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Concentration and Choice in the Provision of Hospital Services

The Relationship Between Concentration, Patient Accessibility and Utilisation of Services

CRD REPORT 8 (Part III)

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Michael Place
York Health Economics Consortium
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Summary Report

I. *The Relationship Between Hospital Volume and Quality of Health Outcomes*

II. *The Relationship Between Volume and the Scope of Activity and Hospital Costs*

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1. BACKGROUND INFORMATION

Introduction

The relationship between **concentration, patient accessibility** and the **utilisation** of hospital services focuses attention on the interface between the user and the provider of those services.

Concentration means bringing together to one point previously dispersed hospital services. It is a process of change which implies offering health services at fewer sites and with more volume of activity per location.

Accessibility means having the right and the means to approach the hospital services with a view to utilising those services. It implies the availability of the service in question.

The act of making use of health care (utilisation) however is a measure of met demand and is not a direct measure of access. It does not indicate whether unnecessary use has been taking place or whether there is need that remains unmet.

This is an issue in health policy because there is pressure to further concentrate hospital services on grounds of presumed improved efficiency, improved outcomes and requirements for training.

Accessibility

The fundamental requirement for accessibility is for there to be an available service. However, " 'accessibility' is viewed as something additional to the mere presence or 'availability' of the resource in any given place at any given time. It comprises those characteristics of the resource that facilitate or obstruct use by potential clients." (Donabedian, 1973)

Frenk (1985) defines accessibility more fully as "the degree of adjustment between the characteristics of health care resources and those of the population within the process of seeking and obtaining care." He views accessibility as the functional relationship between the set of obstacles to seeking and obtaining care ("resistance") and the corresponding capabilities of the population to overcome such obstacles ("utilisation power").

Obstacles are classified as ecological, financial, organisational at the point of entry, and organisational within a health establishment. Table A shows resistance indicators and utilisation power indicators for each of these classifications

Table A: Indicators of obstacles and utilisation power

Obstacle Categories	Resistance Indicators	Utilisation Power Indicators
Ecological	Transportation time to provider	Travel resources
Financial	Price	Income
Organisational - at entry	Wait to get an appointment	"Tolerance" for delay in getting an appointment
Organisational - within an establishment	Wait to see physician	Free time

Source: Frenk (1985)

Donabedian (1973) also recognises that the use of health services will be affected by:

- "attractions" of the quality and reputation of the resource, its specialised nature, its uniqueness or scarcity, and its location.

- "propulsions" related to the perceived threat of illness in terms of urgency and severity.

Moon (1996) points out that a useful distinction can be made between physical accessibility (distance, separation) and social accessibility (is it open when you get there, are the opening hours convenient, is it accessible to minority language groups). Clearly the two interact; if two small facilities are replaced by one big central one, it may be that people face difficulties getting to something unfamiliar across a larger distance.

The concentration of hospital services may have a considerable impact on the distance between the patient and the service. Geographical concepts of spatial interaction help to provide an understanding of the effects that distance might be expected to have on patient accessibility to and subsequent utilisation of hospital services. Distance decay is the inverse relationship between the rates of utilisation of a facility and the distance from that facility. It was first reported by Jarvis in 1851. He noted that "the people in the vicinity of lunatic hospitals send more patients to them than those at a greater distance". (Joseph et al. 1984). The magnitude of decay has been observed to be influenced by diagnosis: the 'friction' of distance decreases with more serious diagnoses. (Welch et al. 1993).

This has been formalised in gravity models descended from Reilly's Law which uses Newton's gravitational principles. This states that "a city will attract retail trade from a town in its surrounding territory, in direct proportion to the population size of the city and in inverse proportion to the square of the distance from the city". (Reilly (1931) quoted in Foot (1981)). The inference is that a larger and more attractive hospital would be expected to attract patients from greater distances. Patients would be prepared to travel further for more serious conditions.

Central place theory was developed by Christaller (1960). As Mayhew (1986) explains, it partitions regions into a regular hexagonal hierarchy of market areas. Regularly demanded low order goods and services are obtained locally but for less frequently needed and more expensive higher order goods and services a special trip is necessary to the next or subsequent layers of the hierarchy. The concentration of services in specific locations inevitably imposes a penalty on some people in the form of reduced accessibility which influences the use of the services accordingly.

The key concept within central place theory is that of the "threshold" population required to support a service, so that some hospital specialties, for example, will necessarily involve concentration. Welch et al (1993) interpret central place theory as identifying the tendency for higher-order hospital services to be located in major population centres and to attract patients from a large geographic range.

Distance can also be considered in economic terms. If demand falls as price rises, then demand or utilisation will be influenced by travel cost. As the number of facilities decreases with concentration then travel costs will rise and demand will fall. The precise effect will depend on the elasticity of demand for the service in question.

These concepts lead us to expect two opposing effects to result from concentration: a barrier and cost created by an increase in the distance between the patient and the hospital service, offset by the increased attraction of a larger and more expert service.

This corresponds with the expectation by Donabedian (1973) that utilisation would decrease with distance and that unmet need would increase in parallel fashion. He goes on to say that "The diminution with distance would be more marked for preventive services as compared with curative services, for generalist care as compared to specialist care, for physician services as compared to hospital services, and for mild illness as compared with severe illness. The effect of urgency might be mixed and therefore difficult to predict."

These ideas also correspond with Andersen's model (Andersen, 1967), which Long (1981) describes as defining the utilisation of inpatient care as a function of socio- economic variables, economic variables, locational variables, and need.

Referral

In the health care system in the U.K. there is not, in general, open accessibility to hospital services (Accident and Emergency services being a notable exception). Most people enter the system through the general practitioner who acts as both gatekeeper to the referral services and as the patient's agent. The doctor as agent may be influenced by financial factors, connections with hospitals and consultants, the extent of his/her knowledge, his/her professional pride, or professional moral codes. Some of these influences on the doctor may change as a result of concentration. There is no automatic right of referral: the referral must be subject to the agreement and discretion of both the doctor and the patient (Boyle, 1994).

Assessing the Effect of Concentration and Accessibility

The concept of accessibility is complex involving issues of need, perceived need, availability and attractiveness of services, the actions of agents, distance, financial and other social and cultural factors. The measurement of accessibility and assessing the effect of concentration on accessibility are therefore complex.

Usually, because of ease of measurement, utilisation is used as a proxy for accessibility, with distance (transportation time to provider in Table A) as the key variable of interest. For example Aday et al (1974) suggest that utilisation provides the objective outcome measure which reflects accessibility. However, comparisons of utilisation cannot be used as reliable measures of differences in accessibility unless all the other factors influencing accessibility, (for example those in Table A), and the push for use are adjusted for (e.g. price, healthcare needs etc.). There is no comparable measure for any failure to gain access where it may have been demanded or desirable, although waiting times may offer a proxy indicator.

Review Questions

Against this background, the review aims to answer the following questions:

- To what extent does concentration of hospital services affect accessibility to those services?

- What aspects of accessibility are influenced by concentration?

Review Methods

A systematic review was carried out to assess evidence on the relationship between concentration and accessibility for hospital services.

Search strategy

A search strategy was designed to identify the maximum amount of relevant research and to develop a bibliography of papers relevant to the U.K. (Annex A). The search was applied to Medline and a range of other electronic databases which cover articles, conferences and the 'grey literature (e.g. unpublished PhD theses) (Annex B). Researchers in the field and relevant bodies in the UK were also contacted (Annex D). Studies in all languages of any research design were examined.

Inclusion criteria

Studies have been included if they are empirical and satisfy the following criteria of relevance and outcome:

Relevance: studies are included where a relationship is examined between aspects of concentration, patient accessibility and utilisation of hospital services.

Outcome: the outcomes of interest are the effects of patient accessibility on health status and the utilisation of services.

Design: a wide range of study designs are eligible for inclusion:

Table B **Eligible study designs**

Randomised controlled trials
Non-randomised controlled trials
Before/after uncontrolled
Prospective cohort
Retrospective cohort
Case-control
Cross sectional

Exclusion criteria

Articles which relate to less developed countries have been excluded as have articles which relate to mental or psychiatric services. Evidence relating to the effects of concentration on clinical outcomes are dealt with elsewhere and have been excluded unless they relate to issues of accessibility.

Methodological quality assessment

Each empirical study satisfying the inclusion criteria was assessed according to the following criteria:

- Study design
- Adjustment for confounding factors

Data extraction

For each relevant study, data have been extracted in a systematic way to establish the objectives of the study, the setting, the methods used and the evidence of accessibility, utilisation, compliance and health outcome, together with how and why this is affected by concentration. (Annex C)

Results

A wide search was necessary to identify as much evidence as possible and it produced over 3000 titles . After previewing these references, approximately 250 papers were obtained and screened against the inclusion criteria of relevance, outcome and design. The majority were rejected because few actually attempted to measure any of the effects that concentration might be expected to have on patient accessibility and utilisation, or on outcome. This left 47 papers to be included in the review which included empirical evidence relevant to the relationship between concentration, patient accessibility and utilisation of hospital services. An analysis of the included studies by main topic and geographical source is given below:

Table C Topic and geographical source of included studies

Topic	Country					
	U.K.	Europe	United States	Canada	Rest of the World	Total
Distance and Outpatients	7	1	7	1	1	17
Distance and Inpatients	5	1	7	3	1	17
Other Distance	8	1	1	2	1	13
Total	20	3	15	6	3	47

All of the studies are concerned with distance. The U.K. and the United States are the two main geographical sources. The distribution of the studies by publication date is given below and indicates that most have been published within the last ten years.

Table D Publication date of included studies

Publication date	Number
1995-96	10
1990-94	20
1985-89	7
1980-84	4
1975-79	3
1970-74	3
Total	47

An analysis of the studies by design is given below:

Table E Study design of included studies

Type of study	Number
RCT	0
Non-randomised control trials	0
Before/after uncontrolled	2
Prospective cohort	0
Retrospective cohort	0
Case-control	1
Cross sectional	44
Total	47

Almost all the studies are cross sectional. These are particularly vulnerable to confounding and therefore of relatively low quality even where attempts have been made to adjust for potential confounding factors. This should be borne in mind when considering the evidence.

The evidence from the review is presented in the following section which considers the effects of distance on patient accessibility and utilisation of services.

2. EVIDENCE OF THE EFFECTS OF DISTANCE ON PATIENT ACCESSIBILITY AND UTILISATION OF SERVICES

Distance and A&E

A&E is one of the few hospital services in the U.K. which the patient can use directly without a referral.

Cross sectional study: well adjusted for confounding

a) McKee et al (1990) found that in Northern Ireland proximity to an A&E department is associated with increased use.

Cross sectional studies: partially adjusted for confounding

a) In Bristol, Walsh (1990) found a strong inverse relationship between distance (range 0.7 to 5.8 km) and attendance rates at A&E for those aged 16-60.

b) In Norfolk, Bentham et al (1985) found that utilisation of the casualty department in Norwich declined with distance (up to 21 miles) and with reduced personal mobility.

Cross sectional studies: not adjusted for confounding

a) In Sweden, Magnusson (1980) observed an inverse relationship between visiting rates to the emergency department and distance (range 5 to 72 minutes travelling time by public transport) which, taking account of immigrants, explained 81% of variation in attendance.

b) In the case of self referral to A & E departments in West Lothian, Campbell (1994) shows a clear distance decay effect on referrals (range 0 to 15½ km).

c) However Campbell also found no such association for GP initiated referral rates. This could indicate that the GPs were giving consistent advice, unrelated to the distance involved, and that the patients complied with this advice.

The evidence shows a clear distance decay effect for self referral to A&E departments.

Distance and Clinics and Daycases

Before and After Study

a) Simon et al (1973) found that fewer students used the student health service clinic at the University of Rochester after it had been moved to a more distant (over half a mile away) and less convenient location.

Cross sectional studies: well adjusted for confounding

a) The dropout rates from clinics have been shown to increase with distance by Fortney et al (1995) in the case of alcoholism aftercare in the United States.

b) Meyers et al (1995) found no correlation between distance, in some cases over 500 km, and non-compliance for paediatric allografts in Johannesburg.

c) A survey by Wright et al (1994) in Hamilton, Ontario, indicated that patients would trade distance (mean 32 km) against differences in brachytherapy procedures and chances for cure: but survey preferences must be treated with extreme caution.

d) In Dublin, Kaliszer et al (1981) found that distance from the ante-natal clinic affected the timing of the first visit, with those living at a distance of four miles presenting 3 weeks later than those nearby. There was no relationship between distance and missed visits.

Cross sectional studies: partially adjusted for confounding

a) Travel time and expense were perceived in a survey by Licciardone (1990) as a barrier to using outpatient services in Missouri: however, no significant relationship was found with actual use.

b) Haynes et al (1979) found that attendance at outpatient clinics in Kings Lynn declined when the distance from home increased to over ten miles.

c) Bentham et al (1985) found that in Norfolk, utilisation of outpatient services declined with distance (up to 21 miles) from Norwich, and more so for those with reduced personal mobility and at a distance from a GP surgery.

Cross sectional studies: not adjusted for confounding

a) The dropout rates from clinics have been shown to increase with distances of over 100 miles by Graber et al (1992) for adult diabetics in Nashville.

b) Attendance at aftercare sessions for alcoholics in Jackson, Mississippi reduced with distance (range 6 - 189 miles), and more so for off-highway distance, in the study by Prue et al (1979).

c) Missed visits in an American ophthalmology clinical trial were found to be associated with distance (of over 100 miles) and travel costs by Orr et al (1992).

d) Patients more than three miles away were found by Smith et al (1994) to miss fewer appointments than those closer to an urban family practice in the American midwest.

e) Where patients in Lanarkshire required further investigation after initial screening for breast cancer, Kohli et al (1995) found no defaults on appointments: some had considered not attending, but not because of distance, time or cost. Patients were helped by being given convenient appointment times and travel expenses if they were on income support. They had to travel from 14 to 46 miles, taking between 30 minutes and 5½ hours for the return trip.

f) In Glasgow, Junor et al (1992) found no refusals, dropouts or non-compliance amongst radiotherapy outpatients. Patients perceived the requirements as important enough to overcome the barriers of time and distance (range 1 to 60 miles) with the help of hospital and charity transport, or overnight hotel accommodation provided by the hospital where necessary.

g) Strong et al (1991) audited day case cataract surgery at Leicester Royal Infirmary. They concluded that although "it might have been expected that geographic factors would affect the decision whether to admit as a day case, our data show this was not the case. Some day case patients travelled over 30 miles each way."

The evidence can be interpreted as being consistent with the expectation that patients will drop out of attending clinics because of the distance involved if they do not see them as being important. On the other hand the evidence indicates that distance does not affect attendance where the clinic is related to cancer.

Distance and Inpatients

There is conflicting evidence for inpatient services, although the majority of the studies present some evidence of a distance-decay effect. The evidence from North America is mixed, whilst that from the U.K. finds evidence of distance-decay in each case.

Cross sectional study: well adjusted for confounding

a) In New Hampshire and Vermont, Greenberg et al (1988) found that referral of lung cancer patients to the University cancer centres was strongly related to the patient's distance from the centres, ranging from less than 25 to more than 75 miles.

Cross sectional studies: partially adjusted for confounding

a) In Maine, New Hampshire and Vermont Goodman et al (1994) found that utilisation of inpatient services for medical diagnosis related groups (DRGs) for children under 15 years old decays with distance, measured as travel time with a range of 0 to 120 minutes.

b) Roos et al (1989) found an apparent reluctance of physicians in Western Manitoba to refer to Winnipeg for coronary artery bypass graft surgery (CABG), even though their own local hospital could not perform the procedures. If this is because of loyalty to their local hospital, even though it cannot perform the procedures, then centralisation will need to consider carefully the referral networks that are in existence.

c) Gittelsohn et al (1995) found that in Maryland distance of more than 80 miles played an important role in determining accessibility for CABG and other discretionary surgery.

d) Grumbach et al (1995) compare CABG rates in New York, California, Ontario and British Columbia at distances extending to more than 100 miles: they found that in Canada distance was not associated with lower CABG rates, whereas in the United States the overall rates were higher but affected by distance decay.

e) Anderson et al (1989) also found no evidence that rates for CABG in Ontario were affected by distances ranging from 15 to 120 miles. Equally, medical admissions for heart disease were not influenced by distance in Gittelsohn's study referred to above.

f) In Manitoba, Roos et al (1985) found that variations in rates of total hip replacement (THR) were not related to distance from the referral centre. They also found no evidence that centralisation had restricted the overall rate of THR.

g) In France, Launoy et al (1992) found that patients in the department of Calvados were less likely to receive specialised treatment for colorectal cancer the further they lived from a specialised centre. They also found more severe symptoms at diagnosis amongst the rural population, especially women, which suggests delay in presentation.

h) Wood (1985) found the effects of distance on hospital utilisation in the Grampian region of Scotland to be selective, and related to both the distance of the patient from the GP (>3 miles or >5 miles) and the distance of the practice from the hospital (> 35 miles). They also found that length of stay was affected by distance for certain operations.

i) Black et al (1995) examined coronary revascularisation in England and Scotland and found that utilisation increases with the presence of a local cardiologist and decreases with distance from a main specialist centre.

j) In North Worcestershire, Packer et al (1995) found that general medical and geriatric emergency admission rates declined as distance between the practice and the hospital increased (for 39 of the 40 practices this was less than 8 miles, and 15 miles for the remaining one).

k) Slack et al (1994) found a significant inverse relationship between hospitalisation rates in Bassetlaw and Nottingham and travelling times from the patient's ward of residence.

l) The ratio of the use of inpatient hospital services to need was found to decline with distances of up to 21 miles from Norwich in the study by Bentham et al (1985): they also found that the decline was greater with reduced personal mobility and with the absence of a local GP surgery.

Cross sectional studies: not adjusted for confounding

a) In Australia, Walmsley (1978) found that hospital utilisation declined with distances of up to 50 km, although there was no relationship between distance and length of stay in hospital.

b) Bagust et al (1991) found much higher rates of cardio-thoracic surgery in Newcastle, where the Freeman provided the regional service, than at distances of up to 65 miles away in the Northern region as a whole. They suggest that centralisation may reduce accessibility and also inhibit the spread of higher treatment rates.

c) When patients have a choice, Dranove et al (1993) found that in California they preferred a nearby hospital although that preference was relatively less for elective and delivery admissions. Folland (1983) found that in South Dakota patients preferred a nearby and a bigger hospital.

Although not conclusive, the weight of evidence therefore suggests that accessibility is likely to be adversely affected by the distance from the hospital.

Visitors

In some cases the ability to visit patients may be of significance and may be affected by the concentration of hospital services.

Cross sectional studies: not adjusted for confounding

a) In the United States, Giacoia et al (1985) found that the frequency of visits to new-born infants in intensive care declined as distance increased, particularly beyond 50 miles.

b) Cross et al (1974) found that visits to long stay geriatric patients decreased gradually at distances over 10 miles, but visiting short stay geriatric patients was not affected by distance.

c) Haynes et al (1979) found that visitors in Norfolk were fewer for pre-convalescent patients who lived further from the hospital, over a range of 0 to 20 miles.

The evidence suggests that avoidance of excessive concentration may be a legitimate goal where families and stress are involved: easy accessibility for relatives can be important, for example in visiting babies and young children.

Distance and Screening

There is some evidence that the uptake of screening declines with distance.

Before and After Study

a) Bentham et al (1995) found that in Norfolk the uptake of opportunistic cervical cytology screening decreased with remoteness. However, remoteness was no longer significant when a new population based call and recall system was introduced.

Cross sectional study: well adjusted for confounding

a) Haiart et al (1990) found that uptake for a mobile mammography unit operating in East and Mid Lothian declined with distance from the unit.

Screening may seem unimportant to the individual and therefore not worth making an effort to attend, but the evidence from Bentham et al. (1995) indicates that positive systematic action such as a call and recall system may help to improve the rate of access to a screening service.

Distance and Willingness to Travel

Two studies provide evidence that patients are willing to travel some distance to overcome delays in accessing hospital services.

Cross sectional studies: not adjusted for confounding

a) Howell et al (1990) showed that a significant number of patients were prepared to travel to Swindon (from Crewe) to avoid long waits for routine elective operations. Nofal et al (1990) found the same for children (accompanied by a parent) travelling from Mid-Glamorgan to Swindon.

Distance and Outcome

Distance in terms of elapsed time before receiving health care might be expected in some cases to influence outcome.

Cross sectional studies: well adjusted for confounding

a) In the case of serious road traffic accidents (RTAs), Jones et al (1995) investigated this in some depth and found that emergency medical service times, of up to 52

minutes from accident to hospital, were not associated with the outcome of RTAs in Norfolk.

b) In organ transplants, there is a higher risk of spoilage if delay occurs, but the chances of receiving a heart or liver transplant in the United States were found by Ozminkowski et al (1993) to be unaffected by distance of over 50 miles.

c) Sampalis et al (1993) found that in Montreal, a total pre-hospital time of more than 60 minutes was associated, for severely injured patients, with a threefold increase in the odds of dying within six days.

There is mixed evidence about the association between outcome and the time taken to access the hospital services.

The distance of the population from the hospital may also be expected to have an affect on outcome for reasons of accessibility or remoteness.

Case-control Study

a) In the semi-rural eastern townships of Quebec, Kelly et al (1974) found that households from 10 to over 30 minutes distant from the nearest hospital had significantly more deaths from acute medical post neonatal syndromes in children under 5 than did the nearest households, less than 10 minutes away.

Cross sectional studies: well adjusted for confounding

a) In Finland, Karjalainen (1990) found that the centralisation of radiotherapy facilities does not appear to have affected the five year survival rates for patients with breast cancer or prostatic cancer.

b) Jones (1996) found that in England and Wales greater distance (extending to over 22 km) from the nearest hospital was associated with increasing mortality for diabetes mellitus, asthma, mortality in the first 28 days of life, and road traffic accidents. There was no such association for breast cancer, cervical cancer, hypertension and stroke, or peptic ulcer.

Cross sectional study: not adjusted for confounding

a) Asthma mortality was also found to be higher in the more rural health areas of Scotland by Wilson (1984), and concern over this issue was expressed by Wareham et al (1993) in their report on a confidential enquiry into deaths from asthma in the Norwich health district.

The evidence indicates that in certain cases mortality may be higher for populations remote from hospital services.

Discussion

The extent of the literature

The measurable proxy indicator for accessibility most used is utilisation. It represents demand (which is a function of need and supply) filtered by accessibility and it also reflects population characteristics and medical practices.

Much of the discussion of distance is based on categorical measurement (near/far) rather than on continuous measurement (so many miles) and the distances discussed vary widely from less than 1 mile up to 300 miles.

Most of the evidence is based on cross sectional studies which are subject to confounding. Even where adjustments are made they may be unreliable, and there are also likely to be unrecognised confounding factors present.

Some of the evidence is also based on surveys which must be interpreted with special care because a patient's stated reason or intention contains a degree of subjectivity.

The evidence should therefore be treated cautiously and regarded as indicative rather than prescriptive.

Interpreting the Results

The studies of A&E departments indicate that the option to self-refer to a facility will encourage the use of that facility. The introduction of the GP as gatekeeper seems to flatten

out the distance-decay curve, but there is still likely to be a decline in utilisation with distance for the more discretionary conditions.
The effect of the barriers to accessibility is modified by the perceived importance of the need for the service in question and the perceived ability of that service to produce results. The effect of these barriers is greatest for those who are the most disadvantaged.

In the case of a life threatening event such as diagnosed cancer and where there is a positive chance of survival there is no evidence of failure to access the requisite facility: indeed there is evidence for the UK that any necessary assistance is given so that the patient can achieve such essential accessibility. There is a possible cause for concern over accessibility to detection of disease because there is some evidence of distance decay in attending for initial cancer screening . This may be of critical importance where the stage of detection affects the outcome for the patient.

No standard distance-decay function has emerged for hospital services. Each situation is specific to its own circumstances. Gravity models are shown to be descriptive rather than predictive. As McLafferty (1988) observes in her study of the closure of Sydenham hospital in New York, "Although such models may accurately describe the use of hospitals at a given time, they may be quite inaccurate in predicting utilisation patterns after a hospital closes". The evidence provides no prescriptive or quantitative guidelines. Each set of local circumstances must be separately examined and specifically addressed in the light of the evidence presented here.

How to do this calls for careful consideration. With a diversity of purchasers, a strictly controlled supply of specialist labour, and competition between providers there is a market place which may not of itself provide an optimum solution: some regulation or control may be required.

Purchasers and providers may wish to consider their local conditions by examining relevant isochrones in the manner referred to by the Leeds Review (Rawlins.1996) and demonstrated by Gattrell et al (1992). In New Zealand there are standards which require, for example, that there are maternity facilities within a thirty minute drive for 90% of pregnant women (Dixon. 1996). Similarly, the Patients Charter (1995) states that you can expect an ambulance to arrive within 14 minutes in an urban area or 19 minutes in a rural area.

The principal message from the literature review is that the quality of evidence in this area (as judged by study design) is generally poor, with a lack of properly controlled studies. The evidence of (mostly) cross-sectional studies suggests that in some cases increasing the

distance between the patient and the hospital service may result in reduced access and possibly worse outcomes. At this stage, however, the evidence must be viewed as suggestive rather than conclusive.

TABLES AND APPENDICES

Tables

Appendices

TABLE 1
DISTANCE AND A&E

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Bentham et al (1985)	Norfolk June 1980 A random sample of the population produced1603 interviews (out of 2262 attempted) of residents >18 years old in the city of Norwich (Nor.) and in 16 villages served by the district general hospital in Norwich (but not by any other district general hospital) The villages are either near to Norwich (4-7 miles) or far from Norwich (15-21 miles) and either with a general practitioner surgery in the village(+GP) or without one (-GP). Cross sectional.	What links are there between the use of hospital services (outpatients-OPs: casualty - CAS: inpatients - INPs) and distance, personal mobility (A= household has car and telephone: B= household lacks car: C= household lacks car and telephone), and health care needs? (Maternity services have been excluded).	An analysis of patients use/needs ratios by hospital service and accessibility categories. Use/needs ratio = % using hospital services in the last 12 months / % of respondents with either limiting long standing illness or with short term restricted activity or both (self reported).	Use/needs ratios for hospital services near to Norwich / far from Norwich Nor. +GP -GP +GP -GP OPs A 1.78 1.20 1.06 1.07 0.52 B 1.12 0.82 0.83 0.66 0.53 C 0.81 1.21 0.95* 0.71 0.43 CAS A 1.21 0.49 0.71 0.49 0.16 B 0.39 0.05 0.00 0.25 0.22 C 0.19 0.32 0.45* 0.31 0.05 INPs A 0.55 0.45 0.71 0.52 0.29 B 0.19 0.32 0.45 0.31 0.18 C 0.19 0.60 0.00*0.32 0.05 * sample <30 The ratio of use to needs tends to decline with distance from Norwich and with reduced personal mobility. Inpatient and outpatient use rates are almost always lowest far from Norwich and without a GP surgery.	Concentration of hospital services and GP services each reduces accessibility as measured by hospital utilisation when corrected for healthcare needs. The effect is greatest for those with least personal mobility.	The results are dependant on the relevance of the use/needs ratios as indicators of health needs. Only 71% response to survey could introduce bias. Partially adjusted for potential confounders

Table 1 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Campbell (1994)	St. Johns Hospital, Livingston New Town, West Lothian, Scotland 8 weeks in 1993 4849 (3369 self referrals, 1130 GP referrals, 350 others) Cross sectional	Are A&E referral rates affected by distance (crow fly: range 0 - 15½ km) from the practice to the hospital?	Regression analysis to examine the relationship between A&E attendance and possible predictors.	Self referral rate per 1,000 in the 8 week period is 27.6 - 1.09 *distance (in km) No association between GP initiated referral rates to A&E and distance Self referrals 70% GP referrals 23% Others (police, school, work etc.) 7% A&E attendance rates per 1,000 in the 8 week period: self referred 20.6 GP referred 7.0	Distance from hospital is reported as an important predictor of self referral rates to A&E GPs would seem to be uninfluenced by the distance.	No correction for severity of illness or availability of GP Not adjusted for potential confounders

Table 1 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Magnusson (1980)	Huddinge Hospital emergency department in Stockholm January 1976 to March 1977 4927 patients who made 9632 visits, from a 10% sample of the population of 166,000 in the catchment area, divided into 20 sub areas. Cross sectional	Does distance from the hospital (measured in minutes traveling time by public transport) affect utilisation of the emergency department?	Association between dependant and independent variables was tested by regression analysis.	$Y = 40.7 + 14.5Z + 344.2/X$ $R\sigma = .81$ Y = rate of visiting the emergency department per 100 population Z = a dummy variable: 1 where immigrant (non-Swedish) proportion of population =>20% and 0 otherwise X = distance in minutes between subarea of residence and the hospital (range 5 - 72 mins). There is an inverse relationship between visiting rates and distance	Centralisation of A&E would remove from the adjacent population an accessible and frequently used service	Not adjusted for potential confounders, other than immigrants.

Table 1 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
McKee et al (1990)	The accident and emergency (A&E) department of an acute general hospital in rural Northern Ireland 1986 A random sample of 1 in 20 new attendances at A&E (n=1029) Retrospective cross sectional	Does the patients distance from an A&E department affect the rate of attendance?	Multiple linear regression of attendance rates against distance travelled and a number of socio-economic variables.	Overall annual attendance rate at the A&E was 220 per 1,000 Attendance rate by electoral ward: $\log_{10}$ (attendance rate per 1000 population) = 2.58 - 0.44 ($\log_{10}$ distance) Attendance rate by practice: $\log_{10}$ (attendance rate per 1000 population) = 2.79 - 0.64 ($\log_{10}$ distance)	Proximity to an A&E department encourages use.	No distinction between self-referral and GP referral. Well adjusted for potential confounders

Table 1 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Walsh (1990)	The Bristol Royal Infirmary accident and emergency (A&E) unit. 1988 2,000 A&E attenders aged 16-60 who were discharged the same day.(a 1 in 13 sample) Retrospective cross sectional	Does travelling distance affect the use of the A&E unit?	Multiple regression analysis of attendance rate against distance, social index, and 15-29 age group.	Attendance rate = 6.793 - 0.860D + 0.031S +0.145A $R\sigma = 0.667$ D = mean distance from A&E in km (range 0.7-5.8). S = social index A = % of population 15-29	The travelling distance is a major factor in determining A&E attendance rates for those aged 16-60 in Bristol	Other hospitals may have an effect. No information on source of referral. Partially adjusted for potential confounders

TABLE 2
DISTANCE AND CLINICS AND DAYCASES

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Bentham et al (1995)	See Table 1 for details					
Fortney et al (1995)	Dept. of Veterans Affairs (VA) Alcohol Dependency Treatment Programs (ADTP) throughout the United States 1987 4.621 male alcoholic patients with an outpatient appointment Cross sectional	Does distance reduce alcoholism aftercare treatment participation?	Binary discrete choice model estimated from observed choice outcomes using logistic regression to predict the probability of attendance for outpatient appointment	Logistic regression parameter estimates for attendance Log(distance) -0.2128 age*log(distance) -0.00763 Distance reduces the probability of attending in a non-linear relationship such that the marginal effect diminishes as distance increases Older alcoholics are more negatively affected by distance than younger ones	A distance decay function is possible for outpatients, and older people may be more sensitive to travel barriers.	Treatment programme characteristics are not taken into account. Well adjusted for potential confounders
Graber et al (1992)	Private clinic in Nashville Dates not given 422 adult diabetic outpatients (29 >100 miles from Nashville) Retrospective cross sectional	Is the dropout (permanent lack of follow up visit) rate affected by distance from the clinic?	$\chi\sigma$test used to determine significance of differences of frequencies between contingencies	% <100 >100 dropout miles miles after 11% 23% initial $\chi\sigma$4.05 education P= 0.04 between 6 37 % 67% and 12 $\chi\sigma$7.37 months P= 0.007	Dropout from follow up is affected by the distance to the clinic.	Not adjusted for potential confounders, such as type of patient, type of treatment, severity of illness, or smoking

Table 2 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Haynes et al (1979)	The Kings Lynn (K.L.)Health District, a rural district within the Norfolk Area Health Authority 1977 The population of the health district was about 170,000 Cross sectional surveys	Does distance from the hospital (range 0 - 20 miles) affect outpatient clinic attendances, in-patient admissions or visiting rates?	Analysis of data from: 1. A survey of outpatients 2. A door to door community survey of accessible and inaccessible villages, which asked if the respondent had ever been a patient in hospital. 3. A survey of hospital inpatients which asked how many visitors they had received in the past week.	Distribution of actual outpatients (AOP) and expected outpatients (EOP) by distance from K.L. distance AOP EOP ratio AOP: EOP within K.L. 138 83 1.7 =<10 miles 79 74 1.1 > 10 miles 90 150 0.6 68% of respondents in accessible villages had been inpatients and 61% of respondents in inaccessible villages had been inpatients. (not statistically significant) visitors to pre-convalescent patients $V=4.115\ D^{-0.1875}\ T^{-0.1863}$ V=visits per day D=distance in miles to patients home T=duration of stay in days	The location of outpatient clinics affects their accessibility for patients, and reduces utilisation with distance. Visitors are less for pre-convalescent patients who live further away from the hospital	There is no correction for outpatients who may have used other hospitals such as Norwich. Partially adjusted for potential confounders

Table 2 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Junor et al (1992) and oral comm-unication.	Beatson Oncology Centre, Glasgow (the specialist cancer treatment unit for the West of Scotland, serving 2.7 million) One day in November 1990 275 patients (216 outpatients, 59 inpatients) Cross sectional survey	What are the travel times for radiotherapy outpatients and do they affect attendance?	Questionnaire (92% response)	Median (Range) Journey distance 20 (2-120) miles Time away from home 170 (35-420)mins Number of visits 20 (1-33) Method of travel Car/ambulance 88.4% Public transport 11.6% No treatment refusals, drop-outs or non-compliance Examining the situation has allowed improvements in accessibility to be made (e.g. parking)	Patients comply with requirements if they perceive them as important, and if they are given assistance (in this case hospital and charity transport, and admission or overnight hotel accommodation where necessary)	Not adjusted for potential confounders

Table 2 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Kaliszer et al (1981)	A hospital maternity clinic and two satellite maternity clinics run by the same hospital in Dublin. A four month period, year not given. A sample of 200 pregnant women: 50 at each satellite clinic (groups L1 and L2), 50 at the main hospital clinic living within one mile(MN), and 50 at the main hospital clinic living four miles away (MF) Cross sectional.	How does distance from the ante-natal clinic affect attendance at the clinic?	Comparison betweeen the groups of: a) the mean number of weeks of pregnancy at first attendance at the clinic, and b) the mean number of missed visits.	Weeks of pregnancy at first visit to the clinic Clinic groups / Group mean / Difference of means (fromMF) L1 17.1 1.7 L2 16.9 1.9 MN 15.5 3.3* MF 18.8 *significant at 5% There is a significant difference between the mean of MN and the mean of MF. There is also a significant difference between the combined mean of L1, L2, MN and the mean of MF. Distance from the clinic affects the timing of the first visit. There is no significant relationship between missed visits and the groups.	Accessibility may affect the timing of patient presentation, with more distant patients presenting later.	Groups L1 and L2 were from homogeneous housing estates, MF and MN were well matched. Well adjusted for potential confounders

Table 2 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Kohli et al (1995)	Calder Street breast screening regional assessment centre, Glasgow Feb. 1992 through Jan. 1993 A sample (109) of the 914 patients attending the centre for further investigation (8% of those screened for breast cancer in Lanarkshire) Cross sectional survey	What are the distances, times and costs of accessing the centre and do they affect attendance?	Survey of all patients on one day (on a rolling basis) every 2 weeks	Defaults on appointments - NIL (out of all 914) (17% had considered not attending, but not because of distance, time or cost) Return journey: Mean (Range) Distance 21.5 (14-46)miles Time 1.73 (0.5-5.5)hours Cost £ 6.08 (1.00-14.40) Method of travel: Car 74% Bus/train/taxi 26% Number of visits: 1 78% 2 10% 3 12%	Patients comply with requirements if they perceive them as important, and if they are given assistance (in this case helpful appointment times, travel expenses for those on income support)	100% completion of survey for every appointment in the sample. Not adjusted for potential confounders

Table 2 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Licciardone (1990)	Rural north eastern Missouri, with the nearest Veterans Administration (VA) outpatient service 90 miles to the south September 1986 A sample of older rural veterans Survey and retrospective cross sectional	Is distance perceived to act as a barrier to use of VA outpatient facilities, and is it actually a barrier to use?	Mail survey of perceived barriers Multiple linear regression of variables predicting use	Perceived barriers to use (multiple responses allowed) users (n=67) non-users (n=102) Travel time 78% 64% Travel expense 49% 41% (no significant difference between users and non-users) Regression coefficients for predicting actual use coefficient P Travel time 0.2801 0.24 Travel expense -0.0558 0.80 (no significant prediction of use)	Stated perceived barriers to use were not significant predictors of use. This highlights the need to treat surveys with extreme caution if not actual disbelief. Acting on survey information alone would not be justified.	Stated intentions or perceptions do not necessasrily correspond with action. Partially adjusted for potential confounders

Table 2 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Meyers et al (1995)	Paediatrics dept., University of the Witwatersrand and Johannesburg Hospital 1984-1989 94 paediatric allografts(17 excluded from the study) Retrospective cross sectional	Is non-compliance affected by distance from the hospital?	Correlatioal analysis.	17 of 77 were non-compliant. No correlation was found with the distance of the home from the hospital, which in some cases was over 500 km.	Non compliance is a significant cause of graft loss but this was not significantly related to distance between home and hospital.	Various socio-economic and illness related potential confounders were examined. Well adjusted for potential confounders
Orr et al (1992)	The Macular Photocoagulation Study(MPS) with 15 participating ophthalmology clinics throughout the United States Trials began 1981 175 patients interviewed out of 292 selected in August 1987 Retrospective cross sectional and survey	What affected compliance with follow up in 3 of the MPS clinical trials?	An interview questionnaire with odds ratios computed by comparison of those with missed visits and those with no missed visits	Odds ratios (OR) for missed visits (with 95% CI) and number of respondents(N) [N] OR Distance from clinic =<100 miles[105] >100 miles [69] 3.3 (1.7, 6.4) Problem with travel costs No [162] Yes [13] 7.5 (1.5, 36.4) Travel costs and distance from the clinic were significantly associated with missed visits.	Attendance at clinics is reduced by distance and difficulties with travel costs.	Response rates were poor: 55% from those with missed visits and 78% from the control group with no missed visits Not adjusted for potential confounders

Table 2 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Prue et al (1979)	The Alcohol Treatment Unit of the Jackson Veterans Administration Hospital, Jackson, Mississippi Dates not given 40 randomly selected from outside Jackson City Retrospective cross sectional	Does distance affect attendance of alcoholics at aftercare sessions?	Multiple regression analysis of the predictor variables ('miles to' the nearest major highway and 'miles on' that high way) with % attendance at aftercare	Increment in Rσ / Beta 'miles to' highway 0.142 / -0.486 'miles on' highway 0.098 / -0.330 (P not given) Attendance reduces with distance, and more so with off-highway distance (round trip distance range 12 - 378 miles)	The 'type' of distance causes a differential in the distance friction effect. This is likely to reflect time, rather than mileage.	Not adjusted for potential confounders

Table 2 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Simon et al (1973)	The Student Health Service at the University of Rochester, before and after it moved in January 1968 from the undergraduate campus to an off-campus location in the University Medical Centre. September 1965 - May 1969 All graduate and undergraduate students. Before and after.	Does distance affect the utilisation of the clinic? (The clinic moved from being adjacent to student activities and within 1/4 mile of the student dormitories to being over 1/2 a mile away from the dormitories and away from student activities.)	Correlational analysis of clinic utilisation and infirmary outpatient utilisation.	Average number of visits per student to the clinic before move 1965-66 3.6 1966-67 3.3 after move 1968-69 2.2 partial correlation coefficient (removing the effect of time trend = -0.343 P = <.05) Greater distance and less convenience reduced utilisation. The authors also find suggestive evidence of a greater reduction in utilisation for minor conditions (colds) and preventive services (immunizations) than for more specialised complaints (genitourinary) and treatment (allergy shots).	Greater distance and greater inconvenience from concentration may reduce utilisation for minor ailments and preventive treatment.	Time trend taken into account.

Table 2 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Smith et al (1994)	American midwestern urban family practice April-June 1991 4669 patients with 7283 appointments Cross sectional	Is appointment keeping affected by proximity to the clinic?	Frequency distributions with confidence intervals No adjustments	% of appointments kept Patient >3 miles away (2404) 78.2% (CI 0.76-0.81) patient 3 miles or less away (4879) 71.7% (CI 0.71-0.73) Nearby patients miss more appointments	Missed appointments can waste resources and affect health - they should be recorded and investigated	An unexpected result possibly caused by confounding over methods of transportation Not adjusted for potential confounders

Table 2 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Wright et al (1994)	Hamilton Regional Cancer Centre, Ontario 1993 38 patients of the centre with carcinoma of the cervix (18 prior, 20 new) Cross sectional survey	Is the preference for treatment options (high dose rate (HDR) or low dose rate (LDR) brachytherapy) affected by distance to travel (mean 32 km)?	Questionnaire with logistic regression to determine any association between preference and characteristics No adjustments for confounders	If HDR and LDR are iso-effective then a patient 40km distant is estimated to be 3 times less likely to prefer 3 HDR treatments to 1 LDR treatment than a patient within 10km of the centre (p=0.04) The further away a patient lives the more likely she is to prefer a single low dose treatment: the high dose rate would have to be at least 2% more curative or 6% less toxic for at least 50% of patients to prefer it to the low dose rate.	It appears that distance may be traded against differences in brachytherapy procedures, numbers of fractions, chances for cure and chances for toxicities	Exercise extreme caution over survey preferences Small numbers Well adjusted for potential confounders

TABLE 3
DISTANCE AND INPATIENTS

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Anderson et al (1989)	Ontario 1979, 1981, 1983, 1985 All residents of the 38 counties of Southern Ontario (total population approximately 5.5 million) with Coronary Artery Bypass Graft Surgery (CABGS) procedures performed in Ontario in those years (number not given) Retrospective cross sectional	What is the effect on CABGS rates of the distance from the centre of the county of residence to the nearest referral centre? (Counties were assigned to specific referral centres by three rules: Strict rule - that centre supplies 90% or more of the procedures done, (which covers 76% of adult population) Majority rule - 50% or more, (covering 19%) Plurality rule - the plurality, (covering the final 5%))	Ordinary least-squares regression to examine the relationship between age-standardised utilisation rates and distance from nearest referral centre (range 15 - 120 miles)	The CABGS rate per 100,000 adults (for all counties) is 48.37 - 0.09 the distance in miles from the nearest referral centre (Rσ= 0.019) and the slope is not significantly different from zero The CABGS rates per 100,000 adults served by the five counties with referral centres (using the strict assignment rule) are: 1 76.0 2 45.0 3 45.8 4 75.8 5 50.0 Centres 1 and 4 had statistically significant higher surgery rates (regionalisation restricts the delivery of services to specific referral centres)	Utilisation of CABGS is not related to distance. Utilisation is related to the referral centre. In 1984 the surgeon numbers were higher per 100,000 in centres 1 and 4 (3.1 and 3.5 v. 1.3, 1.3 and 1.9): this could reflect need, or be a cause of the greater activity Accessibility may therefore depend on the centre serving the patient rather than on the distance between the patient and the centre.	Only corrected for age Partially adjusted for potential confounders

Table 3 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Bagust et al (1991)	Cardio thoracic unit, Freeman Hospital, Newcastle. Providing regional and supra regional services. 1989/90 2845 cardio thoracic episodes of Northern Region residents Cross sectional	Does centralisation of cardio thoracic services in Newcastle affect access to these services in the Northern Region?	Distance decay model and comparison of episode rates per million population	number of episodes = constant x resident population x distance$^{-0.207}$ (distance decay parameter - 0.207) rates per million for all cardiac thoracic surgery Newcastle 1909 Northern Region 926 Distance from the regional services in Newcastle (up to 65 miles) affects access to those services	Centralisation may inhibit equity of access Centralisation may inhibit reaching target rates of treatment for a region	The basis of the distance decay function is not specified. Not adjusted for potential confounders
Bentham et al (1985)	See Table 1 for details					

Table 3 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Black et al (1995)	22 hospitals (NHS and private) providing coronary revascularisation for 11.6 million residents of 42 districts and boards throughout England and Scotland 1992 and 1993 All residents >24 who underwent coronary artery bypass grafting (CABG) or percutaneous transluminal coronary angioplasty (PTCA) in NHS or private hospitals Retrospective cross sectional study of variation	Does distance affect access to coronary revascularisation in England and Scotland?	The association between district rates and the existence of a local cardiologist was tested for using ANOVA for CABG and the Kruskal-Wallis test for PTCA The effect of distance from facilities was assessed visually by mapping the district rates (not shown).	Rates per million for districts with and without a cardiologist: 38 districts with / 7 districts without CABG 535 / 378 (p=0.041) PTCA 306 / 89 (p=0.007) Visual assessment showed that in general the closer a district was to a main specialist centre the higher was the utilisation rate There was no evidence of substitution of one procedure for another. Utilisation declined as SMRs for coronary heart disease increased (inverse care law).	Utilisation increases with the presence of a local cardiologist and decreases with distance from a centre. If concentration reduces the local availability of specialist revascularisation services this may accentuate variations in utilisation.	Only adjusted for age and sex. Utilisation increased with levels of deprivation (DOE social index). This could be related to proximity and so could be confounding the distance effect. Partially adjusted for potential confounders

Table 3 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Dranove et al (1993)	Eight medium size hospital markets in California 1983 and 1989 All patients (number not given) admitted in those years Cross Sectional	Do patients use nearby (in or adjacent to their own zip code)hospitals (as measured by use)? Does the type of medical condition affect hospital choice?	A multinomial logit model estimated by multiple regression using probit analysis and maximum likelihood is used to estimate the relative probabilities with which individuals with given characteristics choose each hospital.	Patients are 1.31 (1983) and 1.28 (1989) times as likely to choose a nearby hospital as a distant one The coefficient of interaction for distance and elective admissions is -0.039, and for distance and delivery admissions it is -0.046	Given a choice patients show a mild preference for using their local hospital The use of local hospitals is relatively less for elective and delivery admissions where patients have more time to make a choice	No correction for severity of illness or socio-economic status Each hospital given equal weight Well adjusted for potential confounders

Table 3 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Folland (1983)	All 58 nonfederal general medical-surgical hospitals in South Dakota, a predominantly rural area. 1977 All patients served by the hospitals during the year. Retrospective cross sectional	How does distance and size of hospital affect market share?	A conditional logit model estimated by ordinary least squares regression using a variety of independent variables against an area wide patient origin survey to predict market shares parsimon-iously	Estimated coefficients of the market share equation (t values in brackets) model 1 model 2 Distance -1.35 -1.63 (27.7) (40.4) Beds 0.92 (23.6) Rσ 0.450 0.656 Distance accounts for almost half the variance in the market shares	If patients have a choice they prefer a nearby hospital and a bigger hospital.	The process of referral in the United States is different from that in the U.K. Well adjusted for potential confounders

Table 3 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Gittelsohn et al (1995)	The Wicomico vascular surgery unit in Salisbury, Maryland, serving residents on the Eastern Shore. 1985-1987 13,009 males age 35+ (4427 diagnostic, 1237 surgical, 7345 medical) Cross sectional	How does distance affect admission rates for vascular procedures and heart disease?	Multiple regression logistic models by age and race with distance coefficient	The odds ratios comparing the relative incidence for distant (>80 miles approximately) and near (<20 miles approximately) cases were: Diagnostic: cerebral arteriography .30 coronary angiography .18 Surgical: angioplasty .17 coronary bypass .24 carotid endarterectomy .21 Medical: acute M. I. 1.01 angina pectoris 1.09 heart failure .96	Distance played an important role in determining use of discretionary surgery. Medical admissions for heart disease were not influenced by distance	It is not clear whether the rates for vascular surgery represent excessive use of a nearby facility or under-utilisation by those living at a distance The significance of the facilities in Boston (on the western shore) is not examined Partially adjusted for potential confounders
Goodman et al (1994)	Maine, New Hampshire and Vermont 1985 through 1989 Children <15 years old (589,290 in 1989): 120,806 discharges over the 5 years Cross sectional	How is utilisation affected by travel time to hospital (range 0 - 120 minutes) or the presence of an academic medical centre?	Logistic regression to estimate the probability of admission for all medical DRGs, given the characteristics being examined	Odds ratio of admission for medical DRGs: Residing in a zip code with a travel burden of 30 minutes 0.85 (0.83 - 0.87) Presence of an academic medical centre in the community 0.67 (0.64 - 0.70)	Utilisation of inpatient services for children <15 years old decays with distance Presence of an academic centre reduces inpatient admissionsfor children <15 years old.	No control for severity of illness, or use of outpatient facilities Partially adjusted for potential confounders

Table 3 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Greenberg et al (1988)	New Hampshire and Vermont: 2 university affiliated cancer treatment centres (with the only medical oncologists) and >40 community hospitals 1973 through 1976 1615 (out of 1904) adult lung cancer patients Cross sectional	Is the referral of lung cancer patients to the University cancer centres (UCCs) affected by distance?	Odds ratios (ORs) of diagnosis and referral from multiple logistic regression analysis which included age, sex, marital status, insurance, functional status, disease stage and cell type, distance, and month of diagnosis.	Odds of diagnosis or treatment at a University Cancer Treatment Centre for lung cancer. miles from UCC / %diag. at UCCs / OR / P val. <25 / 70 / 1.00 / 25-49 / 43 / 0.29 / <0.001 50-74 / 17 / 0.08 / <0.001 75+ / 9 / 0.04 / <0.001 miles from UCC / %refd.. to UCCs / OR / P val. <25 / 57 / 1.00 / 25-49 / 48 / 0.62 / 0.099 50-74 / 14 / 0.10 / <0.001 75+ / 9 / 0.05 / <0.001	Diagnosis at the UCCs and referral for treatment there is strongly related to the patients distance from them. The decline in use with increased distance is geometric	Cost considerations may be significant for referrals where the likelihood of increased survival is small Well adjusted for potential confounders

Table 3 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Grumbach et al (1995)	The states of New York (NY) and California (Cal) and the Canadian provinces of Ontario (Ont), Manitoba (Man), and British Columbia (BC). 1987 through 1989 Patients receiving coronary artery bypass graft surgery (CABGS) during the period: 61,746 in Cal, 36,569 in NY, and 18,278 in Canada. Retrospective cross sectional	Is the CABGS rate affected by the distance to the nearest hospital which carries out CABGS?	Examination of the CABGS rates per 100,000 adult population (after correction for age, sex, and out of state CABGS)	CABGS rates per 100,000 adult population miles to nearest CABGS hospital — Ont / BC / Cal / NY 0-<5: 67 / 66 / 99 / 83 5-<25: 60 / 73 / 111 / 109 25-<50: 58 / 63 / 148 / 105 50-<100: 77 / 77 / 99 / 81 =>100: 72 / 80 / 69 / 47 overall: - / 66 / - / 113 / 97 (data for Man not given) In Ont and BC the rates of CABGS vary little across distance categories. In Cal and NY rates tend to peak at between 5 and 50 miles (this continued to be the case after controlling for income, elderly, and African-American race.)	Distance in Ont and BC is not associated with lower rates of CABGS.	No population risk adjustment. Small numbers where =>100 miles to nearest CABGS hospital in Cal and NY Partially adjusted for potential confounders

Table 3 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Haynes et al (1979)	See Table 2 for details)					
Launoy et al (1992)	The department of Calvados in France. 1978-1984 1331 colorectal cancers out of 1445 in the period Retrospective cross sectional	Does distance affect access to specialised treatment?	Statistical analysis using the $\chi\sigma$ test, student's t test and the Mantel-Haenszel adjustment method.	% of patients treated in specialised centres in Caen Patients residence Other Caen Urban Rural Male 62 53 43 Female 65 45 35 (all differences P<.05) Womens diagnosis Urban Rural Severe clinical symptoms 15.5% 22.1% Metastases 12.3% 18.8% Relative risk of death from colorectal cancer for rural women 1.3 (P<0.02) compared to those living nearer to the hospital. There were no significant diagnostic differences for men	Patients are less likely to receive specialised treatment the further they are from the specialised centre. The greater frequency of severe clinical symptoms and metastases in rural women suggests a delay in diagnosis, leading to a relatively poor prognosis because of later access to treatment.	There may be rurality effects other than distance - health education and awareness for example. Partially adjusted for potential confounders

Table 3 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Packer et al (1995)	North Worcestershire. 1993-1994 All those patients admitted as general medical or geriatric emergencies to the main providers for the residents of North Worcestershire Health Authority. Cross sectional	Is there a relationship between emergency admission rates and the distance from the District General Hospital (DGH) to the practice which serves the patient?	Regression analysis of the emergency admission rate per 1000 practice population against distance of practice from a DGH. (There are 40 practices. 39 are less than 8 miles from a DGH and one is 15 miles away.)	A = 30 - 0.83D A = emergency admission rate. D = distance from DGH in miles General medical and geriatric emergency admission rates reduce as distance from the hospital increases.	Concentration is likely to reduce emergency access to hospitals.	The patients distance from the practice mignt vary considerably in this rural area. Partially adjusted for potential confounders

Table 3 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Roos et al (1985)	Manitoba 1973 through 1978 All 1889 total hip replacements (THRs) performed on patients 25 and older 1973-1978 Cross sectional	Is access to THR in Manitoba affected by distance or centralisation?	Analysis of age and sex adjusted THR rates for Manitoba's 8 regions. Comparison with Olmstead County and Massachusetts	Six years (1973-78) THR per 100,000 / No. of cases Winnipeg 244 781 Brandon 258 60 Western 277 168 Central 252 112 Eastern 165 42 Interlake 291 85 Parkland 197 68 North 209 23 (Distance increases moving down the table) Manitoba (annual average 1977-1980) 27 per 100,000 Olmstead County (annual average 1977-1980) 53 per 100,000 Massachusetts (1980) 29 per 100,000	Variations in THR rates are not related to geographical distance from the referral centre. Olmstead County is the site of the Mayo Clinic and is estimated to have rates 1.7 to 2.1 times those for the United States generally. There is no evidence that centralisation has restricted the overall rate of THR	There is government assistance with travel and medical services for the remote communities. No statistical analysis. Partially adjusted for potential confounders

Table 3 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Roos et al (1989)	Manitoba (where Winnipeg does all the coronary artery bypass graft (CABG) surgery for the province and the hospital in Brandon,Western Manitoba, does none) 1977 - 1984 All patients >24 with CABGs Cross sectional	Is there any variation in referrals to a centrally located teaching hosital?	Intra-province analysis of rates for CABG surgery, adjusted for age and sex.	Mean annual rate per 10,000 population aged >24 Coronary Angiography / CABG surgery Central 9.2 / 3.1 Eastern Manitoba 9.7 / 4.3 Interlake 9.8 / 4.2 Northern Manitoba 12.0 / 5.4 Parkland 9.2 / 3.2 **Western Manitoba 5.5 / 2.6** Winnipeg 11.7 / 4.7 Manitoba overall 10.3 / 4.7 Rates in Western Manitoba are 55% of the average and the lowest in the province.	The low rates for Western Manitoba may indicate a reluctance by physicians to refer to the centrally located teaching hospitals in Winnipeg. .	No significant relationships were found when checking against comorbidity and rates of acute myocardial infarction Partially adjusted for potential confounders

Table 3 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Slack et al (1994)	Bassetlaw (BL) and Nottingham (NG) health authorities, located within Trent regional health authority. Financial year 1988-89 All residents of the 130 electoral wards (27 in BL and 103 in NG) within the 2 health authorities. Cross sectional	Are hospitalisation rates (for general medicine, paediatrics, general surgery, trauma and orthopaedics, and geriatrics) affected by the distance between the patients ward of residence and the hospital?	Multiple regression of hospitalisation rates against number of GP's in the ward, unemployment rate for the ward, access score (a weighted aggregate of private and public transport times from ward of residence to hospital) and proportion of population >65 in the ward.	Regression coefficients (P value in brackets) by health authority where hospitalisation rate is the dependent variable. Independent variables: BL / NG No. of GP's: 3.2 (0.07) / 0.5 (0.28) Unempl-oyment: 4.3 (0.00) / 2.4 (0.00) Access score: -5.3 (0.00) / -1.8 (0.04) Population >65: -1.6 (0.26) / 1.8 (0.00) Constant: 114.9 / 49.2 Rσ: .58 / .56 Accessibility is a significant factor in explaining these hospitalisation rates at ward level.	Concentration may reduce hospital utilisation rates.	No corrections for sex. Partially adjusted for potential confounders

Table 3 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Walmsley (1978)	18 small hamlets within 50 km of Coffs Harbour and District Hospital in New South Wales, Australia. 1972-3 and 1973-4 676 self referred outpatients in 1973-4 (a 5.6% sample) 1162 inpatients in 1972-3 and 1973-4 (a 12.3% sample) Cross sectional	How does distance from the hospital affect utilisation by self referred outpatients, and utilisation and length of stay (LOS) for inpatients?	Simple correlation, and regression of the log of patients per 100 population (Log P) against distance of patients place of residence from hospital (D).	Correlation between LOS and D = +0.036 There is therefore no relationship between LOS and patients distance from hospital. For outpatients: Log P = 1.92 - 0.029D For inpatients: Log P = 1.32 - 0.017D The number of self presenting patients falls away more quickly than the number of referrred patients.	Increased distance because of concentration is likely to reduce utilisation of hospital services, more so for outpatients than for inpatients	No adjustment for any potential confounders. Not adjusted for potential confounders

Table 3 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Wood (1985)	Grampian region in NE Scotland 1971 and 1972 All patients discharged after Mastectomy, Repair of Hernia, Appendicectomy, and Vein operations Retrospective cross sectional	Does distance from hospital affect utilisation or Length of Stay (LOS)?	Data was examined using $\chi\sigma$ tests, multiple regression and correlation coefficients between utilisation and access variables(practice/hospital distance >35 miles (PHD), % of practice patients >3 miles away (%>3), % of practice patients >5 miles away (%>5))	There were significantly (5% confidence level) lower discharge rates (all operations) for males (but not for females) >35 miles from Aberdeen Correlation Coefficients for All operations PHD %>3 %>5 Age 0-64 +0.14 -0.15 -0.17 64-74 -0.25 -0.34 -0.30 75+ -0.19 -0.31 -0.30 Regression results showed a significant relationship between distance and pre-operative LOS for female patients, particularly for mastectomies and hysterectomies. For post-operative LOS there was a distance effect for mastectomies, female hernia and vein operations, and male appendicectomies	The effects of distance appears to be selective. Distance from hospital is shown to affect utilisation amongst the elderly. Distance from GP is also shown to affect utilisation LOS is shown to be affected by distance for certain operations.	Partially adjusted for potential confounders

TABLE 4
DISTANCE AND VISITING

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Cross et al (1974)	All nine geriatric units within the county of Shropshire (population 337,100). The week 19-25 June 1972. All visitors to all patients in the nine geriatric units Cross sectional	What is the relationship between the frequency of visiting and the distance between the hospital and patients homes?	Comparison of visits to short stay (SS) and long stay (LS) patients by the distance to their homes.	The percentage (%) of patients visited and the mean number of visits per patient (MV) by type of patient and distance between patients home and hospital. Distance in miles: SS patients % MV; LS patients % MV 0-5: 96 8.3; 78 3.7 >5-10: 93 7.0; 78 3.5 >10-15: 98 8.6; 73 2.6 >15: 97 6.0; 61 1.8 All: 96 7.7; 75 3.3 Visiting to short stay patients was not afected by distance. Visits to long stay patients decreased gradually at distances over 10 miles.	Concentration of long stay geriatric facilities is likely to reduce their visitors. Short stay geriatric patients may not be affected at the distances considered.	There is no adjustment for any potential confounders. Not adjusted for potential confounders

Table 4 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Giacoia et al (1985)	Regional intensive care unit in Tulsa, Oklahoma August 1983 to February 1984 167 newborn infants (68 from metropolitan Tulsa and 99 from rural north eastern Oklahoma Cross sectional study and survey	Does distance affect visiting by parents of new born infants?	Simple comparison of means without adjustments Questionnaire to parents	Distance, visits and % of patients identifing distance as a limiting factor Distance (miles) — Number — Visits/ week — % In Tulsa: 68 — 6.6 — - 25-50: 36 — 5.4 — 4.3 51-75: 32 — 2.8 — 6.3 76-100: 16 — 2.0 — 12.5 >100: 16 — 2.1 — 43.8	The frequency of parental visits declines as distance increases, which may cause stress at a vulnerable time for the parents.	Not adjusted for potential confounders, such as severity of condition or length of stay.
Haynes et al (1979)	See Table 2 for details					

TABLE 5
DISTANCE AND SCREENING

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Bentham et al (1995)	Norfolk, England 1-11-88 to 31-10-89 Women aged 35-64 receiving invitations to cervical cytology screening Before and after	How does rural remoteness affect non-response to cervical cytology screening?	The relationship between non-response rates and possible explanatory variables was examined by means of regression analysis	Uptake under the old system of opportunistic screening decreased with remoteness. (It was also found to increase with a female GP) Under the new population based call and recall system remoteness was no longer significant.(The presence of a female GP continued to encourage higher levels of response)	Effective and coordinated population approaches may help to overcome access problems for screening. Access to a female GP may be of significance in this and other situations.	
Haiart et al (1990)	Mobile mammography unit operating in 18 towns in East and Mid Lothian 1986 23,229 women aged 40 to 64, of whom 5,631 attended screening Cross sectional	How does distance affect the uptake of opportunistic screening for breast cancer?	Multiple regression analysis of factors influencing attendance .	Distance between home and screening site had the greatest affect on attendance (overall atttendance 24.2%) Multiple regression coefficient for effect of distance on attendance: -0.24 (t value = -3.7) The results show that in this case a 10% increase in distance leads to a 2.4% reduction in attendance.	Opportunistic screening where no personal invitations are issued suffers from a significant distance decay effect and a low response rate	No age related distance analysis. Well adjusted for potential confounders

TABLE 6
DISTANCE AND WILLINGNESS TO TRAVEL

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Howell et al (1990)	Princess Alexandra Hospital, RAF Wroughton, Wiltshire November 1988 - April 1989 116 patients from Crewe. Cross sectional survey	Is long distance travel for elective surgery acceptable to patients on a lengthy surgical waiting list?	Questionnaire to those who travelled to Wiltshire.	"About half" of those offered the facility of travelling 120 miles for their routine elective operation accepted (those who accepted had waited an average of 28 months) 113 of the 116 who travelled responded to the questionnaire: 60 (113) would prefer to travel rather than wait 3 (24) months 102 (75) would travel up to 50 (300) miles (no cross tabulations)	A significant number of patients are prepared to travel to avoid further waiting for routine elective operations They are prepared to travel long distances of up to 300 miles	The study may be biased by only interviewing those who had already travelled. Not adjusted for potential confounders

Table 6 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Nofal et al (1990)	Princess Alexandra Hospital (PAH), RAF Wroughton, Swindon February and April 1989 130 children from Mid-Glamorgan who had been waiting for >2 years for tonsillectomy or adenoidectomy Retrospective cross sectional	Will children travel for a long awaited operation? (Accompanied by a parent)	Simple analysis of outcome of clinical review and examination of 130 children	Outcome of review of children waiting for >2 years for tonsillectomy or adenoidectomy Total 130 Spontaneously resolved 37 Offered operation at PAH 83 Accepted 79 Refused 4 (both parents working)	Distance may be acceptable if immediate surgery is offered	No information on basis for selecting those reviewed or on how much longer they would have to wait Not adjusted for potential confounders

TABLE 7
DISTANCE AND OUTCOME

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Jones (1996)	The 403 Local Authority Districts in England and Wales 1988-1992 100,692 deaths from 8 causes of avoidable mortality: Malignant neoplasm of the female breast (MNFB) (21,436) Malignant neoplasm of the cervix uteri (MNCU) (4,374) Diabetes Mellitus (DM) (1,806) Hypertension and stroke (H&S) (9,682) Asthma (ASTH) (2,030) Peptic ulcer(PU) (7,235) Mortality in the first 28 days of life (28DM) (22,262) Road traffic accidents (RTA) (31,867) Retrospective cross sectional	Is mortality in England and Wales from the 8 specified causes affected by distance to the nearest hospital?	Multilevel regression analysis examining the relationship between levels of mortality and measures of health services accessibility (distance from the nearest acute hospital (0-4 km, >4-8 km, >8-13km, >13-22 km, >22 km) and distance weighted GPs per capita), socio-economic circumstance, and behavioural characteristics .	Each model was fitted on a 'best fit' basis. The addition of the categorical distance variables was significant for the following causes, where greater distance from the nearest hospital was associated with increasing mortality: DM, ASTH, 28DM, RTA. (No significant realationship for the remaining causes: MNFB, MNCU, H&S, PU.) The addition of the GP variable (England only) was significant for the following causes where increased mortality was associated with less accessible GPs : MNFB,PU. (No significant realationship for the remaining causes: MNCU, DM, H&S, ASTH, 28DM, RTA.)	The results indicate that mortality may be affected for certain conditions by the distance-accessibility of the hospital and GP, which would call for corrrective action if equity is to be maintained Careful analysis of the local situation would have to be undertaken for meaningful guidance	Potential confounders may be missing, such as the type of roads later found to be significant in RTAs. The value of the GP accessibility variable (from IRSS, York) is doubtful Well adjusted for potential confounders

Table 7 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Jones et al (1995)	The 18 ambulance stations and the 3 accident and emergency facilities in Norfolk, England 1987-1991 The 464 fatally injured casualties and 464 other seriously injured casualties involved in road traffic accidents (RTAs) during this period Cross sectional	Are outcomes affected by ambulance response times or the time taken to reach an A & E facility?	Logistic regression examining relationship between outcome for each casualty and emergency medical services response	Ambulance to accident time (max. 23 mins), accident to hospital time (max. 31 mins) and total ambulance journey time (max. 52 mins) were not found to be statistically associated with outcome	A&E facilities for the treatment of seriously ill casualties in Norfolk are concentrated in three towns. This does not affect outcomes for casualties in RTAs.	Controlled for accident characteristics including age, road type, and weather Well adjusted for potential confounders

Table 7 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Karjalainen (1990)	The 21 hospital districts of Finland. All practice cancer surgery and 8 had radiotherapy units giving external beam theraoy. 1970-1981 All 16754 breast and 9483 prostatic cancer patients diagnosed in Finland in the period.These were allocated to 21 groups corresponding to the 21 hospital districts. Cross sectional	Does centralisation of radiotherapy facilities affect the survival of patients?	Analysis of the distribution of standardised survival differences for each hospital district for each type of cancer and for localised and non-localised tumors.	Breast cancer. Range of crude 5 year survival rates: 53-67% Range of 5 year relative survival rates: 59-76% There was more variation than expected by chance, with slightly better survival for patients with non-localised tumors living in districts with a University hospital with a radiotherapy unit. Prostatic cancer. Range of crude 5 year survival rates: 20-42% Range of 5 year relative survival rates: 30-65% There was no indication of variation greater than expected by chance.	The centralisation of radiotherapy facilities does not appear to have had an effect on the five year survival rates for patients. (The differences in survival were related to university hospital districts rather than to districts with a hospital radiotherapy unit)	Well adjusted for potential confounders

Table 7 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Kelly et al (1974)	The eastern townships of Quebec, a semi rural area 1-1-70 to 31-12-71 371 dead children < 5 years old and a probability sample of 264 living children (from a population of 45,000 children <5 years old) Retrospective case control	Does distance from hospital affect mortality in children <5 years old? Deaths from Acute Medical Post Neonatal Syndromes (AMPNS) were also compared separately. They include respiratory, unexplained, gastro-intestinal and other acute medical (e.g. meningitis) deaths.	Comparative analysis of the two groups of households using the $\chi\sigma$ test. (Socio-economic variables could not be shown to be related to higher death rates)	Distance from the nearest hospital in miles: % of 264 Living; % of 371 Dead; % of 47 AMPNS <10: 66.7; 63.9 (NS); 48.9 (SIG) 10-<20: 17.0; 17.0; 19.2 20-<30: 13.3; 10.8; 14.9 30+: 3.0; 8.3; 17.0 There is no significant difference (NS) in the locational pattern of the households of the living and the dead children There are significantly (SIG) more deaths from AMPNS in distant households. AMPNS is a subset of "other causes of death" in the original analysis, which also had significantly more deaths in distant households.	Adequate care must be within a reasonable distance to avoid a surplus of AMPNS deaths	There was insufficient data to consider the effect of distance from primary care.

Table 7 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Ozminkowki et al (1993)	The United States 1986 and 1987 22,936 heart (14,307) and liver (8,629) disease cases of whom 398 were heart (211) or liver (187) transplant recipients Cross sectional	Is receipt of a transplant influenced by the distance from a transplant centre?	Multivariate logistic regression analysis of the probability of receiving a transplant	Where distance between residence and approved transplant centre > 50 miles: Relative odds of receiving a heart or liver transplant were not significantly different from 1.	The higher risk of spoilage if the organ is stored longer has had no influence in this study	The number of transplants is small Well adjusted for potential confounders
Sampalis et al (1993)	Montreal 1-4-1987 through 31-3-1988 360 severely injured patients chosen by a multi-stage sampling scheme from 8007 trauma victims during the period. Of the 360, 72 died within 6 days and 288 survived for 6 days or longer. Cross sectional	Does pre-hospital time affect the outcome for severely injured patients?	Multivariate logistic regression to estimate the relative odds of dying within 6 days.	After controlling for type of injury, injury severity, level of prehospital care,and level of in-hospital care, a total prehospital time >60 minutes was associated with a statistically significant threefold increase in the odds of dying within 6 days. OR = 3.0 (95% CI = 1.3 - 5.1) (P = 0.012)	If concentration increases prehospital time to >60 minutes for severely injured patients then more will die within 6 days.	Well adjusted for potential confounders

Table 7 (Cont'd)

Study	Setting, dates, patient numbers, study design	Questions posed	Method	Results	Implications	Commentary and quality
Wilson (1984)	The 13 Health Boards in Scotland 1974-77 Numbers not given Cross sectional	Is death from asthma related to rurality?	Comparison of asthma mortality and the sparsity factor of the health board.	The correlation between asthma mortality and the sparsity factor for each health board for all ages 1974-1977 r=0.75 (P=0.01) (The sparsity factor is the ratio of the observed number of 'patient units' in a health board area to the expected number, based on the whole of Scotland. A 'patient unit' is calculated from the distance of each patient from the general practitioner's base.)	There is a positive relationship between remoteness and mortality from asthma.	Doubts about the accuracy of death certification for older people. No correction for possible confounders Not adjusted for potential confounders

APPENDIX A

Search strategy

Date: 10-Apr-96
Name: mike96
Database: Medline

Set	Search
001	centrali#ation.tw
002	centrali#ed.tw
003	decentrali#ation.tw
004	demography.tw
005	decentrali#ed.tw
006	distance$.tw
007	geographic.tw
008	(gravity adj model).tw
009	"health facility closure"/
010	"health facility merger"/
011	regional health planning/
012	regionali#ation.tw
013	speciali#ation
014	exp catchment area health
015	exp centralized hospital services/
016	(hospital adj closure).tw
017	or/1-16
018	exp health services accessibility/
019	exp hospitalization/
020	exp hospitals/
021	(acces$ adj3 (service or services or hospital or hospitals))
022	or/18-21
023	(treatment adj uptake).tw
024	exp choice behaviour/
025	exp patient acceptance of healthcare/
026	patient dropouts/
027	small area analysis/
028	or/23-27
029	exp asia central/
030	exp asia southeastern/
031	china/
032	korea/
033	macao/
034	mongolia/
035	taiwan/
036	bangladesh/
037	bhutan/
038	india/
039	nepal/

040 pakistan/
041 sri lanka/
042 south america/
043 exp africa central/
044 exp africa eastern/
045 exp africa northern/
046 exp africa western/
047 namibia/
048 or/29-47
049 psychiatric.tw
050 "mental disorders"/
051 (17 and (22 or 28) not 48 not 49 not 50)
052 (17 and (22 or 28) not (48 or 49 or 50))
053 52
MIKEFULL.DOC

The following databases were searched using the Dialog Onesearch option to identify duplicates:

File 155:MEDLINE(R) 1966-1996/May W5
File 151:Hlth.Plan&Admin 1975-1995/
File 73:EMBASE 1974-1996/Iss 14
File 35:Dissertation Abstracts Online 1861-1996/Apr

1 centrali$ation or centrali$ed or decentrali$ation or decentrali$ed
2 centrali?ation or centrali?ed or decentrali?ation or decentrali?ed
3 demography or demography/de or geography/de
4 distance? or geographic
5 gravity()model
6 health()facility()closure/de or
7 regional()health()planning/de or regionali?ation or speciali?ation
8 urbanization/de or urban()poulation/de
9 urban()population/de or regionalization/de
10 catchment()area()health?/de or dc=i1.700 or centralized()health()services?/de
11 health()care()organization/de
12 hospital()closure
13 centralized/de
14 s2-s13
15 health()services()accessibility?/de
16 hospital()bed()capacity/de
17 hospitalization?/de or health()care()access/de or health()care()availability/de
18 hospitals?/de
19 access?(3w)(service or services or hospital or hospitals or center? or centre? or facilities)
20 s15-s19
21 s14 and s20
22 treatment()uptake or choice()behavior?/de or patient()acceptance(2w)health()care?/de
23 patient()dropouts/de or small()area()analysis/de
24 population()dynamics/de or population()density/de or population()structure/de
25 hospital()utilization/de or patient()attitude/de
26 hospital()bed()utilization/de or treatment()failure/de or treatment()outcome/de

27 patient()compliance/de or patient()satisfaction/de
28 outcome or outcomes or compliance or dropout?
29 s22-s28
30 s21 and s29
31 asia()central?/de or asia()southeastern?/de
32 china/de or korea/de or macao/de or mongolia/de or taiwan/de or bangaldesh/de or bhutan/de
33 bangladesh/de or india/de or nepal/de or pakistan/de or sri()lanka/de
34 south()america?/de
35 africa()central?/de or africa()eastern/de or africa()northern?/de or africa()western?/de
36 namibia/de or cc=k2.20.20? or cc=k2.20.60? or cc=k4.60?
37 dc=k2.20.20?
38 dc=k2.20.60? or dc=k4.60? or dc=k2.10?
39 s31-s38
40 s39 not (japan/de or korea/de or south()africa/de)
41 s30 not s40
42 psychiatric or mental()disorders/de or dc=f1? or dc=f3? or dc=f4?
43 s41 not s42
44 remove duplicates

IAC Management Contents on Knight-Ridder Dialog

1 centrali?ation or centrali?ed or decentrali?ation or decentrali?ed
2 distance?
3 gravity()model?
4 closure or merger
5 regional()planning or regionali?ation
6 s1-s5
7 access? or availability
8 s6 and s7
9 hospital? or health or patient? or medical()treatment?
10 s7(5w)s9
11 s10 and s6

SIGLE

1 centralisation or centralization or decentrali:
2 demograph: or geographi: or distance:
3 merger: or closure: or catchment
4 2 or 3 or 4
5 access: or availability or transport
6 hospital or medical or health
7 4 and 6 and 5

DHSS-Data on Knight Ridder Datastar

1 population-dynamics.DE.
2 population-factors.DE.
3 distance$ OR geographic OR gravity ADJ model$

4	hospital WITH (closure$ OR merger$)
5	mergers.DE. AND hospitals
6	regional$ WITH (care OR unit OR units OR facility OR facilities OR service$ OR hospital$)
7	centrali$ WITH (care OR service OR services OR facilities OR unit OR units OR hospital$)
8	regional WITH (center OR centre OR centers OR centres)
9	speciali$ WITH (care OR unit OR units OR facility OR facilities OR service$ OR hospital$)
11	catchment-areas.DE.
12	site-location.DE.
13	regional-health-services.DE.
14	regional-hospitals.DE.
15	centralised-health-services.DE.
16	supraregional-health-services.DE.
17	hospital-decentralised-services.DE.
18	decentralised-health-services.DE.
19	central-services.DE. OR decentralisation.DE. OR centralisation.DE. OR integration.DE. OR specialist-hospitals.DE.
20	2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9 OR 10 OR 11 OR 12 OR 13 OR 14 OR 15 OR 16 OR 17 OR 18 OR 19
21	access-routes.DE. OR patient-access-routes.DE. OR public-transport-routes.DE. OR staff-access-routes.DE. OR approach-roads.DE.
22	access-to-health-care.DE.
23	access OR accessibility
24	availability
25	21 OR 22 OR 23 OR 24
26	20 AND 25

GEOBASE on Knight Ridder Dialog (1980-1996/Jun)
A very broad search was undertaken first, followed by this more specific search.

Set	Description
S1	CENTRALI? OR DECENTRALI?
S2	DEMOGRAPHY OR GEOGRAPH?
S3	DISTANCE?
S4	GRAVITY()MODEL?
S5	CLOSURE?
S6	REGIONALI?ATION OR SPECIALI?ATION
S7	URBANI?ATION OR URBAN()POPULATION
S8	CATCHMENT()AREA?
S9	SPATIAL()ASPECT/DE
S10	URBAN HEALTHCARE/DE
S11	HEALTHCARE PLANNING/DE
S12	MEDICAL GEOGRAPHY/DE
S13	SPATIAL PATTERN/DE
S14	LOCATIONAL BEHAVIOR/DE
S15	DISTANCE-DECAY PATTERN/DE

S16 HEALTH SERVICES LOCATION/DE
S17 SPATIAL ANALYSIS/DE
S18 DISTANCE EFFECT/DE
S19 SPATIAL DISTRIBUTION/DE
S20 CATCHMENT AREA/DE
S21 RESIDENCE LOCATION/DE
S22 TRAVEL-TIME COST/DE
S23 HEALTH SYSTEM DECENTRALISATION/DE
S24 DECENTRALISATION/DE
S25 S1-S24
S26 HEALTH()SERVICE?
S27 HOSPITAL? OR HEALTHCARE OR HEALTH()CARE OR PATIENT?
S28 MEDICAL OR SURGICAL
S29 S26-S28
S30 S25 AND S29
S31 ACCESS? OR AVAILABILITY
S32 HEALTHCARE ()PLANNING/DE
S33 HEALTH CARE ACCESS/DE
S34 MEDICAL PROVISION/DE
S35 HEALTH SERVICE UTILISATION/DE
S36 BED CLOSURE/DE
S37 HEALTH SERVICES LOCATION/DE
S38 HEALTH CARE DEMAND/DE
S39 TRANSPORTATION/DE
S40 HOSPITAL ACCESSIBILITY/DE
S41 S31-S40
S42 S30 AND S41
S43 DEVELOPING WORLD/DE
S44 S42 NOT S43

APPENDIX B

Databases

The following databases have been searched:

Medline	(1976-1996)
Embase	(1974-1996)
Health Planning and Administration	(1975-1995)
Dissertation Abstracts	(1961-1996)
Management Contents	(1986-1996)
PAIS (Public Affairs Information Service)	(1976-1996)
Magazine Index	(1959-1996)
DHSSDATA (Database of the Department of Health)	
NTIS (National Technical Information Service)	
BIDS: Social Science Citation Index	(1983-1996)
Sociological Abstracts	(1963-1996)
Applied Social Science Index and Abstracts	(1987-1996)
International Bibliography of the Social Sciences	(1983-1996)
SIGLE (Database of Grey Literature)	
GEOBASE (Geographical Database)	(1980-1996/Jun)

APPENDIX C

Data Extraction Form

Reviewer :
Date:

Reference

Author

Title

Source

Year

Objectives of the study

Access component

Setting

Dates of activity

Centre information

Description

Location

Patient information

Description

Numbers and groupings

Description of study

Quality of study

Source of patient information

Source of other information

Experimental or observational

Study design

RCT
Non-randomised control trial
before/after
prospective cohort
retrospective cohort
Case-control
cross sectional

Adjustment for confounding factors
case mix
socio-economic factors
other (specify)
none

Possible confounders (not adjusted for)

Measurements

for example: utilisation, distance-decay, compliance, waiting times, health outcome

Statistical methods used

Results

Effects of concentration on:
each identified factor of accessibility

Authors Comments

Reviewers comments

APPENDIX D

People who were contacted to help identify research literature

Graham Bentham - UEA

Gwyn Bevan - Bristol

Mary Button - Womens Nationwide Cancer Control Campaign -

Cancer Relief Macmillan Fund

Martin Clarke - GMAP

Christine Farrell - Kings Fund

Tony Gatrell - Lancaster

Ethna Glean - The College of Radiographers -

Bob Haward - Leeds

Andrew Jones - UEA

Henry Kitchener - St. Marys

Graham Moon - Portsmouth

National Council for Hospice and Specialist Care Services

Stan Openshaw - Leeds

Nigel Rice - CHE

Royal College of Physicians

Royal College of Radiologists

Royal College of Surgeons of England

Karol Sikora - Imperial Cancer Research Fund -

Peter Smith - DERS

Ian Watt - CRD

Ciaran Woodman - Christie

APPENDIX E

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