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Outreach and access to specialist services
Evidence from the general psychiatry in Scotland

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Paper A040

Health Economists' Study Group

York, 26-28 July 2006

Abstract

The absence of prices at many points of access in the United Kingdom give play that other influences on the allocation of resources. This is explored in the context of a GP referred service. Distance and waiting time are considered to have an allocative function, but we found they had a very modest part, if any, when it came to GP referrals and patient attendance rates. One reason is that GPs have conflicting roles: gatekeeper to the NHS, and agent to the patient. One reason why distance and waiting time have their modest role is the dominance of the gatekeeper role. Action normally follows from GP referral, and it is the delay in that action, in this case by specialists, which contributes to the allocative process.

Key words: Outreach; Distance decay functions; General psychiatry; Out-patient services

Acknowledgements

Unpublished data were provided by the Information & Statistics Division of the NHS in Scotland. Financial support from the Chief Scientist Office, grant number CZG/2/184.

1 Introduction

With the absence of charges at the point of access, factors such as travel time and costs are likely to assume greater importance in access to health services. Take up of health services has been found to fall with the distance to access. This relationship is explored in the context of the UK National Health Service [NHS]. The absence of prices also gives waiting time greater importance in rationing health services. The influences of waiting time, and particularly of distance, on access are explored in the context of specialist (consultant) referrals.

2 Access to specialist services in the UK NHS

Three parties are involved: the patient herself, her GP and the specialist. Typically the patient self-refers to her GP. This is the situation explored in this paper. The GP, in his role as 'gate-keeper', then decides whether referral to a specialist is appropriate. The specialist invariably accepts the referral, but decides its priority: patients judged 'urgent' wait less long than those judged 'soon'; 'routine' patients wait longest. The specialist is typically employed by the hospital services provider, and works from the hospital(s) run by the provider. Once the patient is introduced into the system, she may decide whether or not to see the specialist. If the patient persists in 'not attending' the specialist clinic, she is likely to be discharged back to her GP who must then decide whether re-referral to the specialist is appropriate.

Until recently, in practical terms, GPs' choice of provider has been restricted to a single local provider, though not necessarily at a single site. For example, Scotland is divided into fifteen health boards for administrative purposes and, as far as possible, each has local provision of the full range of its own specialist services. Health boards share some specialist services. They also try to avoid the duplication of facilities, and have been moving towards consolidation as fast as public opinion and finance allow. The consolidation of providers into a small number of largely health board based NHS trusts has reinforced this trend, though not necessarily at a single site. Indeed, a concern at the concentration of hospital facilities has lead health boards and NHS trusts to provide specialist services outside hospitals, in the community. We have more to say about this shortly. Patients may choose providers from other health boards, but it has not been common. Other parts of the UK shared this approach. Recently, however, the Department of Health in England has indicated a move from this administrative model towards the American metropolitan model of a fragmented system of hospitals, all competing for patients. In England GPs are expected to give patients a choice of four providers.

Outreach, of normally hospital-based services, in the community can address a number of perceived problems. First, if distance reduces access as the gravity model suggests, then outreach corrects this cost of access. In this scenario referral and attendance rates would be higher where patients *also* have the opportunity to see specialists at their local health centre. And second, quite apart from distance, there may be 'problem patients' in the sense that they have a record of non-attendance. In so far at they are perceived as 'patients with problems', then outreach could be a solution to their problem (): bring the service to patient, if the patient cannot be brought to the service. In this scenario, outreach would reduce non-attendance. In modelling terms it creates a simultaneity problem: outreach reduce non-attendance, but non-attendance leads to outreach.

In Scotland the outreach of specialist services has been closely linked to the health centre building programme, which took off in the 1960s. Health centres are publicly owned facilities at which GPs have their surgery and a variety of other health services may be found. Arguments in favour of this policy include (Macgregor, et al, 1980, pp 7-8):

"… many of the consultations and investigations required carried out under one roof …"
"Close collaboration between specialists and general practitioners …"

This argument was most forcefully put for specialties "… which relate more closely with the work of the primary health team namely maternity, paediatric, geriatric and psychiatric services."

The first health centre was built in 1953, the next two in 1955 and 1962. By 1976 there were 85 health centres, increasing to 188 in 1991 and 231 in 1998 (Milne et al 1992 and 2001).

It has been common for specialist clinics to be held at health centres, and most major specialties are represented. However, the preponderance of clinics is in two specialties, obstetrics and psychiatry (Milne et al, 2001). Outreach takes place in other locations: for example, in Grampian clinics have been held at several of its rural community hospitals. But this practice is not widespread.

Access is measured in terms of GP referrals, and patient attendances and non-attendance.

3 Modelling access

As mentioned above, the absence of prices in allocating many NHS services gives a role to distance and waiting time. The relationship between take-up and distance has long been recognised, and is commonly known as the 'distance decay function' (Shannon et al, 1969). Common forms are (Morrill and Kelly, 1970, Appendix):

$$U=a.D^{-b}, \text{ or} \quad (1)$$

$$U=a.e^{-bD}, \text{ where} \quad (2)$$

U is use per period. In this study it refers to the GP referral and patient attendance rates, where the population at risk is the GP's practice list. D is distance to point of access, and a and b are constants. b is the rate of decay, the coefficient of interest, and often found to be positive.

Distance has a negative influence on use because of the time and travel costs to patients and those accompanying them. If patients have a choice, the one offering easiest access is, *ceteris paribus*, most likely to be chosen, and could well be the nearest location.

Against these costs are the benefits of access. In the case of health care the benefits are *not* usually known with certainty. For example, the patient may be uncertain about her condition and the effectiveness of treatment. The less the uncertainty and the more effective the treatment, the greater would be her expected benefit.

For any given disease episode whose outcome is a consultant referral, the uncertainty is likely to be greatest at the first step the patient makes: that is, when deciding whether or not to visit her GP. Patients usually have to travel further to see the consultant, but the expected benefit promises to be greater. Not only has the GP's referral reduced the uncertainty of benefit, but the referral to specialist care also promises greater benefit.

GPs, as well as acting as 'gate-keepers' to the NHS, have a role as the patient's agent, and are expected to take her interests into account. In such situations the GP would balance the cost to the patient of specialist referral against its expected benefit. When the cost is high, the GP may decide referral is inappropriate, and continue to treat the patient himself. The failure of patients to take up referral may well be evidence that GPs and patients had different perceptions of the cost to the patient and her expected benefit. Aside from this difference, there is no *a priori* reason to expect distance to be associated with the non-attendance of those referred.

Waiting time is a market clearing device used by the specialists, and is a given *unknown* to GPs. Patients learn how long they must wait only after they have been referred. At best GPs have an indication how long this might be. We would not, therefore, expect waiting time to influence GP referrals. On the other hand, waiting time may well influence the patient's decision whether or not to attend. First, some patients claim to have forgotten appointments made, or their date and time (for example: Potamitis et al, 1994; and Gilhooly et al, 1994); and arguably, the longer the wait, the more likely patients will forget. This explanation lies behind a long standing policy of sending reminders and explains the recently introduced patient focussed booking initiative, whereby appointments are made only some four to six weeks in advance. And second, long waits give patients more opportunity to get better and, those that do, may fail to cancel the appointment.

The patient's age, sex and deprivation status are other influences that are correlated with non-attendance. Since these are known to the GP, their persistence suggests GPs act imperfectly as the patient's agent and instead take on a different role.

4 Review of the influence of distance

(a) Referral and utilisation

A number of studies have been published which give some idea of the distance decay function in the UK National Health Service. Details of four such studies are given in table 1. All four are on the *use* of health service: three refer to hospital admissions, one to out-patient attendances (Windmeijer et al, 2005), the subject of this paper. All four recognise patients may have a choice of hospitals within the health authority, but have addressed this in different ways. Only one makes explicit that choice (Windmeijer et al, 2005). Taken from the perspective of the reference hospital, distance to it deters referrals and distance to its alternative encourages patients to choose it. The large size of the elasticities, -0.70 and +0.57, respectively, suggest the two hospitals are close substitutes for patients in that health board.

Insert table 1

Two of the studies differentiate the urgency of treatment as a hospital admission (Croxson et al, 2001 and Gravelle et al, 2003). Arguable, the more urgent the treatment, the less the deterrent effect of distance. This is certainly confirmed in the case of one (Croxson et al, 2001). In the case of emergency admissions, distance had no statistically significant impact, with distances on average 10.77 kms. Non-emergency admissions had an elasticity of –0.039: much smaller that those cited where the choice between hospitals was directly addressed. The other study produced mixed results (Gravelle et al, 2003). For 'non-elective' read 'emergency' admissions, distance patients must travel to see their GP had no effect on admissions, even though the distance travelled on average was 12.05 kms. Distance from the GP's surgery to the hospital had a small but significant deterrent effect, with an elasticity of –0.048, where the average distance travelled was 23.78 kms. For 'elective' read 'non-emergency' admissions, the expected deterrent effect on patients contacting their GP is found. However, the distance from the GP's surgery to the hospital had the opposite to expected effect: long distances encouraged admission.

The two previous studies show the distance decay function had a very weak effect. The remaining study, of a specific elective surgical procedure, found it to have had a strong deterrent effect (Gravelle et al, 2002). The larger variation in distances patients had to travel may have been a contributory factor.

(b) Non-attendance

There has been much less analysis of the impact of distance on non-attendance; and such studies as have been published are generally less sophisticated, with few correcting for confounding influences. The selection given in table 2 are those few that made *some* correction for confounding influences. Notice all are based on American experience. In two studies the appointments were made by the patients themselves, and *not* referred services (Grudz, D et al, 1986); Smith and Yawn, 1994). In neither case did distance have a statistically significant effect on non-attendance. The study by Smith and Yawn (1994) is of particular interest because, *without* control for confounding influences, patients who lived more that three miles from the clinic were more likely to attend.

Insert table 2

The two remaining studies are of appointments made for all patients. In one case, the appointments were to complete drug rehabilitation treatment (Prue et al, 1979). In the other, the visit was to monitor the success of a clinical trail, and not an integral part of the patient's care (Orr et al, 1992). In neither case was there discretion about which patients should have an appointment: all required one, regardless of the perception of the costs and expected benefits to the patient. Some patients had long distances to travel whose cost could well be significant. It is, therefore, hardly surprising that distance is positively correlated with non-attendance.

5 Data

The study of practice referral, attendance and non-attendance draws upon two sets of data: those based on health centres as observations, and those based on patients as observations. The former set is used for the analysis of referral and attendance rates, and based on the lists of the GP practices with a surgery at the health centre. Both sets are used for the analysis of the non-attendance of referred patients. The two sets are taken in turn.

(a) Health centres as observations.

Surveys conducted in 1991 and 1998 identified 180 health centres open in mainland Scotland *both* years. The surveys identified which held specialist clinics on a regular basis [SESS], where was the nearest alternative provision, and its distance from the health centre by road [D]. GP practice data are used for practices which had their main and/or branch surgeries at these health centres. Several practices had surgeries at more than one health centre [DUP]; none had surgeries at more than two. Practice data are aggregated to obtain data by health centre.

The following practice data were used: the list size [P]; its age-sex composition; the distribution by deprivation status [Dep-J], based on the Jarman index; the number of GPs [GPs], their fundholding status [FHS] and the Scottish Rural Practices Fund. The data are for April 1993 and October 1997. The Jarman index has been used to pay GPs for the extra work patients from the more deprived locations are likely to cause. The Scottish Rural Practices Fund was used pay GPs for "… the scattered nature of the practice and the consequently increased time spent in visiting patients living at a distance …"(Scottish Executive Health Department, 2006, Part II, para 43.2). Payment was made for patients who lived more than 3 miles from the surgery; it increased with distance; and was conditional on reaching a certain threshold per GP. We used the Fund data to generate two measures of the distance patients must travel to see their GP [D-pat(cnt) and D-pat(exp)]. These same data are aggregated for the twelve mainland health boards to generate two measures of sparsity for the health board in which the health centre was located [SPARSITY(cnt) and SPARSITY(pay)].

New out-patient GP referrals in general psychiatry are based on SMR00 [R]. There were 27,956 referrals from GPs practising from the 180 health centres, of which 12,588 were for 1993 and 15,008 for 1998. Information was collected on each patient's age, sex, deprivation status, how long they waited for their first appointment [WAIT], and their attendance status – ie attended [A], did not attend [DNA]. The Carstairs Morris index of deprivation [Dep-C] is used, and differs in a number of ways from the Jarman index (McLaren and Bain, 1998).

The remaining explanatory variable is specialist provision in general psychiatry [CON]. This is measured in terms of full time equivalent specialists per capita by health board, with an adjustment for the cross health board boundary flow of patients to take account of services provided by some health boards for neighbouring health boards. In the early period specialists were employed by health boards, in the later by the NHS trusts. However, health boards have had only one trust providing specialist services in psychiatry, and it is assumed the trust served it host health board, except in so far as an adjustment was made for the cross boundary flow of patients.

(b) Patients as observations

It proved possible to link patients who had been referred in 1993 *and* 1998. In all there were 476 patients who had appointments in both years, were drawn from 117 of the 180 health centres, and are used for the analysis of non-attendance. As mentioned above, information is available for each patient's age, sex, deprivation status [using Carstairs Morris index], wait to first appointment, and attendance status.

Information on data definitions and their descriptive statistics are given in the Appendix and table 3, respectively.

Insert table 3

6 Model specification

(a) Referral and attendance rates:

A simple form of the model is given in equation 3.

$$U_t = \alpha_t + \beta^T X_t, \qquad (3)$$

where U = R/P and A/P,

and X is a vector of the following sets of explanatory variables:

- The spatial variables:
  D, D-pat(cnt), D-pat(pay), DUP, SESS, SPARSITY(cnt) and SPARSITY(pay)
- Other non-price rationing variables:
  WAIT
- Patient characterics:
  Dep-J
- Practice characteristics:
  GPs and SFH
- Specialist provision:
  CON

The strong possibility of unobserved heterogeneity suggests a difference-in-difference model such as equation 4 is less likely to give biased estimates, and is preferred to the single year estimates for 1993 and 1998.

$$U_t - U_{t-1} = \alpha + \beta^T [X_t - X_{t-1}], \qquad (4)$$

where subscripts 't' and 't-1' refer to 1998 and 1993, respectively.

Unfortunately, one variable of particular interest, D, is only available for 1998. Data had not been collected on it in the 1991 survey, though experience for other specialties suggest it would have taken the same value for most of the 180 health centres. If the coefficient of D were statistically significant, with only one year's value, that would suggest that the two years had different values of β. It would not indicate whether the sign of β was positive or negative.

A further problem estimates based on differences is the possible lack of variation in the values of the explanatory variables. We chose a period sufficiently long, and a specialty whose provision at health centres is known to have changed in many cases, so that it is possible to make a genuine test of association. Summary descriptive statistics are given later, to allow the reader to judge for him or herself.

It seems plausible that the set of coefficients β might take different values for 1993 and 1998. We, therefore, estimated the model given by equation 5, testing the null hypothesis, H_0, that $\beta_t + \beta_{t-1} = 0$. Rejecting the null hypothesis does not get us round the problem of D having a value for only 1998.

$$U_t\text{-}U_{t-1} = \alpha + (\beta_t)^T X_t + (\beta_{t-1})^T X_{t-1} \qquad (5)$$

In each case OLS estimates are obtained.

(b) Non-attendance rates

Non-attendance is the patient's response to the GP's decision to refer her to the specialist. The available data allow two approaches. One is to use health centres as observations; the other, patients as observations. Using health centres as observations, non-attendance rates, (R-A)/R, are estimated. Apart from WAIT, there is little *a priori* basis for including other variables. However, we have a model of referral and appointment rates, and it is used to estimate non-attendance. It could be argued that GPs refer, bearing in mind the possibility the patient will not attend. So we allow U = (R-A)/R.

Different possibilities open up when using patients as observations. With two years data, each patient faces four possible outcomes: Attended both years; Attended in 1993 and DNA in 1998; DNA in 1993 and Attended in 1998; DNA in both years. Nominal logistic regression analysis is applied to a similar set of explanatory variables. In terms of their measurement, however, age, sex, deprivation [Dep-C] and wait are all specific to the referred patient in question, not to the health centre's lists of patients.

(c) General points

Estimates are based on all the explanatory variables being exogenous: in other words there is no problem of simultaneous bias. However, as noted above, outreach [SESS] may depend on non-attendance, just as much as non-attendance on outreach. This is clearly a problem with health centres as observations: specialists might be quite willing to visit health centres regularly if patients at these health centre had a record of non-attendance. This, however, is scarcely credible with patients as observations: in such a case it is reasonable to assume outreach is exogenous.

The two measures of distance to GP, D-pat, and the two measures of sparsity, SPARSITY, are drawn from the same data source, the Scottish Rural Practices Fund, and could cause multicollinearity. We therefore constrained the model to include all the variables indicated except these four, and then used stepwise regression to assess which, if any, and in which order, have explanatory power.

7 Results

We first look at the results using health centres as observations, as they cover referral and attendance rates, and the non-attendance of referred patients. We find the null hypothesis, H_0, that $\beta_t + \beta_{t-1} = 0$, is rejected in the analysis of referral and attendance, but not non-attendance. The results for referral and attendance are, therefore, based on the specification given by equation 5, and those for DNA by equation 4, and are shown in tables 4 and 6, respectively. We begin with the results for referrals and attendance.

Referral and attendance rates

Insert table 4

The results in table 4 report the coefficients for the two years and, being based on differences, we would expect statistically significant pairs of coefficients to take opposite signs. Thus, if the coefficient for a given variable for 1998 is positive, then we would expect the sign for the corresponding 1993 variable to be negative.

On the whole the set of spatial variables are not statistically significant. An examination of plots of the residuals against D is consistent with the linear model used, U = a + b.D, and the absence of heteroscedasticity. The difficulty of interpreting a single year's value for distance to provision, D, in a model of 'differences' has been noted above. It seemed useful, therefore, to refer to estimates using the same model and estimation procedures, but for the single year, 1998. The results are shown in table 5.

Insert table 5

The results for D, the distance to specialist provision, are much the same as those shown in table 4. Distance had next to no influence on the referral and attendance rate.

Practices which used two health centres [DUP] tended to have higher referral rates and attendance rates. It is not clear why.

Outreach, as measured by SESS, raised referral and attendance rates.

Waiting time, WAIT, the other non-price variable of interest, has occasional statistical significance: long waits in 1993 increased referrals and attendances [if one accepts a p-value of 0.055 as statistically significant], but in 1998 they reduced attendances: hardly consistent results.

There are mixed results for Dep-J, the measure of deprivation expressed as the proportion *not* deprived. The results based on differences, suggest Dep-J had no influence on referral and attendance rates; whereas the results based on 1998 data indicate patients from deprived locations had higher referral and attendance rates.

The practice characteristics - the number of GPs and fundholding status - had no influence on referral or attendance rates. Fundholding might be expected to have an impact, given that specialist referrals were a charge on the GP's practice budget and by 1998 standard fundholding was quite common.

Finally consultant provision, CON, raised referral and attendance rates.

DNA rates

Apart from the influence of waiting time, we offer no *a priori* model of missed appointments and, for the lack of anything better, we entertain the use of the models for referral and attendance.

Three sets of results can be drawn upon: estimates based on differences, table 6; estimates based on 1998, table 5; and estimates based on patients as observations in 1993 and 1998, table 7. The last is subject to the fewest shortcomings. It offers data for two years and, being the analysis for DNA in 1998, one might expect 1998 events to be most significant – as they are. Further, the assumption that outreach is independent of DNA is quite plausible with individuals as observations. The two shortcomings of the last are that it refers to only a sub-set of those studies and the full range of explanatory variables are not used. We report only select results of particular interest.

Spatial variables had limited importance. Distance to provision, D, is non-significant, as is the local provision of outreach [SESS].

Patients who had long waits were most likely to miss appointments.

Patients who lived in deprived locations were also most likely to miss appointments.

Specialist provision, CON, had no influence on non-attendance.

Insert table 6

8 Discussion

What interpretation can we take from the results, and what implications have they for the role of distance and waiting time in allocating referred services?

The previous section provided three sets of estimates: a difference model for the period 1998-1993, and a level model for 1998, both based on health centres as observations; and a difference model using patients as observations. The results are somewhat mixed. All agree distance to provision, D, is not statistically associated with referral and attendance rates; and the select review of recently published studies of other NHS experience is consistent with this, bearing in mind the distance patients had to travel. There are mixed results for the influence of distance on non-attendance: some indicate no association, another a negative one. Our brief review of other studies suggested a positive association is possible, but has not been found by us.

There are mixed results for the influence of waiting time on referral and attendance rates, but they offer some confirmation of results from other studies: that long waits are associated with non-attendance. A similar situation arises for deprivation [Dep].

Otherwise there is a reasonable degree of consistency in the results. Patients from practices where health centre regular specialist clinics were held, tended to have higher referral and attendance rates, but there was no association with non-attendance. A similar situation applied for practices located in health boards with more consultants per capita.

Given the above interpretation of the results, what significance do they have for allocating referred services? We started the paper by noting the possible importance of distance and waiting time in the allocation of NHS services, given access free at their points of access. It might be thought then, that the distance and waiting time would act as signals to ration access to services. But when we look at practice referral and attendance rates, neither seems to have played a part, as witnessed by the absence or small impact of the distance decay function, D, and the lack of any consistent association with WAIT. So, whilst distance and waiting time might have been used to allocate the scarce referred services, this is not what happened.

Supply factors were important. There is consistent evidence that practices with access to more specialists, CON, and with local provision, SESS, had higher referral and attendance rates. In the case of local provision, these outcomes could be explained in terms of the balance of the cost and expected benefit in the case of local provision. The cost in terms of access has fallen, even if there is next to no other evidence of the distance decay function. The same reasoning would not apply to specialist provision. Distance to that provision and waiting time are already in the models, so some other mechanism must be in play. One possibility is the conflicting roles of GPs: gatekeeper to the NHS, rationing access; *versus* agent for the patient. As specialist provision increases – both locally and at the level of the health board - GPs adjust their role as gatekeeper and change the thresholds for referral.

On the whole the results are consistent with GPs effectively combining their roles as agent for the patient as well as gate keeper to the NHS. The absence of a distance decay function would suggest GPs did not differentiate the cost and expected benefit to patients as distance varied. Yet we also find missed appointments did not vary with distance, so there is no evidence of systematic distance bias in acting as agent to the patient. Other results can give a similar positive interpretation. For example, GPs responded to enhanced local and health board specialist provision by raising referral rates, without changing non-attendance.

Even the response of GPs to differences in deprivation can be given a favourable interpretation. The results of the statistical analysis suggest two scenarios. One, where there is no variation by deprivation; and so permitting an interpretation similar to that given for distance. The other, is that patients from deprived locations had higher referral rates, higher attendance rates and more missed appointments. This second scenario portrays GPs' semi-successful attempts to override patients' preferences so that best medical practice may be put into effect.

In conclusion, the absence of prices at the point of access for many NHS services has meant GPs must act both as gatekeeper to the NHS, rationing access to referred services, and as patients' agent. Non-price signals such as distance and waiting time have not been used by GPs to ration access. Nevertheless, GPs have been responsive to differences and changes in provision, acting successfully in both these roles. Specialists perform a similar function, prioritising patients according to the urgency of treatment, and willing to keep routine cases waiting, even at the greater risk the appointment is not kept. Further analysis of the data and its extension to a second specialty might identify how robust these conclusion might be.

Appendix: Definitions

1 Dependent variables:

R [Referral rate], number of referrals per 1000 patients per year in 1993 and 1998.

A [Attendance rate], number of attendances per 1000 patients per year in 1993 and 1998.

DNA [DNA rate]. Defined as (R-A)/R, and given for 1993 and 1998.

2 Explanatory variables

Health centre data:

D [Distance from health centre to nearest alternative provision]. It is measured in miles, and only available for 1998.

D-pat(cnt) [One measure of distance patients must travel to see their GP at his/her surgery]. Based on a head count of patients who live more than three miles from the GP's surgery, being number per patient as at April 1993 and October 1997.

D-pat(pay) [A second measure of the distance patients must travel to see their GP at his/her surgery]. Payment to GPs increases with the distance from the surgery, but is only made if a stipulated threshold per GP is reached. Measured in £s per patient as at April 1993 and October 1997.

DEP-J [The Jarman index of poverty] Differentiates High, Medium and Low levels of poverty. It is measured as the number *not* poor per 1000 patients, as at April 1993 and October 1997.

DUP Recognises that practices may operate from more than one health centre, both of which may have specialist clinics. It is measured as the number of referrals from such practices per 1000 patients at the health centre, as at 1993 and 1998.

GPs [Head count of GPs in practice as principals]. Number per 1000 patients as at April 1993 and October 1997.

SESS [Specialist sessions held at the health centre at least one a month]. Measured as sessions per 1000 patients per year in 1991 and 1998.

SFH [Fundholding status.] SFH=1 if at least one practice using the health centre has standard fundholding status; otherwise zero. Values as at April 1993 and October 1997.

WAIT [Median wait]. It is the time between the receipt of the referral to the date of the appointment, and includes values equal to zero. Extreme values, greater than or equal to 730 days, are treated as 'missing'. It is measured in days. Values for 1993 and 1998.

Health board data:

CON [A measure of consultants per capita]. Values for 30 September 1993 and 1 October 1998.

SPARSITY(cnt) One measure of sparsity, based on head count of patients living more than 3 miles from their GP's surgery. Measured as heads per patient as at April 1993 and October 1997.

SPARSITY(pay), A second measure of sparsity, based on payments made to GPs: see D-pat(pay) above. Measured as payments per patient as at April 1993 and October 1997.

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Table 1 Select information of review on referrals and use of health services

Feature	Croxson et al (2001)	Gravelle et al (2002)	Gravelle et al (2003)	Windmeijer et al (2005)
Dependent variable	Within HA practice admissions rate to the two main hospitals, covering 39 specialties and differentiating (i) emergency from (ii) non-emergency admissions.	Within HA practice hospital admissions rate for cataract operations.	Electoral ward acute hospital admissions rate, directly standardised and differentiating (i) non-elective from (ii) elective admissions.	Within HB practice first out-patient attendance rate for non-maternity non-psychiatric patients at one of the two District General Hospitals, Hospital A.
Dependent variable, mean value.	Not given	36.54 operations per 10,000 patients pa.	1.004 pa.	0.0228 per quarter.
Measure of distance, D	Distance to the nearer hospital of the two main hospitals in HA.	Average for all 13 providers from practice, weighted by use by practice,	(a) Average of patient to practice. (b) Average of practice to hospital.	(a) Distance to Hospital A. (b) Distance to alternative hospital.
Distance variable, mean value.	10.77 kms	54.55 kms	(a) 12.05 kms (b) 23.78 kms	(a) 19.12 kms (b) 20.85 kms
Sample studied	All 58 practices in North West Anglia HA.	All 109 practices in one northern English HA.	All 8414 electoral wards in England.	All 61 practices in Argyll & Clyde HB.
Period studied	Four financial years, 1993-4 to 1996-7.	Three financial years, 1995-6 to 1997-8.	Financial year 1990-1.	Nineteen quarters, 1997q2 to 2001q4.
Functional form	lnU=b.lnD	ln[(U/(1-U)]=b.D	$U/\bar{U} = b.D/\bar{D}$	lnU=blnD
Coefficient of D, and statistical significance. ** , *** significant at 5% and 1% levels, respectively.	(i) Emergency: +0.001 (ii) Non-emergency: -0.039***	-0.0064***	(i) Non-elective: (a) –0.010; (b) –0.048*** (ii) Elective: (a) –0.041***; (b)+0.010**	(a) Hospital A: -0.70*** (b) Alternative hospital: +0.57***
Elasticity with respect to D at mean values.	(i) Emergency: +0.001 (ii) Non-emergency: -0.039	-0.35	(i) Non-elective: (a) –0.010; (b) –0.048 (ii) Elective: (a) –0.041; (b)+0.010	(a) Hospital A: -0.70 (b) Alternative hospital: +0.57

Table 2 Select information of review on non-attendance

Feature	Prue et al ((1979)	Gruzd et al (1986)	Orr et al (1992)	Smith and Yawn (1994)
Outcome measure	Percentage of first five follow-up visits missed.	Missed appointment.	Missed follow-up visit of a clinical trail in ophthalmology.	Missed appointment.
Distance measure	Two components: (i) Patient's home to major highway in miles. (ii) Miles travelled on major highway.	Distance from patient's home to family health centre	Distance ≥ 100 miles.	Distance > 3 miles.
Sample studied	40 patients discharged from alcohol treatment unit.	663 appointments, drawn from three family health centres.	175 patients	4669 appointments drawn from a family practice residency clinic.
Functional form	Not given.	Log odds ratio	Log odds ratio	Log odds ratio
Period studied	Two years, dates not given.	One month, 18 Jan to 19 Feb 1982.	August 1987	Three months, April to June 1991.
Location	Mississippi, USA.	Bernardino, California, USA.	USA.	Minnesota, USA.
Effect on outcome	Both components of distance *positively* correlated with missed visits.	No statistically significant effect.	Distance *positively* correlated with missed visits.	No statistically significant effect.

Table 3 Descriptive data, health centres as observations.

Variables	Dimensions	Period	Mean	Standard deviation
Dependent				
R/P	Referrals per 1000 patients	1993	4.66	2.92
		1998	6.12	4.11
		1998-1993	1.45	3.11
A/P	Attendances per 1000 patients	1993	3.70	2.07
		1998		
		1998-1993	1.01	2.31
DNA	Non-attendances per referral	1993	0.18	0.13
		1998	0.21	0.12
		1998-1993	0.02	0.12
Explanatory				
CON	Consultants per 10,000 population?	1993	3.25	0.78
		1998	3.63	0.89
		1998-1993	0.37	0.62
D	Miles	1998	9.55	10.63
D-pat(cnt)	Headcount per patient	1993	0.12	0.16
		1997	0.12	0.16
		1997-1993	0.0001	0.03
D-pat(pay)	Payment per patient, fy 1997-8 prices	1993	1.69	3.15
		1997	1.28	2.54
		1997-1993	-0.41	2.19
DEP-J	Percentage *not* deprived	1993	91.77	9.01
		1997	91.11	11.87
		1997-1993	-0.66	5.69
DUP	Counts per 1000 patients	1993	0.48	1.33
		1998	0.68	1.96
		1998-1993	0.20	1.32
FHS	0/1	1993	0.16	0.37
		1997	0.28	0.45
		1997-1993	0.12	0.39
GPs	GPs per 1000 patients	1993	0.67	0.13
		1997	0.71	0.16
		1997-1993	0.04	0.08
SESS	Sessions per annum	1991	1.56	2.73
		1998	1.79	3.60
		1998-1991	-0.14	0.54
SPARSITY(cnt)	Headcount per patient	1993	0.089	0.080
		1997	0.097	0.088
		1997-1993	0.008	0.013
SPARSITY(pay)	Payments per patient	1993	1.16	1.49
		1997	1.02	1.09
		1997-1993	-0.66	5.69
WAIT	Days	1993	24.4	14.9
		1998	28.4	13.1
		1998-1993	4.0	15.9

Table 4 Analysis of Referral and Attendance rates, health centres as observations, 1998-1993.

Variable	R/P		A/P	
	Coefficient	T-statistic	Coefficient	T-statistic
Constant	7.498		7.108	
1998 values				
D	-0.004	0.16	-0.004	0.25
D-pat(cnt)				
D-pat(pay)				
DUP	0.73	4.54***	0.55	4.52***
SESS	0.130	2.13**	0.107	2.31**
SPARSITY(cnt)				
SPARSITY(pay)				
WAIT	-0.027	1.53	-0.030	2.22**
Dep-J	-0.037	0.92	-0.006	0.20
GPs	-3.2	1.25	-2.0	1.04
SFH	-0.48	0.81	-0.24	0.52
CON	1.14	3.21***	0.87	3.20***
1993 values				
D-pat(cnt)	-3.9	2.28**		
D-pat(pay)				
DUP	-1.07	4.66***	-0.77	4.38***
SESS	-0.057	0.71	-0.022	0.36
SPARSITY(cnt)				
SPARSITY(pay)				
WAIT	-0.052	3.00***	-0.025	1.93
Dep-J	-0.028	0.52	- 052	1.26
GPs	5.3	1.67	2.3	0.95
SFH	-0.87	1.28	-0.66	1.28
CON	-0.89	2.12**	-0.79	2.46**
R^2 (%)	33.23		29.46	

Notes: **, *** statistically significant at 5% and 1% levels, respectively.

Table 5 Analysis of Referral, Attendance and DNA rates, health centres as observations, 1998.

Variable	R/P		A/P		DNA = (R-A)/R	
	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic
Constant	14.63		9.010		0.3239	
D	-0.042	1.56	-0.021	1.04	-0.00149	1.97**
D-pat(cnt)	-4.8	2.45**	-3.2	2.19**	0.189	3.44***
D-pat(pay)						
DUP	0.22	1.72	0.154	1.62	-0.0002	0.05
SESS	0.252	3.72***	0.187	3.68***	-0.0001	0.06
SPARSITY(cnt)						
SPARSITY(pay)						
WAIT	-0.031	1.63	-0.049	3.41***	0.00443	8.13***
Dep-J	-0.133	5.74***	-0.067	3.85***	-0.00316	4.82***
GPs	-0.0	0.02	-0.2	0.16	0.088	1.70
SFH	-0.19	0.34	-0.25	0.61	-0.011	0.69
CON	1.36	4.48***	0.97	4.20***	0.0062	0.72
R^2 (%)	44.93		37.89		52.22	

Notes: **, *** statistically significant at 5% and 1% levels, respectively.

Table 6 Analysis of DNA rates, health centres as observations, 1998-1993.

Variable	DNA = (R-A)/R	
1998-1993	Coefficient	T-statistic
Constant	0.03520	
D	-0.00113	1.29
D-pat(cnt)		
D-pat(pay)	0.0087	2.16**
DUP	0.0106	1.59
SESS	-0.0004	0.19
SPARSITY(cnt)		
SPARSITY(pay)	-0.062	3.04***
WAIT	0.00137	2.17**
Dep-J	-0.0002	0.13
GPs	-0.24	2.11**
SFH	-0.018	0.82
CON	0.000	0.02
R^2 (%)	15.37	

Notes: **, *** statistically significant at 5% and 1% levels, respectively.

Table 7 Modelling log odds DNA98, using nominal logistic regression analysis, patients as observations

Explanatory variables	Estimate	SE	Z-ratio	P-Value
Constant	-6.15727	14.5782	-0.42236	0.331810
Age93 25-44	-0.23414	0.5417	-0.43224	0.333608
Age93 45+	-1.08411	0.7491	-1.44721	0.463041
Male93	0.33294	0.4640	0.71756	0.118257
Dep-C93	-0.15588	0.1102	-1.41404	0.460662
Dep-C98	0.17355	0.1109	1.56539	0.029373
Wait93	0.01033	0.0084	1.22519	0.055126
Wait98	0.01031	0.0051	2.01967	0.010854
DUP93	-1.28195	1.4261	-0.89890	0.407823
DUP98	0.43376	1.7392	0.24940	0.200762
D98	-0.08097	0.0607	-1.33371	0.454425
LogP93	-2.05559	1.8620	-1.10400	0.432601
LogP97	1.95360	1.9545	0.99953	0.079385
LogCON93	1.69957	1.7558	0.96799	0.083263
LogCON98	-2.21676	1.9072	-1.16231	0.438723
Log(SESS+1)91	-0.01588	0.1165	-0.13629	0.277102
Log(SESS+1)98	0.23852	0.1179	2.02252	0.010781