

**RECENT STUDIES ON ASSESSMENT
OF TELEMEDICINE:
SYSTEMATIC REVIEW OF STUDY QUALITY
AND EVIDENCE OF BENEFIT**
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SUMMARY

- A systematic review of telemedicine assessments was undertaken, as an extension to earlier reviews, with the intention of providing information for decision makers on health care on the status of this technology.
- The earlier reviews had covered 66 comparative studies, published from 1977 onwards. Searches of electronic data bases between January 2000 and June 2001 identified 46 scientifically credible studies that included comparison with a non-telemedicine alternative and which reported administrative changes, patient outcomes or results of economic assessment. A further 21 studies were also considered in relation to measurement of satisfaction with telemedicine.
- Twenty seven of the articles reported comparative clinical or administrative outcomes, 16 were mainly economic analyses, and 9 included both economic and clinical or administrative details.
- Twenty six of the comparative studies covered hospital or clinic based applications in the areas of cardiology, dermatology, geriatric care, infectious disease management, intensive care, mental health, neurology, ophthalmology, radiology, and sleep studies. Nineteen comparative studies dealt with telehomecare applications of various types and one with hospital referrals.
- A system for quality appraisal was applied that took account of both study design and study performance. Of the 46 studies, 9 were judged to be of high quality, 15 good, 11 fair to good, 7 poor to fair and 4 poor.
- The mean performance scores were somewhat higher for studies that used randomized designs. However, some randomized trials were of poor quality while some of the non-randomized studies achieved high performance scores.
- The economic analyses in the studies all used cost analysis. On average, the quality of economic studies was moderate, with 56% of them fulfilling five or more of the ten quality criteria used in the review.
- Thirty two of the studies suggested that telemedicine had advantages over the alternative approach, 10 also drew attention to some negative aspects or were unclear whether telemedicine had advantages and 4 found that the alternative approach had advantages over telemedicine.
- New evidence on the efficacy and effectiveness of telemedicine was given by studies on geriatric care, intensive care and some of those on homecare. In a number of other applications, reports of clinical and/ or economic benefits were essentially confirming or extending previous findings. These included studies on cardiology, dermatology, diabetes management in home care, mental health and radiology.
- Nineteen of the studies appeared to have potential to influence future decisions on the telemedicine application under consideration. A further 21 reported more preliminary results, which might have been helpful to decision makers but which indicated the need for further evaluation. The possible influence of the other six studies was unclear.
- Both the intent and the quality of the satisfaction studies reviewed varied considerably. The majority provided assurance to those responsible for new telemedicine projects that the

technique itself was considered feasible and reasonable by its clients. These studies were effectively concerned with measurement of process as an aid to establishing a viable program. A few studies went beyond this stage in that satisfaction measures supported other findings and could be regarded as providing a surrogate outcome.

- This review indicates that although further useful clinical and economic outcomes data have been obtained for some telemedicine applications, good quality studies are still scarce and generalisability of most assessment findings may be limited.

INTRODUCTION

There continues to be interest in the costs and benefits of telemedicine applications as this form of communications and information technology develops and diffuses. Information on costs and benefits of telemedicine is important for decision makers, but good quality studies addressing these issues continue to be sparse [1,2]. In earlier reviews [3-5] we considered those studies that had included comparison of a telemedicine application with a non-telemedicine alternative and which had reported administrative changes, patient outcomes or results of economic assessment. The intention was to provide an overview of the available reasonable quality evidence on the efficacy, effectiveness and economic impact of telemedicine applications, as a guide to decision makers in health care and those with interest in this technology.

In our previous reviews, searches of the electronic databases between 1966 and December 2000 identified 66 scientifically credible studies. Thirty seven studies suggested that telemedicine had advantages over the alternative approach, 25 drew attention to some negative aspects and 5 found that the alternative approach had advantages over telemedicine.

For several applications, including teleradiology, savings and sometimes clinical benefit were obtained through avoidance of travel and associated delays. Studies of home care and monitoring applications showed convincing evidence of benefit, while those on teledermatology indicated that there were cost disadvantages to health care providers, though not to patients. Forty four of the studies, some with methodological limitations, appeared to have potential to influence future decisions on the telemedicine application under consideration.

It was concluded [5] that although useful clinical and economic outcomes data have been obtained for some telemedicine applications, good quality studies are still scarce and generalisability of most assessment findings may be limited.

The work reported here extends the previous reviews through consideration of newer credible studies of telemedicine applications that have appeared in the literature. A similar basis for selection has been used, focusing on studies that included comparison with a non-telemedicine alternative and that reported clinical, economic or administrative outcomes. Two further areas of analysis have been added. The first of these is an attempt to provide a simple approach to obtaining a measure of quality for telemedicine studies, taking account of study design, study performance

and reporting of findings. In addition, description and discussion has been provided on measurements of satisfaction with telemedicine that were included in some of the studies. We have not regarded satisfaction as a strong measure of outcome and did not discuss this aspect of telemedicine assessment in our earlier reviews. Inclusion of material in this report reflects recent interest and critiques of measures of satisfaction in telemedicine studies [6,7] and a wish to provide some appraisal of the usefulness of such measures.

METHODS

Literature Search

Computerized literature searches were performed using the Medline, Health Star, EMBASE, PsychInfo and CINAHL databases from January 2000 to June 2002, using the search strategy described in Table 1. The HTA database was also checked for relevant studies. Using this approach, 605 papers dealing with the evaluation of telemedicine were identified. In addition, 4 studies were identified from references in telemedicine articles. Thirteen studies from year 2000 were included in our previous review [5].

Table 1: Search Strategy

Step	Search term
001	exp telemedicine/
002	telemedicine.tw. not 1
003	telepsychiatry.tw. not 1
004	teleradiology.tw. not 1
005	teleconsultation\$.tw. not 1
006	or/1-5
007	assess\$.tw. and 6
008	evaluat\$.tw. and 6
009	validat\$.tw. and 6
010	feasib\$.tw. and 6
011	pilot.tw. and 6
012	or/7-11
013	or 6 and 12

Selection of Publications

Initial screening of the identified articles was based on their abstracts. All abstracts were read independently by all the authors. Selection of relevant articles was based on the information obtained from the abstracts and was agreed upon in discussion between the authors. When an abstract did not give sufficiently precise information about the study or such information was not available at all, the article was obtained for further review.

For the main analysis, articles were selected which compared, in a scientifically valid manner, outcomes of a telemedicine application in terms of administrative changes, patient outcomes or economic assessment with those of a conventional alternative. Articles that were limited to describing the feasibility or the technical evaluation of a certain system were excluded. Comparative studies that measured or considered satisfaction with telemedicine were also included for the purposes of appraisal and discussion on satisfaction studies.

Full-text articles obtained for closer inspection were evaluated independently by the authors, who then reached a consensus on whether or not an article should be included in the final review, using the criteria given above.

Studies without a comparison between a telemedicine application and a conventional alternative were rejected. Also excluded were articles that were duplicates of other published studies included in this or our earlier reviews.

Several studies that included comparison of outcomes between telemedicine and non-telemedicine alternatives were excluded because there were substantial reservations regarding their scientific validity. Limitations included inadequate specification of the study population and absence of data to substantiate the conclusions reached.

In describing each study consideration was given to the objectives, approach taken, setting and subjects, type of economic analysis, results and conclusions of the authors. Note was taken of any significant limitations.

Assessment of Quality

In our previous reviews, the strength of evidence given in selected papers was considered with regard to the study design used, according to the nine level classification of Jovell and Navarro-Rubio [8] shown in Table 2. This classifies studies, in order of decreasing rigour of study design (Table 2). Study quality is to be further defined by conditions of scientific rigour.

The Jovell and Navarro-Rubio scheme provides a useful approach, but it was not always easy to apply to telemedicine studies and there was no clear way to provide a quantitative measure of scientific rigour. It was therefore decided to use a quality scoring system that took account both of study design and study performance.

For *study design*, scores were assigned to six of the classifications given by Jovell and Navarro-Rubio, as shown in Table 2.

Table 2: Classification of Study Design

Classification	Design	Score
I	Meta-analysis of randomized controlled trials	
II	Large sample randomized controlled trials	5
III	Small sample randomized controlled trials	3
IV	Non-randomized controlled prospective trials	2
V	Non-randomized controlled retrospective trials	1
VI	Cohort studies	2
VII	Case-control studies	1
VIII	Non-controlled clinical series	
IX	Anecdotes or case reports	

Classification I in the Jovell and Navarro-Rubio scheme was omitted for the purposes of our quality assessment as it was not applicable in the absence of any credible meta-analyses of telemedicine studies. Categories VIII and IX were also excluded, as only comparative studies were considered in the review. Large randomized controlled trials (RCTs), arbitrarily defined for the purposes of this review as those with at least 50 subjects in each arm, were given the highest score.

Lower scores were then given for small RCTs, prospective non-randomized or cohort studies; and retrospective studies.

For *study performance*, five areas of interest were considered, as shown in Table 3.

Table 3: Classification of Study Performance

	Areas of interest	Points to consider
1	Patient selection	Methods of randomization/ selection. Equivalence of intervention and control groups. Drop outs prior to commencement of intervention
2	Description/ specification of the interventions	Adequate description for both intervention and control groups
3	Specification and analysis of study	Sample size; statistical methods used; clear specification of outcome measures
4	Patient disposal	Length of follow up; drop outs; compliance failures
5	Outcomes reported	Fullness and clarity of reporting. Missing results; statistical summary. Whether conclusions were consistent with data.

When reviewing a telemedicine study, each of these five areas was given a score of 0, 1 or 2, based on the following observations:

0 = Relevant information was missing or given in only minimal detail

1 = Reasonable detail was provided but there were some important limitations

2 = Information was satisfactory, there were no significant limitations

Each study therefore had a possible maximum score of 10 for performance and 5 for design (large RCT). The scoring system was applied to all studies. Each author independently assigned scores to each study. In any case where the authors disagreed on the study design classification or where individual scores for any performance item differed from each other by more than one, the discrepancies were discussed and resolved by consensus. For each study, the mean of the authors' individual scores was reported to the nearest 0.5.

In addition, those studies that included cost or economic data were judged against the criteria for economic analysis given by Drummond et al. [9]:

- Was a well-defined question posed in answerable form?
- Was a comprehensive description of the competing alternatives given?
- Was the effectiveness of the programmes or services established?
- Were all the important and relevant costs and consequences for each alternative identified?
- Were costs and consequences measured accurately in appropriate physical units?
- Were costs and consequences valued credibly?
- Were costs and consequences adjusted for different timing?
- Was an incremental analysis of costs and consequences of alternatives performed?
- Was allowance made for uncertainty in the estimates of costs and consequences?
- Did the presentation and discussion of the study results include all issues of concern to users?

Each economic study was assessed using these criteria. A score of 1 was given for each criterion that was fulfilled in a satisfactory way, and if there were no significant limitations. A summary score from 0 to 10 was given to each study that included economic data. If the study fulfils at least 5 criteria, it can be seen to provide at least moderately good information on the economic indications of the telemedicine application.

Consideration of Measurement of Satisfaction

For description of the use of measures of satisfaction, all papers that included some reference to appraisal of satisfaction (or similar term) with the telemedicine application were considered. Seven levels of assessment were specified:

1. Reference to satisfaction with the service in the text, no details provided.

2. Simple questionnaire approach, no comparison with a non-telemedicine alternative.
3. Questionnaire with implied comparative component.
4. Questionnaire with specific comparison questions.
5. Comparative study, with simple outcome measures.
6. Comparative study, satisfaction outcome measures developed further, statistical summary.
7. Randomized study.

No formal assessment of quality was undertaken, but consideration was given to the numbers of subjects, coverage and drop out, any follow up, method of administration and analysis, and any influence on decision making for the telemedicine program.

Influence on Decision Making

As in a previous review [5], judgments were made on the potential influence of each study on future decisions regarding the telemedicine application considered. Indications of influence came from direct reference to influence of assessment results on the telemedicine programs and from demonstration of benefits or other findings which appeared likely to influence decisions.

RESULTS

Retrieved Articles

From the 605 publications identified in the literature search, 124 were retrieved for closer inspection. From these, 44 papers were judged to meet the selection criteria and were included in the review. Four other publications were identified through references cited in one of the retrieved papers and from a separate project to give a total of 48 papers for consideration. A further 21 papers were considered for description of measurement of satisfaction.

When comparative data were considered, 23 of the articles reported clinical or administrative outcomes, 16 were mainly economic analyses, and 9 included both economic and clinical or administrative details. Some kind of economic analysis was included in 25 (52%) of the papers. Identification and selection of the studies are summarized in Figure 1.

Study Classification

The 46 studies described in the selected publications were grouped by the areas of application shown in Table 4. Further details of each study are given in Appendix A. Some of the telemedicine programs were the subject of more than one of the selected papers. In these cases, the papers discussed separate aspects of the application or presented results obtained at different stages in the evolution of the program. Forty two programs were covered by the 48 papers. The settings for the studies are indicated in Tables 5 and 6.

Figure 1: Identification and Selection of Studies

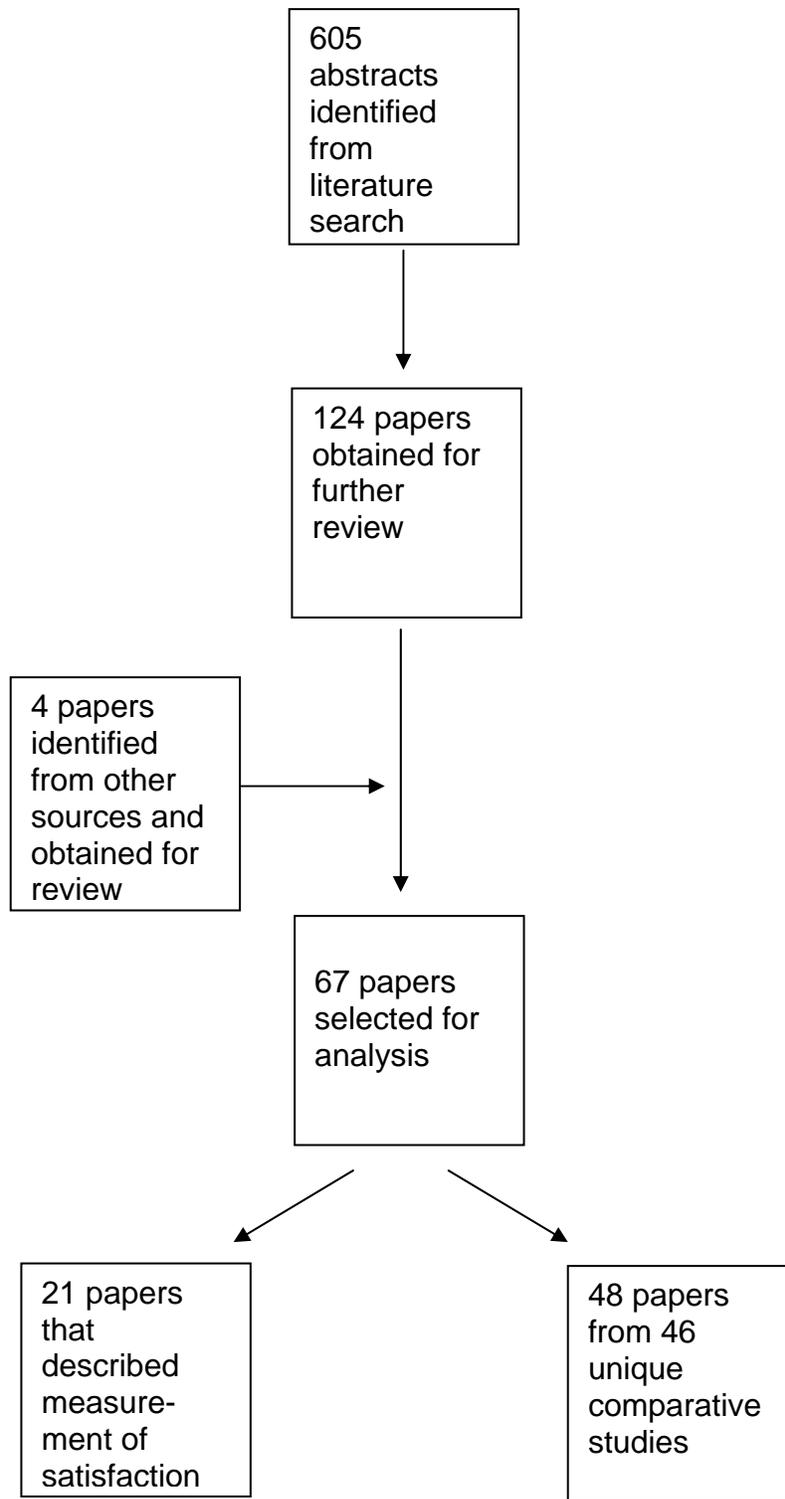


Table 4: Telemedicine Studies by Area of Application

Area of application	Number of studies	Cost or economic analysis	Studies based on RCTs	Potential influence on policy decisions
HOSPITAL – CLINIC SETTINGS				
Cardiology	2	2		1
Dermatology	5*	5	2	3*
Geriatric care - institutional	4**	3	1	3
Hospice care	1	1		1
Hospital referral	1	1		1
Intensive care	2***		1	1
Infectious disease	1	1		1
Mental health	4	3		1
Neurology	1	1	1	1
Ophthalmology	2*	1		1*
Radiology/ NM	4	1	1	2
Sleep studies	1	1	1	1
Telephone nurse triage	1	1		1
HOME CARE APPLICATIONS				
Asthma	3	1	3	2
Cardiovascular	6	2	5	4
Chronic wounds	1			1
Diabetes	5		5	
Epilepsy	1		1	
Obstetrics	1	1		1
Spinal rehab	1		1	1
Totals	46	24	22	26*

* One study considered both dermatology and ophthalmology

** Further paper included under Mental Health

*** One of these referred to neonatal intensive care, link to parents

Table 5: Countries of Origin of Studies

Country	Number of studies
USA	23
PRC (Hong Kong)	6
UK	3
Canada	2
Finland	2
Germany	2
Japan	2
Australia	1
France	1
Italy	1
New Zealand	1
Norway	1
Poland	1

Table 6: Settings for Telemedicine Studies

Type of setting	# of studies	# of papers	# of programs/ links
Hospital and outreach clinic or health centre	8	8	8
Major hospital and smaller hospital	7	9	7
Within hospital	1	1	1
Hospital and nursing home/ long term care	5	5	2
Hospital – specialist	1	1	1
Hospital – home (relatives)	1	1	1
Hospital - hospice	1	1	1
Specialist clinic – general practice	1	1	1
Home care and hospital or clinic	18	18	17
Triage service - home	1	1	1
Clinic – clinic	2	2	2
Totals	46	48	42

Study Quality

Of the 46 studies included in the main analysis, seven were based on large RCTs, 15 on small RCTs, seven were prospective, non – randomized and 17 were retrospective. Details of the quality scores given to the studies are shown in Tables 7 – 9. For the two studies which each had two papers (Chua et al. [10,11] and Simpson et al. [12,13]) the mean of the scores for the papers have been used. Table 7 shows the numbers of studies by the performance scores that they obtained, out of a maximum of 10. Overall quality scores for the studies are indicated in Table 8 (the maximum score was 15). Table 9 shows the distribution of performance scores in relation to study design. Quality scores for individual studies are given in Appendix A.

A high quality score for a study indicates that there can be a high degree of confidence in its results, supported both by the study design and the way in which it was carried out. Nine studies in category A in Table 8 (20% of the total) achieved the highest score range – there will be confidence that there were adequate descriptions of the studies and that they had been carried out competently. Category B studies would have been of good quality but have greater uncertainty regarding their findings and those in Category C would be of fair quality but with some limitations that should be taken into account in any implementation of their findings. Studies in Category D would have more substantial limitations, while results from those in E might be regarded as unacceptably uncertain, given deficiencies in the information provided and potential selection bias.

On that basis, 8% of the studies included in this review might be regarded as unacceptable and a further 15% of possibly limited validity. The study quality score in the convention used here is made up of study design and performance components. The latter gives an indication of how competently the study has been performed and reported. As indicated in Tables 7 and 9, there was substantial variation in the performance scores for the selected studies. Those in Categories C and D, about one third of the selected studies, would give some concern as to validity of their results, as there would be some important limitations in all five of the areas of interest given in the Methods section and in most cases relevant information would be missing or given in only minimal detail.

The data in Table 9 serve to illustrate the point that study design is not necessarily a good indication of study quality. The mean performance scores for the large and small RCTs considered in this review were similar and not substantially greater than those for the non – randomized studies.

The low performance scores given to some of the RCTs indicate that relatively low confidence can be placed in their results. The high performance scores for some of the non – randomized studies indicate high quality in their performance and reporting, though confidence in their findings will be limited by potential selection bias.

Table 7: Performance Scores for Selected Studies

	Summary performance score	Number of studies
A	8.0 – 10.0	14
B	6.0 - 7.5	17
C	4.0 – 5.5	11
D	0 - 3.5	4

Table 8: Quality Scores for Selected Studies

	Overall quality score	Implications for decision making	Number of studies
A	11.5 -1 5	High quality; high degree of confidence in study findings	9
B	9.5 – 11.0	Good quality; some uncertainty regarding the study findings	15
C	7.5 – 9.0	Fair to good quality; some limitations that should be considered in any implementation of study findings	11
D	5.5 – 7.0	Poor to fair quality; substantial limitations in the study, findings should be used cautiously	7
E	1 - 5	Poor quality; unacceptable uncertainty for study findings	4

Table 9: Performance Score by Type of Study Design

Study design	No of studies	Performance score data	
		Mean	Range (SD)
Large RCT	7*	7.1	3.0 – 9.5 (2.5)
Small RCT	15	7.3	5.5 – 9.0 (1.0)
Prospective	7	6.1	2.5 – 9.5 (2.4)
Retrospective	17 **	6.1	3.5 – 9.0 (1.7)

* Using mean for the two papers of Chua et al. [10,11]

** Using mean for the two papers of Simpson et al. [12,13]

The economic analyses in the studies all used cost analysis. None of the studies compared costs to effectiveness or utilities received by telemedicine. Nor did they value outcomes in monetary terms allowing the utilization of cost-benefit analysis. The studies included some high quality cost-minimization analyses where the effectiveness of telemedicine was shown to be equal to conventional care. The use of standardized Health-Related Quality of Life (HRQOL) measures is still rare in assessments of telemedicine. Only two economic studies included HRQOL measures. The perspective of the economic analyses was mainly that of the health care provider, although 65% of the studies included details of patients' and/or health care workers' traveling costs in the analysis. The widest economic perspective, societal perspective, was used in only four (17%) of the studies.

The quality of the economic analysis in the reviewed papers varied between 1 and 10 points. Thirteen of the studies that included economic analysis met five or more of the ten criteria for economic analyses given by Drummond et al. [9]. The individual economic quality scores are shown together with the other quality scores in Appendix A. Good quality economic studies were found in 6 (26%), good to fair in 7 (30%), low in 8 (35%) and very low quality studies in 2 (9%) of the articles. Almost all studies defined the research question well and also compared telemedicine to the conventional alternative. This was to be expected as the inclusion criteria of our review required this to be the case. About 60% of studies valued the costs credibly and discussed the study results (especially connected to economic factors). About 50% of studies identified and valued the costs and effects in a satisfactory way, and 43% measured the effectiveness in an appropriate way considering the requirements of economic analysis of the study. Timing and uncertainty was included in 30% of studies and some kind of incremental analysis interpretation could be made from 13%.

A summary of the economic quality scores is shown in Table 10. The overall quality rating was 5.3, which can be considered to be fairly good, considering that some of the studies were not full economic studies.

Table 10: Classification of Quality of Economic Studies Scores

Score	Number	Quality
10 - 8	6	Good
7 - 5	7	Good to fair
4 - 3	8	Low
2 - 1	2	Very low

Conclusions Reached in Studies

General conclusions reached in the reviewed papers are summarized in Table 11. Most indicated that telemedicine had advantages over the alternative approach, though a number also drew attention to disadvantages or uncertainties. For some of those that did not establish advantages for telemedicine, subsequent economic studies might indicate benefits through using the telemedicine approach. Further details on the study conclusions are given in Appendix A.

Overall conclusions by application are shown in Table 12, which includes summaries from a previous review [5], for comparison. For several applications, cost savings and/or clinical benefit were obtained through avoidance of travel and associated delays. As in the previous review, there were a number of home care studies. Many of these showed convincing evidence of benefit, often through use of telephone – based approaches.

Table 11: Conclusions Regarding Telemedicine

General conclusions	Number of studies
Telemedicine had advantages over the alternative approach	32
Telemedicine had advantages over the alternative approach but there were also some negative aspects	3
Unclear whether telemedicine had advantages, further work probably needed	7
Alternative approach had advantages over telemedicine	4

Table 12: Indications of Outcomes by Type of Application

Area of application	Number of studies	Indications of costs and benefits	Indications from previous review ⁵
Cardiology	2	Cost benefits from use in a prison service. Telecardiology was effective in providing specialist pediatric advice.	Limited evidence of clinical or cost benefits in the settings for these studies.
Dermatology	5 *	Cost savings in 4 studies, mainly to patients through avoiding travel. Teledermatology more costly in 1 study.	Teledermatology gave additional costs to health care providers, savings to patients. Savings suggested for nursing home setting, with limitation on accuracy. Availability in a health system increased access to services.
Geriatric care	4	Decreased hospitalization, lower travel costs, fewer falls, increased caseload by geriatrician.	
Hospice care	1	Telehospice service produced cost savings.	
Hospital referral	1	Increase in health care productivity, improved cost – effectiveness.	Increased efficiency and cost savings associated with electronic referral for a general hospital.
Mental health	4	Indications of lower or similar costs using telepsychiatry.	Savings to health system and patients through avoidance of travel – related costs. Improved outcomes with telephone – based nurse telehealth care.
Infectious disease	1	Reduced morbidity among HIV – positive inmates of prison.	Indications of cost savings for prison health services.
Intensive care	2	Use of off-site intensivist gave decreased mortality and costs. Use of Internet link to NICU improved family satisfaction.	
Neurology	1	Realtime teleneurology is not as cost-effective as conventional care.	Preliminary indications of feasibility.
Ophthalmology	2*	Cost savings through avoidance of travel, and reduction in numbers of consults in cataract surgery planning.	Savings through avoiding patient travel, benefits to health professional training.
Radiology	4	Time savings in intraoperative mammography, cost savings through avoidance of transfer of trauma cases; unclear whether improved outcomes in transfer of neurosurgery cases. Improved compliance with practice guidelines.	Savings through avoidance of unnecessary patient transfer or patient travel. Improved timeliness of patient management.
Sleep studies	1	Telemedicine was more costly than alternative approach.	
Telephone nurse triage	1	Provided cost savings, encouraged appropriate use of services.	
Home care – cardiovascular	6	Telephone – based interventions effective for heart failure cases in 2 studies, benefits unclear in 1 study. Outcomes improved for hypertensives. Tele-cardiac rehabilitation as effective as on - site	Improved outcomes for cardiac function, antihypertensive compliance.
Home care – asthma	3	Telephone intervention improved outcomes, reduced utilization of health services.	

Table 12: Indications of Outcomes by Type of Application (Continued)

Area of application	Number of studies	Indications of costs and benefits	Indications from previous review ⁵
Home care – diabetes	5	Improved glycemc control in 3, equal improvement in 1. Internet –based approach feasible but not very effective.	Improved outcomes for diabetes.
Home care – chronic wounds	1	Improved outcomes and availability of specialist.	
Home care – obstetrics	1	Improved clinical and economic outcomes for cases of pre-term labour.	Equivalent outcomes for high risk pregnancies
Home care – epilepsy	1	Unclear if telemedicine approach to counseling produced different outcomes.	
Home care – spinal rehabilitation	1	Telerehabilitation can give long term clinical and economic benefits.	

* One study considered both dermatology and ophthalmology

Potential Influence on Decision Making

Judgments made on reviewing the contents of the papers suggested that 19 studies appeared to have a potential to influence future decision making on telemedicine services. A further 21 reported more preliminary results, which may have been helpful to decision makers but which indicated the need for further evaluation. The possible influence of the remaining six studies was unclear.

Appraisal of Satisfaction

Nineteen of the 46 studies selected for analysis (Group A) included material on appraisal of satisfaction with the telemedicine application. A further 21 studies which did not meet the selection criteria for the main analysis (Group B) also included material on measurement of satisfaction. All 40 of these studies were reviewed, using the classification on approaches to satisfaction measurement noted under Methods. Comments on studies under the different classification categories are given below (in some studies more than one approach was used, so that the total by category is greater than 40). Further details of individual studies are in Appendix B.

1. Reference to satisfaction with the service in the text

Three studies included essentially passing reference to satisfaction with the telemedicine services provided. Such anecdotal findings might have provided reassurance for investigators but

are of little value for any independent appraisal of the study. Nevertheless, such accounts might reflect useful feedback obtained during the course of the study.

2. Simple questionnaire approach, no comparison with non-telemedicine alternative

There were 17 studies in this category, in which participants were being asked about the acceptability of the telemedicine intervention. Such simple questionnaire approaches may provide useful data during a study and give an indication of potential difficulties with the application. With two of the studies in Group A [14,15] there were possibly useful indications of difficulties with the approaches that were used. In Group B, Inouye et al. [16] found low satisfaction due to equipment problems and followed up to show that difficulties persisted at 6 months after the start of the study. Another Group B study included follow up over 6 months with indications of comparatively modest support for the intervention. Two large surveys of clients of a telephone nurse triage service [17,18] would have provided useful input to appraisal of an on –going program. Satisfaction measures in the other studies in this category would have provided reassurance to investigators of the feasibility of the approaches being used, sometimes at an early stage in a telemedicine project.

3. Questionnaire with implied comparative component

In two Group A studies [19,20] there was general reassurance that the telemedicine services were comparable with the alternative. In Group B, a large telephone survey regarding a telenursing service [21] would have been helpful in program evaluation.

4. Questionnaire with specific comparison questions

In three related Group A studies [19,22,23] reservations of nurses regarding comparison with traditional services would have provided useful feedback for the program. In two telepsychiatry studies [12,24] there was good feedback on acceptance of the technology and on preferences of clients. Satisfaction measures in the paper by de Lusignan et al. [25] supported other findings in the study indicating that videoconsultation was not useful. In Group B, there was useful feedback on technical issues in one study [26] and inconclusive results in another [27].

5. Comparative study, with simple outcome measures

Four studies in this category included material that indicated general support for use of telemedicine with similar levels of satisfaction with the non-telemedicine alternative.

6. Comparative study, satisfaction outcome measures developed further, statistical summary.

In Group A, satisfaction measures in the study by Bynum et al. [28] provided assurance that the telecounselling method was acceptable and supported the main findings of the study. Similar findings, with telemedicine being accepted equally to alternatives, emerged from two Group B studies [29,30].

7. Randomized study

There were 7 studies in this category. In Group A, satisfaction findings provided direct support for other findings in two studies [10, 31]. In two other studies, satisfaction measures were a minor component and few details were provided. The three studies in Group B all included satisfaction measures that appeared helpful for future decisions on the telemedicine services. Demiris et al. showed growing acceptance of telehomecare over a period of four weeks [32]. Satisfaction measures on consultation after unsuccessful IVF provided strong support for use of a telephone approach [33]. Patient and physician opinions indicated support for a telephone based anticoagulation service [34].

Both the intent and the quality of the satisfaction studies reviewed varied considerably. Patterson et al. [35] suggest that the aim of satisfaction studies in telemedicine is to show that the process is reasonably tolerated and acceptable to patients. Under that definition, the majority of the studies considered here were providing assurance to those responsible for new telemedicine projects that the technique itself was considered feasible and reasonable by its clients. A number also measured satisfaction of health professionals involved with the service. A smaller number made some comparison with the non-telemedicine alternative. Such studies play an important part in the development of a telemedicine program. As indicated elsewhere [36] coordinators of telemedicine programs must be responsive to the needs of healthcare professionals and their clients and include user assessment in their evaluation. As shown by several of the studies considered here, there can

be useful feedback regarding difficulties that will require resolution before a telemedicine program can be effective.

All of these studies are effectively concerned with measurement of process as an aid to establishing a viable program. In most, the indications of satisfaction cannot be considered as clinical or other outcomes of the telemedicine program. Their value to persons outside the program may be mainly as an indication of matters that should be considered when establishing a telemedicine application in a different setting. This would be true also for the program evaluations undertaken by the telephone surveys of clients using established networks.

A few of the studies that were reviewed went beyond this stage in that satisfaction measures supported other findings concerned with outcomes. In some cases, as with the study by Stewart et al. on consultation after unsuccessful IVF [33], client satisfaction could be regarded as a surrogate outcome.

No detailed assessment was made of the quality of the satisfaction studies but it is notable that in about a third of the reviewed papers only minimal details were provided, so that there would be limited confidence in the findings that were reported.

DISCUSSION

The results of this systematic review indicate that there is still relatively little good-quality information on the efficacy, effectiveness and cost-effectiveness of telemedicine. About 8% of the articles identified in the literature search reported a controlled comparison of a telemedicine application with conventional means of providing services. The proportion of controlled studies located in our previous reviews was 5% [3 – 5], so that there has been some improvement. However, a number of the selected papers described further findings from studies that had been included in the earlier review so that comparatively few new telemedicine assessments were identified. These relationships are shown in Table 13. Also, two of the programs included for the first time in this review were covered by more than one paper. Four papers described different aspects of a link to long term geriatric care from the Shatin Hospital/Prince of Wales Hospital, Hong Kong [19,22,23,37]. Two papers by Kokubu and colleagues [15, 38] presented information on telemedicine in the management of asthma.

Table 13: Relationship of Reviewed Studies to Earlier Studies

First author	Relationship to earlier studies
Chua [10,11]	These two papers relate to same study and follow earlier papers by Craig et al. on tele-neurology in Northern Ireland [39,40].
Poon [41]	The same group in Hong Kong published an earlier paper on neurosurgical transfer [42].
McCue [43]	Two earlier studies of a prison – hospital link have been published [44,45].
Pelletier – Fleury [46]	An earlier paper was noted in our earlier review, though it was not selected for analysis [47].
Simpson [12,13]	These papers provide updated data/ analysis for a telepsychiatry study included in our earlier review [48,49].
Rendina [50]	Further analysis of neonatal care in N Carolina; three previous papers were included in our earlier review [51 – 53].
Loane [54]	Follow up to a dermatology study by Oakley et al. [55] that was included in our earlier review.
Bergmo [56]	This is a further study on a telemedicine link with Tromsø, with a new application; three earlier papers were included in the earlier review [57-59].
Loane [60]	This study on teledermatology in Northern Ireland follows on from three previous papers [61-63], considered in the earlier review.

An encouraging aspect of the present review was the increased numbers of RCTs that were identified. The 22 RCTs in the 46 selected studies compares with a total of 22 RCTs from 66 studies in the previous reviews [5], giving an indication of possible improvement in study quality. Study quality was considered in more detail in this review than in our previous papers, with a quality scoring system being used for the first time. It was developed because we felt that the earlier classification which places most emphasis on study design does not give enough information for decision makers on the quality of a study. Our estimates of quality showed that there was considerable variation in performance scores for all study design groups, indicating that it is very important to consider how competently a study has been performed and reported. We found, for example, large RCT's with relatively low performance scores and also prospective and retrospective studies with high performance scores.

An advantage of the quality scoring system used here is that it provides a simple way to get an idea about the quality of telemedicine assessments. In previous reviews [3-5] our misgivings about the low quality of many studies were not substantiated in any detail. The scoring system used in the present review provides a numerical indication of the study limitation which should be helpful to decision makers.

A disadvantage of the quality scoring system is that it is based on subjective judgments which, however, were somewhat controlled for by the fact that any large deviations in opinion were discussed and resolved by the authors. The values used for the scores are somewhat arbitrary, since every study is different and so are the requirements for good quality study performance and reporting. It is possible that we have been too generous with some scores, for example the value given to very small RCTs. However, it is hoped that the approach taken will be helpful in drawing attention to the need to consider both study quality and study performance and that others will be encouraged to refine this method.

The economic analyses indicated that telemedicine is cost saving in many cases, especially if all cost implications are considered, including patients' travel and lost working time costs. Many of the economic studies did not give enough details of identification, measurement or valuation of cost parameters, to fully assess their reliability and quality. On average, the quality of economic studies was moderate, with 56% of them fulfilling five or more of the ten quality criteria used in the review. The selected studies included several good quality cost minimization analyses, such as those from the field of teledermatology, that provide good information for decision making. However, there are still many low quality studies that do not provide accurate enough information for appropriate decision making and can therefore result in inefficient use of health care resources. In general, the quality of economic studies has improved a little from that of those considered in the previous reviews.

Convincing new evidence on the efficacy and effectiveness of telemedicine was given by studies on geriatric and hospice care and some of the studies on homecare, such as those on management of asthma. There were also useful reports on applications in intensive care. In a number of other applications, reports of clinical and/ or economic benefits were essentially confirming or extending previous findings, rather than breaking new ground. These included some of the studies on

cardiology, dermatology, diabetes management in home care, mental health and radiology where benefits through avoidance of travel or of patient transfer were confirmed.

Benefits from telemedicine were not demonstrated in studies on neurological consultations, where the services were feasible but not cost-effective, in sleep studies, or in home care of persons with epilepsy.

As with our previous reviews, it was notable that services based on use of the telephone were beneficial in many areas, including nurse triage, telehomecare of patients with asthma and cardiovascular disorders. In many cases the telephone should be considered as an alternative to conventional care. In our review we have considered simple telephone interventions as telemedicine and it appears that in many cases this simple technology (that has been available for decades) is cost-effective.

While there is emerging evidence of the benefits of telemedicine in some new areas of application, in many cases evidence is provided by only a few preliminary studies. The harder evidence of benefit is still confined to a few applications that have been studied in more detail and in several centers. Because the implementation of telemedicine applications varies a lot between sites and especially between countries, there is a need for critical mass of studies showing benefits of telemedicine before an application can be recommended. Even then the local conditions should be considered carefully in the implementation of the program. For example, the effect of telemedicine on organizational and health care process changes may have a significant impact on the success of the program, but these issues were rarely discussed in the articles we have reviewed.

Although the field of telemedicine is no longer very novel, most of the available literature still refers only to pilot projects and short term outcomes. Few papers considered the long term or routine use of telemedicine and there was little information regarding follow up data on clinical outcomes or health status of patients. Clearly, the lack of good quality outcome measurement and economic studies is a weakness in the field. If measurement of effectiveness is not done using proper methodology, it is not possible to validly match effectiveness data to costs of the program in cost-effectiveness, cost-utility or cost-benefit analyses. These types of economic studies would be most valuable for the decision making purposes.

In a previous review [5] we concluded that “Useful data are emerging on some telemedicine applications, but good quality studies are still scarce and generalisability of most assessment findings may be limited.” From the data presented here, the picture is still much the same.

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Appendix A: Details of studies

Abbreviations

AED – Accident and emergency department

€– Euros

HKD – Hong Kong dollars

HMO – Health maintenance organization

ISDN – Integrated Services Digital Network

LOS – Length of stay

NICU – Neonatal intensive care unit

NKr – Norwegian crowns

PRC – People's Republic of China

PSG – Polysomnography

RCT – Randomized controlled trial

SS – Statistically significant

Quality scores

In the following tables, quality scores are given for each study. The numerical values for total quality and performance scores are included together with letters showing the categories from Tables 7 and 8, which give an indication of the confidence that might be placed in the study results. An economic quality score is also included for those studies that included some form of economic analysis.

Cardiology

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
McCue MJ, 2000 [43] Cost study using data on consultations	To evaluate cost savings from telecardiology in a prison.	Compared numbers and costs of telecardiology sessions with those for in person cardiology consultations at a major hospital. Administrative and billing data used.	Virginia, USA. Link between prison and university hospital. Inmates of prison; 188 telecardiology consults over a 3 y period.	Authors note that payment data were used, as accounting costs were not available for the prison centre.	Total 8.5 [C] Performance: 7.5 [B] Economic quality score: 4	Cost per telecardiology service was \$45 higher than that for a conventional consult in 1996, but became \$15 per visit lower in 1997 and \$46 per consult lower in 1998 as numbers of teleconsultations increased.	Clear indication of cost benefits arising from increased utilization of the telemedicine service.
Rendina MC, 2001 [50] Quasi – experimental study, retrospective comparison of neonatal data base records	To investigate effect of immediate tele-echocardiography on rates of neonatal transfer to academic medical centres.	Comparison of transfers of neonates to academic (major) medical centres 18 months before and 18 months after introduction of telecardiology at one regional NICU. Second regional NICU with on-site cardiology expertise acted as comparison institution.	North Carolina, USA n= 2,142 neonates in two Level 3 NICU units.	Some limitations on patient data, authors note study population data were not risk – adjusted. Authors also note absence of some desirable data that were not recorded or were unreliable. Comparatively brief details of analysis and outcomes. Savings estimate based only on figure given for “typical transfer charges”.	Total 7.0 [D] Performance: 6.0 [B] Economic quality score: 1	Introduction of telecardiology was associated with a 58% reduction in neonatal transfers [p < 0.001, CI 30% - 70%]. There was no such reduction at the comparison NICU. Transport savings through transfers avoided estimated at \$150,000 for the 18 month period.	Indication that availability of telecardiology was effective in providing specialist pediatric advice.

Dermatology

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Loane MA, 2001[54] Randomized controlled trial and cost analysis	To compare societal costs of real time teledermatology and conventional consultations.	Cost minimization analysis, comparison of teleconsultation and travel by patients for conventional consultations at a hospital. Data for variable cost estimations obtained by survey.	North Island, New Zealand. Two rural health centres linked to a specialist hospital. Patients referred for specialist care, n = 109 randomized to teledermatology and n=94 to hospital consultation. Also 14 follow up consults in telemedicine group and 12 in hospital appointment group.	No major limitations. Authors note that there were some missing data from survey forms.	Total 13.5 [A] Performance: 8.5 [A] Economic quality score: 10	Average societal cost per teledematology consult was NZ\$279.23 compared to NZ\$ 283.79 for conventional consult. Marginal costs of seeing additional patients was \$135 by teledermatology and \$284 by conventional consultation. Most savings accrued to patients and not providers; from provider perspective, cost of teledermatology was over four times higher.	Useful input to any policy decisions re implementation of service. Authors conclude that introduction of a routine teledermatology service is justified, though that is from a societal perspective.
Chan HHL, 2000 [37] Prospective study, administrative data, cost estimates	To assess feasibility of establishing a teledermatology service: cost – effectiveness considerations. [study also measured diagnostic and management accuracy]	Comparison of costs of teleconsultation and those for consultations at a specialty clinic.	Hong Kong, PRC. 74 persons either in a nursing home or a hospital, who had dermatologic problems. Both institutions linked to a major hospital.	Some assumptions in the analysis of costs, eg that only one patient was transported at a time.	Total 8.5 [C] Performance: 6.5 [B] Economic quality score: 2	If staff and transport costs are considered, cost per consultation was HKD57.7 for teleconsultation and HKD322.8 for consultation at the major hospital. Set up costs for telemedicine were HKD38,325 and maintenance and line charges HKD12,600 per y. At the present caseload of 89 patients per y, estimated time required to offset the set up cost will be 3.55y.	Indication that teledermatology service is realistic in this situation.

<p>Loane MA, 2001 [60]</p> <p>Randomized controlled study with cost - effectiveness study</p>	<p>To measure the cost – effectiveness of real time teledermatology.</p>	<p>Comparison of outcomes (follow up consultations) and costs for the telemedicine and conventional approaches. Data for variable cost estimations obtained by survey.</p>	<p>Northern Ireland, UK. One urban and one rural health centre linked to a regional hospital.</p> <p>Patients with non-urgent dermatologic conditions randomized to telemedicine consultations [n = 126] and outpatient consultations [n=148].</p>	<p>Low response rate to patient economic questionnaire.</p> <p>Sensitivity analysis conclusions possibly based on optimistic scenarios.</p>	<p>Total 14.0 [A]</p> <p>Performance: 9.0 [A]</p> <p>Economic quality score: 10</p>	<p>Similar clinical outcomes.</p> <p>Marginal cost per patient of real time teledermatology £52.85 for urban areas and £59.93 for rural areas; corresponding marginal costs for conventional consultation were £47.13 and £48.77.</p>	<p>Useful identification of factors influencing cost – effectiveness of services.</p>
<p>Bergmo TS, 2000 [56]</p> <p>Cost minimization study drawing on retrospective consultation data</p>	<p>To determine the cost differences between alternative methods of providing dermatology care to patients living in remote areas.</p>	<p>Cost study comparing telemedicine and conventional consultation options and excluding costs borne outside the social and health care sector.</p>	<p>Norway. Telemedicine link between hospital at Kirkenes and university hospital in Tromsø, Actual workload (1998) was 375 patients.</p>	<p>No substantial limitations.</p>	<p>Total 10.0 [B]</p> <p>Performance: 9.0 [A]</p> <p>Economic quality score: 8</p>	<p>Total cost of teledermatology was NKr 470,780 compared to NKr 880,530 for a visiting service + patient travel, NKr 1,635, 075 for patient travel to secondary care centre and NKr 958,660 for a locally – employed dermatologist.</p> <p>Real time teledermatology was less costly than the three alternatives for annual workloads over 195 patients/y.</p>	<p>Useful input into any policy decisions on such services. Notes need to take account of local circumstances and to exercise caution in generalizing results.</p>

Geriatric – Institutional, Long Term Care

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Chan WM, 2001 [19] Retrospective analysis of services	To assess the feasibility of providing some nursing services via telemedicine to residential homes for the elderly.	Comparison of falls by residents before and after use of telemedicine for risk assessment (videoconferencing). [Also qualitative descriptions of other services that are not considered here.]	Hong Kong, PRC. Nursing home with link to Shatin Hospital. All 198 patients in the residential nursing home.	Based on administrative records. Few details on approaches to analysis or of patient disposal.	Total 5.0 [E] Performance: 4.0 [C]	Number of falls decreased from 9.8 to 6.8 per month during period of telemedicine use and proportion of falls producing fracture decreased from 8% to 3%. However, change was not SS.	Geriatric nursing outreach services could be provided by telemedicine which may be effective for reducing the occurrence of falls.
Dansky KH, 2001 [64] Randomized controlled study and economic analysis	To test the effects of telehomecare on clinical outcomes and to estimate the financial costs associated with providing telehomecare services.	Intervention group receiving video visits in addition to nursing visits, control group receiving nursing visits only. Both direct and indirect costs examined.	Philadelphia, PA, USA. 86 patients in the intervention and 85 in the control group.	Relatively short follow-up (2 months).	Total 9.5 [B] Performance: 4.5 [C] Economic quality score: 8	Fewer telehomecare patients required recertification after 60 days or were hospitalized during the intervention. Telehomecare imposes additional expenses for care delivery but contributes substantial savings without compromising quality.	Telehomecare is a cost-effective way of providing some of the services needed by the aging population.

<p>Hui E, 2001 [22]</p> <p>Case series, retrospective cost collection</p>	<p>To assess the feasibility and costs of providing geriatric services to nursing home residents using telemedicine.</p>	<p>Comparison of costs for 12 months with operation of the videolink with those for face-to-face services, based on pre-study data.</p>	<p>Hong Kong, PRC.</p> <p>Video link between nursing home and convalescent hospital.</p> <p>1,001 patient episodes at nursing home.</p>	<p>Some limitations on reporting of patient selection and patient outcomes</p>	<p>Total 7.5 [C]</p> <p>Performance: 6.5 [B]</p> <p>Economic quality score: 4</p>	<p>Geriatrician was able to increase caseload from 45 to 65, spending an average of 2.5h/ session compared to 4h/ session in an outreach clinic.</p> <p>AED attendance decreased by 8.8%, and admissions to acute hospital by 10.6%; bed days in convalescent hospital rose by 20%.</p> <p>Savings of HKD236,451 for provision of geriatrician's services and HKD73,700 for transport and escort services to outpatient clinics and AED. Telemedicine is a feasible means of delivering multidisciplinary care to frail nursing home residents and may result in savings.</p>	<p>Strong indication to continue with this method of service provision.</p>
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<p>Pringle Specht JK, 2001 [65]</p> <p>Cost study using retrospective administrative data</p>	<p>To measure the costs of a telemedicine chronic wound consultation clinic.</p>	<p>Cost study, identifying components of cost for teleconsultation and for alternative options of a wound expert traveling to the patients or patients traveling to an acute care centre [ACC].</p>	<p>Iowa, USA.</p> <p>Wound nurse expert at ACC linked to long term care centre [LTC].</p> <p>Estimates based on caseload of 15 patients / month at LTC who required consults for their wound care.</p>	<p>Sparse information on patient selection and patient disposal. Total 'combined care' cost is stated incorrectly. Cost avoidance results appear to combine information from two scenarios. No details are provided on patient travel cost estimates.</p>	<p>Total 4.5 [E]</p> <p>Performance: 3.5 [D]</p> <p>Economic quality score: 5</p>	<p>Average cost of a telemedicine consultation, taking account of both facilities was \$236.</p> <p>Teleconsultation would save travel costs, for the scenario where wound expert visits the LTC, of \$220 per trip, equivalent to \$36.66 per consultation undertaken at the LTC.</p> <p>Compared to the scenario where patients travel from the LTC to the ACC, teleconsultation would save travel costs of \$191.28 per patient.</p> <p>Patient time is estimated at 20 minutes for teleconsultation and 8.5 h if travel to the ACC is undertaken.</p>	<p>Unclear. Various factors requiring consideration are presented.</p>
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Hospice Care

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
<p>Doolittle GC, 2000 [66]</p> <p>Economic analysis, retrospective data</p>	<p>To assess the cost for traditional hospice care as well as those associated with launching and operation of a telehospice service.</p>	<p>Hospice services were provided utilizing ordinary telephone-based videoconferencing equipment to link hospice provider with patients and their families.</p> <p>All operational costs of traditional hospice services were included in both years.</p>	<p>Kansas Univ. TeleMedicine Services Department and Kendallwood Hospice, Kansas City, USA.</p> <p>Data collected from traditional hospice care from January to March 1997 and 1998, and for telehospice for January to March 1998.</p>	<p>The cost analysis did not have all the details of both alternatives. It is noted that the televisit and the conventional visits are not the same, and the effectiveness of these alternatives was not measured.</p>	<p>Total 5.5 [D]</p> <p>Performance: 4.5 [C]</p> <p>Economic quality score: 3</p>	<p>For traditional hospice care the cost per visit was \$126 in 1997 and \$141 in 1998. The average telehospice visit cost in 1998 was \$29.</p> <p>Telehospice visit is much less expensive than a traditional in-person visit, and it can offer a method to deliver services efficiently to patients who are living far away from service providers.</p>	<p>Utilizing telehospice services may help Medicare system to provide end-of-life services to patients in an efficient way even if the patient lives away from services.</p>

Hospital Referrals

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
<p>Harno K, 2000 [67]</p> <p>Prospective trial and economic analysis</p>	<p>To examine the clinical effectiveness and costs of telemedicine in improving the referral process from primary to secondary care.</p>	<p>Primary Health Centre GPs made electronic referrals to an internal-medicine outpatient clinic where specialist could both make bookings for outpatient visits and give teleconsultations.</p> <p>In conventional system, mailed paper referrals were used.</p>	<p>Hospitals in Finland.</p> <p>Electronic referral system used at Peijas District Hospital, Vantaa, while a paper-based referral system was used in Hyvinkää Hospital.</p> <p>Study period was 8 months in Peijas Hospital and 6 months in Hyvinkää Hospital. 209 patients were referred electronically and 85 had paper-based referrals.</p>	<p>The services were not the same, since paper consultations were not so common in conventional alternative and telephone consultations were more frequent.</p> <p>Information technology costs were difficult to estimate, since the systems were paid off many years ago.</p>	<p>Total 10.5 [B]</p> <p>Performance: 8.5 [A]</p> <p>Economic quality score: 8</p>	<p>The population-based number of referrals (7.5/1000) was twice as high in the hospital using electronic referrals than in the paper referral system (3.8/1000). 37% of electronic referrals from GPs requested for online medical advice (teleconsultation). The number of outpatient visits resulting from referrals were 43% and 79% in tele- and paper-based systems, respectively. The direct outpatient visit cost was €11, and that of e-mail consultation €32. A net benefit of €7876 in favour of the teleconsultation system.</p>	<p>Use of interactive electronic referral system between secondary and primary care can increase productivity in health care as well as improve cost-effectiveness.</p>

Infectious Disease

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
<p>Wong MT, 2001 [68]</p> <p>Retrospective study with economic analysis</p>	<p>To measure the effectiveness and the costs of HIV care within a state corrections program, and estimate the relative cost savings in the treatment of HIV-positive incarcerated persons.</p>	<p>Primary health care was provided to known HIV-positive inmates through conventional outpatient clinical and telemedicine settings. All primary costs, including hospitalizations, were captured in this closed system.</p>	<p>Virginia, USA.</p> <p>Four clinical sites contracted by Virginia Dept. of Corrections, Medical College of Virginia Hospital (MCVH) and the University of Virginia had telemedicine facilities. From 14 correctional facilities 3 had telemedicine program.</p> <p>Retrospective data on 200 clients (43 in telemedicine, and 157 in conventional care) between 1997-1998.</p>	<p>The study was initially designed to be observational, and the numbers in telemedicine group were relatively small. There were a number of limitations in using cost-of-service data from the point of care, and the telemedicine equipment and other related costs were not reported.</p>	<p>Total 8.5 [C]</p> <p>Performance: 7.5 [B]</p> <p>Economic quality score: 3</p>	<p>Since the introduction of this treatment program, there has been a sharp decrease in viral load levels among HIV-positive inmates, treatment compliance has improved, and there has been a reduction in all HIV-related morbidities except malignancies.</p> <p>Despite the increased use of HIV drug therapy, total costs per patient remained stable because of reduced morbidity.</p>	<p>Telemedicine programs in correctional facilities can improve the educational possibilities of health care providers, improve the standard-of-care level, and improve the health status of HIV-positive inmates.</p>

Intensive Care

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
<p>Rosenfeld BA, 2000 [69]</p> <p>Retrospective study with economic analysis</p>	<p>To evaluate the use of telemedicine as a means of achieving 24-hour intensivist oversight to a surgical ICU, and measure the clinical outcomes and economic implications.</p>	<p>Intensivist provided management during the intervention using remote monitoring methods (videoconferencing and computer-based data transmission) to obtain clinical information and to communicate with on-site personnel.</p>	<p>Baltimore, USA</p> <p>Ten bed surgical ICU in an academic-affiliated community hospital.</p> <p>All adult patients whose entire ICU stay occurred within one of the 16-weeks study periods (between September 1996 and December 1997). Two first cohorts provided control data (225 and 202 patients) and last cohort included 201 telemedicine patients.</p>	<p>Retrospective study. The economic analysis did not show in detail the investment and operation costs of telemedicine technology.</p>	<p>Total 9.5 [B]</p> <p>Performance: 8.5 [A]</p> <p>Economic quality score: 6</p>	<p>Severity-adjusted ICU mortality decreased during the intervention period by 68% and 46%, compared with baseline periods one and two, respectively. Severity-adjusted hospital mortality decreased by 33% and 30%, and the incidence of ICU complications was decreased by 44% and 50%. ICU length of stay decreased by 34% and 30%, and ICU costs decreased by 33% and 36%, respectively.</p>	<p>The study suggests that remote care program may provide a means of improving quality of care and reducing costs when on-site intensivist coverage is not available.</p>

<p>Gray, 2000 [31]</p> <p>Randomized controlled study</p>	<p>To evaluate an Internet-based telemedicine program to families of very low birth weight (VLBW) infants during and after NICU stay.</p>	<p>Eligible infants were randomized within 10 days of birth. Families of intervention group were given access to the Baby CareLink telemedicine application, [incorporates videoconferencing and WWW technologies to enhance interaction between families, staff, and community providers].</p> <p>Control group received care as usually practiced in the NICU.</p>	<p>NICU in Boston, MA, USA.</p> <p>For providing information to families, a multimedia computer with WWW browser was installed in the homes of the intervention group babies within 3 weeks of birth.</p> <p>Of the 176 VLBW infants, 26 randomized to study group, 30 to control group.</p> <p>Quality of care assessed with satisfaction survey. Hospital LOS and family visitation and interaction with infant and staff were measured.</p>	<p>High percentage (50%) of excluded patients, intervention thus suitable for a limited number of cases only. Small number of patients.</p> <p>Lower costs associated with hospital to hospital transfer claimed but no economic analysis to support this argument.</p>	<p>Total 11.0 [B]</p> <p>Performance: 8.0 [A]</p>	<p>Intervention group reported significantly higher overall quality of care. Frequency of family visits, telephone calls to the NICU, and holding of the infant, however, did not differ between the groups. LOS until final discharge similar in the two groups.</p> <p>All infants in the telemedicine group were discharged directly to home whereas 6/30 (20%) of control infants were transferred to community hospital first.</p>	<p>Telemedicine significantly improves family satisfaction, and supports the educational and emotional needs of families facilitating earlier discharge of VLBW infants to home. The expansion of the telemedicine model to the post-discharge period may improve the coordination and efficiency of care but effect on administrative outcomes and economics is still unknown.</p>
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Mental Health

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Elford R, 2001 [24] Cost study based on estimates from previously performed psychiatric consultations	To compare costs of telepsychiatry with those for conventional consultations with travel by the patients to a major centre. [Also measures of satisfaction for children and adolescents, which are not considered here].	Telepsychiatry capital and operating costs compared to costs of conventional consultation, including travel and accommodation for patients and their parents.	Newfoundland, Canada. Link between child health centre and a regional hospital. Thirty patients (5 -16 y) accompanied by their parents; psychiatric assessment using videoconferencing.	Patient travel costs based on information from parents on how they would have traveled and how long they would have stayed, relationship to actual experience or payment policy unclear. No assessment of indirect costs.	Total 6.5 [D] Performance: 5.5 [C] Economic quality score: 4	Average cost for telepsychiatry slightly lower than travel costs for conventional consultation (\$419 per patient vs \$428 per patient). For 70% of patients, telepsychiatry had higher costs.	Possibly helpful indication on the feasibility of the service.
Rohland BM, 2001 [70] Prospective crossover study	To compare satisfaction and functional status in persons using telemedicine with those receiving face-to-face services at two rural sites.	Psychiatric care provided at two rural sites, one with and one without telepsychiatry. After 1y, telepsychiatry function was switched to the other (non telemedicine) site. Global Assessment Function (GAF) scores.	Texas, USA n=26 psychiatric patients, of whom n = 12 received both telepsychiatry and face-to-face consultation.	Small number of patients in the study. Limited detail provided on selection and outcomes. In conclusions, acceptability relate to satisfaction scores from patients but their reliability is unclear because of the low rate of recruitment.	Total 7.5 [C] Performance: 5.5 [C]	Changes in GAF scores between first and last visits by telemedicine in the two groups [n = 12] were 8.1 and 1.2, compared to - 6.9 and 3.8 for face-to-face consults. Combined results were 5.8 for telemedicine and - 3 for face-to-face. Telepsychiatry appears to offer acceptable and adequate alternative mode of service delivery in rural areas.	Unclear. Indication of feasibility but program with low utilization.

<p>Simpson J, 2001 [12, 13]</p> <p>Cost study as part of an observational study. Retrospective control</p>	<p>To obtain data on costs associated with operation of a routine telepsychiatry service.</p>	<p>Breakeven analysis of telepsychiatry versus services provided by a psychiatrist travelling to smaller centres.</p> <p>Estimates of cost to patients who would have to travel to a major centre for consultation.</p>	<p>Alberta, Canada.</p> <p>Videoconsultations between major psychiatric hospital and five hospital clinics at a distance of 80 to 214 km.</p> <p>Study covered 546 tele-consultations (379 patients) over a period of 2 years.</p>	<p>Limited details on costs to patients, estimate of impact is only indicative.</p>	<p>Total 8.0 [C]</p> <p>Performance: 7.0 [B]</p> <p>Economic quality score: 7</p>	<p>Breakeven point was 348 consultations/y (\$630/consultation). With use of video -conferencing for administration, breakeven point was 224 consultations/y. Costs to patients who would have to travel to a major centre were \$240 per consultation.</p>	<p>Indication that costs of the telepsychiatry service are acceptable, and below breakeven point when use of administrative videoconferencing is considered. Also indications of savings to patients.</p> <p>Results informed decisions to expand the telemental service on a province-wide basis.</p>
<p>Tang WK, 2001 [23]</p> <p>Retrospective cost study</p>	<p>To examine the feasibility, acceptability, costs, benefits and limitations of telepsychiatry.</p>	<p>149 psychiatric assessments by videoconferencing over 11 months.</p>	<p>Hong Kong, PRC.</p> <p>45 elderly persons in care and attention home who received psychiatric consultations, link to hospital.</p>	<p>In the cost comparison details, consultation time for 11 face-to-face visits was double that for telemedicine consults, with consequently higher doctor's costs. This suggests limited validity for the comparison as clinical characteristics of patients in the two groups may have been different.</p>	<p>Total 6.5 [D]</p> <p>Performance: 5.5 [C]</p> <p>Economic quality score: 5</p>	<p>Cost of teleconferencing was HKD91.81 per consultation, compared with HKD105.78 for an in person consultation where the psychiatrist travelled to the home.</p>	<p>Indication of feasibility</p>

Neurology

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
<p>Chua R, 2001 [10, 11]</p> <p>Randomized controlled study [92] and economic analysis [592]</p>	<p>To test the efficiency and costs of telemedicine for new neurological outpatient referrals.</p>	<p>Patients randomized into telemedicine and face-to-face group.</p> <p>Number of investigations and reviews, consulting and junior doctor's time, travel time and distance and ISDN call charges taken into account in economic analysis.</p>	<p>A neurological center and outlying clinics at two distant hospitals in Northern Ireland.</p> <p>Neurologist interviewed the patient and witnessed the standardized neurological examination (carried out by a research registrar) via telemedicine.</p> <p>86 patients in telemedicine and 82 in face-to-face group.</p>	<p>Urgent neurological patient referrals excluded from the study.</p>	<p>Total 12.5/10.5 [A/B]</p> <p>Performance: 7.5/ 5.5 [B/C]</p> <p>Economic quality score: 3</p>	<p>Telemedicine patients had significantly more investigations. Concerns of confidentiality and embarrassment in the telemedicine group. Average cost of conventional consultation £49, that of telemedicine consultation £72.</p>	<p>Realtime teleneurology is not as cost-effective as conventional care.</p>

Ophthalmology

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Lamminen H, 2001 [71] Cost study, drawing in part on data from patients in case series	To find whether tele - ophthalmology and teledermatology services were cost effective.	Questionnaires completed by patients at time of consultation, included information on travel, expenses. Breakeven analysis.	Finland. University hospital clinics, Tampere, and health centre 55 km away. Patients with various eye and skin disorders, 42 teleconsultations and 249 conventional consultations.	While conclusions are drawn in terms of cost – effectiveness, there is little information in the paper regarding patient selection, management or outcomes.	Total 7.0 [D] Performance: 6.0 [B] Economic quality score: 5	Teleconsultations became cost saving when annual numbers of patients were >110 for ophthalmology (€126) and > 92 for dermatology (€143). Teleconsultations can be provided in a cost-effective way in a relatively small health centre.	Useful indication of the feasibility of a teleconsultation service.
Zahlmann G, 2002 [20] Prospective case study with historical controls	To assess the changes in the communication among different medical care providers and between them and patient, in perioperative cataract management by means of ophthalmic teleconsultation.	Referring ophthalmologist sent patient data by e-mail and then used videoconferencing to arrange meeting with the patient and the surgeon, where the decision on cataract surgery was reached.	Germany. 3 referring ophthalmologists and 2 ophthalmic surgeons. Over a period of 3 months 42 patients in teleconsultation group and 20 historical controls were studied.	Relatively small sample including historical data. No economic analysis of the service.	Total 6.0 [D] Performance: 5.0 [C]	The teleconsultation group had one consultation fewer with the ophthalmic surgeon because of the teleconsultation service. Telemedicine also reduced patients' use of time. Patient satisfaction was slightly higher in telemedicine system, and the patients would like to see this technique used if the second eye will be operated.	It is possible that teleconsultation in the context of perioperative cataract management can improve patient care and satisfaction. However, the study results are still very preliminary.

Radiology/ NM

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
<p>Brumage MR, 2001 [72]</p> <p>Cost study, prospective observational</p>	<p>To test hypothesis that teleradiology would reduce patient transfers, leading to savings.</p>	<p>Comparing the costs (to provider) of managing injuries with teleradiology and through immediate transfer to a hospital.</p>	<p>Hawaii, USA.</p> <p>Military training area with telemedicine link to a medical centre and road access to hospital.</p> <p>Soldiers in exercise for an average of 17 days; – 7 evacuated to hospital, 32 initially examined via teleradiology.</p>	<p>Opportunistic comparison of teleradiology for 51 days and evacuation costs for eight days when teleradiology was not available.</p> <p>Few details of patient injuries in the teleradiology group or of intervention. Few details on outcomes.</p> <p>Projections of costs and benefits over five years included, but slender data base with assumptions and no sensitivity analysis.</p>	<p>Total 6.0 [D]</p> <p>Performance: 4.0 [C]</p> <p>Economic quality score: 6</p>	<p>Cost per case for 7 cases with evacuation to hospital was \$1,261.</p> <p>Of 32 cases managed using teleradiology, 29 did not require transfer. On the basis of the costs for evacuation to hospital, this represented a saving of \$36,569.</p>	<p>Teleradiology in this setting saved money and man hours. Suggested as a model for future teleradiology in similar environments.</p>
<p>Diekmann F, 2000 [73]</p> <p>Prospective comparative study.</p>	<p>To assess the efficiency of intraoperative mammography plus teleradiology assessment with that for conventional mammography.</p>	<p>Operation of intraoperative digital radiography with a teleradiology link to the radiology department compared with diagnosis using conventional magnification mammography.</p>	<p>University hospital, Berlin, Germany.</p> <p>Patients undergoing evaluation for breast lesions. Diagnosis for n = 38 using teleradiology procedure, n =36 with conventional mammography.</p>	<p>Limited information on data and analysis from study, only mean times are reported. Relatively limited information also on selection of patients.</p>	<p>Total 7.5 [C]</p> <p>Performance: 5.5 [C]</p>	<p>Use of the teleradiology procedure produced time savings for the surgeon and the radiologist. Time interval from removal of specimen to reporting of results reduced from 23 min to 13 min.</p>	<p>Indication of usefulness of this intra – hospital link from a preliminary study.</p>

<p>Poon WS, 2001 [41]</p> <p>Randomized controlled trial</p>	<p>To evaluate the impact of telemedicine technology on the provision of neurosurgical health services.</p>	<p>Neurosurgical patients from two peripheral hospitals were referred to district hospital. Prospective trial compared A) telephone consultation, B) teleradiology and telephone consultation, and C) videoconsultation.</p>	<p>Hong Kong, PRC.</p> <p>Two peripheral hospitals connected via ISDN lines to University Hospital.</p> <p>In a 10-month period 327 neurosurgical patients were recruited; 26% head injury, 49% cerebrovascular accident, 25% miscellaneous.</p>	<p>Failed consultations were excluded from the data. Unstable patients were excluded from the videoconferencing mode.</p> <p>Details of the patients' health status before and after the consultation were not given.</p>	<p>Total 8.0 [C]</p> <p>Performance: 3.0 [D]</p>	<p>There was a trend towards a favourable outcome in the video-consultation mode (44%) compared to teleradiology (31%), and telephone (38%) consultation. About half of the video-consultations were failures whereas the other technologies were reliable. Preparation and decision making times were longest in video-consultation mode (about 1 hour).</p> <p>There may be an advantage to seeing a neurosurgical patient during the consultation.</p>	<p>Unclear. Although the study was an RCT, the weaknesses in the inclusion of the patients and reporting the outcomes make the interpretation of the results very difficult.</p>
<p>Tually P, 2001 [74]</p> <p>Surveys</p>	<p>To describe the effect of nuclear medicine telediagnosis (NMT) on referral patterns and delivery of care.</p>	<p>Comparison of groups with access to the NMT service with a similar community that did not have access. Surveys of referral trends towards best clinical practice guidelines.</p>	<p>Remote and rural areas of Western Australia.</p> <p>n = 209 medical practitioners; survey response rates 82% for NMT, 77% for non-NMT.</p>	<p>Only sparse details are presented, particularly on analysis and outcomes. Reference to costs is made in the conclusions, but no cost data are presented.</p>	<p>Total 4.5 [E]</p> <p>Performance: 2.5 [D]</p>	<p>Substantial increase in proportion of practitioners complying with clinical practice guideline recommendations for musculoskeletal and oncology cases, in comparison with pre-NMT and with non-NMT regions.</p> <p>“While NMT is more costly than conventional nuclear medicine services, it permits faster access to specialist consultation, provides for better management and is likely to reduce overall health costs by reducing the volume of inappropriate tests and treatment practice.”</p>	<p>Unclear. Indications of improvements in referral patterns but details are limited.</p>

Sleep Studies

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
<p>Pelletier – Fleury N, 2001 [46]</p> <p>Prospective crossover trial and cost-minimization analysis</p>	<p>To compare effectiveness and costs of home unattended polysomnography (Hpsg) and telemonitored polysomnography (TMpsg) in satellite hospital.</p>	<p>Patients underwent on two consecutive nights TMpsg in a satellite hospital and Hpsg at patient's home in randomized order. Sleep laboratory monitored satellite units and data were transmitted to it. In home service, patient returned the device and recordings. Societal perspective for economic analysis.</p>	<p>Sleep laboratory and satellite hospitals at Paris and Versailles, France.</p> <p>n= 99 patients had PSG to diagnose obstructive sleep apnea syndrome.</p>	<p>Travel costs are difficult to interpret due to small distances in the study.</p>	<p>Total 11.5 [A]</p> <p>Performance: 8.5 [A]</p> <p>Economic quality score: 9</p>	<p>The recording was ineffective in 11.2% of TMpsg and in 23.4% of Hpsg. Estimated health care cost in telemonitored system \$244, that for home-based system \$153.</p> <p>Sensitivity analyses showed that both alternatives could be chosen if different end points of the inefficiency rates were used.</p>	<p>The home-based strategy for PSG was cost saving compared to telemonitored system. The decision makers have to consider the geographical situation, since in the societal perspective, patient's traveling can be a significant cost factor.</p>

Telephone Nurse Triage

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
<p>O'Connell JM, 2001[17]</p> <p>Retrospective case-control study with economic analysis</p>	<p>To assess patient satisfaction and a health plan's return on investment associated with a telephone-based nurse triage service.</p>	<p>HMO members were given a toll-free number, which they could contact 24 hours every day. A registered nurse used computer algorithm to perform the assessment and gave a recommendation about the level of medical care. The health care utilization and patient satisfaction were measured.</p> <p>Compared with data collected prior to the service.</p> <p>Return-on- investment was used in the economic analysis.</p>	<p>Coventry Health Care, Kansas City, USA.</p> <p>The data was collected prior to service (December 1995 through November 1996) and during the program service (December 1996 through November 1997).</p> <p>From about 60.000 health plan members more than 10.000 called the service.</p>	<p>The estimates were based on pre-post study design. The clinical accuracy of the recommendations was not tested. The cost implications to the health care system since the first visit were not included.</p>	<p>Total 9.5 [B]</p> <p>Performance: 8.5 [A]</p> <p>Economic quality score: 5</p>	<p>The utilization of hospital emergency department and physician office services decreased significantly after the service was implemented. These changes resulted in reductions in health plan expenditures that exceeded the plan's costs of providing the service. The estimated return for every dollar invested in the service was about US\$1.70.</p> <p>The telephone-based nurse triage service is cost saving and encourages appropriate use of medical services.</p> <p>[The average nurse response time was less than 50 seconds. More than 90% of users were satisfied.]</p>	<p>24 hour, 7 day, telephone-based nurse triage system provides patients ready access to medical information and advice. The service can be used to advice people to utilize the most appropriate form of medical care.</p>

Home Care Applications

Home Care – Asthma

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Bynum A, 2001 [28] Randomized controlled trial	To examine the effect of telepharmacy counseling on metered-dose inhaler technique and patient satisfaction.	Pharmacists used interactive compressed video in teaching metered dose inhaler technique to asthmatic adolescents. Controls received written instructions.	Rural Arkansas, USA. 15 adolescent patients in telepharmacy counseling group, 21 in control group.	Small number of subjects. Participation in telepharmacy sessions was rewarded with a \$20 incentive fee. No clinical outcomes.	Total 10.5 [B] Performance: 7.5 [B]	Telepharmacy counseling group showed more improvement in metered dose inhaler technique than controls.	Interactive compressed video may enhance effectiveness of patient education.
Kokubu F, 2000 [15] Randomized multicentre study and economic analysis	To examine the effectiveness of an asthma telemedicine system.	Telemedicine group monitored regarding airway status at home and provided instructions via telephone.	Several medical centres in Japan. 32 patients in intervention and 34 in control group.	Relatively small number of subjects. Relatively short follow-up (6 months).	Total 10.0 [B] Performance: 7.0 [B]	83% reduction in hospitalization, improvement of peak expiratory flow and symptoms in the telemedicine group compared to controls. 757 000 Japanese Yen cost saving per patient.	Simple monitoring and advice via telephone improves well being of asthmatic patients, reduces utilization of services and leads to cost savings. Clear support for continuation of the telemedicine program
Kokubu F, 1999 [38] Randomized controlled study	To examine the effectiveness of a telemedicine system to monitor the airway status at home for patients with poorly controlled asthma.	Telemedicine group monitored at home and provided instructions via telephone to manage exacerbations.	Medical centres in Japan. Poorly controlled asthmatic patients with a high hospitalization risk: 24 in intervention and 26 in control group.	Relatively small number of subjects. Relatively short follow-up (6 months).	Total 10.0 [B] Performance: 7.0 [B]	Number of emergency room visits decreased significantly and activities of daily living improved in the telemedicine group.	System effectively contributes to the management of poorly controlled asthma.

Home Care – Cardiovascular

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Artinian NT, 2001 [75] Randomized controlled study	To test whether nurse-managed home telemonitoring improves blood pressure control of hypertensive African American patients compared to usual care only.	Patients randomized into 3 groups: usual care, home telemonitoring plus usual care, nurse-managed community based monitoring plus usual care. Telemonitoring patients received feedback and counseling from the intervention nurse through telephone calls.	Detroit, USA. Subjects recruited from a family community center. 26 African-American patients of whom only 21 had a complete set of data at the end of the 3-month study (6 in both intervention groups, 9 in usual care group).	Small number of patients. High percentage of excluded patients (>50%) during initial screening, intervention thus suitable for a limited number of patients only. Short follow-up (3 months).	Total 11.0 [B] Performance: 8.0 [A]	Telemonitoring and community-based monitoring groups had clinically and statistically significant drops in blood pressure whereas there was only little change in the usual care group.	Pilot results, which if replicated in a larger sample could be important for improving blood pressure control of hypertensive patients.
de Lusignan S, 2001 [25] Randomized controlled study	To examine the acceptability, effectiveness and reliability of home telemonitoring.	Telemonitored patients measured pulse, BP, weight and had the ability to video consult. Controls received standard general practice treatment.	Patients registered at Woodbridge Hill Surgery, UK. 10 intervention and 10 control patients.	Pilot study. Small number of patients.	Total 8.5 [C] Performance: 5.5 [C]	Telemonitoring patients complied better with collecting prescriptions for drugs but there were no significant differences in quality of life and Chronic Heart Failure questionnaire scores between the groups. Video consulting did not show sustained benefit.	Pilot results. Benefits in terms of compliance with medication sustained for at least 1 y but no clear benefits regarding clinical outcomes.

Riegel B, 2002 [76] Randomized controlled study with cost analysis	To assess the effectiveness of a standardized telephonic case-management intervention in decreasing resource use in chronic heart failure patients.	Physicians admitting patients with heart failure randomized into intervention and usual-care groups. Intervention patients received on average 17 phone calls during the 6-month follow-up. Care for patients in the usual care group not standardized, no formal telephonic case-management.	2 Southern California hospitals, USA. 130 patients in the intervention and 228 in the usual-care group.	Only approximately 30% of patients screened included in the study. Intervention may thus be suitable for a limited number of patients only	Total 13.0 [A] Performance: 8.0 [A] Economic quality score: 3	Heart failure hospitalization rate 46-48% lower in the intervention group. Heart failure hospital days, multiple readmissions, and inpatient heart failure costs \$ lower in the intervention group.	A simple intervention can lead to reduced use of resources and cost savings.
Rogers MA, 2001 [77] Randomized controlled study	To determine the efficacy of a telecommunication service in reducing blood pressure in patients with essential hypertension.	A telecommunication service consisting of: automatic blood pressure recording, central processing, and weekly electronic reports to the patient and physician. Usual care group treated according to national guidelines.	University affiliated primary care outpatient clinics in Syracuse, NY, USA. 60 patients in the intervention and 61 in the control group.	No economic analysis.	Total 14.5 [A] Performance: 9.5 [A]	Mean arterial pressure decreased by 2.8 mmHg in the intervention group and increased by 1.3 mmHg in the control group (p=0.013). Mean systolic and diastolic blood pressure decreased \$ more in the intervention group compared to controls.	A relatively simple telecommunication service improved important clinical outcomes mainly due to more frequent changes in type or dose of antihypertensive medications. Use of other resources was similar in both groups.
Ades PA, 2000 [78] Multicentre controlled trial	To compare the effectiveness of home-based, transtelephonically monitored cardiac rehabilitation with standard, on-site supervised cardiac rehabilitation.	Transtelephonically monitored rehabilitation program with simultaneous voice and electrocardiographic transmission to centrally located nurse coordinator. Controls participated in on-site exercise program.	5 medical centers in USA. 80 patients in the intervention and 50 in the control group.	Study not randomized (but no significant difference in baseline characteristics between the groups). Relatively small study may not detect possible adverse effects.	Total 11.5 [A] Performance: 9.5 [A]	Transtelephonically monitored rehabilitation was as effective as on-site rehabilitation.	Transtelephonically monitored home-based rehabilitation is effective but additional data on safety and costs would be useful.

Jerant AF, 2001 [79] Randomized controlled study and economic analysis	To compare in congestive heart failure patients the effectiveness of home telecare, nurse telephone calls, and usual outpatient care.	Video-based telecare group received scheduled home visits, telephone group scheduled phone calls.	University of California, Davis Hospital, CA, USA. 13 patients in home telecare, 12 in telephone care and 12 in usual care groups.	Small number of patients.	Total 11.5 [A] Performance: 8.5 [A]	Mean congestive heart failure – related readmission charges 86% lower in telecare and 84% lower in telephone group, significantly fewer emergency department visits in the intervention groups compared to usual care group.	Simple post-hospitalization monitoring by telephone provides significant economic savings. Home video – based telecare does not offer incremental benefit.
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Home Care - Chronic Wounds

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Kobza L, 2000 [80] Case-control study	To examine the impact of telemedicine on outcomes of chronic wounds in the home care setting.	In telemedicine, wound specialist consulted with home health nurse in patient's home. During video visit, the wound specialist assessed the patient and made recommendations for treatment. Patients were seen by telemedicine 1-2 times/wk. Retrospective chart review of patients seen in previous year for comparison.	Barrington IL, USA. Chronic wound patients with one or more Stage III or IV pressure ulcers, diabetic foot ulcer, venous stasis ulcer, or any patient with order for a twice-daily dressing change. n = 76 were seen by telemedicine, n = 120 controls.	Comparison to retrospective chart data. No statistical testing of results. No economic analysis although cost savings were suggested.	Total 4.5 [E] Performance: 3.5 [D]	Number of home visits were on average 60 per patient in the control group and 33 per patient in telemedicine group. Wound healing rates were better in telemedicine group, except for Stage III pressure ulcers that healed at an equal rate. Healing time decreased in all wound types with the use of telemedicine (average change 11 weeks). Wound related hospitalizations decreased (18% vs 6%) with telemedicine, use of advanced wound dressings increased.	Use of wound specialist can positively influence the outcome of wound care. Without telemedicine the access to a wound specialist is not available to all home care settings. Telemedicine can increase the number of patients seen by the wound specialist from five or six to up to 20 patients per day.

Home Care – Diabetes

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
<p>Tsang MW, 2001 [14]</p> <p>Randomized crossover study</p>	<p>To compare glycemic control of diabetic patients between intervention (using computerized diabetes monitoring system) and control periods.</p>	<p>Information about meal portions and blood glucose were recorded in a hand-held electronic diary. After transmitting data immediate feedback about carbohydrate, protein, fat, and calorie content of the meal. During the control period, patients had conventional follow-up consultations and did not use the monitoring system.</p>	<p>Hong Kong, PRC.</p> <p>19 patients randomized into two groups, each using diabetes monitoring system for 3 months and serving as controls for another 3 months.</p>	<p>Small sample.</p> <p>No economic analysis.</p>	<p>Total 8.5 [C]</p> <p>Performance: 5.5 [C]</p>	<p>Overall, significant improvement in glycemic control in the intervention group compared to controls.</p> <p>However, no significant change in glycemic control in the group that first served as controls for 3 months and only after that received the intervention.</p>	<p>System is feasible but larger studies to assess its value in everyday use and to examine cost-effectiveness still needed.</p>
<p>Wojcicki JM, 2001 [81]</p> <p>Randomized controlled trial</p>	<p>To assess the efficiency of an intensive diabetes care telematic system in pregnant women.</p>	<p>Telematic system transfers every night all data from glucometer memory to central clinical unit where diabetologist can review and advice.</p> <p>Control group received treatment based on clinical examination performed every 3 weeks.</p>	<p>Medical Academy of Warsaw, Poland.</p> <p>15 pregnant, type I diabetic women in intervention and 15 in control group.</p>	<p>Small sample.</p> <p>Efficiency study. No cost data.</p>	<p>Total 9.5 [B]</p> <p>Performance: 6.5 [B]</p>	<p>Better glycemic control in the intervention group. Less variation in glycemic control within the intervention group.</p>	<p>System must still be considered experimental. Effectiveness data and economic analyses needed.</p>

<p>Whitlock WL, 2000 [82]</p> <p>Randomized controlled study</p>	<p>To compare home telemedicine consultation with standard outpatient care in diabetic patients.</p>	<p>Nurse case manager contacted telemedicine group once a week through video and voice interaction discussing diabetic control, weight, nutrition etc.</p> <p>Control group was followed by routine standard of care.</p>	<p>Eisenhower Army Medical Center, GA, USA.</p> <p>15 patients in intervention and 13 in control group.</p>	<p>Small sample. Short follow-up (3 mo). No economic data.</p>	<p>Total 10.5 [B]</p> <p>Performance: 7.5 [B]</p>	<p>Glycemic control (16% reduction in HbA1c) and body weight (4% reduction) improved significantly in the intervention group.</p> <p>A non-significant decrease in HbA1c in controls, no reduction in body weight.</p> <p>No significant change in quality of life in either group.</p>	<p>System must still be considered experimental. Effectiveness data and economic analyses needed.</p>
<p>Di Biase N, 1997 [83]</p> <p>Randomized controlled study</p>	<p>To assess whether telemedicine can improve management of insulin dependent diabetic women during pregnancy.</p>	<p>Automatic DIANET-system used to send recorded data (glucose, insulin doses, diet etc.) once a week and to receive recommendations about therapeutic adjustments.</p> <p>Control group instructed to measure blood glucose several times a day, face-to-face therapeutic adjustment once a week.</p>	<p>Università degli Studi “La Sapienza”, Rome, Italy.</p> <p>10 patients in intervention and 10 in control group.</p>	<p>Small sample. No economic analysis.</p>	<p>Total 10.0 [B]</p> <p>Performance: 7.0 [B]</p>	<p>Significant improvement in glycemic control in both groups. No major differences between the groups.</p>	<p>Telemedicine follow-up and computerized feedback provide adequate control of diabetes during pregnancy.</p> <p>System still experimental. Effectiveness data and economic analyses needed.</p>

<p>McKay HG, 2002 [84]</p> <p>Randomized controlled study</p>	<p>To evaluate effect of internet-based diabetes self-management and peer support intervention on diet, mental health and physiologic outcomes.</p>	<p>All participants provided with computer dedicated to diabetes self-management. Patients randomized into four conditions with respect to two main components: peer support and personalized self-management and feedback dietary intervention.</p>	<p>Primary care practices in Oregon, USA.</p> <p>160 patients (40 in each condition) with type 2 diabetes.</p>	<p>16% drop-out rate. Small sample size in each group. Short follow-up.</p>	<p>Total 12.0 [A]</p> <p>Performance: 9.0 [A]</p>	<p>Little change in biological measures but general improvements in dietary practices, substantial reductions in fat intake, and very slight improvements in quality of life.</p>	<p>Providing basic diabetes information and self-management intervention entirely over the internet is feasible but not very effective. Larger studies to identify characteristics of those who most benefit from such interventions needed.</p>
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Home Care – Epilepsy

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
<p>Glueckauf RL, 2002 [85]</p> <p>Randomized controlled trial</p>	<p>To assess the effects of videoconferencing-based counseling on the psychosocial functioning of rural teenagers with epilepsy.</p>	<p>Teenagers and their parents got either six sessions of home-based video counseling, home-based speakerphone counseling, or office-based counseling.</p>	<p>Department of Psychiatry, Indiana University, USA.</p> <p>Services offered to families of rural teens with seizure disorders across five Midwest and three Southeast states.</p> <p>n = 22 teenagers with seizure disorders, 14 male and 8 female, and their parents (n=36).</p>	<p>Patients selected to videoconferencing group that did not have ISDN lines or 56 Switch service received speakerphone service (non-randomized). 12 families dropped out before the study and 5 families between initial assessment and sixth-session post-testing.</p>	<p>Total 10.0 [B]</p> <p>Performance: 7.0 [B]</p>	<p>Teenagers and parents reported significant reduction in both problem severity and frequency in social skills, school work and treatment adherence during the treatment period and the 6-month follow-up. In contrast, both parents and teachers reported no change in problem behavior over time.</p> <p>Mode of delivery did not influence initial treatment outcomes or adherence.</p>	<p>No evidence was obtained that mode of service differentially influenced treatment outcomes. [A bigger study is on the way, and it will give a better idea of the sustainability of the study results.]</p>

Home Care – Obstetrics

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
<p>Morrison J, 2001 [86]</p> <p>Retrospective comparative study and economic analysis</p>	<p>To evaluate the cost-effectiveness of telemedicine services in patients diagnosed with preterm labor (PTL).</p>	<p>After a PTL diagnosis, telemedicine services (home uterine activity monitoring with daily telephonic nursing contact) were provided to telemedicine group. All pregnant patients were encouraged to attend on-site educational classes free of charge.</p>	<p>Univ. of Mississippi Medical Centre, USA.</p> <p>Patients' physicians prescribed either telemedicine or conventional care to their patients. Patients were enrolled between January 1992 and November 1994. 60 patients were in telemedicine group and 40 in control group.</p>	<p>The patients were chosen to study groups according to their physicians' willingness to participate.</p> <p>Retrospective data collection and lack of patient specific preterm-labor treatments.</p> <p>Cost analysis includes only third-party reimbursement data.</p>	<p>Total 7.5 [C]</p> <p>Performance: 6.5 [B]</p> <p>Economic quality score: 3</p>	<p>There were no differences between the groups at diagnosis. The telemedicine group had SS later mean gestational age at delivery (38.2±1.4 vs 35.3±3.8), higher mean birth weight (3224±588 vs 2554±911), fewer mean total nursery days (2.4±1.8 vs 14.9±26.4), and less admissions to neonatal intensive care unit (6.7% vs 40%) than control group (all p < 0.005). The total mean cost per pregnancy was \$7,225 for telemedicine and \$21,684 for control group.</p> <p>Following an episode of PTL, telemedicine can be cost-effective tool to improve outcome.</p>	<p>Study outcomes indicate that telemedicine is potentially beneficial when applied to an appropriate high-risk preterm labor patient population.</p>

Home Care - Spinal Rehabilitation

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Phillips VL, 2001 [87] Randomized controlled trial	To assess health-related outcomes of intervention designed to reduce the incidence of secondary conditions among people with mobility impairment resulting from spinal cord injury (SCI).	Patients in the video and telephone groups took part in individual educational rehabilitation sessions with a study nurse once a week for five weeks, then once every two weeks for one month. The sessions were in addition to any other regularly scheduled care. Standard care group did not participate in educational sessions.	Shepherd Center, Atlanta, USA. Patients with newly acquired SCI aged 18 - 60 y. Patients with mild mobility impairment, brain injury or active substance abuse were excluded. During 1998 – 2000, 36 patients in video, 36 patients in telephone, and 39 patients in standard care groups were assessed.	The sample sizes are relatively small, and only 42% of the patients were enrolled for one y, so the studies were still preliminary.	Total 10.0 [B] Performance: 7.0 [B]	Health-related quality of life did not differ between the intervention groups after 9 weeks intervention. However, at 1 y post-discharge, scores of those completing 1 y of enrollment were SS higher for intervention than standard care patients. Mean annual hospital days were 3.00 for the video, 5.22 for the telephone, and 7.95 for the standard care groups. Preliminary evidence suggests that in-home telephone and video-based intervention is effective.	Telerehabilitation can have long-term health and cost implications for spinal cord injury patients and for health care. Since health insurance system coverage can change after severe injury, the method of payment should be considered once program is initiated.

Appendix B

Studies That Included Measurement of Satisfaction With Telemedicine

In the following tables, the classification for each study refers to the level of assessment of satisfaction with telemedicine that was undertaken:

1. Reference to satisfaction with the service in the text, no details provided.
2. Simple questionnaire approach, no comparison with a non-telemedicine alternative.
3. Questionnaire with implied comparative component.
4. Questionnaire with specific comparison questions.
5. Comparative study, with simple outcome measures.
6. Comparative study, satisfaction outcome measures developed further, statistical summary.
7. Randomized study.

Abbreviations

ANOVA – Analysis of variance

ICSI – Intra -cytoplasmic sperm injection

IVF – In vitro fertilization

LOS – Length of stay

NICU – Neonatal intensive care unit

NSD – No significant difference

RCT – Randomized controlled trial

SS – Statistically significant

A: Papers That Were Included In the Main Analysis

First author, country	Application	Design, features of study	Number of subjects	Classification	Results	Implications for decisions
Brumage MR, 2001 [72] USA	Radiology (military)	Anecdotal report, interviews with medical staff	39	1	Agreed teleradiology improved patient care, pleased with response time, increased confidence in management of patients.	Minor, major focus of study was on cost issues.
Bynum A, 2001 [28] USA	Pharmacy counseling, asthma	Inhaler technique evaluation instrument included 11 questions on satisfaction (2 of these analyzed separately), 5 point scale	15 vs 21 controls	6	NSD between tele-counseling and control groups, both had high satisfaction with sessions.	Supportive of main findings re improved inhaler technique, feasibility of method.
Chan WM, 2001 [19] PRC (Hong Kong)	Geriatric care, nursing home	Questionnaires for residents and staff, 5 point scale, after 1 y	47 of 198 residents who could communicate plus 18 nurses, 9 outreach staff.	3: residents, 3 + 4 : nurses	For residents median score of 4 re telemedicine experience, 5 re time saving. For nurses median score of 4 re time, health care support, but 2.5 re comparison with traditional services. Median of 4 for outreach staff re process details.	Generally supportive of main findings of study. Reservations of nursing staff an issue for further investigation.
Chua, 2001 [10] UK	Neurology	Self administered questionnaire, 8 questions, 3 point scale	86 vs 80 controls	7	67% response rate. Generally satisfied with either method (NSD for 5 questions) but face to face favoured re explanation of symptoms [p = 0.02] and confidentiality and embarrassment [p= 0.017 and 0.005 respectively].	Provides further evidence against the use of this telemedicine application. (Data from other part of study showed increased number of investigations when telemedicine was used.)

First author, country	Application	Design, features of study	Number of subjects	Classification	Results	Implications for decisions
de Lusignan S, 2001 [25] UK	Chronic heart failure – home care	Questionnaires, 7 point scale	10 vs 10 controls. 5 died and 2 dropped out; probably n=6 for satisfaction review.	4	Patients having video consultations would have preferred seeing the nurse face to face (mean of 6.7 on the 7 point scale) and had reservations re quality of consult compared to telephone call or face to face (both 4.7).	Supports other findings in study that videoconsultation was not useful.
Elford R, 2001 [24] Canada	Psychiatry (children and adolescents)	Questionnaires for psychiatrists, parents, patients (different for children and adolescents), 5 point scales.	30, with parents	4	Psychiatrists: 25/30 responded, all satisfied or very satisfied, 21 thought as good as face to face. Parents: all 30 responded and liked system, mean overall satisfaction score 4.9, 97% would prefer telemedicine to travelling for a consult. Patients: 9/11 children responded, 5 preferred telemedicine, 4 no preference. Of 19 adolescents, 16 preferred telemedicine, 17 preferred telemedicine to traveling for face to face consults.	Good support for feasibility of the telepsychiatry system, overall support from all participants.
Gray JE, 2001 [31] USA	Neonatology	Picker Institute NICU Family Satisfaction survey – 80 item questionnaire covering 8 dimensions of care. Administered 1- 4 mo after child's discharge from NICU.	26 vs 30 controls	7	SS (p<0.05) greater satisfaction with quality of care, environment and visitation policy and LOS in NICU for telemedicine arm.	Supportive of other findings from this study, indicating benefits from telemedicine approach.
Hui E, 2001 [22] PRC (Hong Kong)	Geriatric care	Questionnaires, 5 point scales (Few details provided)	1,001 patient episodes; 70% of patients able to register satisfaction level. Also 18 nurses.	Patients: 2 Nurses: 4	Patients: 82 -95% in favour of telemedicine, depending on specialty. Nurses had some reservations re whether telemedicine equal to an on site visit (mean of 2.8 on a 5-point scale), positive (mean 4.0) on better support for the elderly and reduced escort time.	General indications of acceptability while noting limitations of satisfaction measurement.

First author, country	Application	Design, features of study	# of subjects	Classification	Results	Implications for decisions
O'Connell JM, 2001 [17] USA	Telephone nurse triage	Random survey of triage callers. Five point scale (full results not given)	787 callers (64% response rate).	2	93% had scores of 4 or 5 for overall satisfaction; > 90% satisfied with nurses' understanding of complaints and knowledge.	General support for the program.
Riegel B, 2002 [76] USA	Chronic heart failure – home care	Satisfaction survey administered by telephone at 6 months after index admission to hospital; 5 questions.	Data from 184 of 242 patients surveyed.	7	Patient satisfaction SS higher in intervention group.	Probably minimal, other aspects of the trial more significant. Also, no data provided.
Rogers MA, 2001 [77] USA	Hypertension	Questionnaires, details not given.	60 vs 61 controls	5 [overall trial design is 7]	94% in both groups agreed or strongly agreed they were receiving good medical care, 96% telemedicine vs 89% usual care agreed or strongly agreed that the doctor had all the information needed.	Minor component of RCT concerned with other outcomes.
Rohland BM, 2001 [70] USA	Psychiatry	12 item self report satisfaction survey instrument for patients who receive ambulatory services, 5 or 4 point scales.	26 of whom 12 had both telemedicine and face to face consults.	5	Indications of only minor differences in satisfaction between the two types of service. No statistical analysis in view of small sample size and other characteristics of study.	Inconclusive. Could be taken as general reassurance re feasibility.
Simpson J, 2001 [12] Canada	Psychiatry	Patient survey form with yes/no responses and questionnaire, which included 5 point scale items.	230 of 379 patients responded to survey form. 31 patients completed questionnaire via telephone interview.	Survey: 2 Questionnaire: 4	89% of survey respondents satisfied with the session. In telephone interviews, 25/31 preferred telepsychiatry to travel for a consult, 29/31 preferred it to waiting for a consult, but only 9/31 preferred telepsychiatry to seeing a psychiatrist in person.	Input to decisions on future of the service.

First author, country	Application	Design, features of study	# of subjects	Classification	Results	Implications for decisions
Tang WK, 2001 [23] PRC (Hong Kong)	Psychiatry	Opinions obtained from residents by interview. Questionnaire used for nurses at end of study, 5 point scales	45	Residents: 2 Nurses: 4	44.9% of patients in 138 consultations could not respond due to cognitive impairment or other reasons; of remainder 82% agreed they liked teleconsultation. Nurses had reservations re equivalence to on site services (mean score 2.8), positive re saving of staff time (4.1) and provision of health care support (3.9).	Generally encouraging response from residents; supportive of telemedicine service but a high proportion could not respond at all. Reservations of nursing staff an issue for further investigation.
Tsang MW, 2001 [14] PRC (Hong Kong)	Diabetes	Questionnaire, 5 point scale	19	2	18/19 agreed system was easy to use but only 12 agreed it was useful in evaluating eating habits or would use again.	Uncertain – questionnaire responses indicated limited acceptance; paper states that technical problems have been dealt with, so might have had direct input on decisions; however, results do not indicate it was “highly acceptable” as suggested by the paper.
Zahlmann G, 2002 [20] Germany	Ophthalmology - cataract	Questionnaires, 10 point scales Limited details provided	42 vs 20 controls	Overall comparison: 5 Confidence with technology: 3	Both groups highly satisfied with overall treatment but more so in telemedicine group (p = 0.019). Telemedicine group felt more confident with treatment (0.94 on 10 point scale).	Generally supportive of feasibility. Clinical/ social significance of difference between approaches unclear, likely negligible.
Kokubu F, 2000 [15] Japan	Asthma	Questionnaire, 3 point scales	32 vs 34 controls	2	89% considered system was useful for control of their asthma; 92% that telephone consulting was not a burden. 70% reported that measurement and data transfer were not a burden, but 11% reported that they were.	General support for other study results. Difficulty of some patients with measurement a point for possible follow up.

First author, country	Application	Design, features of study	# of subjects	Classification	Results	Implications for decisions
di Biase N, 1997 [83] Italy	Diabetes, pregnancy	Anecdotal	10 vs 10 controls	1	Patients found it “interesting and exciting” to use telemedicine device. Security of information transfer greatly appreciated by patients and their families.	General support in preliminary study.
Harno K, 2000 [67] Finland	Hospital referral	Questionnaire at time of referral, limited detail	47 of 106 patients contacted for interview	2	80% of those contacted wished to continue with electronic referral.	General support for other study results.

B: Papers That Were Excluded From the Main Analysis

First author, country	Application	Design, features of study	Number of subjects	Classification	Results	Implications for decisions
Agrell H, 2000 [88] USA	Home care, hospice	34 item interview instrument, 6 main categories [reliability, validity of instrument to be verified]	15, including two proxies for ill patients	4	General indication of satisfaction, qualified by responses to other questions.	Patients were generally accepting of widespread use of telehomecare. Responses on technical and other issues could provide useful feedback.
Boulanger B, 2001 [89] USA	Follow up of trauma cases	Satisfaction survey, 7 point scale	19	2	Overall satisfaction. Only 2/19 would prefer face to face.	General acceptance in early evaluation of program.
Brodey BB, 2000 [29] USA	Psychiatry - prison	Non – randomized comparative study. Survey using validated structured outpatient questionnaire.	23 telemedicine vs 20 in-person consults	5 -6	NSD between groups	Indicated telemedicine acceptable to that population. Authors caution not necessarily generalisable.
Chae YM, 2001 [90] South Korea	Home care - elderly	Satisfaction measure as part of broader survey, 5 point scale	50, n= 40 at own home, n = 5 in nursing home	2	82% in their own home satisfied, 50% if in nursing home.	Preliminary indication from a pilot study.
Davis P, 2001 [91] Canada	Rheumatology consultations	Satisfaction survey, 4 point scale. No details of administration of survey	50	2	48 satisfied overall, 42 thought as good as face-to-face.	Overall, general indication of support for feasibility.
Doarn CR, 2002 [92] Ecuador	Pre and post surgical consultation	Subjective response on five point scale	8 pre-op, 20 post-op	2	3 physicians expressed high satisfaction. Only five patients' opinions recorded.	Inconclusive. More a feasibility study.

First author, country	Application	Design, features of study	Number of subjects	Classification	Results	Implications for decisions
Gattas MR, 2001 [26] Australia	Clinical genetics - counselling	Evaluation by telephone; 4 values; 5 point scale	N=24, 16 by telemedicine [also counselors]	5	Preliminary study. General acceptance re understanding of information provided. Some patients found procedure daunting.	General indication of feasibility [study still in progress].
Hagan L, 2000 [21] Canada	Telenursing	Survey approach	N = 4,705	3	High proportion satisfied with understanding etc through service.	General support for service. Perceived benefits speed of access, better information, avoidance of travel. Helpful in program evaluation.
Hall JA, 2000 [30] USA	Drug abuse service, telephone management	Randomized assignment to one of four arms. Used 35 item scale [validated]; relevance/impact/gratitude subscales. ANOVA. No data on satisfaction scores or their analysis are provided.	Of 1,553 subjects 230 were randomly assigned to telecommunications group. Other experimental groups – one with case managers located in one treatment agency, one with case managers located at ‘outside’ agency. Control group had standard treatment services from their primary drug counselor. [Numbers and method of assignment not given]	6	Telecom group SS more satisfied with relevance than outside case management subjects, SS less than those who received standard services. Overall, telecom SS better than outside case management, NSS different from inside management or standard care.	Telecom said to be 50% less costly (no data given). Points to suggested acceptance of approach. Absence of information lessens value.

First author, country	Application	Design, features of study	Number of subjects	Classification	Results	Implications for decisions
Inouye J, 2001 [16] USA	Child abuse prevention program, telephone approach	Survey of client and nurse satisfaction, questionnaires for each group [said to have been evaluated by experts in the field for validity] 5 point Likert scale plus 4 open ended questions. Questionnaire at start of study and after 6 months. Authors note that patient questionnaire had low to moderate reliability.	n = 20 families (1 drop out), 5 nurses. Selected on expectation that they would be agreeable to participate.	2* but note measures over time, statistical comparison.	For nurses mean scores for satisfaction items ranged from 1.85 – 2.47, those for clients from 1.44 to 2.14. NSD between first and last videoconferences. Satisfaction rather low due largely to equipment problems, including meddling by families.	Results would have provided important feedback on difficulties with the technical approach being used and other requirements for future programs of this sort.
Johnson – Mekota JL 2001 [93] USA	Assessment of chronic wounds	Telemedicine exam followed immediately by on –site consult in all cases. Satisfaction survey for patients and nurses, no details given.	n = 11 patients, 2 unable to respond. n=7 nurses using telemedicine and 1 on site.	4	6/9 patients said they were very satisfied with the telehealth visit, 5/9 very satisfied with face to face. All nurses using telemedicine very satisfied, as was the on site nurse with face-to-face consults.	Preliminary support for feasibility, limited study quality.
Lin C-C, 2001 [94] Taiwan	Telemedicine network supporting diagnosis and consultation services. Radiology and ultrasound most common exams	Nine item questionnaire for patients.	n= 431 valid questionnaires from total of 1,107 cases. Also n = 644 valid questionnaires from specialists.	2	94% patients satisfied with the telemedicine service. 91.6% of responding specialists satisfied with results of telemedicine.	Support for continued use of system.
Mallett R, 2000 [95] UK	Teledermatology	Feedback from GPs as part of observational study	8 practices participated, no other details.	1	‘GPs liked the rapid response to email referrals’.	Unclear.

First author, country	Application	Design, features of study	Number of subjects	Classification	Results	Implications for decisions
Mehta AR, 2001 [27] USA	Pediatric echocardiography	Five item questionnaire for physicians who had requested interpretation of echocardiograms	n=21 returned (60%) ; n = 8 had used telemedicine and n = 13 courier to deliver echos for interpretation.	5	Those using courier service had SS more concern re availability of a pediatric cardiologist and image quality. However, there was NSD in satisfaction with turnaround time. Data include opinions on telemedicine from those who had used courier services.	Indication of satisfaction with telemedicine approach, would help as preliminary input, validity of findings unclear.
Nanevicz T, 2000 [96] USA	Outpatient support for congestive heart failure cases	Patients completed Minnesota Living with Heart Failure Survey. Follow up at 1 and 6 months. Separate physicians survey	n=50 enrolled from three types of clinic. n=21 (57%) of physicians	2	At 1 month, overall satisfaction with the program was 84%. At 6 months, n=33 returned survey, 76% would use program on a long term basis. 76% of responding physicians said program met their expectations.	Some indication of support for feasibility study.
O'Connell JM, 2001 [18] USA	Telephone based nurse triage service	Telephone survey – callers' responses to standard questions, satisfaction responses on a five point scale.	Survey of n=35,800 – random sample of nurse triage callers – 58.9% of callers reached.	2	Overall satisfaction with the service over 90% (further stratified by patient characteristics).	Possible reassurance on use and effectiveness of service.
Redlick F, 2002 [97] Canada	Burn care follow up	Patients completed questionnaire with 5 point response to questions on teleconsultation. Overall satisfaction given as mean of these responses, no specific question. Similar questionnaire for physicians.	n = 9 burn patients receiving follow up consultations. n = 14 physicians	2	Summary score indicated 86% patients satisfied or very satisfied. Corresponding score for physicians 87%.	Preliminary data supporting new service.

First author, country	Application	Design, features of study	Number of subjects	Classification	Results	Implications for decisions
Sezeur A, 2001 [98] France	Oncology consultations re chemotherapy	Patients completed a form indicating satisfaction on a visual analogue scale (no details).	n = 16 patients awaiting hospitalization for chemotherapy.	1 - 2	Satisfaction evaluated at 79.9% on VAS. 87.5% considered teleconsultation an advantage [no details].	Support for this approach as alternative to visit to hospital for conventional consult.
Stewart L, 2001 [33] UK	Consultation after unsuccessful IVF or ICSI	RCT, comparing telephone counseling with face to face session. Questionnaires completed by couples within 2 weeks of consultation. Included items on satisfaction [3 point scale] and on preference for future follow up consults.	Couples who had had first embryo transfer or >1 embryo transfer randomized to follow up at a clinic [n= 47 and 38] or by telephone [n= 49 and 41]. Response rate > 91%	7	> 94% of couples satisfied or very satisfied with consults, NSD between groups. Couples living < 50 miles from clinic more likely to prefer face to face consultation (62% vs 29%, p< 0.001).	Strong support for feasibility of using telephone consultations.
Waterman AD, 2001 [34] USA	Telephone based anticoagulation service	RCT –clinics randomized to provide telephone – based service or face to face management. Randomly selected patients from each of these clinic groups. 20 item questionnaire combining validated questions for face-to-face anticoagulation consult with new questions for telephone based service, 5 point scale for satisfaction, 7 point for feelings of safety. [Separate survey of physicians providing telephone service.]	n = 150 patients in each arm. 288 surveys delivered of which 75% completed. n = 17 physicians, 100% response.	7	Patients using telephone based service more satisfied with timeliness of test results [4.31 vs 4.03, p = 0.02] and felt safer taking warfarin [5.7 vs 5.2, p = 0.04]. All physicians were highly satisfied with the telephone service.	Strong support for use of the telephone – based approach.

First author, country	Application	Design, features of study	Number of subjects	Classification	Results	Implications for decisions
Demiris G, 2001 [32] USA	Telehomecare project	RCT – Standard home care services plus videoconferencing, Internet access vs standard care only. Validated 17 item questionnaire using 5 point scale. Completed at start of study and after 4 weeks [or at exit].	n = 17 telehealth group, n= 11 control	7	Telemedicine group showed more positive perception of system after 4 weeks [SS]; NSS change in perception in control group.	Support for use of telehome care.

