Virtual outreach: economic evaluation of joint teleconsultations for patients referred by their general practitioner for a specialist opinion

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Abstract

Objectives To test the hypotheses that, compared with conventional outpatient consultations, joint teleconsultation (virtual outreach) would incur no increased costs to the NHS, reduce costs to patients, and reduce absences from work by patients and their carers.
Design Cost consequences study alongside randomised controlled trial.
Setting Two hospitals in London and Shrewsbury and 29 general practices in inner London and Wales.
Participants 3170 patients identified; 2094 eligible for inclusion and willing to participate. 1051 randomised to virtual outreach and 1043 to standard outpatient appointments.
Main outcome measures NHS costs, patient costs, health status (SF-12), time spent attending index consultation, patient satisfaction.
Results Overall six months costs were greater for the virtual outreach consultations (£724 per patient) than for conventional outpatient appointments (£625): difference in means £99 ($162; €138) (95% confidence interval £10 to £187, P=0.03). If the analysis is restricted to resource items deemed "attributable" to the index consultation, six month costs were still greater for virtual outreach: difference in means £108 (£73 to £142, P < 0.0001). In both analyses the index consultation accounted for the excess cost. Savings to patients in terms of costs and time occurred in both centres: difference in mean total patient cost £8 (£5 to £10, P < 0.0001). Loss of productive time was less in the virtual outreach group: difference in mean cost £11 (£10 to £12, P < 0.0001).
Conclusion The main hypothesis that virtual outreach would be cost neutral is rejected, but the hypotheses that costs to patients and losses in productivity would be lower are supported.

Introduction

Between 6% and 10% of contacts between patients and primary care result in a referral for a specialist opinion.[1] The efficacy of this process depends on effective communication across the primary-secondary care interface, which may be lacking in practice.[2–4] The current referral practice can result in unnecessary follow up of patients and a duplication of tests and investigations, leading to dissatisfaction among patients and clinicians.[5–7] Studies in the Netherlands have shown that involvement of general practitioners in joint consultations can lead to better patient management, reductions in hospital follow up appointments, fewer tests and investigations, improvements in health status one year after referral, and fewer subsequent referrals to hospital.[8 9] However, consultations that require all participants to be in the same place are difficult to organise and costly. A videoconferencing link avoids the need for physical proximity, while potentially offering the same benefits in communication.

The NHS information technology strategy predicted an important role for telemedicine in the future provision of healthcare services.[10] The clinical reliability of the technology has been established.[11] A recent systematic review commented on the poor quality of studies on the economic effectiveness of telemedicine and found no evidence that telemedicine was cost effective.[12] Very little has been published on the cost effectiveness of teleconsultation—"real time" consultations in which doctors and patients are separated geographically but communicate through the use of videoconferencing.[13] The economic evaluation of the virtual outreach project, the largest reported randomised trial of teleconsultations, thus provides important new information.

Methods

The design of the trial, details of the method, and other outcomes have been described in full elsewhere.[14 15] The investigators established virtual outreach services in the Royal Free Hampstead NHS Trust in inner London and the Royal Shrewsbury Hospital Trust in Shropshire. Virtual outreach involved a "real time" joint consultation between the general practitioner, present with the patient in the practice, and consultants in the hospital. The general practitioners referred a total of 3170 patients, of whom 2094 consented to participate in the study and were eligible for inclusion—862 in Shrewsbury and 1232 in London. The investigators randomised 1051 patients to the virtual outreach group and 1043 to standard outpatient

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appointments; they followed participants for six months after their index consultation.

We adopted a cost consequence approach for this study, as it involved an array of health outcome measures alongside costs.[16 17] Although the perspective of the evaluation embraces the patient in addition to the NHS, it falls short of the societal approach involved in a full cost benefit study. The hypotheses of the economic evaluation were that, compared with conventional outpatients, virtual outreach would incur no increased costs to the NHS; reduce the costs incurred by patients attending outpatient appointments; and reduce the time taken off work, so having a positive impact on productivity.

Costs to the NHS

The economic evaluation focused on actual resources used. We derived a cost for each patient for the index consultation and the six month follow up period.

Index consultation

We costed the consultations to which patients were randomised by using an "ingredients" approach.[16] The main ingredients were capital and overhead costs, professionals' time, and telephone line costs. We estimated professionals' time by using observation by non-participants of a small sample of consultations selected opportunistically, because of the logistical problems of scheduling observations and the substantial research time involved. Joint teleconsultations were observed at the general practice and hospital clinic in order to estimate the time input of the two clinicians. Table 1 gives the complete record for the timing of index consultations. Table 2 summarises the ingredients' costs for each type of consultation. We used sensitivity analysis to explore the implications of errors resulting from these estimates.

Table 1 Timings from a sample of consultations

	Mean (SD) minutes	Range (minutes)	95% confidence interval
Joint teleconsultation			
Duration of consultation (n=31)	10.5 (5.1)	3-22	8.6 to 12.4
Total time: general practitioner (n=14)	26.0 (10.1)	9-45	20.2 to 31.8
Total time: consultant (n=22)	19.9 (8.3)	8-37	16.2 to 23.6
Conventional outpatient appointment			
Duration of consultation (n=35)	9.3 (5.2)	3-25	7.5 to 11.0
Total time: consultant (n=35)	11.8 (6.2)	5-27	9.7 to 13.9

Table 2 Cost of an index consultation

	Virtual outreach (£)	Standard outpatients (£)
Labour:		
General practitioner	50.96	NA
Consultant	57.71	34.22
Consumables:		
Call charges	0.71	NA
Capital:		
Videoconferencing units	23.52	NA
Trolleys	0.12	NA
Cabinets	0.10	NA
Overheads:		
ISDN rental	31.50	NA
Software installation	12.37	NA
ISDN installation	15.19	NA
Marginal cost of consultation	109.38	34.22
Average cost of consultation	192.17	34.22

NA=not applicable.

The cost of general practitioners' time, based on data compiled by Netten and Curtis,[18] was £1.96 ($3.22; €2.73) a minute, including practice overheads and training costs. We estimated the cost of a minute of consultants' time as £2.90. To ensure comparability between general practitioner and consultant costs, we derived the cost of consultants' time by adding nursing and clinic costs supplied by the Royal Free Hampstead NHS Trust to Netten's figure of £1.82, which includes an allocation for secretarial support but not the overheads associated with running an outpatient clinic. We estimated the costs of telephone calls for the consultation according to the duration of the triadic consultation. We assumed that the small training costs could be absorbed in the costs of clinicians' time, which includes a component for training costs. We considered administrative functions undertaken by the research team to be artefacts of the trial design and not a cost of delivering the service.

In addition to the normal overheads incorporated into the labour costs of general practitioners and consultants, new overheads are incurred by virtual outreach. We assigned these costs, which included rental of an ISDN line and installation of software, to individual consultations by dividing the total cost by the number of teleconsultations. We calculated the equivalent annual costs of videoconferencing equipment and accessories over the expected lifetime of the asset with an interest rate of 6%.[19 20] We assumed a lifetime of five years for the videoconferencing equipment and 20 years for cabinets and trolleys. A total of 889 teleconsultations took place in the virtual outreach project over 21 months—approximately 500 teleconsultations per year. We therefore divided the equivalent annual cost by 500 to derive a capital cost per consultation. The number of consultations is a key variable in assigning fixed capital and overhead costs (which do not vary with output) to an individual consultation, so the average cost is to some extent a volume artefact. To take this into account, we report the costs for a single consultation with and without the fixed cost component. In total, 225 patients did not attend their index consultation, but as most of them gave notice of this we have assumed that the NHS incurred minimal costs. We investigated the effects of relaxing this assumption in the sensitivity analysis.

Prescription data

We collected prescription data and costs electronically from the computerised record systems of general practices using EMIS v.5 software and from one practice using Torex Premiere. We excluded patients from practices using different computerised systems, as we were unable to export cost data electronically. These patients were evenly distributed across the two arms of the trial (153 in the virtual outreach group and 150 in the standard outpatient group). We collected prescription data for patients in the six months either side of the index consultation. We deemed a prescription issued after the index consultation to be "attributable" to the index consultation if the patient did not receive the same named prescription for the six months before the index consultation. A non-clinician carried out the attribution, and a clinician validated it for one practice.

Table 3 Use of resources during the six month follow up period, with unit costs

Item	Mean (SD) use of resources: Virtual outreach (n=1033)	Mean (SD) use of resources: Standard outpatients (n=1025)	Unit cost or range (£)	Source of unit cost*
Primary care services:				
General practitioner	2.40 (2.59)	2.27 (2.39)	25	1
Practice nurse	0.73 (1.49)	0.63 (1.32)	9	1
Other clinical staff	0.04 (0.38)	0.06 (0.43)	9	1
Home visits	0.05 (0.30)	0.07 (0.44)	45	1
Other contacts	0.25 (0.68)	0.24 (0.74)	6-20	1, 2
Contacts between hospital and practice	0.24 (0.62)	0.16 (0.49)	19	1, 2
Tests, investigations, and procedures:				
Radiological investigations	0.48 (0.95)	0.54 (0.92)	36-580	3, 4
Blood tests and laboratory investigations	2.36 (3.93)	3.01 (4.57)	1.02-236	3, 4
Other tests and investigations	0.39 (0.74)	0.46 (0.77)	2.58-990	3, 4, 5
Hospital services:				
Visits to outpatient departments	1.32 (1.57)	1.28 (1.59)	9-127	1, 3, 4, 5
Inpatient admissions	0.11 (0.35)	0.13 (0.39)	76-218/day	3, 4
Accident and emergency	0.06 (0.30)	0.06 (0.28)	112	3
Day surgery and other inpatient procedures	0.11 (0.36)	0.12 (0.38)	29-4956	3, 4, 5
Other hospital visits	0.07 (0.30)	0.12 (0.42)	9-71	3, 4, 5
Other hospital contacts	0.05 (0.26)	0.09 (0.36)	6-18	1, 2
Prescriptions:				
No of patients	852	859		
Prescriptions	8.72 (12.97)	8.15 (12.53)	0.03-466	6

*Sources of unit costs: 1=Netten and Curtis[18]; 2=general practitioner estimate; 3=Royal Free Hampstead NHS Trust; 4=Royal Shrewsbury Hospital Trust; 5=*NHS Reference Costs 2000*[21]; 6=computerised records at general practices.

The two reached agreement on 182/184 items, indicating that the method was acceptably robust.

Tests, investigations, procedures, and contacts with healthcare services

Using a standard form and coding system, research nurses collected data from hospital and practice records on participants' use of NHS resources in the six months after the index consultation. The nurses recorded visits by patients to the practice to see a doctor, a nurse, or other clinical practice staff; visits to a patient's home by general practitioners or other staff; other contacts with the practice; visits to outpatients department; inpatient admissions; accident and emergency department visits; attendances for day surgery or other inpatient procedures; any other hospital visits or contacts; and contacts between hospital consultants and general practitioners. The nurses also collected data on radiological investigations, blood tests and laboratory investigations, and other tests and investigations.

We assigned a unit cost to each resource item (table 3). We obtained these from 1999-2000 data from the Royal Free Hampstead NHS Trust, the Royal Shrewsbury Hospital Trust, and *NHS Reference Costs 2000*,[21] except for the costs of consultations, which we derived from Netten and Curtis.[18] Much of the use of resources over the six months was unrelated to the condition that led to the patient's recruitment into the trial. We developed criteria for identifying items of resource use that could be deemed to be attributable to the index consultation specialty—for example, a gastroscopy for a patient referred to a gastroenterologist. We classified other non-specific items, such as visits to the general practitioner, blood tests, and laboratory investigations, as attributable if they occurred within four weeks of the index consultation. We based all costs to the NHS on actual rather than prescribed resource use, in order to reflect true clinical practice.

Costs to the patient and impact on productivity

We used a postal questionnaire to collect data on the costs incurred by patients as a direct result of their index appointment. We asked patients to record any travel costs incurred by themselves or anyone accompanying them and the time taken, including travel time, to attend the index consultation. We also collected information about the impact on the paid work of patients and anyone accompanying them. If any work time was lost, the questionnaire asked about whether pay was reduced or whether anyone had taken annual leave. We estimated productivity losses identified by using data from the *New Earnings Survey*.[22]

Statistical methods

The statistical analysis used for the economic evaluation followed a prespecified plan based on the groups as randomised. We used *t* tests to investigate differences in costs to the patient and the NHS between the two arms of the trial.[23] Use of bootstrapping to allow for the skewed distribution of costs gave very similar results, as expected because the sample size was large.[24] We carried out adjusted analyses by using multiple ordinary least squares regression with adjustments for site (London or Shrewsbury), specialty (orthopaedics; urology; ear, nose, and throat; gastroenterology; or other), age at randomisation, sex, and baseline overall score on the Duke severity of illness inventory.[25] In addition, we used tests of interaction to investigate whether the effect of virtual outreach varied by site or specialty.

For 21 patients for whom no six months data were available, we imputed resource use by using the mean values for patients with data by site and consultation type. For the 353 patients with missing prescription data, we imputed mean values by the same method. We also imputed values for data that were missing from patient questionnaires—for example, we calculated costs to patients who reported travel by private car but

Table 4 Summary of costs (£) by sector. Values are means (SDs) unless stated otherwise

Cost	Virtual outreach	Standard outpatients	Difference (95% CI)	P value
NHS costs*:	(n=1044)	(n=1035)		
Index consultation†	163.64	31.91	–	–
Primary care visits and contacts‡	75.11 (77.40)	70.41 (72.14)	4.70 (–1.74 to 11.14)	0.15
Secondary care visits and contacts‡	188.76 (532.28)	208.08 (1068.86)	–19.32 (–91.86 to 53.21)	0.60
Tests and procedures‡	182.21 (403.23)	209.23 (384.31)	–27.02 (–60.90 to 6.87)	0.12
Prescription costs§	114.26 (206.48)	105.63 (173.62)	8.63 (–7.79 to 25.04)	0.30
Total NHS cost (imputed)	723.98 (832.07)	625.26 (1199.77)	98.72 (9.98 to 187.46)	0.03
Adjusted¶	–	–	101.79 (15.26 to 188.32)	–
Attributable NHS costs (imputed)	393.33 (388.93)	285.75 (406.95)	107.58 (73.35 to 141.82)	<0.0001
Adjusted¶	–	–	110.50 (76.79 to 144.21)	–
Patient costs**:	(n=777)	(n=820)		
Transport costs††	1.12 (3.06)	4.52 (8.18)	–3.40 (–4.02 to –2.79)	<0.0001
Lost pay‡‡	2.53 (16.58)	6.46 (32.51)	–3.93 (–6.48 to –1.38)	0.003
Childcare costs§§	0.03 (0.37)	0.40 (3.93)	0.37 (0.09 to 0.64)	0.01
Total patient costs (imputed)	3.69 (16.89)	11.38 (33.85)	–7.70 (–10.35 to –5.05)	<0.0001
Adjusted¶	–	–	–7.65 (–10.30 to –5.01)	–

*These data exclude 15 patients who withdrew their consent from the study.
†225 patients in the trial did not attend their index consultation: 155 patients in the virtual outreach group and 70 patients in the standard outpatient group. A zero cost has been assigned to the index consultation for these patients.
‡Values imputed for 21 patients with missing data; imputed value was mean cost for patients with data.
§Values imputed for 368 patients with missing data; imputed value was mean cost for patients with data.
¶Adjusted (by missing indicator method[27]) for age at randomisation, sex, specialty, site, and score on Duke severity of illness inventory.
**Based on questionnaires obtained from 1597 eligible patients six months after their index consultation.
††Values imputed for 163 patients with missing data.
‡‡Values imputed for 12 patients with missing data.
§§Values imputed for 70 patients with missing data.

did not specify the actual costs by estimating the distance of a return trip with www.multimap.com and imputing a cost on the basis of an average cost of travel of 20p a mile.[26] Where we could not tell whether the patient had incurred a cost, we imputed a value on the basis of the mean of all patients with complete data by site and consultation type.

Sensitivity analysis is used to explore the robustness of results when uncertainty exists about the assumptions. In this trial, the key uncertainty concerned the costs of the index consultation. We therefore did one way sensitivity analysis on the following parameters associated with the index consultation: duration of teleconsultation, duration of conventional consultation, total general practitioner time, total consultant time, the cost of videoconferencing equipment, the lifespan of videoconferencing equipment, the cost of non-attendance, and the number of consultations per year. In addition, we used a multiway sensitivity analysis to assess a "best case" scenario for joint teleconsultations. This involved making optimistic assumptions about parameter values relating to the costs of a virtual outreach appointment and pessimistic assumptions about the duration of a conventional appointment.

Results

From a total of 3170 eligible patients, the study included 2094 patients. Of these, 15 later withdrew their consent. One thousand and fifty one participants were randomised to virtual outreach consultations and 1043 to standard outpatient appointments. As reported elsewhere, the randomised groups were well balanced across sites, by specialty, and by sex, ethnicity, age, and marital and employment status.[14 15]

Costs to the NHS

Index consultation—Table 2 gives the costs for the virtual outreach consultations and standard outpatient consultations. A total of 225 patients did not attend their index consultation, 155 in the virtual outreach group and 70 in the standard outpatient group. Assuming that the NHS did not incur any costs as a result of the non-attendance of patients in the trial, the estimated mean cost of a patient's index consultation was £164 in virtual outreach and £32 in standard outpatients, a difference of £132 (table 4).

Prescription costs—Table 3 and table 4 show the mean number and cost of all prescriptions issued for each patient in the six months after the index consultation. We found no significant differences between the costs in the two arms of the trial overall, nor by site or specialty. Basing the analysis on the subset of "attributable" prescriptions also failed to show any significant differences.

Costs of tests, investigations, and contacts with healthcare services—We divided the use of NHS resources in the six months after the index consultation into those associated with primary care visits and contacts, secondary care visits and contacts, and tests and procedures (tables 3 and 4). In none of these categories did a significant difference occur between the two arms of the trial, and this remained so after adjustment for baseline characteristics. As reported elsewhere,[14] the number of tests was larger in the standard outpatients group, and this is reflected in the higher mean costs for tests and procedures.

Total NHS costs—We estimated the total mean costs to the NHS as £724 per patient in the virtual outreach group and £625 per patient in the standard outpatient group, a difference of £99 (95% confidence interval £10 to £187, P=0.03) (table 4). Tests of interaction did not show heterogeneity by site (P=0.17) or specialty (P=0.19) (fig 1). When we restricted the analysis to "attributable" resource use (table 4), costs to the NHS were £393 per patient in the virtual outreach group and £286 per patient in the standard outpatient group. The mean difference of £108 (£73 to £142) was similar

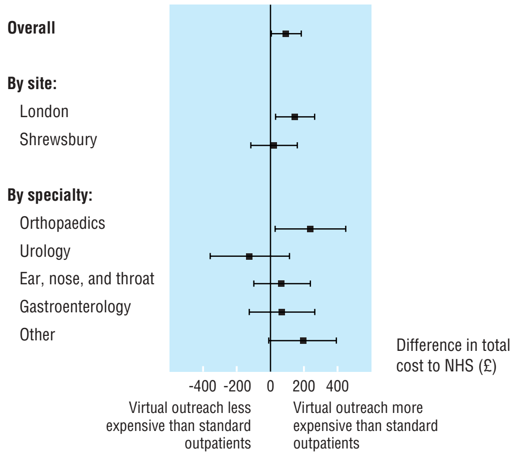

Fig 1 Difference in mean total NHS cost (£) between virtual outreach and standard outpatients groups (P=0.17 for treatment interaction with site; P=0.19 for interaction with specialty)

to that obtained for total resource use but was highly significant ($P<0.001$). Adjustment for baseline characteristics did not greatly affect these results. Tests of interaction suggested that attributable resource use and costs varied by specialty (P=0.02) but not by site (P= 0.52). In urology, mean costs per patient were actually lower in the virtual outreach group, although this difference was not statistically significant (fig 2). In all other specialties, however, the mean cost per patient was significantly higher in the virtual outreach group.

Costs to patients

A total of 1597 (77%) patients returned questionnaires—777 (74%) in the virtual outreach group and 820 (79%) in the standard outpatient group (table 4). One hundred and thirty eight patients reported that they incurred transport costs but did not record an amount. However, 742 patients reported that they incurred no transport costs, including 89 patients in the Shrewsbury standard outpatients group. Patients in the virtual outreach group incurred lower transport costs for the index consultation than those in the standard outpatients group. The mean difference in travel cost was £3.40 ($P<0.0001$). Mean travel costs were higher in the Shrewsbury arm of the trial for both virtual outreach and standard outpatient groups, but the magnitude of difference between the two arms of the trial was almost identical for both sites. In addition, mean childcare costs arising from the index consultation were £0.37 (P=0.02) lower for virtual outreach patients (table 4). The mean loss of pay for patients in the virtual outreach group was £2.53 compared with a mean of £6.46 in the standard outpatients group, a difference of £3.93 ($P<0.01$). Total patient costs were significantly lower in the virtual outreach arm, with a mean difference of £7.70 ($P<0.0001$).

Losses in productivity

On the basis of the time taken to attend the index consultation, potential productivity was greater in the virtual outreach arm. The mean improvement was £10.76 (£9.77 to £11.75, $P<0.0001$) per patient. We found little difference by site: the potential productivity in the virtual outreach group was £10.09 higher in London and £11.57 higher in Shrewsbury. Fewer patients in the virtual outreach group (197/772, 26%) than in the standard outpatient group (266/813, 33%) took time off work for the index consultation. The difference between the groups was more marked in Shrewsbury (87/360 (24%) *v* 134/369 (36%); difference 12%) than in London (110/412 (27%) *v* 132/444 (30%); difference 3%).

Consequences

The results in terms of health outcomes and health services outcomes have been described elsewhere.[14] Contrary to the central hypothesis that fewer follow up appointments would be needed in the virtual outreach group, a significantly greater proportion of patients in the virtual outreach group were offered a follow up appointment (intention to treat analysis, 52% *v* 41%; odds ratio 1.52 (1.27 to 1.82), $P<0.0001$). The difference was more marked in Shrewsbury than in London and in ear, nose, and throat and orthopaedic specialties than in other specialties. No difference in health outcomes occurred at six months according to the physical and psychological scores of the SF-12 and child health questionnaire. Patient satisfaction, measured with the Ware specific visit questionnaire,[28] was significantly higher in patients who had a virtual outreach consultation—difference in means 0.33 (0.23 to 0.43), $P<0.0001$. In addition, the patient enablement inventory,[29] which is used to measure the extent to which patients feel able to cope after their consultation, showed no significant differences in immediate outcomes between the two arms of the trial.

Sensitivity analysis

Table 5 shows the results of the one way sensitivity analysis, indicating two costs for an index teleconsultation. In order to reflect the current situation in the NHS, where a virtual outreach service could now be offered over existing networks at no additional costs, the lower value excludes the telecommunication costs incurred in the trial. Virtual outreach appointments remained more expensive in all scenarios presented here. Furthermore, total costs to the NHS (based on attributable resource use) also remained significantly higher in the virtual outreach group in all cases. The magnitude of the difference in costs was particularly

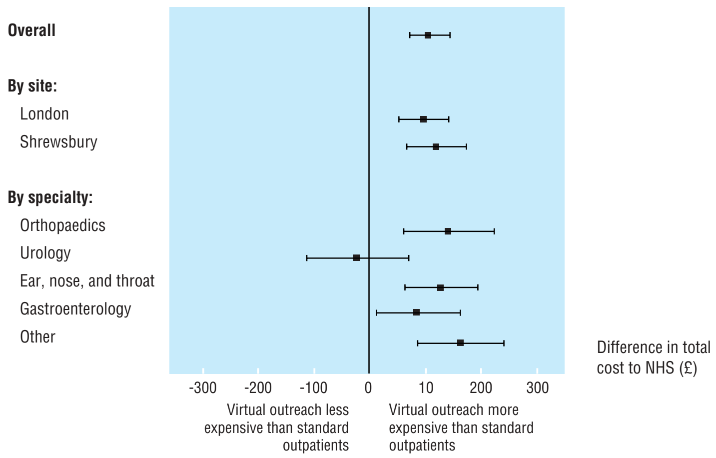

Fig 2 Difference in mean total attributable NHS cost (£) between virtual outreach and standard outpatients groups (P=0.52 for treatment interaction with site; P=0.02 for interaction with specialty)

Table 5 One way sensitivity analysis. Times are in minutes unless stated otherwise

			Cost of index consultation (£)		
Parameter	**Default**	**Range**	**Virtual outreach (0)**	**Virtual outreach (1)***	**Standard outpatient**
Consultants' time: conventional appointment†	11.8	11-19	164	123	30-51
Duration of teleconsultation‡	10.5	3-22	132-212	92-171	32
General practitioners' time: teleconsultation‡	26	10.5-46.5	138-198	97-158	32
Consultants' time: teleconsultation‡	19	10.5-30.5	140-190	100-149	32
Videoconferencing equipment (£)	£52,000	£10 000-100 000	147-182	107-141	32
Videoconferencing equipment: lifespan	5 years	1-7 years	233-159	193-118	32
No of teleconsultations per year	500	100-10 000	244-144	204-103	32

*As virtual outreach (0) but assumes service can be offered over existing NHS telecommunications network.
†Range based on mean of values observed in non-participant observation and Royal Free Hampstead NHS Trust cost data, which are based on 11 consultations in a 3½ hour outpatient clinic.
‡Includes 10.5 minute consultation; range based on extremes observed in non-participant observation.

sensitive to the duration of the teleconsultation, reflecting the importance of clinicians' time. The difference in total attributable NHS costs was least significant if, for example, we assumed the duration of the teleconsultation to be very short or general practitioners' time was substantially reduced.

Relaxing the assumption that non-attendance at appointments did not result in any costs being incurred increased the cost of virtual outreach appointments relative to conventional ones, because there was a greater prevalence of non-attendance in the virtual outreach group. We constructed a "best case" scenario, which estimated a £23 excess cost for virtual outreach consultations. For professional time this involved setting a parameter value based on the lower quartile of observed teleconsultations. For the duration of conventional consultations we used Royal Free Hampstead NHS Trust cost data, which assume a consultation time of 19 minutes. In addition, this best case assumed 10 000 consultations a year (as opposed to 500 in the default calculation) and a total videoconferencing equipment cost of £30 000 (default £52 500). These values were arbitrary, but we used them to reflect the fact that equipment costs are falling and that scope exists to use the equipment more intensively.[30 31] Taken together, these best case assumptions may not be entirely realistic but can provide insights into how teleconsultation would have to be delivered if cost differences were to be reduced.

Discussion

Implications for the NHS

The analysis based on total use of NHS resources over six months shows that overall the mean cost per patient was significantly higher in the virtual outreach group than in the standard outpatients group by almost £100. When we restricted the analysis to attributable resource data the mean cost per patient was £108 more in the virtual outreach group. The similarity in the mean difference between the two approaches suggests that the attributable data excluded a similar number of resource items from both arms of the trial. This attributable analysis is likely to reflect the true position more accurately, because of the "noise" inherent in an analysis based on total resource use.

We based the hypothesis that virtual outreach would not lead to increased costs to the NHS on the expectation that better patient management arising from improved communication would lead to "downstream" savings. The results as presented here do not provide evidence that such savings exist. Although virtual outreach led to a significant reduction in tests and investigations,[14] this resulted in only small downstream cost savings. The difference in costs was not as marked as the difference in the number of tests, as the greatest difference in tests and investigations between the two groups occurred in low cost routine tests. The real, but small, cost saving from fewer tests can no longer be detected when combined with resource use data on hospital procedures. However, a six month follow up period may have been too short to enable us to detect such savings, as these would have to have been large to compensate for the additional costs of the index teleconsultation. Furthermore, if the virtual outreach consultation is of educational value to general practitioners all patients would benefit through better overall management, but these potential savings are not captured by this study.[31]

The "ingredients" based cost used could overestimate costs for several reasons. Firstly, the average cost of a virtual outreach consultation is in some respects an artefact of the trial, as the cost per consultation depends crucially on the number of consultations.[32] We included the marginal cost of a consultation to take this into account (table 2). Nevertheless, the sensitivity analysis showed that at 500 consultations a year the volume had passed the threshold where important economies of scale remained available. Secondly, the technical failures of virtual outreach are likely to be a function of training, experience, and the state of technology; they could potentially be reduced, leading to more efficient use of physicians' time. Thirdly, ISDN lines and videoconferencing equipment had to be installed and purchased specifically for the purposes of the trial. In future, virtual outreach services would use existing facilities in the hospital and general practices. For example, the Digital All Wales Network is now configured to support videoconferencing, with a 256 kilobit link into every practice. NHSnet 2 will offer a similar service in England. Therefore, only a proportion of these capital costs would accrue to virtual outreach, and so the marginal telecommunication costs would be very low. Finally, the problems of evaluating emerging telemedicine technology have been well documented.[33] By evaluating the teleconsultations at a fixed point in time, we could not incorporate changes in quality or price of information technology and telecommunications equipment. The technology used in the trial was basic; the price of such equipment might fall, or subsequent technology may be more sophisticated and consequently more costly. The trial was pragmatic and avoided undue constraints on the participating clinicians, but the introduction of the technique into routine practice may differ from that in a trial setting.[14 15] This might involve different methods of scheduling appointments and changes in staffing arrangements. Economies of scale and scope could emerge in future service configurations. Systemic unpredictable changes might be observed if teleconsultations become a routine method of delivering outpatient care.

Implications for patients

Patients attending a teleconsultation incurred significantly lower transport costs than did those attending conventional outpatient appointments, although the magnitude of the difference (£3) was relatively small. Our second hypothesis was thus supported. The results are similar to those obtained in another randomised controlled trial of telemedicine.[31] Although travel costs may have been underreported, this is unlikely to have affected the findings materially, and the study also found that patients in the virtual outreach group lost significantly less pay. Thus, overall, strong evidence exists of small financial benefits to patients in attending virtual outreach consultations.

Patients in the virtual outreach group reported significantly shorter time off work than for patients in the standard outpatient group. However the distribution of the answers to the questions suggests that some respondents interpreted the question as referring solely to travel time. None the less, the trial results provide good evidence that virtual outreach consultations are less time consuming for patients and are thus likely to have a positive impact on productivity. This is also supported by the results of the patient questionnaire, showing that the proportion of patients in the virtual outreach group who reported taking time off work was lower than that in the standard outpatients group. This represents further evidence of the potential benefits of virtual outreach on economic activity, thus supporting our third hypothesis. Loss of time suggests loss of productivity but may not reflect actual loss. Productivity may be lost forever or may be made up later by the patient or other workers.

The cost consequences approach is considered a variant of cost effectiveness analysis,[16] but it does not use the cost effectiveness ratios associated with that technique. We chose it for this study because the multidimensional character of the outcomes made aggregation difficult. Firstly, health outcomes were measured using the SF-12. As described in a previous paper,[14] the physical and psychological scores of the SF-12 at six months did not differ between the randomised groups. Such generic health measures are of limited value in the context of an economic evaluation, because they do not indicate the value placed on any change in outcome. A preference based index has been published for SF-36,[34] but mapping algorithms for SF-12 are still being developed (J E Brazier, personal communication, 2002). The additional measure used in the project to assess patient satisfaction indicated that virtual outreach consultation was associated with greater levels of satisfaction than standard outpatient consultation. This is consistent with increased patient satisfaction reported in other studies of telemedicine.[35 36] However, these qualitative measures cannot be combined to form a single effectiveness measure. A contingent valuation measure (such as willingness to pay) might have been used as part of a cost benefit analysis, but this technique is still in a developmental stage and would have required additional surveys of participating patients.

What is already known on this topic

Videoconferencing allows joint consultations between the patient, general practitioner, and hospital specialist

The clinical reliability of telemedicine has been established, but very little has been published on its cost effectiveness

What this study adds

Virtual outreach consultations incur greater costs to the NHS than standard outpatients appointments

Virtual outreach consultations result in savings to patients in terms of costs and time

Adoption of virtual outreach cannot be justified on economic grounds

Conclusion

We chose virtual outreach as the trial intervention because the literature suggested that joint consultations might improve communications between primary and secondary care, leading to better patient outcomes and management. Our prior hypotheses were that telemedicine would be a cost effective technology to deliver such joint consultations. However, the results of this study suggest that this is not so; the costs of clinicians' time to support virtual outreach was large and is unlikely to be offset by subsequent savings to the NHS in the short term.

Thus little justification on economic grounds seems to exist for the adoption of virtual outreach. However, all the benefits may not have been recouped within the six month follow up period, and we did not estimate values of improved patient satisfaction. We may therefore have underestimated the beneficial consequences of virtual outreach. Changes in costs and technological advances may improve the relative position of virtual consultations in future. Furthermore, the results of the study are a function of how the virtual outreach project was established. It was a pragmatic trial with broad inclusion criteria. Previous subanalysis showed that certain specialties may be more appropriate for virtual outreach than others,[14] and improved selection of patients may also improve the relative cost effectiveness of virtual outreach. Virtual consultations might also be delivered more cost effectively along more conventional lines, without the presence of the general practitioner. However, further research would be needed to investigate this, as it is not possible to extrapolate the outcomes of this study to such a mode of consultation.

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