Telemedicine versus face to face patient care: effects on professional practice and health care outcomes (Review)

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[Intervention Review]

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ABSTRACT

Background

Telemedicine is the use of telecommunications technology for medical diagnosis and patient care. From its beginnings telemedicine has been used in a variety of health care fields, although widespread interest among healthcare providers has only now become apparent with the development of more sophisticated technology.

Objectives

To assess the effects of telemedicine as an alternative to face-to-face patient care.

Search methods

We searched the Effective Practice and Organisation of Care Group's specialised register, The Cochrane Library, MEDLINE (1966-August 1999), EMBASE (to 1996), CINAHL (to August 1999), Inspec (to August 1996), Healthstar (1983-1996), OCLC, Sigle (to 1999), Assia, SCI (1981-1997), SSCI (1981-1997), DHSS-Data.

We handsearched the Journal of Telemedicine and Telecare (1995-1999), Telemedicine Journal (1995-1999) and reference lists of articles. We also handsearched conference proceedings and contacted experts in countries identified as having an interest in telemedicine.

Selection criteria

Randomised trials, controlled before and after studies and interrupted time series comparing telemedicine with face-to-face patient care. The participants were qualified health professionals and patients receiving care through telemedicine.

Data collection and analysis

Two reviewers independently assessed trial quality and extracted data.

Main results

Seven trials involving more than 800 people were included. One trial was concerned with telemedicine in the emergency department, one with video-consultations between primary health care and the hospital outpatients department, and the remainder were concerned with the provision of home care or patient self-monitoring of chronic disease. The studies appeared to be well conducted, although patient numbers were small in all but one. Although none of the studies showed any detrimental effects from the interventions, neither did they show unequivocal benefits and the findings did not constitute evidence of the safety of telemedicine. None of the studies included formal economic analysis. All the technological aspects of the interventions appear to have been reliable, and to have been well accepted by patients.

Authors' conclusions

Establishing systems for patient care using telecommunications technologies is feasible, but there is little evidence of clinical benefits. The studies provided variable and inconclusive results for other outcomes such as psychological measures, and no analysable data about the cost effectiveness of telemedicine systems. The review demonstrates the need for further research and the fact that it is feasible to carry out randomised trials of telemedicine applications. Policy makers should be cautious about recommending increased use and investment in unevaluated technologies.

PLAIN LANGUAGE SUMMARY

Telemedicine versus face to face patient care: effects on professional practice and health care outcomes

Telemedicine is using telecommunications technology for medical diagnosis and health care. It includes transmitting test results down phone lines, using video technology for long distance consultations or education, and many other uses. The review found studies showing various forms of telemedicine are feasible, but there is not yet enough evidence to show the effects on health outcomes or costs of many expensive uses of technology. Overall, people self-monitoring at home or having video consultations were satisfied with their experience. More research is needed to assess the effects of the range of telemedicine techniques.

BACKGROUND

The use of telemedicine has been reported in a variety of forms, from the 1960's onwards, and it has been defined in a variety of ways. For example Scannell (Scannell 1995) provide a very broad definition:

"Telemedicine is the use of telecommunications for medical diagnosis and patient care. It involves the use of telecommunications technology as a medium for the provision of medical services to sites that are at a distance from the provider. The concept encompasses everything from the use of standard telephone services through high speed, wide band width transmission of digitized signals in conjunction with computers, fibre optics, satellites and other sophisticated peripheral equipment and software."

Some of the early projects were part of military and space technology research programmes (Bashshur 1980), but from its beginnings telemedicine has been used in a variety of health care fields. For example, it has been used in psychiatry (Covey 1975), in paediatrics, (Cunningham 1978), and to provide expert general medical advice from a major teaching hospital to an airport medical centre (Dwyer 1973). Although these early projects appeared successful clinically and technically, widespread interest and enthusiasm among healthcare providers has only now become apparent, with the development of more sophisticated technology.

Recent applications of telemedicine encompass activities such as remote consultations in specialities from dermatology to psychiatry, the transmission of electrocardiograms and radiological images, the provision of accident and emergency expertise to off shore oil rigs, remote fetal monitoring, and education for health professionals. The rapid developments in the technology are enabling health care organisations to see new ways of providing health care, and as the boundaries between health care settings become increasingly blurred, so too do the traditional roles of health care professionals. It might be expected that the fundamental relationships between patients and their health care attendants could also be significantly changed through the use of telemedicine. Telemedicine therefore raises questions of transfer of resources from hospitals

to primary care settings, accessibility and acceptability of services for patients, and major issues of education, substitution and re-skilling for health care staff.

The current interest in telemedicine is apparently being driven in part by the proliferation of portable, affordable, desktop systems and the development of international telecommunications standards such as ISDN, allowing the development of telemedicine to be carried out in local projects by enthusiasts, rather than in a planned and systematic way. The literature suggests that there has been a rapid expansion of telemedicine in North America, for example, Scannell (Scannell 1995) and in Europe (Wootton 1995). With this rapid pace of change there is a risk that proper evaluation of new applications may not be taking place. However, there is evidence in the literature that the need for rigorous assessment has been recognised and that evaluation studies are being carried out. As with any other form of health technology there is a need to assess the effectiveness, efficiency and safety of telemedicine, before it is brought into widespread use. The possible benefits of telemedicine are not yet clear. It may be possible to improve care at less cost. Even if the same health outcomes can be achieved through telemedicine as with conventional care, there may be differences in costs to patients and to the health services, there may be differences in its acceptability for staff and for patients in different settings, and issues of equity may arise. New forms of care may become possible for wider sets of patient populations, bringing new sets of cost consequences.

Telemedicine has been the subject of a number of major bibliographies. The most recent include a review by Balas et al (Balas 1997), who reviewed randomised controlled trials evaluating 'distance medicine' using telephone or computer. They identified 80 trials, of which seven involved computerised communication and the rest involved various uses of the telephone - for follow-up, counselling, reminders, access to care and screening. The authors indicate the areas in which telephone use has been shown to be beneficial, but also note the lack of studies on physician use of such systems and on the process of care and patient outcomes, and the need for more economic studies of these technologies. Taylor (Taylor 1998a; Taylor 1998b) has reviewed both telemedicine systems and telemedicine services. In the review of the development of telemedicine systems, Taylor examined the methods by which diagnostic accuracy is arrived at, particularly in radiology, pathology and dermatology, areas in which asynchronous as well as real time systems are in use. In the review of telemedicine services Taylor examined the research into the models of telemedicine services, their development, implementation and their effects, taking a wide view of the uses of technology that might be classified as telemedicine. He concluded that benefits have been shown for telemedicine, but that although the subject is acquiring a degree of maturity, a great deal more work is needed to establish the most appropriate use of telemedicine.

It is clear from the literature that the term telemedicine encompasses many different technologies, used in different ways. It was decided that this review should be confined to aspects of direct patient care, in which the recipient is remote from the clinician, and in which at least two communication media are used interactively, e.g. audio and visual communication through video-conferencing, or audio and data through modem technology. It was intended that the parameters of this review should be broad, encompassing all the various health disciplines which make use of telemedicine, and the whole range of technologies employed. The working definition for this review is intended to exclude the established use of one technology alone such as the telephone, and technologies that may be used to directly replace a postal service. The definition has been chosen for practical purposes. The proliferation and diversity of technologies that might come under a more inclusive definition, ranging from simple telephone conversations to asynchronous internet-based discussion groups, is such that an attempt to include everything in one review would be unmanageable. Watts and Monk (Watts 1999) have argued there is a danger of treating telemedicine as if it were a kind of drug, whereas it may be better conceived as more like a new method of drug delivery. They use the example of skin patches for drug administration, pointing out that: "When skin patches were first considered, research was required to decide on their physical configuration e.g. their size and materials used. Such questions cannot be addressed without considering the conditions in which they might be applied. It does not make sense to attempt a clinical trial of skin patches per se; it must be a trial of skin patches constructed in a particular way and used for a particular purpose. The point is that before trying to answer questions about the efficacy of telemedicine, it is similarly important to distinguish how it is configured and what is to be delivered."

Analogously, one would not conduct a systematic review of surgery, but would rather select specific areas of surgical practice. The evaluation of all these technologies are areas of concern in the use of telecommunications in the health service, but may best be reviewed separately. Even with the restricted definition chosen for this review, with the sharp growth in the use of telemedicine and the changes in technology, it may be necessary at some future date to produce separate reviews of the use of telemedicine for each discipline, or for each kind of technology. The recent paper by Balas (Balas 1999) is an example of this. However, this review aims to provide a baseline upon which these future developments can be built.

OBJECTIVES

The objective of the review was to establish the effectiveness of telemedicine as an alternative to face to face patient care, demonstrated by outcomes of care, aspects of professional practice, eco-

nomic measures, the acceptability of care to patients and staff, and staff and patient satisfaction.

The questions addressed were:

1. Whether there is a measurable difference in the outcomes of care for patients treated remotely via telemedicine compared with those treated face to face;

2. Whether there are measurable differences in the economic consequences of care delivered remotely via telemedicine compared with face to face care;

3. Whether there is a difference for patients/clients in the acceptability of care provided remotely via telemedicine compared with care provided face to face;

4. Whether there is a measurable difference in professional practice during the delivery of care through the medium of telemedicine compared with clinical care delivered face to face;

5. Whether there is a measurable difference in the transfer of skills between clinicians, in care delivered through the medium of telemedicine compared with care provided face to face.

METHODS

Criteria for considering studies for this review

Types of studies

All studies that met the EPOC inclusion criteria for design were included in the review (see EDITORIAL INFORMATION under GROUP DETAILS for METHODS USED IN REVIEWS for complete definitions of study designs). These are:
Randomised controlled trials;
Controlled clinical trials;
Interrupted time series analyses; and
Controlled before and after studies.

Types of participants

The term 'telemedicine' is generally used to refer to all aspects of health care, not to medicine alone, and this review therefore includes:
1. Qualified health care practitioners from any discipline;
2. Patients receiving care from any qualified health care practitioner through the medium of telemedicine, compared with those receiving the equivalent face to face care.

Types of interventions

The review includes:
Studies which compare the provision of patient care face to face with care given using telecommunications technologies, in which at least two communication media are used interactively (e.g. video consultation between hospital consultant and general practitioner).
The review excludes:
1. Studies which compare different technical specifications of telecommunications technologies;
2. Studies in which the use of telecommunications technology has education or administration as the primary purpose and is not linked to direct patient care;
3. Studies in which the patient is not physically present at either point of care, e.g. studies concerned only with electronic transmission of images for routine reporting sessions, or pathology results reporting;
4. Other forms of telecommunications technology used to support health care, eg telephone advice lines, where only one medium is used.

Types of outcome measures

Studies have been included if they have objective measures of provider performance or patient outcome. Objective assessments of the acceptability of the technology or service to providers and patients have been included. Economic assessment measures were to be included in the review, where objective measures had been used.

Search methods for identification of studies

The review considered only English language publications, but updates of the review will include publications in other languages. The search ranged over the clinical, health informatics, telecommunications and bioengineering literature, general reviews and research centres (past and present) dealing with any aspect of telemedicine which were identified first using:
1. The Cochrane Library (Cochrane Database of Systematic Reviews, Cochrane Controlled Trials Register and the EPOC Register)
2. DARE (NHS CRD)
Journal literature and conference proceedings were located using:
1. MEDLINE
2. HEALTHSTAR (to access US reports)
3. CINAHL
4. EMBASE
5. INSPEC
6. ASSIA
7. SCI
8. DHSS-DATA

It was known that much of the work would be found in the grey literature, and that it was likely that some material would not have been published at all. Local experts were therefore contacted within countries identified as having, or having had, an interest in telemedicine. Routes for this included the identification of international and other collaborative projects (for example, EU-funded studies). These experts were asked for help in finding relevant reports for their country or region.

EPOC suggestions and guidelines on MEDLINE searching terms were followed, but specific search strategies were developed for this review and for other databases such as INSPEC. These strategies have been reported to EPOC. The main problems in doing a search for this type of topic are: 1) the range of clinical areas and activities to be considered; 2) the preponderance of feasibility studies in telemedicine; 3) indexing variations (telemedicine is a relatively new MESH term, there are slightly different nuances of interpretation between CINAHL and MEDLINE, and more emphasis on technical aspects in INSPEC). As the telecommunications become incorporated into the normal process of care, the relevant studies (according to our definition) are more difficult to locate under the headings that might be associated with the more technical aspects of telemedicine, as such headings may or may not be used by the indexer. Studies on home uterine monitoring for example, are usually located under 'uterine monitoring' and 'home care services'. The search strategy has therefore been subdivided into clear sections, so that those replicating the search can use the most suitable sets of terms, and updating of the search strategy will be easier. The initial search strategy used was very broad as it was important to locate details of pilot projects as a lead to later publications.

Electronic searches

MEDLINE search strategy
The search strategy uses MeSH terms unless indicated otherwise.
Set A terms (Combined by OR)
Telemedicine (and textword variations)
Teleradiology (and textword variations)
Telepathology (and textword variations)
Remote consultation
Telecommunications
Telephone
Modems
Telemetry
Videoconferencing / Teleconferencing (textword and its variations)
Teleconsultation (textword and its variations)
Set B terms (Combined by OR)
Monitoring, physiologic
Monitoring, immunologic
Telemetry
Electrocardiography, ambulatory
Uterine monitoring
Blood glucose self-monitoring
Monitoring, ambulatory
Fetal monitoring
Blood pressure monitoring, ambulatory
Drug monitoring
Polysomnography
Cardiotocography
Set C (Combined by OR)
Remote consultation
Self care
Home care services
Rural health services
Set D (Combined by OR)
Emergency medical service communication systems
Emergency service, hospital
Military medicine
MEDLINE Search sets are:
A (narrowed by set of terms to retrieve trials or evaluation studies)
B AND C (narrowed by set of terms to retrieve trials or evaluation studies)
D AND (set of telecommunications terms) (and also narrowed by set of terms to retrieve trials or evaluation studies)
CINAHL search strategy
The strategy uses CINAHL thesaurus terms unless indicated otherwise.
Set A (Combined by OR)
Self care
Self diagnosis
Self medication
Set B (Combined by OR)
Uterine monitoring (textword)
Monitoring, physiologic (and all narrower terms)
Emergency medical services
Home health care (and all narrower terms)
Set C (Combined by OR)
Telephone consultation
Telecommunications (and all narrower terms)
Telemetry
Set D
Telemedicine (thesaurus subject index term and textword)
Set E (Combined by OR)(set of terms to narrow search to suitable research designs)
(To include, using terms as subject index terms and textword terms, as appropriate):
Clinical trials (and narrower terms)
Clinical nursing research
Clinical research
Pretest-posttest design (and narrower terms)
Prospective studies
Random assignment (and textword variations)
CINAHL Search Sets

A AND C AND E
D AND E
B AND C AND E

Searching other resources

The main databases searched were MEDLINE (1966 to August1999), CINAHL (to August1999), EMBASE (to 1996) and INSPEC (to 1996). In addition, the following databases were searched (from date of first appearance to the end of 1996 unless otherwise noted): SSCI (1981-1997), SCI (1981-1997), OCLC databases (Papers First, Conference Proceedings, Article First, Contents First), SIGLE (to 1999), HealthStar (1983-1996), DHSS-Data, Dissertation Abstracts and the Index of Conference Proceedings received by the BLDSC (British Library Document Supply Centre). Internet Web sites (Telemedicine Information Exchange and OMNI to August 1999) were also used to locate reports and project details.

The following journals were handsearched:
Journal of Telemedicine and Telecare (Vol 1, 1995 to Vol 5, 1999);
The Telemedicine Journal (Vol 1, 1995 - to Vol 5, 1999).

The following conference proceedings were handsearched:
TELMED 95, TELEMED 96, TELEMED 97, Proceedings of the Healthcare Computing Conferences (HC/Harrogate), MEDINFO, MIE, International Congress of Nursing, BCS Nursing Specialist Group, Alliance in Medical Engineering and Biology, Comp. Optic. Comm Care, Lecture notes in Medical Informatics 42 (Nursing Informatics '91), Nursing uses of computers and information science (Proceedings of the IFIP-IMIA International Symposium on Nursing Uses of Computers and Information Science 1985, The impact of computers on nursing (Proceedings of the IFIP-IMIA International Symposium on Nursing uses of computers and information science 1982).

Letters were sent to the authors or institutions, requesting information about studies reported as ongoing at the time of publication, or in which there was inadequate information in the published account.

Data collection and analysis

All relevant studies were reviewed by two authors, using the criteria for review set out in the EPOC Data Collection Checklist. The quality of all eligible trials was assessed using the criteria described by the EPOC Group (see EDITORIAL INFORMATION under GROUP DETAILS for METHODS USED IN REVIEWS). Two reviewers independently assessed the quality of each study and extracted the data. Any differences were resolved by discussion, or referred to the third author. The EPOC Editor was contacted only for advice on technical points. Relevant data on the quality and results of studies have been summarised in the included trials and results tables. Studies that are so compromised by flaws in their design or execution as to be unlikely to provide reliable data have been excluded. The reasons for exclusions are listed in the excluded trials table and discussed in the narrative section of the review.

Because so few studies were identified as suitable for inclusion in the review, and because of their heterogeneity, it was not appropriate to conduct any pooled statistical analyses. The data have been summarised and are presented in natural units. For dichotomous variables in the randomised controlled trials, we have reported the absolute percentage differences between the two groups and the percentage differences relative to the control group. For controlled before and after studies we have reported both the absolute change between the experimental and control groups after the intervention and the percentage change relative to the control group, and also the absolute change from baseline to post intervention in both groups, together with the difference of the change, between the two groups. We have followed the convention of reporting outcomes as unfavourable events as far as possible and sensible. In some cases this would have been counter-intuitive, and although we have aimed for consistency within studies, this has not always been possible. We have therefore added tags to some outcomes in the results table, to indicate whether the result favours the experimental group or the control group. We have reported p values as described by the study authors.

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies.

The literature search produced a very wide range of relevant studies, surveys, reports and opinion articles all dating from the early 1960's onwards. They encompass technologies of every degree of sophistication from analogue telephone to satellites and virtual reality. All the major healthcare specialties and disciplines are represented. More than 200 studies were identified, most of which were either feasibility studies or were concerned with establishing diagnostic accuracy. Although the technology has changed over the last thirty years, and the arrival of low cost desk top video telephony appears to be responsible for the latest surge of activity in the area, the focus of the studies, their research questions and methodological approaches appear not to have changed. Pathology, radiology, psychiatry and dermatology have particularly focused on diagnostic accuracy. Other specialties mostly report case series or case studies. Some studies have included questionnaires or interviews to elicit the views of health care providers and patients, some have attempted economic evaluations, although always indicating the limitations of any such study within the limited implementations which these studies largely represent. Some studies are primarily concerned with the technical specifications and

difficulties of the work. The most recent US Telemedicine Report to Congress (HCFA 1997) reports very small numbers of patients being seen annually in the USA by teleconsultation (2,110 in 1994 and 6,267 in 1995), despite the scale and long history of some of the US telemedicine projects.

It is therefore not surprising that only 24 studies were identified that met the inclusion criteria for this review. Thirteen are trials of home uterine monitoring which are being reviewed separately and have thus been excluded from this review. Three other studies were excluded. Two studies (Moore 1975; Hastings 1976), which were both reported as randomised controlled trials examining the use of teleconsultation, were excluded because there was insufficient data for analysis in the published reports and attempts to contact the authors received no response. One other study was excluded because the methodological design did not meet the review criteria. Coccolini et al (Coccolini 1995) used transtelephonic ECG recordings before prescribing thrombolysis for myocardial infarction in a rural emergency room, but used a two group design, with no randomisation process and no baseline data were given for either group.

Of the seven studies which have been included in the review, five were concerned with the use of telecommunications to support the care of patients in their own homes. In a prospective randomised controlled trial by Cartwright et al (Cartwright 1992), the blood pressure of women with hypertension in pregnancy was either monitored at home using telemetry, or they were admitted to hospital for conventional care. The study then compared the anxiety levels of the women in the two groups and a number of clinical outcomes. The telemetry system consisted of a Dinamap blood pressure monitor linked to a controlling microprocessor which automatically took ten blood pressure readings over ten minutes, and then downloaded them to the hospital computer via an integral telephone modem. High-pressure readings automatically triggered a radio-pager carried by a member of the hospital clinical team, who then rang the woman and implemented appropriate care. Women who were found at a routine antenatal check to have a blood pressure level indicating a need for hospital admission, were referred to the study. Those who agreed to take part were randomised either to routine hospital care or home telemetry, and were observed until their blood pressure had returned to acceptable levels, or the blood pressure of the women in the home group rose to levels requiring hospital admission, or the women were admitted to the delivery unit. Anxiety in the women was measured using the Spielberger state-trait anxiety inventory. All women attending the hospital clinic at 30 weeks gestation completed the trait anxiety questionnaire, and women recruited to the study completed the state anxiety questionnaire on entry to the study, on the first evening, third evening and following alternate evenings, and also completed self assessment report on the first evening and after delivery.

The other four studies were all aimed at assisting patients in the self-management of chronic conditions. All made use of the patients' own telephone lines, with the appropriate monitors for recording blood pressure, ECG, heart rate or blood glucose levels. Two of the studies were concerned with the care of diabetic patients. Ahring et al (Ahring 1992) examined glucose self-monitoring for insulin dependent diabetics. This was a randomised controlled trial, in which all the patients did five daily blood glucose measurements for a period of twelve weeks. The control group patients took their measurements to their clinic visits (either written down or stored in the memory of the glucometer), and the study group patients transferred their results to the hospital computer once a week, using a telephone modem. These patients were then given telephone counselling on their diabetic management, based on their results. The control group were not given any counselling outside their hospital visits. HbA1c, random blood glucose, and weight were measured at the beginning of the study, after six weeks and twelve weeks, and the total number of hypoglycaemic episodes. The study group also completed a questionnaire at the end of the study.

The study by Marrero et al (Marrero 1995) was a randomised controlled trial which aimed to evaluate the efficacy of using telecommunications technology to monitor paediatric insulin dependent diabetic patients, from home. Patients over the age of five years, attending a hospital outpatient clinic, were recruited to the study. All patients in the study monitored their blood glucose levels at home using a glucose reflectance meter, over a period of one year. The patients in the control group took the meter to their routine three monthly clinic visits, where the data was downloaded into a hospital computer. The experimental group used the same system, but transmitted their test results to the hospital computer via a telephone modem every two weeks. Depending on the test results, a nurse practitioner would then ring the patient and discuss with them or their parents, any need for adjustment in their management. If the results were satisfactory, the patients were sent a postcard praising them for maintaining good gylcaemic control. The outcome measurements for the study were: glycaemic control, psychosocial status, family functioning, perceived quality of life and patterns of parental/child responsibility for daily diabetes management.

Friedman et al (Friedman 1996) used telecommunications technology to provide support for hypertensive patients over the age of 60 years. Patients were recruited from community sites in Greater Boston, and the study aimed to assess the impact of the system on patients' adherence to antihypertensive medication and blood pressure control, over a period of six months. This was a randomised controlled trial, in which the experimental group, in addition to their routine care, were provided with a telephone modem to link them to a computer-based system. This was an interactive system in which the patient used a touch tone keypad to report their blood pressure recordings and other clinical information particularly related to their medication, and the system responded with education and counselling. All this information was then stored in the computer database and transmitted to the patient's

physician. The control group continued with their routine care alone. The outcome measures included adherence to medication, blood pressure levels and usefulness to the physicians.

Sparks et al (Sparks 1993) provided a rehabilitation programme for patients following myocardial infarction, using transtelephonic exercise monitoring. A group of twenty male patients beginning a cardiac rehabilitation programme, approximately six weeks after discharge from hospital, were randomly allocated to take part in exercise training either in hospital or at home. They were all given the same written information about diet, medication, benefits of exercise, symptoms and the exercise programme, before being allocated to a study group. The programme consisted of a one hour session, three times a week for twelve weeks. The home monitoring system allowed simultaneous transmission of ECG recordings and voice to the hospital, and allowed up to five patients to take part at the same time, and to talk to one another as well as to the hospital staff. The outcome measures were maximal oxygen consumption, blood pressure, pressure rate product and workload, all measured at the start of the programme and again after twelve weeks. During the study, two patients showed new arrhythmias but there were no medical emergencies, and all 18 of the patients who had formerly been working, returned to work. This study only recorded physiological outcomes, and the authors noted that more information is needed about the social and psychological factors involved, and about long term life style changes.

All these studies used ordinary telephone lines. None of them reported major technical problems, or any patient difficulties in managing the equipment, and Cartwright et al (Cartwright 1992) reported that some women set up the home equipment themselves without any assistance from the health care team. Ahring et al (Ahring 1992) discussed the cost implications of the intervention without any formal analysis, and Friedman et al (Friedman 1996) suggested that the system would be a cost effective means of lowering diastolic blood pressure, but this conclusion was not based on data from their own study.

Of the other two included studies, one was a pilot study of teleconsultation involving patients with their GPs and hospital-based consultants and the other was of telemedicine in the emergency department. Harrison et al (Harrison 1999) used desk-top PC-based video-conferencing equipment connected via ISDN II lines to link the outpatients department at one London hospital with four inner-city GP practices. The hospital specialties included were: orthopaedics; otolaryngology; gastroenterology; urology; paediatrics; and endocrinology, with one consultant from each taking part. There were 132 patients randomised to either video-consultation (62) or conventional outpatients appointment (70). The outcome measures were: the SF12 generic measure of wellbeing; the Ware Specific Visit Questionnaire; the Spellberger State-Trait Anxiety Inventory; a cost questionnaire for patients; the Duke Severity of Illness questionnaire; and a protocol specifically designed to extract data from hospital and GP records.

The final included study (Brennan 1999) was a randomised controlled trial of telemedicine in an emergency department in the USA. Video workstations were used to link a central and a peripheral site some 40 miles distant. The workstation included room and close up cameras, microphone, keyboard and network interface, with a radiograph reader, a digital stethoscope, otoscope, and dermascope. Fourteen physicians and four emergency room nurses were trained in the use of the equipment. Patients attending the peripheral centre with any of 18 pre-determined minor conditions (n= 122) were randomised to be seen by either a telemedicine nurse (54 patients) or to conventional physician care (50 patients) (18 patients were lost to the study). The telemedicine patients were then seen via teleconsultation by a physician at the central site, assisted by the telemedicine nurse who manipulated the medical equipment. Following the video consultation patients were evaluated by a physician at the peripheral site. Patients were further contacted by telephone one week later to collect data about satisfaction and need for further care.

Risk of bias in included studies

All seven included studies were randomised controlled trials, which appear to have been well conducted. Only Brennan et al (Brennan 1999), Harrison et al (Harrison 1999) and Cartwright (Cartwright 1992) reported adequate concealment of allocation. All the studies except Harrison et al had patients as the unit of allocation and analysis. None of the studies reported a power calculation and all of the studies were limited by their small sample size. This was further compounded by the small number of practitioners involved in each study, although Harrsion et al described using cluster randomisation to reduce the impact of contamination between physicians. In adopting this strategy Harrison et al introduced a unit of analysis error, randomising by practice but reporting results by patient, although this is only of academic interest, as this was a pilot study with a small sample and the data were not intended to be used for statistical analysis. None reported the involvement of consumers, and only Cartwright (Cartwright 1992), Sparks (Sparks 1993) and Brennan et al (Brennan 1999) reported gaining ethics committee approval. All described the drop out rates from the studies, both the reasons for not including apparently eligible patients initially, and the reasons for included patients dropping out as the studies progressed. Cartwright reported that the women lost to the study did not differ from those included on any of the baseline characteristics. All the studies provided baseline data for the experimental and control groups, showing that the groups were well matched. All the studies reported both the clinical rationale for the medical intervention and the rationale for using telemedicine to provide it.

The nature of the interventions meant that the control groups could not have received the intervention, but it appeared that the same health professionals probably provided care for patients in both groups in all the studies. Friedman (Friedman 1996) reported that technicians making the baseline and final measurements were

blind to the patients' group allocation, and baseline studies in the paediatric diabetes study (Marrero 1995) were all done before patients were allocated. All reported patient compliance with the intervention.

With the exception of Harrsion et al (Harrison 1999) and Brennan et al (Brennan 1999), who reported only between-group differences, all the studies included some analyses of within group and between group differences over the study periods. Friedman et al (Friedman 1996) described the significance of medication adherence within the study, defining baseline adherence as a dichotomous variable with patients taking 80% or more of medication defined as adherent. They created change scores for individual patients for medication adherence and blood pressure. Although the methods of analysis used in this study appeared to be appropriate, some of the published data was difficult to interpret without more information. A number of the results in the Marrero study (Marrero 1995) were reported in the publication as p-values only, with no other supporting data. Sparks et al (Sparks 1993) presented their data in bar charts, and the reviewers made calculations from these which might not be reliable. It does not appear that the quality of these studies is in any way compromised, but rather that these are issues for referees and publishers of medical literature to ensure that study results are reported adequately.

Effects of interventions

None of the seven included studies showed any detrimental effects from the interventions, although the small sample sizes mean that this cannot be taken to indicate that telemedicine is therefore without risk.

1. Measurable differences in the outcomes of care for patients treated remotely via telemedicine compared with those treated face to face:

Although it was hypothesised that women cared for at home would be less anxious than those admitted to hospital for observation of raised blood pressure in pregnancy, Cartwright (Cartwright 1992) did not show any significant differences in the anxiety levels or birth outcomes for the women cared for at home, compared with those cared for in hospital. Sparks et al (Sparks 1993) aimed to increase compliance with an exercise programme for patients recovering from myocardial infarction, but did not show any significant differences between the experimental and control groups, although there were significant within group improvements in physiological measures after completion of the programme. Friedman et al (Friedman 1996) showed a significant improvement in medication adherence in the non-adherent patients in the experimental group, but no significant difference for adherent patients (p = .03). (Medication adherence was already very high in this group, and there may have been a threshold effect). There was also a trend to a greater drop in mean diastolic blood pressure in the originally non-adherent experimental group. The authors suggested that this was likely to be attributable to the improvement in medication adherence rather than to any other characteristic of the intervention. The authors questioned the generalisability of their results as all the patients were over the age of 60 years, and there was no indication how this would apply to younger patients. Ahring et al (Ahring 1992) reported a significant within group improvement in HbA1c in the experimental group (p=.05) and a nonsignificant improvement in the control group (p=.10), but there were no other significant differences between the experimental and control groups. The authors also reported a non significant difference in hypoglycaemic incidents in the two groups with 112 in the experimental group compared with 99 in the control group. However, there was some discrepancy here, as later in the text the authors stated: 'The modem group experienced about twice as many hypoglycaemic incidents compared with the control group'.

Marrero et al (Marrero 1995) did not report any significant differences in the metabolic control between the two groups, although there was a trend towards improvement in both. They suggested that there might have been a threshold effect as all the patients had good metabolic control at the start of the study, and also suggested that the changes accompanying puberty might have been a confounding factor. The experimental group in this study reported a decrease in family problem solving, which the authors suggested might be attributable to the greater involvement of the specialist nurses in their care.

2. Measurable differences in the economic consequences of care delivered remotely via telemedicine compared with face to face care:

The studies included in the review had little to say about economic consequences. Harrison et al (Harrison 1999) used a cost questionnaire for patients but they reported only the reduction in time taken to visit the surgery for a teleconsultation as compared with the time for an outpatient appointment. The median time for the surgery visit was 0.5 hours, compared with 2.5 hours for the hospital visit. Brennan et al (Brennan 1999) reported no significant difference in need for additional care following the emergency department visit between the experimental and control groups. They did report a reduction in the time taken for the teleconsultation as compared with conventional care, with the experimental group averaging 106 minutes and the control group 117 minutes. However such measures gave little or no real sense of the economic consequences of the intervention. Ahring et al (Ahring 1992) discussed the cost implications of the intervention without any formal analysis, and Friedman et al (Friedman 1996) suggested that the system would be cost effective, but their conclusion was not based on data from their own study.

3. Difference for patients/clients in the acceptability of care provided remotely via telemedicine compared with care provided face to face:

Harrison et al (Harrison 1999) reported a consistent trend towards a higher level of satisfaction in the intervention group, although as this was a pilot study they did not report statistical significance.

Brennan et al (Brennan 1999) reported no significant difference between the experimental and control groups on measures of positive patient-physician interaction (98% vs. 100%), positive patient-nurse interaction (98% vs. 98%) or overall patient satisfaction (98% vs. 95%). However, given the high levels of satisfaction in both groups and the small sample size this might well represent a threshold effect. There was also a possibility that sampling bias might affect any assessment of patient satisfaction or acceptability of the technology used in these studies. In view of the requirements of informed consent it was perhaps unlikely that any patients with a marked aversion to new technology, or who perhaps disliked the idea of video cameras and so on, would have volunteered for trials of such equipment. The samples therefore represented self selected groups of those at least willing to try the new technology. It is thus likely that true satisfaction and acceptability will only be assessed when these technologies are in widespread use.

4. Differences in professional practice during the delivery of care through the medium of telemedicine compared with clinical care delivered face to face:

Friedman et al (Friedman 1996) suggested that physician behaviour might be influenced by the information they received from the system although they did not report data to support this. Marrero (Marrero 1995) suggested that the regular contact with health professionals was a motivating factor for the patients in the experimental group. Harrison et al (Harrison 1999) were concerned that the potential educational effect of the joint consultations might have an effect on the management of patients and took steps to minimise the effect of this through their randomisation strategy. However none of the studies addressed this issue specifically.

5. Differences in the transfer of skills between clinicians, in care delivered through the medium of telemedicine compared with care provided face to face:

This issue was not addressed by any of the included studies.

All the authors suggested that all these interventions needed to be carefully targeted to the right patients, and that there needed to be further investigation into the optimal rate of transmission of data and the level of personal contact required.

DISCUSSION

The predominant themes in the telemedicine literature during the last thirty years have been: the use of teleconsultation, the diagnostic accuracy of systems for teleradiology and telepathology, technical development and standards, the medical needs of under-served populations, acceptability of telemedicine to providers and patients, evaluation frameworks for telemedicine, and how telemedicine services might be funded and regulated. Despite the broad scope and definition of this review the 24 identified studies are not primarily concerned with any of the themes listed above.

The included studies are all well constructed and aimed at evaluating the effectiveness and acceptability of different technologies for providing healthcare from a distance. The predominant theme of these studies, with two exceptions, is the use of technology to support home care and patient self-care and management of chronic disease. They have all shown the feasibility of their respective interventions, with no reported detrimental effects. All the authors concluded with questions about appropriate levels of support for patients and families with different diseases and social needs. A study by Brennan et al (Brennan 1994) reported a randomised controlled trial in which a computer network was used to provide home care for people with AIDS, and whilst it did not meet the review criteria, it did represent and test a similar application of telecommunications technology in healthcare, which appears to be growing in significance.

The review demonstrates that there have been relatively few studies of the technologies and applications conventionally described as telemedicine. We suggest some possible explanations. In many of the trials in the USA and elsewhere, the number of patients treated in any particular system or specialty has been too small for proper evaluation, as shown in the Telemedicine Report to Congress, December 1997 (HCFA 1997). Trials in these areas have been more difficult to set up for a number of reasons. They may have relied heavily on leading edge but immature technologies, and they have often relied on individual enthusiasts, rather than clinical need. Whilst the included studies were all conducted by relatively self-contained teams, trials in the other areas have required the co-operation of other health professionals and organisations. Over the past twenty years studies have frequently suggested reluctance on the part of clinicians to give the effort needed to make these systems work.

From a reading of the literature, there also appears to be an assumption that care provided through the medium of telemedicine should always be measured against current practice, without questioning the effectiveness of the traditional face to face encounter. It has been known for many years, for example Bashshur (Bashshur 1975) that a thorough evaluation of telemedicine requires the concerted efforts of a wide range of clinical and academic disciplines, and large scale multi-disciplinary studies are far from easy to fund or set up.

The sustainability of telemedicine projects has been also been a problem. Bashshur (Bashshur 1995) said: "With minor exceptions, no serious contextual or situational analysis was conducted to establish a logical fit between the characteristics of the environment and the types of systems that were put in place". The implementation of telemedicine systems could have a major impact on the organisation of health services and service delivery and administration, but these factors, together with the cost implications, have been largely ignored. There is thus a clear need for more health

services research in this area, in addition to any further clinical trials. The studies included in the review do not provide clear evidence about the effectiveness or safety of telemedicine, or that telemedicine provides equivalent care at lower cost. It is difficult to disentangle the various factors that appear to have been a barrier to the proper evaluation of telemedicine over the last twenty years. We suggest that the basis upon which telemedicine should be evaluated should now be re-assessed.

AUTHORS' CONCLUSIONS

Implications for practice

The findings of the review have demonstrated the feasibility of establishing systems using telecommunications technologies for patient care, but provide very little evidence of clinical benefits. The studies provide variable and inconclusive results for other outcomes such as psychological measures. The studies provide no analysable data about the cost effectiveness of these telemedicine systems, and little evidence on which to base major investment in such systems.

When considering the use of communication technologies, practitioners need to ensure that the clinical rationale for the proposed application is established. Practitioners must recognise that the use of telemedicine technologies may require different clinical skills such as, for example, the use of specific communication skills, and approaches to information giving, and indeed may significantly alter the nature of the clinical encounter and the relationship between the professional and the patient. These issues may need to be considered quite separately from the assessment of the technology: in short telemedicine may result in fundamental changes in practice.

There is a danger that unevaluated technologies could be introduced into the service, and policy makers should be cautious about recommending increased use of unproven technologies.

Implications for research

1. The review demonstrates that randomised controlled trials of telemedicine applications are feasible, and wherever possible should be carried out.

2. There is a need to re-consider the focus and scope of telemedicine, and consequently the appropriate research questions.

3. Developments in telemedicine must take account of corresponding changes in distribution and use of telematics in society generally, not just in the health care context.

4. Research in the field of telemedicine must consider changing patterns of health care needs with the ever-increasing emphasis on care for people with chronic conditions and for the elderly, disease prevention and health promotion.

5. The emphasis in previous studies has focused on the clinical and service perspective with the patient perspective limited to 'patient satisfaction'. Patient-centred approaches to care are becoming better understood and more sophisticated in their methods of investigation.

6. Studies of effectiveness, efficiency and appropriateness of telematics applications to health care urgently need to be performed, but technology may permit provision of care which is presently not possible by conventional means. Comparing a telemedicine application with conventional care may not always be possible or sensible.

7. Formal economic appraisal of telemedicine applications may be difficult, but should be an integral part of any telemedicine research study.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Ahring 1992

Methods	Randomised Controlled Trial Randomisation concealment: NOT CLEAR Follow up Providers: NOT RELEVANT Follow up Patients: DONE (90%) Blinded Assessment: DONE Baseline Measurement: DONE Reliable Outcomes: DONE Protection against contamination: DONE Consumer involvement and ethical approval not reported in the study
Participants	Patients who were insulin dependent diabetics, aged 16-65 years, had Hba1c > 0.070, and owned a touch-tone telephone, selected consecutively from two endocrine clinics. Then stratified block randomisation used. 22 patients randomly assigned to experimental (modem) group and 20 to the control group. 2 patients dropped out of each group. Patients unit of allocation and unit of analysis. Country: Canada
Interventions	Patients transferring self monitored blood glucose results to clinic via telephone modem, weekly, and receiving appropriate telephone counselling, compared with patients taking results to routine clinic visit only. Duration of intervention: 12 weeks.
Outcomes	HbA1c (%), random blood sugar, number of hypoglycemic episodes and weight. Satisfaction of experimental group (not analysed here).
Notes	Ames/Miles Diagnostics provided Glucometer M and modems.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Brennan 1999

Methods	Randomised Controlled Trial Randomisation concealment: NOT CLEAR Follow up Providers: DONE Follow up Patients: DONE (85%) Blinded Assessment: NOT CLEAR Baseline Measurement: NOT CLEAR Reliable Outcomes: NOT CLEAR Protection against contamination: NOT CLEAR Consumer involvement not reported in the study. Ethical approval:DONE
Participants	14 physicians and 4 nurses in 2 emergency departments. 104 patients attending one emergency department with one of 15 selected complaints
Interventions	Emergency department patients evaluated and care prescribed by remote physician via telemedicine compared with patients receiving routine emergency department care
Outcomes	Return visit within 72 hours. Need for additional care. Time from admission to discharge. Patient satisfaction. Nurse and physician satisfaction
Notes	Authors acknowledge assistance from: Emergency Medical Associates, VTEL Corporation, Andries Tek Inc. and Northwest Covenant Medical Center

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Cartwright 1992

Methods	Randomised Controlled Trial Randomisation concealment: DONE Follow up Providers: NOT RELEVANT Follow up Patients: NOT DONE (74%) Blinded Assessment: DONE Baseline measurement: DONE Reliable outcomes: DONE Protection against contamination: DONE Consumer involvement is not reported, but ethical approval was obtained
Participants	99 women found at a routine antenatal visit (at hospital or in community) to be hypertensive requiring hospital admission. 4 women refused to participate, 4 withdrew. 6 women in experimental group admitted to hospital urgently and excluded from analysis. 16 women failed to complete the questionnaire and 2 women excluded for other clinical reasons. Final total of 36 women in experimental group and 31 in control group (74%) Patients unit of allocation and analysis. University obstetrics department and local community. Care provided by midwives, obstetricians and

Cartwright 1992 (*Continued*)

	general practitioners. Country: UK
Interventions	Home monitoring of women with hypertension in pregnancy, using a blood pressure telemetry system, compared with women receiving routine hospital care
Outcomes	Mean number of referrals; duration of monitoring; blood pressure during monitoring; clinical outcomes for mother and baby; trait and state anxiety levels
Notes	Study was funded by the Health Promotion Research Trust.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

Friedman 1996

Methods	Randomised Controlled Trial Randomisation concealment: NOT CLEAR Follow up Providers: NOT RELEVANT Follow up Patients: DONE Blinded Assessment: DONE Baseline measurement: DONE Reliable outcomes: NOT CLEAR Protection against contamination: DONE Authors do not report consumer involvement or ethical approval
Participants	Patients over 60years of age, taking anti-hypertensive medication and with BP greater than 160 mmHg systolic or 90 mmHg diastolic, recruited from 29 community sites in Greater Boston. 974 patients potentially eligible of whom 30% refused, 3% ineligible, 7% uncontactable. Remaining 573 visited and 299 confirmed as eligible and enrolled in trial. 267 (89%) completed the trial. Authors note that drop out rate was significantly higher in the experimental group (p = 0.05). Patients unit of allocation and unit of analysis. Patients cared for by their own physicians. Country: USA
Interventions	Routine medical care plus the weekly use of an interactive, computer controlled telephone monitoring and counselling system, compared with routine medical care only. Duration of intervention: 6 months.
Outcomes	Change in medication adherence, change in systolic and diastolic blood pressure. Attitudes of patients and physicians to Telephone-linked Computer System (TLC)
Notes	The study was supported by grant HL 40076 from the National Heart, Lung and Blood Institute

Risk of bias

Friedman 1996 (*Continued*)

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Harrison 1999

Methods	Randomised Controlled Trial (balanced randomisation) Randomisation concealment: DONE Follow up: Providers:NOT RELEVANT Patients: NOT DONE (87%-73%) Blinded Assessment: DONE Baseline measurement: DONE Reliable outcomes: DONE Protection against contamination: NOT CLEAR Consumer involvement and ethical approval: not reported.
Participants	9 GPs from 4 practices and 6 hospital consultants. Patients referred by the GPs for outpatient consultation. 132 patients randomised. 101 took part
Interventions	Patient and GP joinly consult ing hospital consultant via a video link from the GP surgery, compared with routine hospital outpatient appointments
Outcomes	Patient time taken for the visit. SF12 scores after 3 months. Ware Specific Visit questionnaire (patient satisfaction)
Notes	The study was funded by BT Laboratories and NHS R&D Programme. Randomisation was by GP and Zelan method used for gaining consent.

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

Marrero 1995

Methods	Randomised Controlled Trial Randomisation concealment: NOT CLEAR Follow up Providers: NOT RELEVANT Follow up Patients: DONE (100%) Blinded Assessment: DONE Baseline measurement: DONE Reliable outcomes: DONE Protection against contamination: DONE Consumer involvement and ethical approval not reported.
Participants	106 families with children over age 5 years, who had had insulin dependent diabetes for more than 6 months, all attending the paediatric diabetes clinic of one hospital. All recruited patients completed the study. Patients unit of allocation and unit of analysis. Care given to all patients by a multi disciplinary team. Telephone contact with the experimental group maintained by specialist nurse practitioner members of the team. Country: USA
Interventions	Paediatric patients transferring self monitored blood glucose results to clinic via telephone modem, every two weeks, and receiving appropriate telephone counselling, together with routine three monthly clinic visits, compared with patients taking results to routine three monthly clinic visit only. Duration of intervention: 12 months
Outcomes	Glycosated Haemoglobin A1 at baseline, 6 and 12 months. Nursing time-on-task. Authors also examined: Total number of hospital visits and emergency room visits Psychological status (OFFER Self-image questionnaire) Family dynamics (Family Assessment Device) Diabetes-Specific Quality of Life (diabetes Quality of Life for Youth measure) Responsibility for diabetes care (Parent-Child Responsibility Scale) Attitudes about the diabetes regimen.
Notes	Further information is being sought from the authors. Study supported in part by NIH Grant No. PHS P60DK20542, and a grant from Miles Inc. Diagnostics Division, and the Regenstrief Institute for Health Care, Indiana University School of Medicine

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Sparks 1993

Methods	Randomised Controlled Trial Randomisation concealment: NOT CLEAR Follow up Providers: NOT RELEVANT Follow up Patients: DONE (87%) Blinded Assessment: DONE Baseline measurement: DONE Reliable outcomes: DONE Protection against contamination: DONE Ethical approval gained. Consumer involvement not reported.
Participants	Twenty male cardiac patients entering a Phase II cardiac rehabilitation programme, approximately 6 weeks after hospital discharge, volunteered to take part in the study. One patient in experimental group returned to work at 6 weeks and dropped out of the study. Patients were the unit of allocation and the unit of analysis. Exercise sessions supervised by an exercise physiologist and a nurse. Country: USA
Interventions	A home based cardiac rehabilitation programme using transtelephonic exercise monitoring, compared with a hospital based exercise programme. Intervention duration: twelve week programme.
Outcomes	Changes after training in test workload measurements, maximal oxygen consumption, pressure rate product, systolic blood pressure, heart rate
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Blondel 1992	Home uterine monitoring study being assessed in a separate review
CHUMS 1995	Home uterine monitoring study being assessed in a separate review
Coccolini 1995	Two group design, but no randomisation process and no baseline data are given for either group
Dyson 1991	Home uterine monitoring study being assessed in a separate review
Dyson 1998	Home uterine monitoring study being assessed in a separate review

(*Continued*)

Hastings 1976	Insufficient data. Unable to contact author.
Hill 1990	Home uterine monitoring study being assessed in a separate review
Iams 1988	Home uterine monitoring study being assessed in a separate review
Katz 1986	Home uterine monitoring study being assessed in a separate review
Knuppel 1990	Home uterine monitoring study being assessed in a separate review
Moore 1975	Insufficient data on the numbers of patients included in the study and how patients receiving 'wrong consultation mode' were dealt with in the analysis. Unit of allocation was the nurse, but unit of analysis is the patient. Unable to contact author for further information
Morrison 1987	Home uterine monitoring study being assessed in a separate review
Mou 1991	Home uterine monitoring study being assessed in a separate review
Nagey 1993	Home uterine monitoring study being assessed in a separate review
Wapner 1995	Home uterine monitoring study being assessed in a separate review
Watson 1990	Home uterine monitoring study being assessed in a separate review

DATA AND ANALYSES

Comparison 1. Experimental telemedicine system compared with face to face patient care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Results			Other data	No numeric data

Analysis 1.1. Comparison 1 Experimental telemedicine system compared with face to face patient care, Outcome 1 Results.

Results

Study	Outcome Measurement	Targeted Behaviour	Main Process Effect	Main outcome Effect	Notes
Ahring 1992	Baseline, six weeks and twelve weeks.	To improve diabetes control in insulin dependent diabetic patients	None	% HbA1c at baseline: 0.106 vs 0.112 % HbA1c at six weeks: 0.094 vs 0.105 Absolute change (post): -0.011 Relative % change (post): -10.5% Absolute change from baseline: - 0.012 vs -0.007 Difference in absolute change: -0.005 % HbA1c at baseline: 0.106 vs 0.112 % HbA1c at twelve weeks: 0.092 vs 0.102 Absolute change (post): -0.01 Relative % change (post): -9.8% Absolute change from baseline: - 0.014 vs 0.010 Difference in absolute change: -0.004	

				Random blood glucose (mM) at baseline: 8.6 vs 8.9 Random blood glucose (mM) at six weeks: 7.5 vs 9.5 Absolute change (post): -2.0 Relative % change (post): -21.1% Absolute change from baseline: -1.1 vs 0.6 Difference in absolute change: -1.7 Random blood glucose (mM) at baseline: 8.6 vs 8.9 Random blood glucose (mM) at 12 weeks: 7.7 vs 8.0 Absolute change (post): -0.3 Relative % change (post): -3.75 Absolute change from baseline: -0.9 vs -0.9 Difference in absolute change: 0 Weight (Kg) at baseline: 78.8 vs 76.5 Weight (Kg) at six weeks: 78.5 vs 6.8 Absolute change (post): 1.7 Relative % change (post): 2.2% Absolute change from baseline: -0.3 vs 0.3 Difference in absolute change: -0.6	

				Weight (Kg) at baseline: 78.8 vs 76.5 Weight (Kg) at twelve weeks: 78.6 vs 77.0 Absolute change (post): 1.6 Relative % change (post): 2.1% Absolute change from baseline: -0.2 vs 0.5 Difference in absolute change: -0.7 Mean daily insulin dose at baseline: 43.25 vs 45.50 Mean daily insulin dose at twelve weeks: 44 vs 45.80 Absolute change (post): -1.8 Relative % change (post): -3.9% Absolute change from baseline: 0.75 vs 0.30 Difference in absolute change: 0.45 Authors report p = 0.05 for the improvement in HbA1c after 6 weeks and 12 weeks within the experimental group and p= 0.10 for the improvement within the control group. They report that none of the other measures showed a statistically significant change.	

				Questionnaires given to study group patients indicated improvements in knowledge about diabetes and self management	
Brennan 1999	One week after the visit.	Enable emergency physician to evaluate and prescribe care for patients with specific conditions, using realtime interactive telemedicine	Average time from admission to discharge: 106 vs 117 mins. Absolute difference: -11mins Relative % difference: -9.4% (Authors report p = 0.99)	Return visit within 72 Hours: 0% vs 0% Need for additional care: 2.3%vs 2.4% Absolute difference: -0.1% Relative % difference: -4.2% (authors report p=o. 99) Positive patient-physician interaction: 98% vs 100% Absolute % difference: -2% (authors report p=0. 32) Positive nurse-patient interaction: 98% vs 98% Absolute % difference: 0% (authors report p=0. 97) Positive overall patient satisfaction: 98% vs 95% Absolute % difference: 3% (authors report p=0. 54)	
Cartwright 1992	At recruitment, day 1, day 3 and alternate days thereafter.	Alternative provision of care for women with hyper-	None	Mean number of referrals: 1.4 vs 1.3 Absolute difference:	Authors also report state anxiety on third and fifth evenings,

	One week postnatally	tension in pregnancy		0.1 Relative % difference: 7.7% Duration of monitoring (days): 4.6 vs 4.9 Absolute difference: -0.3 Relative % difference: -6.1% Blood pressure during monitoring Systolic (mean): 137.5 vs 126.6 Absolute difference: 10.9 Relative % difference: 8.6% Blood pressure during monitoring Diastolic (mean): 74.1 vs 77.2 Absolute difference: -3.1 Relative % difference: -4.0% Gestation at delivery (mean no of weeks): 39.7 vs 39.9 Absolute difference: -0.2 Relative % difference: -0.5% Birth weight (mean in Kgs): 3.9 vs 3.3 Absolute difference: 0.6 Relative % difference: 18.2% Operative delivery: 17/36 (47%) vs 10/31 (32%) Absolute % difference: 15% Relative % difference: 47% Trait anxiety at 30 weeks: 34.5 vs 33.1 Absolute difference: 1.4 Relative % difference: 4.2% State anxiety at ran-	but numbers had dropped to 27 and 8 in the experimental group, and 16 and 2 in the control group

				domisation: 39.7 vs 38.5 Absolute difference: 1.2 Relative % difference: 3.1% State anxiety at evening of first day: 36.8 vs 33.7 Absolute difference: 3.1 Relative % difference: 9.2%	
Friedman 1996	At baseline and at six months.	Improved patient adherence to antihypertensive medications and improved blood pressure control	None	Mean change in medication adherence (%) from baseline to 6 months: 17.7 vs 11.7 Absolute % change: 6.0 (experimental better) Authors report p = .03 Adjusted mean change in systolic blood pressure (mmHg): 11.5 vs 6.8 Absolute change: 4.7 (experimental better) Authors report p = .20 Adjusted mean change in diastolic blood pressure (mmHg): 5.2 vs 0.8 Absolute difference: 3.4 (experimental better) Authors report p = .02 Sub Group analyses: Adherent patients: n	Linear covariable adjustments were applied by the authors to medication adherence and blood pressure change scores to adjust for age, sex, baseline medication. Baseline adherence was a dichotomous variable with patients taking 80% or more of medication defined as adherent. Ordinary least squares regression used for adjusted change scores. For significant results (p<.05) pairwise t test was used. Mathematical models used are included in the report

				= 121 experimental group/ n = 120 control group Non adherent patients: n = 14 experimental group/ n = 12 control group Mean change in medication adherence (%) from baseline to 6 months: Adherent patients: 0.6 vs 3.0 Absolute % change: -2.4 (control better) Authors report p = .69 Non adherent patients: 36.0 vs 26.0 Absolute % change: 10 (experimental better) Authors report p = .03 Adjusted mean change in systolic blood pressure (mmHg): Adherent patients: 10.3 vs 12.8 Absolute change: -2.5 (control better) Non adherent patients: 12.8 vs 0.9 Absolute change: 11.9 (experimental better) Adjusted mean change in diastolic blood pressure (mmHg): Adherent patients: 4.5 vs 4.4	

				Absolute change: 0.1 (experimental better) Non adherent patients: 6.0 vs -2.8 Absolute difference: 8.8 (experimental better) Attitudes of automated telephone system users: Authors report 69% of users scored in the upper quartile of a satisfaction scale after 6 months use of TLC. Attitudes of physicians to automated telephone system: Authors report 87/102 physicians said they read the TLC reports regularly and 41/102 discussed the information regularly with their patients	
Harrison 1999	At recruitment, after the visit and at 3 months.	Improvement of communications about referrals, between secondary and primary care	Median time taken by patient to visit GP surgery vs hospital: 0.5 hrs vs 2.5 hrs Absolute difference: -2 hrs Relative % difference -80%	SF12 scores for general health at 3 months: 37.7 vs 33.7 Absolute difference: 4.0 Relative % difference: 11.9% SF12 scores for mental health at 3 months: 36.8 vs 34.9 Absolute difference: 1.9 Relative % difference: 5.4%	Authors also report SVQ indicated a trend towards higher levels of satisfaction for the teleconsultation patients compared with the control patients
Marrero 1995	At baseline, six months and twelve months.	Management of insulin dependent diabetes in children.		% HbA1 at baseline: 9.4 vs 9.9 % HbA1 at six	Authors note a possible threshold effect for metabolic con-

				months: 9.6 vs 9.7 Absolute change (post): -0.1 Relative % change (post): -1.0% Absolute change from baseline: 0.2 vs -0.2 Difference in absolute change: 0.4 % HbA1 at baseline: 9.4 vs 9.9 % HbA1 at 12 months: 10.0 vs 10.3 Absolute change (post): -0.3 Relative % change (post): -2.9% Absolute change from baseline: 0.6 vs 0.4 Difference in absolute change: 0.2 Hospitalisations and emergency room visits: authors report no significant differences between the two groups (p = .787 and p = .614) Psychological status (OFFER Self-image questionnaire) - both groups showed an increase over time in importance of control (p = .01) Family dynamics (Family Assessment Device) - over time the experimental group showed a	trol

				decrease in problem solving scores and the control group an increase (p = .01). Both groups showed a small decrease in affective involvement scores (p = .03). Diabetes-Specific Quality of Life (Diabetes Quality of Life for Youth measure) - report no significant differences. Report significant increase in activities related ot general health over time for both groups (p value not given). Responsibility for diabetes care (Parent-Child Responsibility Scale) - report no significant differences. Attitudes about the diabetes regimen - report no significant differences except experimental group had fewer negative perceptions at one year about necessity for record keeping and sticking their fingers (p = .001)	
Sparks 1993	At baseline and twelve weeks.	Improvement of functional capacity in patients following coronary artery disease	None.	Workload after training (watts): Pretest : 123.5 vs 130 Post test: 156 vs 156 Absolute change (post): 0 Relative % change : 0	All outcomes are presented in bar charts only and the reviewers have extracted the data from these. The assumption has been made that all the patients have been included

				Absolute % change from baseline: 32.5 vs 26 Difference in absolute change: 6.5 (experimental better) Authors report p<0.001 for experimental and control groups. Changes in maximal oxygen consumption (mls): Pretest: 1560 vs 1599 Post test: 1989 vs 1950 Absolute change (post): 39 Relative % change (post): 2% Absolute change from baseline: 429 vs 351 Difference in absolute change: 78 (experimental better) Authors report p<0.05 experimental group and p<0.01 control group for within group differences. Changes in pressure rate product after training: Pretest: 23400 vs 20670 Post test: 19110 vs 17550 Absolute change (post): 1560 Relative % change (post): 8.8% Absolute change	in the analyses, and that the figures given are the mean values. p values only are given for within group differences before and after exercise programme. Attempts have been made to contact the authors without success

				from baseline: -4290 vs -3120 Difference in absolute change: -1170 (experimental better) Authors report p<0. 01 for experimental and control groups for within group differences. Changes in systolic blood pressure (mmHg): Pretest: 175 vs 170 Post test: 155 vs 151 Absolute change (post): 4 Relative % change (post): 2.7% Absolute change from baseline: -20 vs -19 Difference in absolute change: -1 (experimental better) Authors report p<0. 01 for experimental group and p<0.05 for control group for within group differences. Changes in heart rate (beats per minute): Pretest: 130 vs 121 Post test: 123 vs 115 Absolute change (post): 8 Relative % change (post): 7% Absolute change from baseline: -7 vs -6 Difference in abso-	

				lute change: -1 (experimental better) Authors report p< 0. 05 for within control group difference. Authors state that independent Student t test showed no significant differences between the groups before and after training, but no figures are given	

WHAT'S NEW

Last assessed as up-to-date: 23 January 2000.

Date	Event	Description
11 November 2009	Amended	Contact author details updated

HISTORY

Protocol first published: Issue 4, 1997

Review first published: Issue 2, 2000

Date	Event	Description
9 September 2008	Amended	Converted to new review format.
24 January 2000	New citation required and conclusions have changed	Substantive amendment

DECLARATIONS OF INTEREST

Since completing the funded work on the review two of the authors (RAC & PW) have been involved with the Virtual Outreach Project, a large-scale trial of video-consultation. The project is led by Professor Paul Wallace, of the Royal Free Hospital, London and the senior research officer is Robert Harrison. Harrison and Wallace are two of the authors of the Harrison et al (Harrison 1999) study included in this review. The Virtual Outreach Project is the main study for which Harrison et al report the pilot.

SOURCES OF SUPPORT

Internal sources

- University of Wales, Aberystywth, UK.
- University of Wales, Swansea, UK.

External sources

- Wales Office of Research and Development in Health and Social Care, UK.
- EPOC Review Group, University of Aberdeen, UK.

INDEX TERMS

Medical Subject Headings (MeSH)

*Communication; *Outcome and Process Assessment (Health Care); *Physician's Practice Patterns; *Physician-Patient Relations; *Telemedicine

MeSH check words

Humans