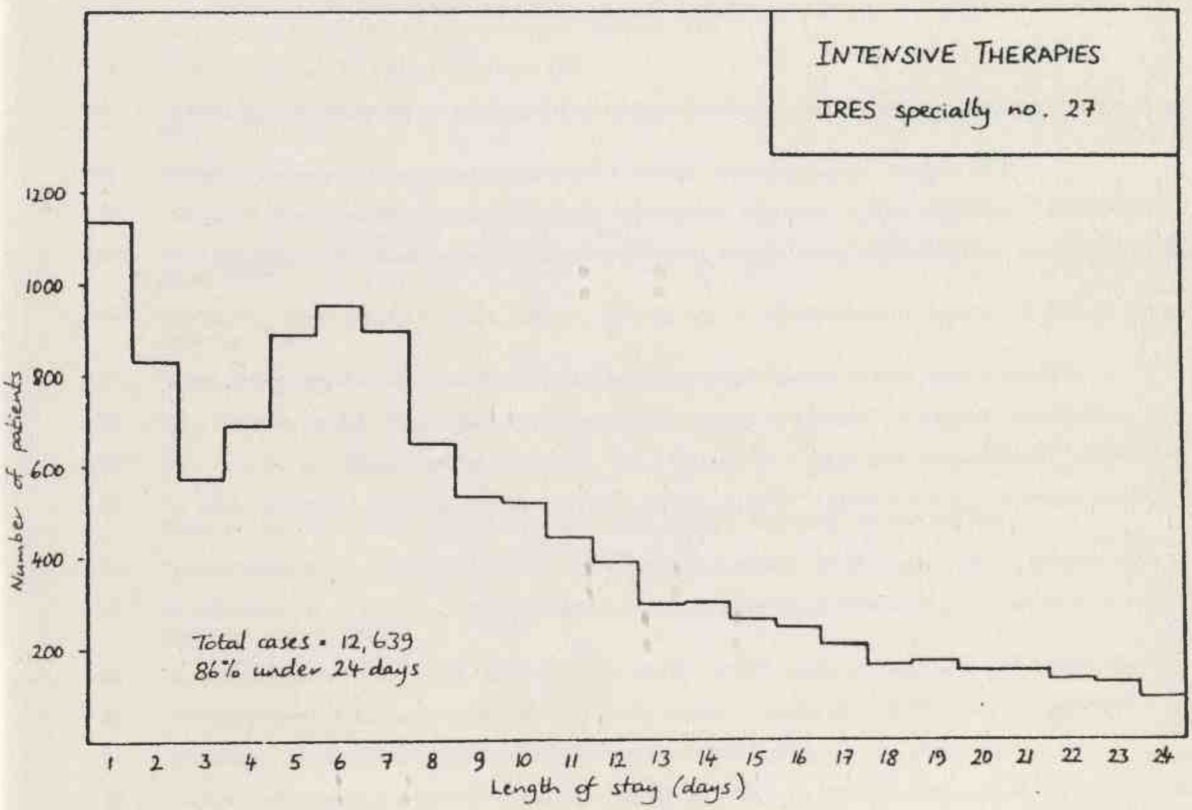

ONCOLOGY
IRES specialty no. 21
Total cases = 11,754
86% under 24 days
Number of patients
3000
2000
1000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)


PNEUMOLOGY
IRES specialty no. 22
Total cases = 10,672
77% under 24 days
Number of patients
500
400
300
200
100
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)

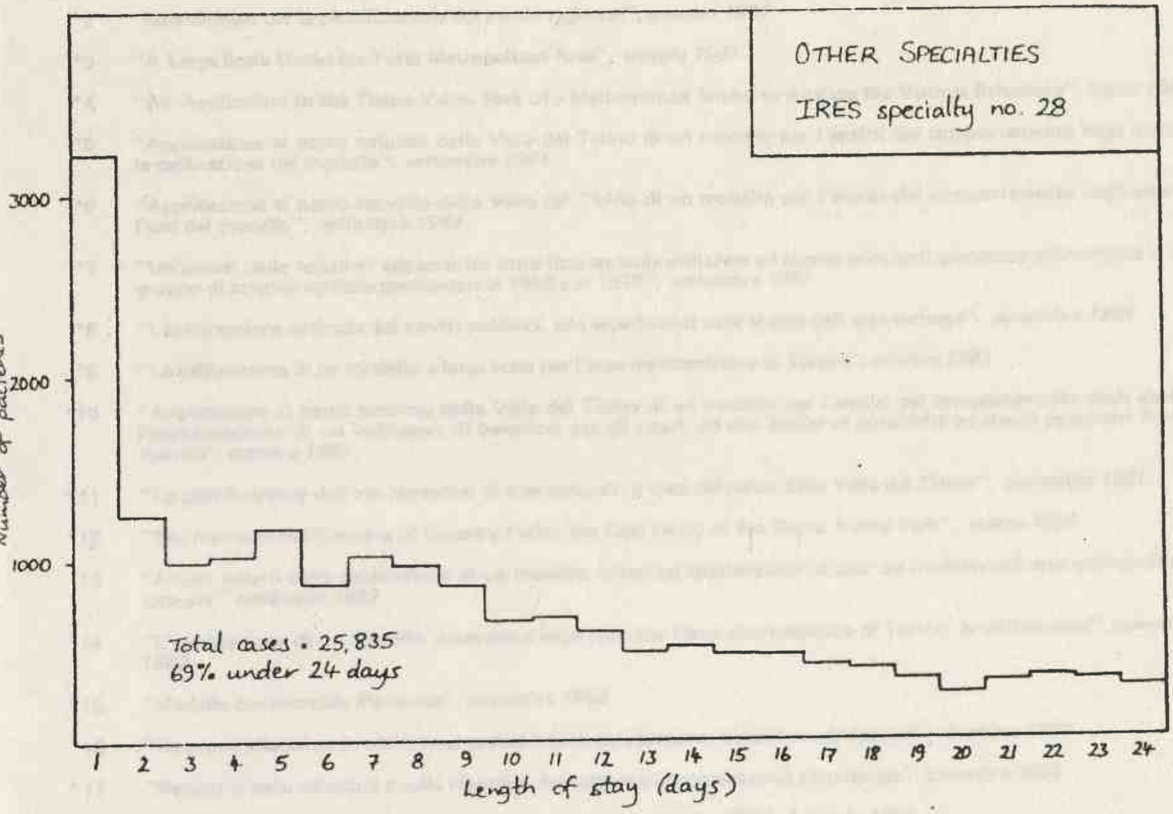

RHEUMATOLOGY
IRES specialty no. 24
Number of patients
10
20
30
40
50
Total cases = 1148
63% under 24 days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)


PHTHISIOLOGY
IRES specialty no. 25
Number of patients
500
1000
1500
2000
2500
Total cases = 13,446
65% under 24 days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)


SURGICAL SPECIALTIES
IRES specialty no. 26
Number of patients
2500
2000
1500
1000
500
Total cases = 20,976
88% under 24 days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)


INTENSIVE THERAPIES
IRES specialty no. 27
Number of patients
1200
1000
800
600
400
200
Total cases = 12,639
86% under 24 days
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Length of stay (days)

Length of Stay Distributions in Piemonte Appendix



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*1 "Un modello urbano a larga scala per l'area metropolitana di Torino", *gennaio 1981*

*2 Metodologie per la pianificazione dei parchi regionali", *gennaio 1981*

*3 "A Large Scale Model for Turin Metropolitan Area", *maggio 1981*

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* Esaurito

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