

EVIDENCE ON THE EFFECTIVENESS OF TELEREHABILITATION APPLICATIONS

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SUMMARY

This review considers the evidence of benefit from use of telerehabilitation (TRH) from studies that had clinical or administrative outcomes.

Methods

Relevant publications were identified through computerized literature searches on multiple databases to November 2009.

Inclusion criteria were as follows: scientifically valid articles that described studies on the outcomes of TRH applications; controlled studies comparing TRH with a non-TRH alternative; and uncontrolled studies that reported outcomes and had no fewer than 20 subjects.

Exclusion criteria were as follows: articles that considered only technical issues; articles in which the information provided was insufficient to establish scientific credibility; studies on mental health conditions and substance addiction; and studies in which the only outcome measures were related to satisfaction with TRH.

The quality of the selected studies was assessed using an approach that considers both study performance and study design.

Judgments were made on whether each TRH application had been successful, whether reported outcomes were clinically significant, and whether further data were needed to establish the application as suitable for routine use.

Results

Sixty-six papers that corresponded to 61 studies were included in the review. Thirty-one (51%) of the studies were of high or good quality, 18 (29%) were fair to good, and 12 (20%) were poor to fair.

Results from the studies showed that 71% of the TRH applications were successful. For 11% the status was unclear and 18% were unsuccessful. The reported outcomes for 51% of the applications appeared to be clinically significant.

Further study was judged to be required for 62% of the TRH applications and desirable for 23%. For another 11% additional work appeared unnecessary as the interventions were clearly unsuccessful.

Evidence for TRH benefits by clinical area was as follows:

- *Cardiology*: There were good indications of success for home cardiac rehabilitation, with TRH being successful in ten studies. Application of a prevention program was successful in decreasing cardiac risk factors. Success was not demonstrated in studies on use of a “booster intervention”, symptom management, improvement in self efficacy and physical activity, and psychological adjustment.
- *Neurology*: In five studies on support for stroke patients, TRH was successful in three, but of limited or no benefit in two. Studies with persons who had suffered traumatic brain injury showed benefits in ameliorating depressive symptoms, improving behavioural outcomes, and increasing the probability of returning to employment. Telephone groups were as effective as on-site groups in providing support and education for rural caregivers of persons with brain injury.

- Two reports on TRH in the management of patients with multiple sclerosis and two studies with patients who had spinal cord injuries had limited success with TRH approaches.
- *Cancer*: Of two studies on TRH to support patients with breast cancer, one was not successful, while the other may have improved physical activity and decreased fatigue.
- *Speech disorders*: Two short term studies of TRH for speech disorders had successful outcomes.
- *Urology*: Two studies provided good evidence that TRH methods were successful in improving continence of post–prostatectomy patients and of older women, with results equivalent to those from face to face treatment.
- *Rheumatology*: Four studies of TRH in rheumatology applications (management of arthritis and fibromyalgia) provided some evidence of benefit, but not for all outcomes.
- *Pulmonary disease*: One of three studies on TRH in chronic obstructive pulmonary disease had successful outcomes, while benefits found in the others were limited.
- *Chronic pain*: Both studies that considered use of TRH for management of chronic pain reported successful outcomes.
- *Mobility impairment*: A study on patients using mobility devices gave an indication that the TRH approach may be acceptable for delivery of services.
- *Orthopedics*: Four of five studies on management of joint disorders found TRH was successful, with unclear outcomes in the other study.
- *Childhood obesity*: An Internet–based intervention for follow up care of obese children and adolescents after in–patient rehabilitation was unsuccessful.
- *Various morbidities*: A successful study found use of TRH for persons at risk of readmission to hospital resulted in fewer emergency admissions and in improvements to quality of life. A second study showed improvements in communication for home health care services. The success of TRH in three other studies was unclear.

Conclusions

A number of studies have demonstrated the success of TRH in some clinical areas. However, while TRH shows promise in many fields, compelling evidence of benefit and of impact on routine rehabilitation programs is still limited. There is a need for more detailed, better quality studies and for studies on the use of TRH in routine care.

ABBREVIATIONS

CBT: Cognitive-behavioural therapy

CCTV: closed-circuit television

COPD: Chronic obstructive pulmonary disease

CR: Cardiac rehabilitation

FTF: Face to face

HRQoL: Health-related quality of life

MCID: Minimal clinically important difference

MS: Multiple sclerosis

NSD: No significant difference

PR: Pulmonary rehabilitation

QALY: Quality-adjusted life year

QoL: Quality of life

RCT: Randomized controlled trial

SS: Statistically significant

TBI: Traumatic brain injury

TRH: Telerehabilitation

UC: Usual care

VC: Videoconferencing

VR: Virtual reality

6MWD: Six minute walk distance

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INTRODUCTION

An area of considerable promise for telehealth is the delivery of rehabilitation services, which are much in demand. The World Health Organization states that an estimated 10% of the world's population experience some form of disability or impairment. The most common causes of impairment and disability include chronic diseases, injuries, mental impairments, birth defects, malnutrition, and communicable diseases. These trends are creating overwhelming demands for health and rehabilitation services [http://www.who.int/disabilities/publications/dar_action_plan_2006to2011.pdf].

As an illustration of the demand for rehabilitation services, in 2006-07 there were 33,879 inpatient rehabilitation cases in Canada, in 15 categories which exclude people receiving rehabilitation for a mental health condition or for drug or alcohol addiction.¹⁵ The largest client groups were those in the categories Orthopedic conditions, Stroke, Medically complex, and Brain dysfunction. Persons in these and other categories require significant ongoing rehabilitation services following discharge from hospital or other specialized facility.

Telerehabilitation (TRH) is the provision of rehabilitation services at a distance using telecommunications technology as the delivery medium.⁵⁴ TRH has been proposed as a way of increasing accessibility and enhancing continuity of care for vulnerable populations such as those with disability, with potential time and cost-savings.³⁶ Reviews of TRH have reported that there is much promise in this area though, as indicated by Huis et al.,³⁵ evaluation of the effects of some categories of TRH interventions is still in its early stages, with an emphasis on technical feasibility and acceptability.

In this report we present a systematic review of literature on the effectiveness of TRH applications. The intention is to provide guidance to decision makers in health care, in the context of current demands for rehabilitation services. The emphasis is on studies that have provided an indication of the use or potential of TRH in routine practice.

In the review, we have taken the scope of TRH to be indicated by that for rehabilitation medicine. Rehabilitation medicine is involved with the prevention and reduction of functional loss, activity limitation, and participation restriction arising from impairments; the management of disability in physical, psychosocial, and vocational dimensions; and the improvement of lost function.

We considered reports on rehabilitation for any disability, other than mental health conditions and drug or alcohol addiction. All forms of telecommunications technology for TRH were considered including telephone, Internet, videoconferencing (VC), and virtual reality (VR) approaches. We excluded studies on applications that we judged to be essentially routine monitoring or consultation as part of normal practice.

The focus of our review was on papers that reported health-related outcomes for patients and/or caregivers. As in an earlier review²⁹ we did not consider publications that reported outcomes only in terms of satisfaction with or acceptance of a telemedicine application.

METHODS

Literature search

In November 2009, computerized literature searches were performed on the following databases: MEDLINE (includes in process articles), EMBASE, PsycINFO, CINAHL, and Cochrane Library (includes Cochrane Database of Systematic Reviews, the Controlled Clinical Trials Register (CENTRAL), Database of Abstracts of Reviews of Effects (DARE),

NHS Economic Evaluation Database (NHS EED) and HTA database). The complete search strategy is available in Appendix 1. No time limit or language restrictions were used in the search.

Selection of publications

Initial screening of the identified articles was based on the information obtained from their abstracts. All abstracts were read independently by at least two of the authors and selection of relevant articles agreed upon in discussion. 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.

Each full-text article obtained for closer inspection was evaluated independently by at least two of the authors, who then reached a consensus on whether or not an article should be included in the final review, using the following selection criteria.

Inclusion criteria

Articles that described, in a scientifically valid manner, studies reporting clinical, economic, or administrative outcomes of TRH applications.

Studies of rehabilitation for somatic disorders, including orthopedic conditions, stroke, medically complex conditions, brain dysfunction, debility, limb amputation, spinal cord dysfunction, cardiac disorders, pulmonary disorders, neurological conditions, major multiple trauma, pain syndromes, arthritis, and burns.

Studies on psychological rehabilitation in connection with a somatic disorder.

Studies on support and outcomes for carers of persons undergoing rehabilitation.

Controlled studies in which TRH was compared with a non-TRH alternative.

Non-controlled studies that reported appropriate outcomes and in which there were no fewer than 20 subjects.

Exclusion criteria

Studies on rehabilitation for mental health conditions or substance abuse.

Studies in which the only outcome measures were related to satisfaction with or acceptance of TRH.

Articles in which the information provided was insufficient to establish scientific credibility.

Studies on technical development or feasibility of a rehabilitation technology.

Studies on telehome care that had no rehabilitation objective.

Duplicate reports on the same study.

Non-controlled studies with fewer than 20 subjects.

Reviews and general articles, other than for citation in discussion of the results of the review.

Articles concerned with medical and continuing education.

Data extraction

Data were extracted independently from each of the selected publications by at least two of the authors using a table that was created *a priori*. Any disagreements were resolved by consensus. Information extracted included the study objectives, design, setting and duration; patient numbers and characteristics; and reported outcomes.

Assessment of study quality

The quality of the selected studies was assessed with an approach that considers both study performance and study design.³¹ This approach has been used in previous reviews of the telehealth literature, and in a review of the use of quality-adjusted life years (QALYs) for the estimation of healthcare effectiveness.⁵¹

For *study performance*, five areas of interest were considered, as shown in Table 1. When reviewing an article on a TRH study, each of these 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, with no significant limitations.

Table 1: Classification of study performance

	Areas of interest	Points considered
1	Patient selection	Methods of randomization/selection; equivalence of intervention and control groups; dropouts 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 disposition	Length of follow up; dropouts; compliance failures
5	Outcomes reported	Fullness and clarity of reporting; missing results; statistical summary; whether conclusions were consistent with data

An additional score was allocated to each publication, according to the study design that had been used. Details are shown in Table 2. Large RCTs, defined as those with at least 50 subjects in each arm, were given a score of 5. Smaller RCTs had a score of 3, prospective non-randomized studies a score of 2, retrospective comparative studies a score of 1, and non-comparative series a score of 0.

Table 2: Classification of study design

Study design	Score
Large RCT	5
Small RCT	3
Prospective, non-randomized comparative	2
Retrospective comparative	1
Non-controlled series	0

RCT: randomized controlled trial

At least two authors independently assigned scores to each study. If there was disagreement on the study design classification or if individual scores for any performance item differed from each other by more than one, the discrepancies were discussed and resolved by consensus. For each publication, the mean of the authors' individual scores was reported to the nearest 0.5.

The performance and design scores were then combined into an overall score for each publication to give an indication of the confidence that decision makers should place in the findings that were reported. The maximum value was 15 (corresponding to a large RCT with no significant limitations). On the basis of the combined scores, we assigned each study to

one of five categories to give an indication of the reliability of the findings that the study reported. Details are shown in Table 3.

Table 3: Quality scores and implications for decision making

Overall quality score ^a		
Category	Range	Implications for decision making
A	>11.0 to 15.0	High quality; high degree of confidence in study findings
B	>9.0 ≤11.0	Good quality; some uncertainty regarding the study findings
C	>7.0 ≤9.0	Fair to good quality; some limitations that should be considered in any implementation of study findings
D	>5.0 ≤7.0	Poor to fair quality; substantial limitations in the study, findings should be used cautiously
E	≤5.0	Poor quality; unacceptable uncertainty for study findings

^a Total of scores for study design and study performance

When there was more than one publication relating to the same study, the papers were considered together and a judgment made on the overall quality and reliability of the evidence applicable to the TRH application.

A qualitative research component of one of the studies was assessed using an approach previously applied to teleoncology publications, which provides study quality ratings of Good, Fair, or Poor.³⁰

Other judgments on result from the reviewed studies

As in previous telemedicine reviews²⁹⁻³¹ for each of the reviewed publications, we considered the objectives, approach taken, setting and subjects, results and conclusions of the authors, and implications for decision makers. Note was taken of any significant limitations.

For the comparative studies, note was also taken of the type of comparison that had been made with the TRH intervention.

In addition to the appraisal of quality, described earlier, judgments were made on whether each study, or group of related studies, had indicated that the TRH application had been successful. Success was defined in terms of whether TRH performed at least as well as a similar alternative intervention. For comparative studies, where the interventions in each group were similar, TRH was considered successful when it provided better or equivalent outcomes to those for the comparator. In studies where the TRH intervention included additional resources to those of the comparator intervention, it was considered successful when it provided better outcomes.

To provide additional perspective, judgments were made on whether study findings included outcomes that were clinically significant (results such as a treatment effect large enough to be of practical importance to patients and healthcare providers). Assessment of clinical significance took account of factors such as relationship of a treatment effect to the minimal clinically important difference (MCID), the severity of the condition being treated, and any side effects of the treatment.

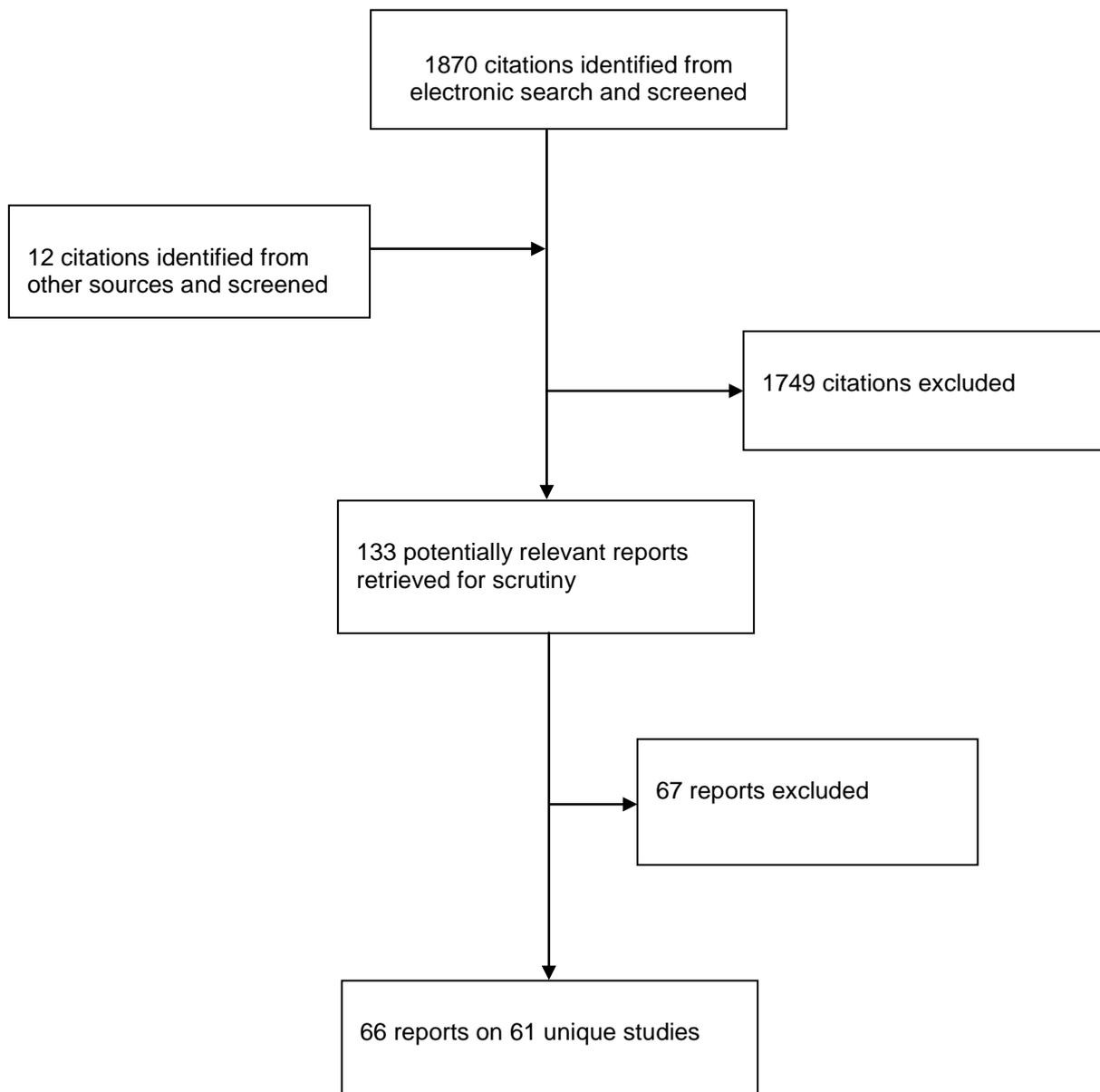
Judgments were also made as to whether additional data were needed to establish the TRH method as suitable for routine use (ratings: yes, desirable, or no). A 'no' rating was used both for studies that had provided a strong indication that TRH was suitable for routine use, and for those that had indicated that an intervention was clearly unsuccessful.

RESULTS

From 1870 publications identified in the literature search, 121 were retrieved for closer inspection. Twelve other publications were identified through references from other sources to give a total of 133 papers for consideration. From these papers, 66 dealing with 61 unique studies were judged to meet the selection criteria and were included in the review.

Identification and selection of the studies are summarized in Figure 1.

Figure 1: Selection of reports on telerehabilitation



Study sources

Numbers of studies by country are shown in Table 4. More than half were from the USA and 28% from European countries.

Table 4: TRH outcome studies by country

Country	Publications (studies)
USA	34 (32)
Germany	8 (7)
Canada	5
Italy	4
Australia	3
PRC (HK)	3
Sweden	3 (2)
Netherlands	2
Japan	1
Belgium, Italy, UK	1
Belgium, Italy, Spain	2 (1)
Total	66 (61)

Study quality

Study quality by specialty is detailed in Table 5. Thirty-one of the studies (51%) were of high or good quality, 18 (30%) fair to good, and the remainder poor–fair. Limitations included the low power of some studies, high drop out rates, and short follow up. Also, as pointed out by Kairy et al.,³⁶ a general problem with studies on TRH is the absence of blinding. However, overall, the standard of the publications compared favourably with those covered in earlier reviews of telemedicine applications.²⁹⁻³¹

Table 5: Quality of studies by speciality

Clinical category	Study quality			
	High	Good	Fair - good	Poor - fair
Cardiology	7	2	3	4
Neurology	4	4	7	3
Cancer	2			
Speech disorders		1		1
Urology	1	1		
Rheumatology	2		2	
Pulmonary	1	1	1	
Chronic pain		2		
Mobility			1	
Orthopedics	1		2	2
Child obesity	1			
Elderly, various	1		2	2
Total	20	11	18	12

Types of comparison

As discussed in a previous review²⁹ different types of comparison are applied in clinical studies of telemedicine. Telemedicine may be compared with an alternative providing an identical intervention, but in many studies the interventions being compared are different. In

some studies, the intervention provided through telemedicine may be more elaborate than that in the comparator. Patients may be contacted more frequently or provided with additional services so that studies may establish that a more elaborate intervention, rather than the method of delivery that is used, has an advantage. In such cases, the availability of telemedicine to deliver the intervention may be important in terms of logistics.

Table 6 shows types of comparisons considered in the reviewed papers that described comparative studies. The papers on the 56 studies described 69 comparisons. In one third of the comparisons the interventions were similar, while in 56% the intervention in the TRH arm was more elaborate than that offered to the control group. In one study, the TRH intervention was less elaborate than that used by the control group.

Table 6: Types of comparisons made in controlled studies of TRH

Clinical category	Similar intervention by both TRH and comparator	Additional intervention by TRH relative to comparator	Additional comparator intervention relative to TRH	Comparison of two TRH approaches
Cardiology	6	11		1
Neurology	8	10	1	2
Cancer		2		
Elderly, various		5		1
Speech therapy	1			
Urology	1	1		
Rheumatology	1	3		1
Pulmonary	1	1		
Chronic pain	1	1		1
Mobility impairment	1	1		
Orthopedic	3	2		1
Child obesity		1		
Totals	23	38	1	7

Evidence of benefits from TRH by clinical category

This section includes summaries of findings from TRH studies for each of the clinical categories. A more detailed description of the studies is provided in Appendix B.

Cardiology

Details of TRH studies in cardiology applications are shown in Table 7.

There were good indications of success for home cardiac rehabilitation (CR). In eight studies TRH was successful and there was evidence of clinically significant outcomes.^{1,4,26,37,38,42,59,63,64} In five of these studies the interventions in both groups were similar; there were additional components for the intervention in two^{42,63} and there was one non-comparative series.⁵⁹

In two studies TRH was successful but the clinical significance was unclear.^{6,66} One of these reported a reduction in anxiety levels in patients following cardiac surgery.⁶ The other study showed TRH was successful in increasing exercise levels for heart failure patients, but there were limited details on some outcomes.⁶⁶ In both studies there was additional support for the intervention group compared to controls.

The success of TRH was unclear in two studies.^{16,77} In the first the aim was to increase participation in CR.¹⁶ The other study assessed the feasibility of using the Internet for delivery of CR (similar interventions and a wait list control).⁷⁷

Studies on use of a booster intervention,⁷⁵ symptom management,⁵ and improvement in self efficacy and physical activity² were unsuccessful (all additional components in interventions compared to control groups). A high quality study found that telephone counselling was unsuccessful for psychological adjustment in women who had suffered a cardiac event (additional intervention).²⁴

Further study was judged to be needed in eight of the cardiology TRH applications, to be desirable in five and not needed in three where the interventions were unsuccessful.

Table 7: Outcomes of studies in cardiology TRH

First author	Theme	Mode	Length of study	Study Quality	TRH successful?	Clinically significant?	Further study needed?
Sparks ⁶⁴	Effectiveness of a home exercise program vs hospital	Telephone	12 wks	High	Yes (equiv FTF)	Yes	Desirable
Ades ¹	Effectiveness of a home exercise program vs hospital	Telephone	12 wks	High	Yes	Yes	Desirable
Scalvini ⁵⁹	Effectiveness of a home exercise program vs hospital	Telephone	Mean 22 d	Poor - fair	Yes	Yes	Yes
Giallauria ²⁶	Effectiveness of a home exercise program (\pm monitoring) vs hospital	Telephone	8 wks + 8 wks follow up	Poor - fair	Yes	Yes	Yes
Körtke ^{37,38}	Effectiveness of a home rehab program vs hospital	Telephone	12 mo	Good	Yes	Yes	Desirable
Southard ⁶³	Effectiveness of rehab program	Internet	24 wks	High	Yes	Yes	Yes
Arthur ⁴	Effectiveness of a home rehab program vs hospital	Telephone	24 wks	High	Yes	Yes, some measures	Desirable
Beckie ⁶	Effectiveness of home support from CR team	Telephone	6 wks post discharge	Fair - good	Yes	Unclear	Yes
Zutz ⁷⁷	Safety and effectiveness of rehab to patients at a distance	Internet	12 wks	Poor-fair	Unclear	No	Yes
Allison ²	Effectiveness of intervention on self efficacy and physical activity	Telephone	12 wks post cardiac event	Fair - good	No	No	Yes
Mittag ⁴²	Prevention program vs provision of written information	Telephone	12 mo	High	Yes	Yes	Desirable
Yates ⁷⁵	Effectiveness of booster intervention	Telephone	24 wks post surgery	Fair – Good	No	No	Yes

Table 7: Outcomes of studies in cardiology TRH (cont'd)

First author	Theme	Mode	Length of study	Study Quality	TRH successful?	Clinically significant?	Further study needed?
Barnason ⁵	Effectiveness of symptom management intervention post surgery	Monitoring device + telephone	6 wks intervention; 24 wks post op follow up	High	No	No	No – unsuccessful intervention
Carroll ¹⁶	Whether intervention increased participation in CR programs and reduced readmissions	Telephone	12 mo	Good	Unclear	No	No – unsuccessful intervention
Gallagher ²⁴	Effect of counseling on women's psychological adjustment following a cardiac event	Telephone	6 wks post discharge	High	No	No	No – unsuccessful intervention
Tomita ⁶⁶	Effectiveness of self-management program in heart failure patients. Information, exercise protocol, monitoring, feedback	Internet	12 mo intervention	Poor – fair	Yes	Unclear	Yes

Neurology

Details of studies on use of TRH in neurological applications are shown in Table 8. Five studies were concerned with support for stroke patients. Those by Piron et al.^{49,50} used a VR based system delivered via the Internet and VC for rehabilitation of patients who had motor deficits of the upper arm. Success of this approach was shown, with clinically significant outcomes, but further work would be needed to confirm findings from these small preliminary studies.

A telephone based intervention was shown to provide significant benefits to caregivers of persons who had experienced ischemic stroke.²⁸ There were improvements to caregivers' problem-solving skills and preparedness and to their mental health and social functioning.

An outreach program for recently discharged patients provided only modest benefits, with no significant differences from controls for most outcomes.¹⁰ A small study on a VC based program to provide linguistic therapy for post-stroke patients with aphasia was unable to establish the success of this approach.⁷⁰

Five studies on TRH for brain injury provided evidence that the interventions were successful, though there were differences in study quality.^{7,9,14,25,56,71} In three others, the effectiveness of the approaches used was unclear.^{11,40,60}

High quality studies with persons who had suffered traumatic brain injury (TBI) showed benefits in ameliorating depressive symptoms,⁹ improving behavioural outcomes,⁷ and increasing the probability of returning to employment.^{56,71} A good quality study with rural caregivers of persons with brain injury found telephone groups were as effective as FTF groups in providing support and education.¹⁴

A study on the ability of persons with acquired brain injury (from TBI or stroke) to retell stories found there was no difference in performance between persons in TRH and FTF settings, giving an indication that TRH is an alternative to FTF treatment for that patient group.²⁵ A study on persons with chronic stroke, TBI, or MS found there was NSD in the performance of exercise tasks between patients treated using TRH and those managed with usual care. The TRH system used might be an acceptable alternative for usual care in stroke, TBI and MS patients living at home.^{32,34}

A study on effects of training approaches on the self-efficacy of persons with brain injury gave some indication that a TRH approach could produce acceptable performance in cognitive skill training, but FTF interaction with patients was considered to also be required.⁴⁰ A fair to good quality study on effects of training on memory problems of persons with TBI found some benefits from an errorless training approach, compared to didactic training, but the clinical significance was unclear.¹¹ A fair to good study provided some evidence that a teletherapy intervention and FTF rehabilitation of persons with TBI provided similar benefits (improvements in independence) at a similar total cost, but TRH success was not established.⁶⁰

Two reports on TRH in the management of patients with MS were located. The first was a poor – fair quality observational study which found SS reductions in fatigue severity and impact, and improvements in bodily pain and general health.²³ This preliminary work was seen as an indication for further work in this area. The second study, with patients who had advanced MS of long standing, was a fair to good quality small RCT which did not establish benefits of a TRH intervention for this group.²¹

Two studies with patients who had spinal cord injuries had limited success with TRH approaches.^{19,47} A preliminary investigation on reduction of secondary conditions found no effect of TRH on HRQoL though there was a reduction in the number of hospital days.⁴⁷ The second study found no clear advantage of TRH over standard care with an intervention that provided additional resources to those available to the control group.¹⁹

Overall, further study was judged to be needed in 13 of the TRH applications, to be desirable in three and not needed in two (one in which effectiveness had been demonstrated and one in which the intervention was unsuccessful).

Table 8: Outcomes of studies in Neurological TRH

First author	Theme	Mode	Length of study	Study Quality	TRH successful?	Clinically significant?	Further study needed?
Piron ⁵⁰	Motor rehabilitation in stroke patients	VR, Internet and VC	4 wks	Poor - fair	Unclear	Unclear	Yes
Piron ⁴⁹	Motor rehabilitation in stroke patients	VR via Internet	4 wks post therapy	Good	Yes – both approaches effective	Yes	Yes
Boter ¹⁰	Effectiveness of an outreach program, recently discharged stroke patients	Telephone	24 wks post discharge	High	Unclear, modest benefits	No	Yes
Vauth ⁷⁰	Linguistic therapy, post-stroke patients with aphasia	“Synchrotel therapy”	8-12 wks	Poor - fair	No	No	No – (Unsuccessful intervention)

Table 8: Outcomes of studies in Neurological TRH (cont'd)

First author	Theme	Mode	Length of study	Study Quality	TRH successful?	Clinically significant?	Further study needed?
Grant ²⁸	Social problem-solving for primary family caregivers for stroke survivors after discharge from a rehabilitation facility	Telephone	13 wks post discharge	Fair - good	Yes	Yes	Desirable
Bombardier ⁹	Whether intervention to improve functioning after TBI also ameliorates depressive symptoms	Telephone	Intervention 36 wks follow up to we mo	High	Yes	Yes	Yes
Man ⁴⁰	Effects of different training approaches on self-efficacy outcomes of persons with brain injury	Internet, VC	8 wks	Fair to good	Unclear	Unclear	Yes
Bell ⁷	Effect of counselling and education on behavioural outcomes of people with TBI	Telephone	Intervention 36 wks follow up 12 mo post injury	High	Yes	Yes	Yes
Salazar ⁵⁶ Warden ⁷¹	Efficacy of inpatient cognitive rehabilitation for patients with TBI	Telephone	12 mo follow up	High	Yes	Yes	No – effectiveness was established
Brown ¹⁴	Support, education for caregivers of persons with brain injury	Telephone	10 wks	Good	Yes	Yes	Desirable
Bourgeois ¹¹	Effects of training on everyday memory problems of adults with chronic TBI	Telephone	4 wks follow up	Fair - good	Yes	Unclear	Yes
Schoenberg ⁶⁰	Outcomes of patients 1y after moderate – severe TBI who received cognitive rehabilitation teletherapy or FTF speech–language therapy	Internet	Mean of 24 wks	Fair - good	Unclear	No	Yes

Table 8: Outcomes of studies in Neurological TRH (cont'd)

First author	Theme	Mode	Length of study	Study Quality	TRH successful?	Clinically significant?	Further study needed?
Phillips ⁴⁷	Reducing the incidence of secondary conditions among spinal cord injury patients	VC or telephone	Follow up to 12 mo	Fair - good	Yes – health care utilization No - HRQoL	Unclear	Yes
Dallolio ¹⁹	Outcomes of TRH intervention for spinal cord injury	VC	24 wks	Good	No; TRH no better than control, used additional resources	Unclear	Yes
Finlayson ²³	Effect of energy conservation education program to people with MS	Telephone	6 wks	Poor - fair	Yes	Unclear	Yes
Egner ²¹	Impact of a TRH intervention on people with mobility declines due to advanced MS	Telephone or VC	24 mo	Fair - good	No	No	Yes
Hermen ³² Huijgen ³⁴	Effectiveness of portable home care activity desk for execution and monitoring of exercises to improve main arm functions. Patients with chronic stroke, TBI or MS	Internet	Follow up 4 wks post rehab for intervention group, 16 wks from baseline for controls	Good	Yes – equiv to UC	Unclear	Yes
Georgeadis ²⁵	Ability to re-tell stories in adults with acquired brain injury (TBI, stroke)	VC	Immediately post - intervention	Fair - good	Yes, equiv to FTF	Yes	Desirable

Cancer

Two high quality studies considered telephone – based TRH interventions intended to support patients with breast cancer (Table 9). The intervention for women with first breast cancer recurrence was not successful.²⁷ The other intervention, for early-stage breast cancer patients was successful in improving self-reported physical activity and decreasing fatigue.⁴⁸ However, changes in physical activity were not reflected in objective activity monitoring. Further study would be required.

Table 9: Studies of TRH for breast cancer

First author	Theme	Mode	Length of study	Study Quality	TRH successful?	Clinically significant?	Further study needed?
Gotay ²⁷	Psychosocial outcomes of a brief intervention in patients with first breast cancer recurrence	Telephone	Intervention 4 wks, follow up to 12 wks	High	No	No	No – unsuccessful intervention
Pinto ⁴⁸	Use of home-based physical activity intervention for early-stage breast cancer patients	Telephone	Intervention 12 wks, follow up to 36 wks	High	Yes	Unclear	Yes

Speech disorders

Two short term studies of TRH for speech disorders had successful outcomes (Table 10). A good quality study by Mashima et al.⁴¹ found that a TRH approach gave similar findings to FTF treatment, and that it could be an alternative approach to providing voice therapy services. A non-controlled study provided more limited evidence that TRH was effective in treatment of a group with Parkinson’s disease and a possible alternative to FTF speech pathology services.⁶⁵

Table 10: Studies of TRH for speech disorders

First author	Theme	Mode	Length of study	Study Quality	TRH successful?	Clinically significant?	Further study needed?
Mashima ⁴¹	Vocal rehabilitation for patients with voice disorders	VC	9 wks	Good	Yes, NSD from FTF	Yes	Desirable
Tindall ⁶⁵	Voice treatment for patients with idiopathic Parkinson’s disease and hypokinetic dysarthria	Videophone	5 wks	Poor - fair	Yes	Unclear	Yes

Urology

Two RCTs (high and good quality) provided evidence that TRH methods were successful in improving continence of post-prostatectomy patients⁴³ and of older women,³³ with results equivalent to FTF treatment (Table 11).

Table 11: Studies of TRH in urology

First author	Theme	Mode	Length of study	Study Quality	TRH successful?	Clinically significant?	Further study needed?
Moore ⁴³	Support for home pelvic floor muscle training post radical prostatectomy.	Telephone	24 wks	High	Yes, NSD from FTF	Yes	No – successful intervention
Hui ³³	Continence training, community-dwelling older women	VC	8 wks	Good	Yes, NSD from FTF	Yes	Desirable

Rheumatology

Studies of TRH in rheumatology applications are shown in Table 12. A high quality study by van den Berg et al.⁶⁷ provided evidence that an individualized Internet training intervention was more effective in promoting physical activity than a general training intervention. However, there was NSD between the intervention groups regarding changes in monitored physical activity, functional ability, QoL, or disease activity. Improvement in all of these areas was small.

A further high quality study, on an Internet-based arthritis self improvement program, found there was improvement in four of six health status measures at 1 year. However, there was NSD compared to UC in health behaviours or in health care utilization.³⁹

A fair to good quality study of a telephone based intervention for coping with pain found there was some benefit through improved coping for persons with fibromyalgia, rheumatoid arthritis, or ankylosing spondylitis. There was no effect on self-efficacy expectations or on behavioural coping with pain.⁵² A further fair to good quality study on a telephone intervention for older adults with arthritis was unable to show SS differences in self efficacy depression, pain, or fatigue when compared to UC.⁴⁶

Table 12: Studies of TRH in rheumatology

First author	Theme	Mode	Length of study	Study Quality	TRH successful?	Clinically significant?	Further study needed?
van den Berg ⁶⁷	Effectiveness of physical activity interventions for patients with rheumatoid arthritis	Internet	12 mo	High	Yes	Unclear	Desirable
Lorig ³⁹	Self-management program for arthritis patients	Internet	6 wk intervention 12 mo follow up	High	Yes	Yes	Desirable
Rau ⁵²	Motivational support, coping with pain. Patients with fibromyalgia, rheumatoid arthritis, ankylosing spondylitis	Telephone	follow-up of 36 wks after first study admission	Fair - good	Unclear	Unclear	Yes
Pariser ⁴⁶	Effects of intervention on self efficacy depression, pain, and fatigue in older adults with arthritis	Telephone	6 wks	Fair - good	No	No	No - unsuccessful approach

Pulmonary disease

Three studies on TRH in COPD were located (Table 13). The high quality study by Ries et al.⁵³ found that maintenance following a pulmonary rehabilitation program had only modest success. Nguyen et al.⁴⁵ found that Internet-based and FTF programs gave similar outcomes for management of dyspnea with activities of daily living, though the study was stopped early because of technical issues. A short term, non-controlled study on an intervention to increase activity at home had some success in improving HRQoL.⁷³ However, the mean improvement in exercise capacity was below the MCID.

Table 13: Studies of TRH in pulmonary disease

First author	Theme	Mode	Length of study	Study Quality	TRH successful?	Clinically significant?	Further study needed?
Nguyen ⁴⁵	Effect of self-management program on dyspnea with activities of daily living in people with COPD	Internet	6 mo	Good	Yes	In part	Yes
Wewel ⁷³	Whether short-term intervention increased activity at home in COPD patients and resulted in a gain in exercise capacity	Telephone	2 wks	Fair - good	Yes	In part (mean change in 6MWD < MCID; HRQoL > MCID)	Yes
Ries ⁵³	Evaluation of a maintenance program after pulmonary rehabilitation	Telephone	24 mo	High	Yes (modest success) All benefits disappeared by 24 mo	No	Yes, e.g. as follow up to group with more successful PR

Chronic pain

Both studies that considered use of TRH for management of chronic pain reported successful outcomes (Table 14). Brattberg et al.^{12,13} found that the intervention had a significant long term effect on work capacity, considered an important outcome for individuals with complex, long term problems. Other benefits seen on completion of the intervention were not maintained. The study by Appel et al.³ found that two telemedicine methods each gave similar outcomes to a FTF approach in self regulation training for chronic pain management. Larger, longer term studies would be required to establish effectiveness.

Table 14: Studies of TRH for chronic pain

First author	Theme	Mode	Length of study	Study Quality	TRH successful?	Clinically significant?	Further study needed?
Brattberg ^{12,13}	Rehabilitation of people on long-term sick leave with chronic pain and/or burnout	Internet	20 wk intervention, follow up to 12 mo	Good	Yes	Yes, but only short term for some outcomes	Desirable
Appel ³	Efficacy of behavioural telemedicine interventions to teach self – regulation skills to chronic pain patients	CCTV, telephone	Immediately post 1 day intervention	Good	Yes	Yes	Yes

Mobility impairment

A fair to good quality study on patients with new mobility devices provided a preliminary indication that the TRH approach gives similar outcomes to FTF intervention and may be an acceptable alternative for delivery of services (Table 15).^{57,58} Further study would be needed to establish efficacy and cost-effectiveness.

Table 15: TRH for mobility impairment

First author	Theme	Mode	Length of study	Study Quality	TRH successful?	Clinically significant?	Further study needed?
Sanford ^{57,58}	Use of occupational/physical therapy intervention, focus on transfer and mobility tasks	Televideo	Intervention 4 wks, with follow up at 6 wks	Fair - good	Yes	Yes	Yes

Orthopedic

Studies on TRH in orthopedic applications are summarised in Table 16. All were concerned with management of joint disorders.

A high quality study on telephone counselling of persons with osteoarthritis found that the intervention gave improvement in physical health compared with FTF counselling and UC. However, significant differences between groups for other outcomes were not demonstrated.⁷²

A small, fair to good quality study on TRH for patients who had knee arthroplasty found physical and functional improvements were similar to those in patients who had FTF rehabilitation.⁵⁵ This showed the feasibility of using a VC approach in rehabilitation of this patient group.

A small observational study on a VC based approach showed short-term improvements for elderly people with knee pain.⁷⁴ A poor to fair quality study on Internet-based TRH after elbow arthroplasty found that the intervention group had shorter mean stay in hospital and lower hospital costs, but that there was NSD from a UC control group in functional outcomes.²⁰ The success of a VC based intervention for home TRH after shoulder joint replacement was unclear.²²

Table 16: TRH studies in orthopedic applications

First author	Theme	Mode	Length of study	Study Quality	TRH successful?	Clinically significant?	Further study needed?
Weinberger ⁷²	Management of joint pain, patients with osteoarthritis	Telephone	44 wks	High	Yes	In part. Yes, for some outcomes	Yes
Russell ⁵⁵	Rehabilitation for patients with total knee arthroplasty	Internet/VC	6 wks	Fair - good	Yes	Yes	Yes
Wong ⁷⁴	Exercise program for elderly people with knee pain	VC	12 wks	Poor - fair	Yes	No	Yes
Eberl ²⁰	Rehabilitation after arthroplasty following posttraumatic contracture of the elbow	Internet	6 wks intervention 24 wks follow up	Poor - fair	Yes	No for functional outcomes	Yes
Eriksson ²²	Home rehabilitation after shoulder joint replacement	VC	8 wks	Fair - good	Unclear	No	Yes

Childhood obesity

A high quality study found that an Internet - based intervention for follow up care of obese children and adolescents after in - patient rehabilitation was unsuccessful.⁶⁹ Low utilization of the intervention was a significant factor.

Table 17: TRH in management of childhood obesity

First author	Theme	Mode	Length of study	Study Quality	TRH successful?	Clinically significant?	Further study needed?
Van Egmond-Fröhlich ⁶⁹	Follow up care for obese children and adolescents following inpatient rehabilitation	Internet	12 mo after discharge	High	No	No	No, Unsuccessful intervention

Elderly persons, various morbidities

Five studies were concerned with the use of TRH for support of elderly people who had various morbidities (Table18). A high quality study found use of TRH for persons at risk of readmission to hospital resulted in fewer emergency admissions and GP visits and improvements in HRQoL.¹⁸ A poor to fair quality study found some evidence that using videophones as a supplement to home health care services provided improvements in communication for the intervention group.⁴⁴

The success of TRH in the other studies in this group was less clear. Use of a TRH program to promote self care and safety at home did not result in any differences in health care costs.⁸ A case control study provided weak evidence suggesting that home TRH, linked to care coordination, could improve the functional and cognitive status of frail older individuals.¹⁷ A study on use of a telephone based TRH intervention for caregivers of frail rural patients provided limited evidence of benefit, though there was NSD from results obtained from use of a help line service.⁷⁶

Further study was judged to be needed for four applications and desirable for another.

Table 18: Studies on elderly persons with various morbidities

First author	Theme	Mode	Length of study	Study Quality	TRH successful?	Clinically significant?	Further study needed?
Courtney ¹⁸	Exercise-based model of hospital and in-home follow-up care for older people at risk of readmission	Telephone	24 wks post discharge	High	Yes	Yes	Desirable
Nakamura ⁴⁴	Effectiveness in improving independence of home health care clients	Videophone	12 wks	Poor - fair	Yes	Yes	Yes
Bendixen ⁸	Use of TRH program focusing on self care and safety within home, elderly patients with functional deficits in at least two activities of daily living	Telephone + adaptive equipment and environmental modifications	12 mo post - enrolment	Fair - good	No	No (primarily cost outcomes)	Yes

Table 18: Studies on elderly persons with various morbidities (cont'd)

First author	Theme	Mode	Length of study	Study Quality	TRH successful?	Clinically significant?	Further study needed?
Chumbler ¹⁷	Outcomes for frail elders receiving care coordination via distance monitoring	Health Buddy, telemonitor and videophone	Follow up to 12 mo	Poor - fair	Potentially	Unclear	Yes
Zerth ⁷⁶	Intervention or help line for rural caregivers and patients	Telephone	8 week intervention 24 wk follow up	Fair - good	Potentially	No	Yes

Overview

An overview of judgments for the reviewed TRH studies is given in Table 19. Overall, for a variety of populations and types of outcome, 71% of the TRH applications were successful. For 11% the status was unclear and 18% were unsuccessful.

The reported outcomes for 51% of the TRH applications appeared to be clinically significant. Clinical significance was unclear in 20% and was not achieved or not reported in 29%.

Further study was judged to be required for 62% of the TRH applications and desirable for 23%. For two of the applications further study was not needed as there was sufficiently strong supporting evidence. For another seven applications (11%) additional research appeared unnecessary as the interventions were clearly unsuccessful.

It is of interest that in the literature that was reviewed, the poorer quality studies had worse outcomes, in terms of judgments on the success of TRH and on whether outcomes were clinically significant (Table 20).

Table 19: Overview of judgments for reviewed TRH studies

Clinical area	Study quality *	Whether TRH successful			Whether outcomes clinically significant			Whether further study needed		
		Yes	Unclear	No	Yes	Unclear	No	Yes	Desirable	No ^c
Cardiology	H: 7, G: 2 F-G:3,P-F: 4	10 ^a	2	4	9	1	6	8	5	[3]
Neurology	H: 4, G: 4 F-G: 7, P-F: 3	11 ^a	4	3	7	7	4	13	3	1 + [1]
Cancer	H: 2	1		1		1	1	1		[1]
Speech disorders	G: 1 P-F: 1	2			1	1		1	1	
Urology	H: 1 G: 1	2			2				1	1
Rheumatology	H: 2 F-G: 2	3 ^a		1	1	2	1	1	2	[1]
Pulmonary	H: 1, G: 1 F-G: 1	3			2		1	3		
Chronic pain	G: 2	2			2			1	1	
Mobility	F-G: 1	1			1			1		
Orthopedic	H: 1, F-G: 2 P-F: 2	4	1		3 ^b		2	5		
Child obesity	H: 1			1			1			[1]
Elderly, various	H: 1, F-G: 2 P-F: 2	2	2	1	2	1	2	4	1	
Totals		43	7	11	31	12	18	38	14	2 + [7]

* H = High, G = Good, F-G = Fair to good, P-F = Poor to fair

a. 1 study not successful for all outcomes b. 2 studies not successful for all outcomes c. [] indicates intervention was unsuccessful

Table 20: Success of TRH applications and study quality

Study quality	Whether TRH successful, %			Whether outcomes clinically significant, %		
	Yes	Unclear	No	Yes	Unclear	No
High or Good	81	6	13	47	34	19
Fair – good or Poor - fair	48	31	21	24	31	45

DISCUSSION

In this review we sought to cover evidence on the effectiveness of TRH applications, with an emphasis on studies that provided an indication of the use or potential of such approaches in routine practice. Our focus was on publications that reported health - related outcomes for patients and/ or their caregivers, moving beyond the details provided in reports that considered only the feasibility of rehabilitation technologies.

Using rather broad selection criteria, which included all types of study design, we located only 61 studies on all areas of rehabilitation for somatic disorders. Twelve clinical specialties or areas were covered by the studies we reviewed, with most in neurology (30%) or cardiology (26%). There is still a very small data base for TRH studies that provide useful data on clinical outcomes.

During the abstract selection process we noted a number of studies that provided descriptions or considered the feasibility of innovative approaches to TRH, but which did not meet our criteria because patient outcomes were not provided or numbers of patients were very small. Many of these reports had been published some years ago but more detailed follow up investigations have not emerged. Russell points out that to date much research has been technology focused and with small sample research designs.⁵⁴ He concludes that demonstration of viable TRH services in real world environments using well-controlled research methodologies and large patient cohorts is required.

While the studies we reviewed included some that made use of recently developed technologies it was notable that telephone based interventions continue to play an important role in TRH. Over 60% of the reviewed studies included use of telephone links for communication (over 80% in the cardiology group).

Over half of the studies in our review were of high or good quality, consistent with comments by Kairy et al.³⁶ on the high proportion of such investigations in their review. However, 29% of the studies in our review had limitations that should be considered in any implementation of their findings and a further 20% had substantial limitations.

Overall, we found that TRH had been shown to be successful in 71 % of the studies, unsuccessful in 18%, with unclear findings in the remainder. Demonstration that outcomes were clinically significant, as well as statistically significant, was apparent in 51% of the studies. Clinical significance was often not addressed in the publications we reviewed. Given the variety of patient groups and conditions considered there may well be difficulties in defining clinical significance in some circumstances. In some cases indicators such as MCIDs could be used to make judgments on clinical significance. Judgments on 38 (62%) of the studies suggested that further work would be needed to establish that the TRH applications covered were suitable for routine use. Further work was seen as desirable for a further 14 applications. In two cases, it was considered that suitability for routine use had been established, with no need for additional research.

In the two largest groups, successful TRH was shown in 72% and 63%, respectively, of the studies on neurology and cardiology applications. The cardiology group had a higher proportion of studies where clinical significant outcomes had been shown (56% vs 39%) and a lower proportion of applications that were considered to need further work (50% vs 72%).

As noted in the overview of results, poorer quality studies tended to have worse outcomes than those from high or good quality studies. The usefulness of TRH applications was especially evident in the good quality studies. The significance of this distribution is uncertain, given the range of TRH applications, patient populations, and settings. Perhaps better quality studies are needed to establish the true benefits of TRH. Another possibility is that some good quality studies with negative findings have not been reported, giving a publication bias.

Limitations of available evidence and need for further work on TRH have been noted by other groups. Schwaab concluded that trials of home-based CR were predominantly feasibility studies with few patients.⁶¹ Also, most patients in the studies he reviewed were uncomplicated low risk males, most of whom were not included in studies until weeks or months after the cardiac event. A statement from the American Heart Association and the American Stroke Association⁶² notes that TRH has the potential to provide timely and efficient post-acute care for stroke patients beyond the hospital and into their homes. However, the few studies that have explored the use of telemedicine technologies with stroke survivors and their caregivers provide preliminary evidence of satisfaction and feasibility. More work is needed to demonstrate the efficacy of these methods in promoting in-home rehabilitation. A review by van Dijk et al.⁶⁸ found there were some promising applications of distance motor training, including use of VR and robotic devices, but that the strength of evidence from these studies was poor.

Our findings are consistent with the conclusions of Kairy et al. that further research on TRH with stronger studies is essential.³⁶ Kairy et al. also make the point that research on TRH needs to be matched by an understanding of factors influencing the sustainability of TRH programs to be useful to clinical and policy decision makers. Our review identified a number of studies that demonstrated the success of individual TRH applications, but in most reports there was little or no discussion of how these approaches might be integrated into health care systems. It may be that some additional information was not available because of publication delays,³⁶ but we suspect that the large, good quality studies that have been called for have yet to be put in place. TRH shows promise in many fields but compelling evidence of benefit, and of impact on routine rehabilitation, seems likely to await the availability of adequate research funding and a high level of commitment by rehabilitation professionals to engage in longer-term studies.

REFERENCES

1. Ades PA, Pashkow FJ, Fletcher G, Pina IL, Zohman LR, Nestor JR. A controlled trial of cardiac rehabilitation in the home setting using electrocardiographic and voice transtelephonic monitoring. *American Heart Journal* 2000;139:543-8.
2. Allison MJ, Keller C. Self-efficacy intervention effect on physical activity in older adults. *Western Journal of Nursing Research* 2004;26:31-58.
3. Appel PR, Bleiberg J, Noiseux J. Self-regulation training for chronic pain: can it be done effectively by telemedicine? *Telemedicine Journal and E-Health* 2002;8:361-8.
4. Arthur HM, Smith KM, Kodis J, McKelvie R. A controlled trial of hospital versus home-based exercise in cardiac patients. *Medicine and Science in Sports and Exercise* 2002;34:1544-50.
5. Barnason SZ. Influence of a symptom management telehealth intervention on older adults' early recovery outcomes after coronary artery bypass surgery. *Heart & Lung: The Journal of Critical Care* 2009;38:364-76.
6. Beckie T. A supportive-educative telephone program: impact on knowledge and anxiety after coronary artery bypass graft surgery. *Heart & Lung: The Journal of Critical Care* 1989;18:46-55.
7. Bell KR, Temkin NR, Esselman PC, Doctor JN, Bombardier CH, Fraser RT, et al. The effect of a scheduled telephone intervention on outcome after moderate to severe traumatic brain injury: a randomized trial. *Archives of Physical Medicine and Rehabilitation* 2005;86:851-6.
8. Bendixen RM, Levy CE, Olive ES, Kobb RF, Mann WC. Cost effectiveness of a telerehabilitation program to support chronically ill and disabled elders in their homes. *Telemedicine Journal and E-Health* 2009;15:31-8.
9. Bombardier CH, Bell KR, Temkin NR, Fann JR, Hoffman J, Dikmen S. The efficacy of a scheduled telephone intervention for ameliorating depressive symptoms during the first year after traumatic brain injury. *Journal of Head Trauma Rehabilitation* 2009;24:230-38.
10. Boter H for the HESTIA Study Group. Multicenter randomized controlled trial of an outreach nursing support program for recently discharged stroke patients. *Stroke* 2004;35:2867-72.
11. Bourgeois MS, Lenius K, Turkstra L, Camp C. The effects of cognitive teletherapy on reported everyday memory behaviours of persons with chronic traumatic brain injury. *Brain Injury* 2007;21:1245-57.
12. Brattberg G. Internet-based rehabilitation for individuals with chronic pain and burnout II: a long-term follow-up. *International Journal of Rehabilitation Research* 2007;30:231-4.
13. Brattberg G. Internet-based rehabilitation for individuals with chronic pain and burnout: a randomized trial. *International Journal of Rehabilitation Research* 2006;29:221-7.
14. Brown R, Pain K, Berwald C, Hirschi P, Delehanty R, Miller H. Distance education and caregiver support groups: comparison of traditional and telephone groups. *Journal of Head Trauma Rehabilitation* 1999;14:257-68.

15. Canadian Institute for Health Information, *Inpatient Rehabilitation in Canada, 2006–2007*. Ottawa: CIHI, 2008.
16. Carroll DL, Rankin SH, Cooper BA. The effects of a collaborative peer advisor/advanced practice nurse intervention: cardiac rehabilitation participation and rehospitalization in older adults after a cardiac event. *Journal of Cardiovascular Nursing* 2007;22:313-19.
17. Chumbler NR, Mann WC, Wu S, Schmid A, Kobb R. The association of home-telehealth use and care coordination with improvement of functional and cognitive functioning in frail elderly men. *Telemedicine Journal and E-Health* 2004;10:129-37.
18. Courtney M, Edwards H, Chang A, Parker A, Finlayson K, Hamilton K. Fewer emergency readmissions and better quality of life for older adults at risk of hospital readmission: a randomized controlled trial to determine the effectiveness of a 24-week exercise and telephone follow-up program. *Journal of the American Geriatric Society* 2009;57:395-402.
19. Dallolio L, Menarini M, China S, Ventura M, Stainthorpe A, Soopramanien A, et al. Functional and clinical outcomes of telemedicine in patients with spinal cord injury. *Archives of Physical Medicine and Rehabilitation* 2008;89:2332-41.
20. Eberl R. The televisit as a telemedical technique in daily clinical practice. First results for elbow joint arthrolysis [German]. *Unfallchirurg* 2006;109:383-90.
21. Egner A, Phillips VL, Vora R, Wiggers E. Depression, fatigue, and health-related quality of life among people with advanced multiple sclerosis: results from an exploratory telerehabilitation study. *NeuroRehabilitation* 2003;18:125-33.
22. Eriksson L, Lindström B, Gard G, Lysholm J. Physiotherapy at a distance: a controlled study of rehabilitation at home after a shoulder joint operation. *Journal of Telemedicine and Telecare* 2009;15:215-20.
23. Finlayson M. Pilot study of an energy conservation education program delivered by telephone conference call to people with multiple sclerosis. *NeuroRehabilitation* 2005;20:267-77.
24. Gallagher R, McKinley S, Dracup K. Effects of a telephone counseling intervention on psychosocial adjustment in women following a cardiac event. *Heart & Lung: The Journal of Critical Care* 2003;32:79-87.
25. Georgeadis AC. Telerehabilitation and its effect on story retelling by adults with neurogenic communications disorders. *Aphasiology* 2004;18:639-52.
26. Giallauria F, Lucci R, Pilerici F, De Lorenzo A, Manakos A, Psaroudaki M, et al. Efficacy of telecardiology in improving the results of cardiac rehabilitation after acute myocardial infarction. *Monaldi Archives for Chest Disease* 2006;66:8-12.
27. Gotay CC, Moinpour CM, Unger JM, Jiang CS, Coleman D, Martino S, et al. Impact of a peer-delivered telephone intervention for women experiencing a breast cancer recurrence. *Journal of Clinical Oncology* 2007;25:2093-9.
28. Grant JS, Elliott TR, Weaver M, Bartolucci AA, Giger JN. Telephone intervention with family caregivers of stroke survivors after rehabilitation. *Stroke* 2002;33:2060-5.
29. Hailey D, Roine R, Ohinmaa A. *Evidence of benefits from telemental health: a systematic review*. Edmonton: Institute of Health Economics and Finnish Office for Health Technology Assessment, October 2007.

30. Hailey D, Paquin M-J, Casebeer A, Harris LE, Maciejewski O. Evidence about tele-oncology applications and associated benefits for patients and their families. *Journal of Telemedicine and Telecare* 2006; 12:S3:40-3.
31. Hailey D, Ohinmaa A, Roine R. Study quality and evidence of benefit in recent assessments of telemedicine. *Journal of Telemedicine and Telecare* 2004;10:318–24.
32. Hermens H, Huijgen B, Giacomozzi C, Ilsbrouckx S, Macellari V, Prats E, et al. Clinical assessment of the HELLODOC tele-rehabilitation service. *Annali dell'Istituto Superiore di Sanità* 2008; 44:154-63.
33. Hui E, Lee PS, Woo J. Management of urinary incontinence in older women using videoconferencing versus conventional management: a randomized controlled trial. *Journal of Telemedicine and Telecare* 2006;12:343-7.
34. Huijgen BC, Vollenbroek-Hutten MM, Zampolini M, Opisso E, Bernabeu M, Van Nieuwenhoven J, et al. Feasibility of a home-based telerehabilitation system compared to usual care: arm/hand function in patients with stroke, traumatic brain injury and multiple sclerosis. *Journal of Telemedicine and Telecare* 2008;14:249-56.
35. Huis in 't Veld MH, van DH, Hermens HJ, Vollenbroek-Hutten MM. A systematic review of the methodology of telemedicine evaluation in patients with postural and movement disorders. *Journal of Telemedicine and Telecare* 2006;12:289-97.
36. Kairy D, Lehoux P, Vincent C, Visintin M. A systematic review of clinical outcomes, clinical process, healthcare utilization and costs associated with telerehabilitation. *Disability and Rehabilitation* 2009;31:427-47.
37. Körtke H, Stromeyer H, Zittermann A, Buhr N, Zimmermann E, Wienecke E, et al. New East-Westfalian Postoperative Therapy Concept: a telemedicine guide for the study of ambulatory rehabilitation of patients after cardiac surgery. *Telemedicine Journal and E-health* 2006;12:475-83.
38. Körtke H, Zittermann A, El-Arousy M, Zimmermann E, Wienecke E, Körfer R. New Eastern Westfalian Postoperative Therapeutic Concept (NOPT). A telemedically guided study for ambulatory rehabilitation of patients after cardiac surgery [German]. *Medizinische Klinik* 2005;100:383-9.
39. Lorig KR, Ritter PL, Laurent DD, Plant K. The internet-based arthritis self-management program: a one-year randomized trial for patients with arthritis or fibromyalgia. *Arthritis and Rheumatism* 2008;59:1009-17.
40. Man DW, Soong WY, Tam SF, Hui-Chan CW. A randomized clinical trial study on the effectiveness of a tele-analogy-based problem-solving programme for people with acquired brain injury (ABI). *NeuroRehabilitation* 2006;21:205-17.
41. Mashima PA, Birkmire-Peters DP, Syms MJ, Holtel MR, Burgess LP, Peters LJ. Telehealth: voice therapy using telecommunications technology. *American Journal of Speech-language Pathology* 2003;12:432-9.
42. Mittag O, China C, Hoberg E, Juers E, Kolenda KD, Richardt G, et al. Outcomes of cardiac rehabilitation with versus without a follow-up intervention rendered by telephone (Luebeck follow-up trial): overall and gender-specific effects. *American Journal of Speech Language and Pathology* 2006;29:295-302.
43. Moore KN, Valiquette L, Chetner MP, Byrniak S, Herbison GP. Return to continence after radical retropubic prostatectomy: a randomized trial of verbal and written

- instructions versus therapist-directed pelvic floor muscle therapy. *Urology* 2008;72:1280-86.
44. Nakamura K, Takano T, Akao C. The Effectiveness of videophones in home healthcare for the elderly. *Medical Care* 1999;37:117-25.
 45. Nguyen HQ, Donesky-Cuenco D, Wolpin S, Reinke LF, Benditt JO, Paul SM, et al. Randomized controlled trial of an internet-based versus face-to-face dyspnea self-management program for patients with chronic obstructive pulmonary disease: pilot study. *Journal of Medical Internet Research* 2008;10:e9.
 46. Pariser D, O'Hanlon A, Espinoza L. Effects of telephone intervention on arthritis self-efficacy, depression, pain, and fatigue in older adults with arthritis. *Journal of Geriatric Physical Therapy* 2005;28:67-73.
 47. Phillips VL, Vesmarovich S, Hauber R, Wiggers E, Egner A. Telehealth: reaching out to newly injured spinal cord patients. *Public Health Reports* 2001;116:Suppl-102.
 48. Pinto BM, Frierson GM, Rabin C, Truzno JJ, Marcus BH. Home-based physical activity intervention for breast cancer patients. *Journal of Clinical Oncology* 2005;23:3577-87.
 49. Piron L, Turolla A, Agostini M, Zucconi C, Cortese F, Zampolini M, et al. Exercises for paretic upper limb after stroke: a combined virtual-reality and telemedicine approach. *Journal of Rehabilitation Medicine* 2009;41:1016-20.
 50. Piron L, Turolla A, Tonin P, Piccione F, Lain L, Dam M. Satisfaction with care in post-stroke patients undergoing a telerehabilitation programme at home. *Journal of Telemedicine and Telecare* 2008;14:257-60.
 51. Räsänen P, Roine E, Sintonen H, Semberg-Kontinen V, Ryyänen OP, Roine R. Use of quality-adjusted life years for the estimation of effectiveness of health care: a systematic literature review. *International Journal of Technology Assessment in Health Care* 2006; 22:235-41.
 52. Rau J, Ehlebracht-König I, Petermann F. Impact of a motivational intervention on coping with chronic pain: results of a controlled efficacy study [German] *Schmerz* 2008;22:575-85.
 53. Ries AL, Kaplan RM, Myers R, Prewitt LM. Maintenance after pulmonary rehabilitation in chronic lung disease: a randomized trial. *American Journal of Respiratory and Critical Care Medicine* 2003;167:880-8.
 54. Russell TG. Physical rehabilitation using telemedicine. *Journal of Telemedicine and Telecare* 2007;13:217-20.
 55. Russell TG, Buttrum P, Wootton R, Jull GA. Low-bandwidth telerehabilitation for patients who have undergone total knee replacement: preliminary results. *Journal of Telemedicine and Telecare* 2003;9:Suppl-7.
 56. Salazar AM, Warden DL, Schwab K, Spector J, Braverman S, Walter J, et al. Cognitive Rehabilitation for Traumatic Brain Injury: a randomized trial. *JAMA* 2000;283:3075-81.
 57. Sanford JA, Hoenig H, Griffiths PC, Butterfield T, Richardson P, Hargraves K, A comparison of televideo and traditional in-home rehabilitation in mobility impaired older adults. *Physical & Occupational Therapy in Geriatrics* 2007;25:3-16.
 58. Sanford JA, Griffiths PC, Richardson P, Hargraves K, Butterfield T, Hoenig H. The effects of in-home rehabilitation on task self-efficacy in mobility-impaired adults: A randomized clinical trial. *Journal of the American Geriatric Society* 2006;54:1641-48.

59. Scalvini S, Zanelli E, Comini L, Tomba MD, Troise G, Giordano A. Home-based exercise rehabilitation with telemedicine following cardiac surgery. *Journal of Telemedicine and Telecare* 2009;15:297-301.
60. Schoenberg MR, Ruwe WD, Dawson K, McDonald NB, Houston B, Forducey PG. Comparison of functional outcomes and treatment cost between a computer-based cognitive rehabilitation teletherapy program and a face-to-face rehabilitation program. *Professional Psychology, Research and Practice* 2008;39:175.
61. Schwaab B. Telemedicine in cardiac rehabilitation--a literature review and critical appraisal [German]. *Rehabilitation* 2007;46:276-82.
62. Schwamm LH, Holloway RG, Amarenco P, Audebert HJ, Bakas T, Chumbler NR, et al. A review of the evidence for the use of telemedicine within stroke systems of care: a scientific statement from the American Heart Association/American Stroke Association. *Stroke* 2009;40:2616-34.
63. Southard BH, Southard DR, Nuckolls J. Clinical trial of an Internet-based case management system for secondary prevention of heart disease. *Journal of Cardiopulmonary Rehabilitation* 2003;23:341-8.
64. Sparks KE, Shaw DK, Eddy D, Hanigosky P, Vantrese J. Alternatives for cardiac rehabilitation patients unable to return to a hospital-based program. *Heart & Lung: The Journal of Critical Care* 1993;22:298-303.
65. Tindall LR, Huebner RA, Stemple JC, Kleinert HL. Videophone-delivered voice therapy: a comparative analysis of outcomes to traditional delivery for adults with Parkinson's disease. *Telemedicine Journal and E-Health* 2008;14:1070-7.
66. Tomita MR, Tsai BM, Fisher NM, Kumar NA, Wilding GE, Naughton BJ. Improving adherence to exercise in patients with heart failure through internet-based self-management. *Journal of the American Geriatric Society* 2008;56:1981-3.
67. van den Berg MH, Ronday HK, Peeters AJ, le Cessie S, van der Giesen FJ, Breedveld FC, et al. Using internet technology to deliver a home-based physical activity intervention for patients with rheumatoid arthritis: A randomized controlled trial. *Arthritis and Rheumatism* 2006;55:935-45.
68. van Dijk H, Hermens HJ. Distance training for the restoration of motor function. *Journal of Telemedicine and Telecare* 2004;10:63-71.
69. Van Egmond-Fröhlich A. Effects of a programme for structured outpatient follow-up care after inpatient rehabilitation of obese children and adolescents - A multicentre, randomized study. *Rehabilitation* 2006;45:40-51.
70. Vauth F, Hampel P, Scibor M, Handschu R, Richter J, Keidel M. Synchronic telepractise: a new (additional) form of aphasia therapy [German]. *Forum Logopädie* 2008;22:12-19.
71. Warden DL, Salazar AM, Martin EM, Schwab KA, Coyle M, Walter J. A home program of rehabilitation for moderately severe traumatic brain injury patients. The DVHIP Study Group. *Journal of Head Trauma Rehabilitation* 2000;15:1092-1102.
72. Weinberger M, Tierney W, Booher P, Katz BP. Can the provision of information to patients with osteoarthritis improve functional status? A randomized, controlled trial. *Arthritis and Rheumatism* 1989;32:1577-83.

73. Wewel AR, Gellermann I, Schwertfeger I, Morfeld M, Magnussen H, Jorres RA. Intervention by phone calls raises domiciliary activity and exercise capacity in patients with severe COPD. *Respiratory Medicine* 2008;102:20-6.
74. Wong YK, Hui E, Woo J. A community-based exercise programme for older persons with knee pain using telemedicine. *Journal of Telemedicine and Telecare* 2005;11:310-5.
75. Yates BC, Anderson T, Hertzog M, Ott C, Williams J. Effectiveness of follow-up booster sessions in improving physical status after cardiac rehabilitation: health, behavioral, and clinical outcomes. *Applied Nursing Research* 2005;18:59-62.
76. Zerth EO. Applying a manualized intervention for rural caregivers to caregivers of older medical rehabilitation patients. *Dissertation Abstracts International: Section B: The Sciences and Engineering*. 2009;69:5066.
77. Zutz A, Ignaszewski A, Bates J, Lear SA. Utilization of the internet to deliver cardiac rehabilitation at a distance: a pilot study. *Telemedicine Journal and E-Health* 2007;13:323-30.

APPENDIX A: LITERATURE SEARCH SUMMARY

No date limits applied and no language limits applied

Table A.1: Search strategy

Database	Edition or date searched	Search Terms ^{††}
Core Databases		
The Cochrane Library (Wiley Interface) (Includes CDSR, CENTRAL, NHS EED, HTA and DARE) http://www.thecochrane-library.com	Issue 4, 2009	#1 (tele-rehab* or telerehab*) #2 (tele?medicine or tele?health or tele?care or tele?consult* or tele?therap* or tele?monitor or videoconferen* or videophon* or "virtual reality" or (virtual NEXT world*) or (virtual NEXT environment*)):ti,ab,kw #3 (remote* or video) NEAR/3 (assess* or consult* or monitor*):ti,ab,kw #4 (#2 OR #3) #5 (physical NEXT therap*) or physiotherap* or rehab* :ti,ab,kw #6 (occupational NEXT therap*) or (allied NEXT health) or (exercise NEXT therap*):ti,ab,kw #7 (speech NEAR/3 patholog*) or (speech NEAR/3 therap*):ti,ab,kw #8 (#5 OR #6 OR #7) #9 (#4 AND #8) #10 (#1 OR #9) 0 results in CDSR 78 results in CENTRAL 3 results in DARE 3 results in HTA 3 results in NHS EED (all before duplicates removal)
Medline (Ovid Interface) (includes in process articles)	1950 - Nov 25, 2009	1. (telerehab* or tele-rehab*).tw. 2. Telemedicine/ 3. Remote Consultation/ 4. Therapy, Computer-Assisted/ 5. telecommunications/ or electronic mail/ or satellite communications/ or telephone/ or videoconferencing/ 6. (teleconferenc* or videoconferenc* or videophone*).tw. 7. (telemedic* or teletherap* or telehealth* or telecare or tele-care or teleconsult* or telemonitor*).tw. 8. telemedicine.nw. 9. (e?mail* not "e?mail survey").tw. 10. ((remote* or video) adj3 (assess* or consult* or monitor*)).tw. 11. internet/ 12. (((internet* not internet survey) or (on?line not on?line survey) or (web-based not web-based survey) or world wide web) adj7 (rehab* or physiotherap* or physical therapy or occupational therapy or speech* patholog* or speech* therap* or allied health)).tw. 13. chat.tw. 14. technology-based.tw. 15. (virtual reality or virtual world or virtual environment* or (virtual adj5 (rehab* or physiotherap* or physical therapy or occupational therapy or speech* patholog* or speech* therap* or allied health))).tw. 16. or/2-15 17. exp Physical Therapy Modalities/ 18. rehabilitation/ or art therapy/ or dance therapy/ or early ambulation/ or exp exercise therapy/ or music therapy/ or occupational therapy/ or exp "rehabilitation of speech and language disorders"/ or rehabilitation, vocational/ or rehabilitation centers/ 19. "physical therapy (specialty)"/ or speech-language pathology/

		<p>20. (physiotherap* or physical therap* or rehab* or occupational therap* or speech patholog* or speech therap*).tw. 21. allied health.mp. 22. or/17-21 23. 1 or (16 and 22) 24. exp "costs and cost analysis"/ 25. (economic adj1 (evaluat* or analys* or study or studies or assess* or consequence*).tw. 26. (cost-benefit or benefit-cost or cost effectiv* or cost utility).tw. 27. (cost minimization or cost minimisation or cost consequence* or cost offset*).tw. 28. ((cost or costs) adj2 analys*).tw. 29. "cost of illness".tw. 30. (cost* or economic* or expenditures or price or fiscal or financial or efficiency or pay or valuation).ti. 31. or/24-30 32. 23 and 31 33. exp epidemiologic studies/ or intervention studies/ or pilot projects/ or evaluation studies/ 34. exp clinical trial/ or comparative study/ 35. (randomi?ed or randomly).tw. or trial.ti. or effects.ti. or groups.ab. 36. ((systematic* adj2 review*) or Medline or pubmed or psychinfo or psycinfo or search*).tw. 37. meta-analy*.mp.pt. 38. limit 23 to ("in data review" or in process or "pubmed not medline") 39. 38 and (study or trial or method or methods or effectiveness or efficacy or outcomes).tw. 40. (or/33-37) and 23 41. 39 or 40 42. 32 or 41</p> <p>924 results before duplicates removal</p>
EMBASE (Ovid interface)	1980 - Nov 25, 2009	<p>1. (telerehab* or tele-rehab*).tw. 2. telemedicine/ or telehealth/ or teleconsultation/ or telemonitoring/ or teletherapy/ 3. computer assisted therapy/ 4. telecommunication/ or teleconference/ 5. e-mail/ 6. videoconferencing/ 7. (telemedic* or teletherap* or telehealth* or telecare or tele-care or teleconsult* or telemonitor*).tw. 8. "tele*".jx. 9. (e?mail* not "e?mail survey").tw. 10. ((remote* or video) adj3 (assess* or consult* or monitor*).tw. 11. internet/ 12. (((internet* not internet survey) or (on?line not on?line survey) or (web-based not web-based survey) or world wide web) adj7 (rehab* or physiotherap* or physical therapy or occupational therapy or speech* patholog* or speech* therap* or allied health)).tw. 13. chat.tw. 14. technology-based.tw. 15. (virtual reality or virtual world or virtual environment* or (virtual adj5 (rehab* or physiotherap* or physical therapy or occupational therapy or speech* patholog* or speech* therap* or allied health))).tw. 16. or/2-15 17. physiotherapy/ or home physiotherapy/ 18. physiotherapy practice/ 19. rehabilitation/ or athletic rehabilitation/ or cognitive rehabilitation/ or community based rehabilitation/ or constraint induced therapy/ or functional assessment/ or functional training/ or geriatric rehabilitation/ or heart rehabilitation/ or home rehabilitation/ or muscle training/ or occupational therapy/ or pediatric rehabilitation/ or pelvic floor muscle training/ or</p>

		<p>psychosocial rehabilitation/ or pulmonary rehabilitation/ or recreational therapy/ or vocational rehabilitation/ 20. speech therapy/ 21. occupational therapist/ or occupational therapy assessment/ or occupational therapy practice/ 22. (physiotherap* or physical therap* or rehab* or occupational therap* or speech patholog* or speech therap* or allied health).tw. 23. or/17-22 24. "cost"/ 25. exp economic evaluation/ 26. ((economic or cost*) adj2 (evaluat* or analys* or study or studies or assess* or consequence*).mp. 27. ((cost-benefit or benefit-cost or cost effectiv* or cost utility) adj2 (analys* or evaluat* or assess* or study or studies)).mp. 28. (cost minimization or cost minimisation or cost consequence* or cost offset*).mp. 29. "cost of illness".tw. 30. health economics/ 31. or/24-30 32. 16 and 23 33. 32 and 31 34. cohort analysis/ or control group/ or experimental design/ or qualitative research/ or observational study/ 35. exp comparative study/ or clinical study/ or clinical trial/ or intervention study/ or longitudinal study/ or major clinical study/ or prospective study/ or retrospective study/ or exp controlled study/ or experimental study/ or human experiment/ 36. quasi experimental study/ or pilot study/ 37. exp evidence based medicine/ 38. or/34-37 39. (16 and 23) or 1 40. 39 and 31 41. 39 and 38 42. 40 or 41</p> <p>(601 results before duplicates removal)</p>
<p>PsycINFO (Ovid interface)</p>	<p>2006 – Nov Week 4, 2009</p>	<p>1. (telerehab* or tele-rehab*).tw. 2. telemedicine/ or computer assisted diagnosis/ or computer assisted therapy/ 3. telecommunications media/ or online therapy/ or teleconferencing/ 4. (teleconferenc* or videoconferenc* or videophone*).tw. 5. ((remote* or video) adj3 (assess* or consult* or monitor*).tw. 6. (telemedic* or teletherap* or telehealth* or telecare or tele-care or teleconsult* or telemonitor*).tw. 7. (e?mail* not "e?mail survey").tw. 8. internet/ 9. technology-based.tw. 10. (((internet* not internet survey) or (on?line not on?line survey) or (web-based not web-based survey) or world wide web) adj7 (rehab* or physiotherap* or physical therapy or occupational therapy or speech* patholog* or speech* therap* or allied health)).tw. 11. (virtual reality or virtual world or virtual environment* or (virtual adj5 (rehab* or physiotherap* or physical therapy or occupational therapy or speech* patholog* or speech* therap* or allied health))).tw. 12. or/2-11 13. rehabilitation/ or cognitive rehabilitation/ or occupational therapy/ or physical therapy/ or self care skills/ 14. speech therapy/ 15. physical therapy/ 16. occupational therapy/ 17. exp allied health personnel/ 18. Neuropsychological Rehabilitation/ 19. (physiotherap* or physical therap* or occupational therap* or speech patholog* or speech therap* or allied health).tw.</p>

		<p>20. or/13-19 21. 1 or (12 and 20) 22. "Costs and Cost Analysis"/ 23. (economic adj1 (evaluat* or analys* or study or studies or assess* or consequence*).tw. 24. ((cost-benefit or benefit-cost or cost effectiv* or cost utility) adj2 (analys* or evaluat* or assess* or study or studies)).tw. 25. (cost minimization or cost minimisation or cost consequence* or cost offset*).tw. 26. ((cost or costs) adj2 analys*).tw. 27. "cost of illness".tw. 28. (cost* or economic* or expenditures or price or fiscal or financial or efficiency or pay or valuation).ti. 29. or/22-28 30. 21 and 29 31. clinical trials/ or cohort analysis/ or experimental design/ or qualitative research/ or quantitative methods/ 32. 21 and 31 33. limit 21 to ("0400 empirical study" or "0430 followup study" or "0450 longitudinal study" or "0451 prospective study" or "0452 retrospective study" or "0600 field study" or "0830 systematic review" or 1200 meta analysis or 1600 qualitative study or 1800 quantitative study or "2000 treatment outcome/randomized clinical trial") 37. 30 or 32 or 33 (211 results before duplicates removal)</p>
CINAHL (EBSCO interface)	1937 – Nov 25, 2009	<p>S1: telehealth OR telemedicine OR teleconsult* or telemonitor* or teletherapy or teleconferenc* or videoconferenc* or telecare or videophone S2: remote consult* or remote assess* or remote* monitor* or video consult* or video assess* or video monitoring S3: MH electronic mail or instant messaging or internet or telephone S4: virtual reality or virtual world* or virtual environment* S5: S1 or S2 or S3 or S4 S6: (MH "Home Rehabilitation+") S7: (MH "Allied Health Professions") or (MH "Speech-Language Pathology") or (MH "Rehabilitation") or (MH "Occupational Therapy+") or (MH "Physical Therapy"+) S8: MH "rehabilitation, athletic" or MH "rehabilitation, cancer" or MH "rehabilitation, cardiac" or MH "rehabilitation, cognitive" or MH "rehabilitation, community-based" or MH "rehabilitation, geriatric" or MH "rehabilitation of hearing impaired" or MH "rehabilitation of vision impaired" or MH "rehabilitation, pediatric" or MH "rehabilitation, psychosocial" or MH "rehabilitation, pulmonary" or MH ("rehabilitation, speech and language") S9: (MH "Rehabilitation Patients") S10: physiotherap* or physical therap* or occupational therap* or speech patholog* or speech-language patholog* or speech therap* S11: S6 or S7 or S8 or S9 or S10 S12: S5 and S11 S13: ((MH "Costs and Cost Analysis")) or (MH "Cost Benefit Analysis") or (MH "Economic Aspects of Illness") or (MH "Health Care Costs") S14: (cost-benefit or benefit-cost or cost effectiv* or cost utility) or (economic evaluat* or economic analys*) or (cost analys* or costs analys*) or "cost of illness" S15: TI cost* or economic* or expenditures or price or fiscal or financial or efficiency or pay or valuation S16: S13 or S14 or S15 S17: S12 AND S16 S18: (MH "Experimental Studies+") S19: (MH "Nonexperimental Studies+") or (MH "Quasi-Experimental Studies+") or (MH "Quantitative Studies") or (MH "Qualitative Studies+")</p>

		S20: (MH "Systematic review") S21: (MH "meta analysis") S22: MH "Comparative Studies" S23: (MH "Administrative Research") S24: systematic* review* or meta-analysis or MEDLINE or PsyclINFO or search* S25: randomized or participants S26: (MH "Evaluation Research+") S27: (MH "Pilot Studies") S28: (MH "Comparative Studies") S29: S12 Limiters - Publication Type: Research S30: controlled S31: S18 or S19 or S20 or S21 or S22 or S23 or S24 or S25 or S26 or S27 or S28 or S29 or S30 S32: S12 and S31 S33: S17 OR S32 (593 results before duplicates removal)
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Notes:

* and ? are truncation characters that retrieve all possible suffix variations of the root word e.g. surg* retrieves surgery, surgical, surgeon, etc.

+ indicates an exploded subject heading in an EBSCO platform database (such as CINAHL)

Searches separated by semicolons have been entered separately into the search interface

APPENDIX B: DETAILS OF REVIEWED STUDIES

Abbreviations:

ADL	Activities of daily living
CABG	Coronary artery bypass graft
CCTV	Closed circuit television
CHD	Coronary heart disease
COPD	Chronic obstructive pulmonary disease
CR	Cardiac rehabilitation
ECG	Electrocardiogram
FTF	Face-to-face
GOLD	Global Initiative for Chronic Obstructive Lung Disease
HRQoL	Health-related quality of life
MCID	Minimal clinically important difference
MI	Myocardial infarction
MS	Multiple sclerosis
NSD	No statistically significant difference
PTCA	Percutaneous transluminal coronary angioplasty
QoL	Quality of life
RA	Rheumatoid arthritis
RCT	Randomized controlled trial
SCI	Spinal cord injury
SF 36	Short Form (36) Health Survey
SS	Statistically significant
TBI	Traumatic brain injury
TRH	Telerehabilitation
UC	Usual care
VC	Videoconference
VR	Virtual reality
6MWD	Six minute walk distance

Table B.1: Details of studies on TRH

Cardiology

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/ Conclusion	Implications for decision making
Sparks et al. 1993 ⁵⁴ RCT	To determine the effectiveness of a home exercise program using trans- telephonic exercise monitoring	Prospective, two-group experimental, random assignment of patients to 12-week home- or hospital-based exercise program. Maximal oxygen consumption, blood pressure, pressure-rate product, and workload as outcome measures.	Urban centered hospital and surrounding community, USA. 20 patients with coronary artery disease	Small sample size.	Total: 11.5 = High	Cardiac function improved SS in both groups. No SS difference between groups before or after training.	Indications that trans-telephonic monitoring was an effective supplement to hospital-based monitoring, though authors consider it not a replacement for patients who are able to attend hospital.
Ades et al. 2000 ¹ Multicentre controlled trial	To compare the effectiveness of home-based, transtelephonically monitored CR) with standard, on-site supervised CR	3 month transtelephonically monitored rehabilitation program with simultaneous voice and ECG transmission to centrally located nurse coordinator. Controls participated in on-site exercise program	Five medical centres in USA. Patients with a history of an acute coronary event within the past 3 months. 80 patients in the intervention group and 50 in the control group.	Study not randomized (but no SS difference in baseline characteristics between the groups). Relatively small study may not detect possible adverse effects.	Total 11.5 = High	Transtelephonically monitored rehabilitation was as effective as on-site rehabilitation, included SS improvement in aerobic capacity (18% and 23%).	Transtelephonically monitored home-based rehabilitation is effective but additional data on safety and costs would be useful.

Cardiology (cont'd)

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/ Conclusion	Implications for decision making
Tomita et al. 2008 ⁶⁶ RCT	To test the effectiveness of an Internet-based self-management program (e-health) in heart failure patients	Provision of relevant information and exercise protocol on a publicly accessible Web site, daily recording of vital signs and amount of exercise on a secure Web site, monthly feedback from healthcare professionals using e-mail.	40 older adults (≥65 years) with New York Heart Association Class II and III heart failure in Buffalo, NY, USA, participated in the study (intervention N=22, control N=8). Control intervention apparently usual care? 12 month intervention, assessment at 6 month intervals.	Small study and a significant number of patients lost from 1-year follow-up (intervention 3, control 5). Limited details on patients and some outcomes.	7 = Poor to fair	During study year, treatment group increased the amount of all types of exercise, control group did not show any changes. Older adults with heart failure had a high adherence rate of 85% to Web-based recording and 89% to an exercise program. At follow-up, systolic blood pressure was SS higher than at baseline for controls, lower in intervention group. Body mass index fell only in women in intervention group. SS improvements in dyspnea and fatigue in intervention group, controls remained the same or worsened.	Evidence for effective use of e-health by home-based older adults with heart failure.
Scalvini et al. 2009 ⁵⁹ Observational study	To evaluate the feasibility of a home-based rehabilitation program following cardiac surgery	Home rehabilitation supervised by a nurse-tutor and physiotherapist included exercises and transmission of recorded ECGs by telephone to a service centre and telephone support if needed.	47 patients in Brescia, Italy, enrolled in the study. 55% had undergone CABG, 23% heart valve operation, and 21% other kinds of cardiac surgery. 22 (SD 8) days home rehab, no further follow up.	Small sample size, no control group. Interpretation of results limited to walking test.	6 = Poor to fair	SS increase in the 6-minute walking test at the end of the program compared to baseline (307m to 404m, also above MCID for this test). N=7 (15%) hospitalized during intervention.	Indications that this approach is feasible, with safety (hospitalization) and adherence similar to those reported for hospital – based programs.

Cardiology (cont'd)

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/ Conclusion	Implications for decision making
Giallauria et al. 2006 ²⁶ Prospective controlled study	To verify if telecardiology (TC) improves the results of cardiac rehabilitation (CR) in patients following a home-based CR Program (CRP) after acute MI	Patients instructed to exercise 3 times/week for 30 minutes on their cyclette at home, and to measure heart rate to achieve the target (about 75% of peak heart rate). ECG data during home-based exercise program transmitted by home telephone to a call centre.	In Naples, Italy, 15 patients, who followed a standard in-hospital CRP of 3 weekly sessions for 2 months (group A); 15 patients enrolled in a home-based CRP of similar duration and were monitored by TC with the aid of an ECG-device (group B), 15 patients, who followed a home-based CRP without ECG monitoring by TC (group C). Follow up 2 months after completion of program. 2 patients lost to follow up in both A & C, none in B.	Small number of patients, no randomization. Sparse details of some results.	6.5 = Poor to fair	Increase of maximal heart rate, exercise duration, maximal workload, and an improvement of anxiety, a trend to reduction of depression compared to group C. Results in group B very similar to those in Group A patients following a hospital-based rehabilitation (though change in depression score for B well below MCID). Max workload changes for A & B both > MCID.	TC improved compliance and some outcomes of a home-based CRP, compared to home-based CRP without ECG monitoring. TC is helpful in improving home-based CR in those patients unable to attend in-hospital programs. Preliminary data, follow up with larger group.
Mittag et al. 2006 ⁴² RCT	To study the effects of a nurse-managed secondary prevention program for patients after acute cardiac events	Patients in the treatment group contacted monthly by phone over 1 year by specially trained nurses. The control group received written information only every 2 months.	343 patients from three hospitals in Northern Germany randomized to intervention (N=171) or control (N=172) group (154 and 143, respectively, completed follow up exam).	Power of the study to detect effects in women low as only 18% of patients were women. Authors conclude that intervention seems a cost-effective way to achieve a lasting reduction in cardiac risk factors and to maintain the effects of CR, but no cost data are presented.	13 = High	Average of 10 calls per patient. After 12 months Intervention patients showed lower Framingham risk scores than controls. This was mostly due to the men in the sample. Women showed a SS rise of clinically relevant anxiety/ depressiveness in control but not in the intervention group.	Intervention was effective for reducing risk factors in men, and depression in women.

Cardiology (cont'd)

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/ Conclusion	Implications for decision making
Körtke et al. 2005 ³⁸ & 2006 ³⁷ Prospective non-randomized	To evaluate telemedically monitored rehabilitation at home as an alternative to an in-hospital rehabilitation	Ambulatory rehabilitation after heart surgery under coverage of telemedical monitoring for 3 months. Transmission of ECG over telephone lines twice a week and round the clock possibility to contact the hospital. Follow up 12 months post surgery.	170 patients after heart surgery (mostly CABG or valve replacements) in Eastern Westfalia, Germany. One hundred patients performed ambulatory rehabilitation, 70 regular conventional in-hospital rehabilitation.	No randomization. Ambulatory rehabilitation longer (3 months) than conventional rehabilitation (3 weeks).	11 = Good	6 and 12 months after surgery, maximal physical performance SS increased in both study groups compared to baseline. Physical and psychological QoL increased in both study groups compared to baseline. However, only in the ambulatory group all items had increased SS. Fewer insults of angina pectoris during follow-up in the ambulatory group compared to the in-hospital group ($p < 0.01$). Total costs of rehabilitation 59% lower in the ambulatory group compared to the in-hospital group.	Home rehabilitation using telemedicine is a realistic alternative to in-hospital rehabilitation.
Yates et al. 2005 ⁷⁵ RCT	To examine the effects of a booster intervention on health, behavioural, and clinical physical status outcomes among CR graduates	Booster sessions to discuss progress delivered by nurses FTF or by telephone at 3 and 9 weeks following CR. Follow up 6 months post Phase II CR.	Subjects from a regional referral centre in a Midwestern rural community in USA randomly assigned to one of three groups: structured educational/ counselling sessions by telephone (N=24), clinic (N=20), or usual care (N=20).	Small sample size, the study may have been underpowered to detect SS changes. Suggestion by authors that there is evidence to suggest that a booster intervention, compared with usual care, can have a positive effect appears optimistic.	7.5 = Fair to good	Effects of the booster interventions not SS different from control. Modest adherence rates at 6 months for all groups.	Inconclusive for purposes of decision making. Larger, better study would be required.

Cardiology (cont'd)

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/ Conclusion	Implications for decision making
Southard et al. 2003 ⁶³ RCT and cost analysis	To evaluate an Internet-based CR program that allows nurse case managers to provide risk factor management training, risk factor education, and monitoring services to patients	Participation in the intervention included logging on to the site at least once /week for 30 minutes, communicating with a case manager, completing education modules, entering data into progress graphs. Intervention over 6 months.	104 patients with cardiovascular disease in South Western Virginia, USA. 53 used the program as a special intervention, 51 received usual care. Follow up data for 49 in intervention group, 51 in usual care group.	Outcome assessments not blinded which might have resulted in bias. “Usual care” not described.	12.5 = High	Fewer cardiovascular events among intervention subjects (4.1%) than among controls (15.7%) but the difference was not SS. SS more weight loss in intervention group. Net cost savings from using intervention estimated at \$965 (\$1418 to \$453) per person.	Internet-based intervention appears to be effective and cost-saving approach to CR. Further data on larger numbers of subjects would be needed to establish/ confirm clinical outcomes.
Arthur et al. 2002 ⁴ RCT	To examine the benefit of 6 months of hospital-based exercise training versus 6 months of monitored, home-based exercise training with respect to physical, HRQoL, and social support outcomes in patients after CABG	Home exercise group advised to train 5 times/ week (10-15 min warm-up, 40 min aerobic training, 10-15 min cool-down) (similar to hospital – based protocol). Telephoned every 2 weeks to monitor progress, assess adherence, review logs, revise exercise prescription, provide support, education.	Patients in Hamilton, ONT, Canada, randomized to individualized home exercise program with biweekly telephone monitoring (N=120) or hospital based, group exercise classes (N=122) 35–49 days post CABG.	Generalizability of findings may be restricted because participants were relatively low-risk. Authors note that influence of telemedicine component (telephone calls) unknown as no comparison with unmonitored home care.	14 = High	Peak oxygen consumption improved SS in both groups after 6 months. Home group reported greater total social support at 3 and 6 months and demonstrated a greater improvement in HRQoL (SF 36 physical) by 6 months, though the difference between groups was less than the MCID NSS improvement for both groups in SF 36 mental composite score.	Low-risk CABG surgery patients may be served as well with a monitored, home-based exercise program than with an institution-based program.

Cardiology (cont'd)

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/ Conclusion	Implications for decision making
Zutz et al. 2007 ⁷⁷ RCT + comparison with historical controls	To assess the safety and feasibility of using the Internet as a medium for delivery of an interactive "virtual" CR to patients at a distance	"Virtual" rehabilitation consisted of on-line intake forms, one-on-one chat sessions with nurse, dietician, and exercise specialist, exercise heart rate monitoring, education and data monitoring of blood pressure, weight and glucose. 12 weeks study period.	15 patients on a waiting list for hospital-based CR in British Columbia, Canada, randomized to Internet-based rehabilitation (N=8) or observational control (N=7). Group of historical controls identified from hospital-based CR.	Very small study, and two drop outs from control group. Control group did not receive any treatment. No between group statistical comparison, (likely NSD). No detail to support claim that changes in intervention group and historical controls were clinically significant.	7 = Poor to fair	The intervention group SS improved their HDL-cholesterol, triglycerides, exercise capacity, weekly physical activity and exercise-specific self-efficacy. Improvement was similar to that observed in historical hospital-based rehabilitation controls. The concurrent control group receiving no treatment did not show any SS improvements.	Preliminary study providing weak evidence. Suggests use of Internet-based approaches to CR are feasible. Further study needed to establish whether effective.
Beckie 1989 ⁶ RCT	To investigate the impact of a supportive-educative telephone program on levels of knowledge and anxiety in patients undergoing CABG	4-6 supportive-educative telephone contacts between the patient and the CR nurse specialist during the first 6 weeks after hospital discharge.	74 patients scheduled for CABG in Alberta, Canada, randomized to experimental (N=37) or control (N=37) group which did not receive care from cardiac rehab team during 6 weeks following discharge.	Fairly small study with a limited number of outcome measures.	8.5 = Fair to good	A SS difference between the state anxiety level of the experimental and the control group.	Evidence that telephone based educative approach decreases anxiety when compared with a non supportive education approach.

Cardiology (cont'd)

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/ Conclusion	Implications for decision making
Barnason et al. 2009 ⁵ RCT	To examine effect of symptom management (SM) telehealth intervention on patients post-CABG	SM + UC vs. UC. Intervention (for 12 weeks) provides strategies to address commonly experienced symptoms post-CABG. Follow up to 12 months post op.	Four Midwestern tertiary hospitals, USA. n = 232 patients ≥ 65 years who had CABG.	Authors note that subjects had 'fairly high' levels of preoperative functioning, so findings possibly not generalizable to wider CABG population. Also baseline measure of physical activity was by patient self – report. Not specific on usual care details	12.5 = High	Both groups had SS improvements over time for SF 36 physical and mental measures, and had similar health care use.	No evidence that the symptom management intervention delivered by telehealth offered advantages over usual care for this group of patients
Carroll et al. 2007 ¹⁶ RCT	To determine if community based nurse intervention increased participation in CR programs and reduced readmissions	Intervention vs UC for patients recovering from MI or CABG. Intervention included telephone calls to participants by peer advisor for 12 weeks, plus at least three calls by advanced practice nurse. Study over 12 months.	Five academic medical centres from east coast (n = 184) and west coast (n = 63) USA. n = 247, 121 in intervention, 126 in UC. n= 93 post MI, n = 154 post CABG.	18.6% attrition rate Details of UC (which was not described) would have varied between centres. Apparent error in table for 12 months participation value.	10.5 = Good	Participation in CR programs increased over time. NSD between groups in rate of change, though numbers in intervention group SS higher than usual care after 3 months. NSD between groups in number of rehospitalizations. (% rehospitalization increased over time for MI, decreased for CABG).	Unclear; some evidence that intervention increased participation in CR for this patient population. However, no effect on rehospitalisation.

Cardiology (cont'd)

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/ Conclusion	Implications for decision making
Gallagher et al. 2003 ²⁴ RCT	To test the effect of post discharge telephone counseling on women's psychological adjustment following a cardiac event	Individualized information and support during admission followed up by telephone counseling 1, 2, 3, & 6 weeks after discharge. UC included education program & referral to local cardiac rehab.	Four hospitals in Sydney, Australia. n = 196 women hospitalized for MI, CABG, PTCA or stable angina. n = 93 treatment, n = 103 usual care.	No significant limitations	13 = High	Intervention had no effect on psychosocial adjustment, anxiety or depression at 12 weeks post discharge. Predictors of poor psychosocial outcomes were age <55 years, being unemployed or retired, poor psychosocial adjustment at baseline, readmission, stressful personal event during follow up.	Women at risk for poor outcomes following hospitalization for cardiac event can be identified, but intervention that was trialled was not effective.
Allison & Keller. 2004 ² RCT	To determine the effectiveness of an intervention designed to improve self efficacy and physical activity in older adults following a cardiac event	Three-group design. Two treatment groups had self-efficacy coaching (SEC) intervention, n = 28, (based on social-cognitive theory) or telephone follow up every 2 weeks (AC), n = 27. Control group, n = 28, had usual care, no telephone calls. Assessment at baseline, 6 weeks and 12 weeks postcardiac event.	N = 83 Patients 65 - 80 y, diagnosed with CHD, and referred to Phase I CR (71% CABG, others non-surgical). Two medical centres in Southwest Texas, USA.	23% attrition rate, n = 25. Little on absolute values for outcome measures, statistical significance of differences between groups not clear. Clinical significance of changes in outcome not explored.	9 = Fair to good	Change in mean self-efficacy scores at 12-week period: 81% for the SEC group, 66% for AC, 54% for controls. Self-reported physical activity scores declined from baseline to 6 weeks, then returned to near baseline at 12 weeks. % increases in distance walked scores at 12 weeks almost identical for SEC and AC (>130%), higher than controls (84%).	SEC intervention did not show a direct effect on level of self-efficacy; there was an indirect interaction effect on distance walked. Indicates benefits from telephone based interventions, but the more elaborate SEC was not consistently better than telephone only follow up.

Neurology

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Piron et al. 2009 ⁴⁹ Single-blinded RCT	To compare the effects of TRH with traditional motor rehabilitation methods in stroke patients	A virtual reality based system delivered via the Internet, providing motor tasks to patients from a remote rehabilitation facility. The control group underwent traditional physical therapy for the upper limb. Both treatments were of 4 weeks duration. Follow up 1 month post therapy.	Hospital in Italy. 18 patients in each group, all had had a single small ischemic stroke.	Small study and short follow up.	11 = Good	Both strategies were effective, but the experimental approach induced better outcomes in motor performance (Fuji-Meyer score), effect size 0.3. At follow up, both groups maintained benefits achieved. However, NSD in muscle tone or manual ability. Authors suggest results may favour early discharge from hospital sustained by a TRH program.	Preliminary indication that TRH is suitable approach for patients in this category. Further work would be needed to establish effectiveness and cost – effectiveness.
Bombardier et al. 2009 ⁹ Single-blinded RCT	To determine whether an intervention designed to improve functioning after TBI also ameliorates depressive symptoms	Up to seven scheduled telephone sessions over 9 months designed to elicit current concerns, provide information, and facilitate problem solving in domains relevant to TBI recovery. Follow up to 1 year.	171 persons with TBI discharged from an inpatient rehabilitation unit of a level 1 trauma centre in Seattle, USA. N=82 intervention, N=86 usual care controls. At 1 year N=61 and N=64 had one or more depression outcome measures.	No diagnostic assessment of major depression was used. Baseline and outcome measures based on self-report. Generalizability of the findings may be limited.	13 = High	The treated group reported SS lower depression symptom severity on all outcome measures. For those more depressed at baseline, the treated group demonstrated greater improvement in symptoms than did the controls.	The telephone intervention showed promise in ameliorating depressive symptoms during the first year after TBI. Follow up studies would be desirable.

Neurology (cont'd)

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Dallolio et al. 2008 ¹⁹ Multicentre RCT	To compare the 6-month outcomes of a VC TRH intervention with those of standard care for spinal cord injury (SCI)	All patients received standard care after discharge from the spinal cord unit. In addition, patients in the telemedicine group received eight telemedicine weekly sessions in the first 2 months, followed by biweekly telemedicine sessions for 4 months.	137 adult patients with non-progressive, complete, or incomplete SCI discharged for the first time from the spinal cord unit to their homes (sites in Belgium and Italy) or to their homes or another facility (sites in England) randomized to intervention (N=69) or control (N=68) group. N=53 and 62, respectively, completed trial.	23% drop-out rate in the intervention group. 2 of the 3 sites did not reach the target for recruitment. Summary statistics presented only for individual sites (with two UK sites treated as one unit).	9.5 = Good	NSD between groups in clinical complications and readmissions. A SS difference in improvement of functional scores in the telemedicine group found only at one of the four participating sites (for motor and total FIM). NSD for other functional measures at that site. TRH may offer benefits to patients discharged from a spinal cord unit compared with standard care in terms of functional improvement.	Overall, no clear advantage of TRH over standard care. Improvement in functional scores at one site suggests need for further study to replicate and identify contributing factors.
Hermens et al. 2008 ³² & Huijgen et al. 2008 ³⁴ RCT	To investigate the clinical effectiveness of a portable home care activity desk (H-CAD) which allows the execution and monitoring of a configurable set of home exercises to improve the main arm functions	Intervention patients received 1 month of usual care & then 1 month H-CAD intervention, with one training session a day lasting 30 minutes for 5 days a week. Control patients received usual care and generic exercises, average 9 h/ month. Follow up measurements 1 month after H-CAD for intervention group, 4 months from baseline for controls.	81 (50 in intervention and 26 in control group) with chronic stroke, TBI, or MS recruited from three centres (in Italy, Spain, and Belgium). Intervention group N=46, controls N=20 for final measurement.	The study was underpowered. Usual care was heterogeneous in approach and intensity.	10 = Good	There was NSD in outcomes between the H-CAD and UC groups (Action Research Arm Test and Nine Hole Peg Test).	H-CAD system might be an acceptable alternative for usual care in stroke, TBI and MS patients living at home. Offers potential for more intensive exercise and for savings in therapist resources, which would need to be explored in further studies.

Neurology (cont'd)

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Man et al. 2006 ⁴⁰ RCT	To evaluate the effects of different trainer–trainee interaction patterns on the self-efficacy outcomes of trainees with brain injury, using tele-analogy-based problem-solving program	Cognitive skill training delivered in 18 sessions (plus two sessions pre and post training), via FTF by therapist, self-paced computer-assisted, or on-line with real-time audio-visual interaction. Assessment after 2 months.	103 persons in rehabilitation services, Hong Kong, PRC. N=83 with brain injury randomized to FTF (N=30), computer-assisted (N=28), or real-time audio-visual groups. N=20 as control group.	A fairly small study. Randomization process not entirely clear. Control group not used in comparison of interventions.	7.5 = Fair to good	NSD in problem solving skills among the three groups. Change in problem solving self efficacy scores higher for FTF (where change was SS) than other modalities, though NSD between groups.	Some indication that telemedicine approach could produce acceptable performance in cognitive skill training. However, authors consider human interaction (FTF) important in promoting self efficacy. This would need to be tested in more extensive studies.
Piron et al. 2008 ⁵⁰ RCT	To compare degree of satisfaction of patients undergoing a VR therapy program at home to those undergoing it in a hospital setting	In tele-therapy rehabilitation data were transmitted on line and via VC. 1 hour of rehabilitation per day for 1 month.	10 patients in a rehabilitation department, Padova, Italy, with mild to intermediate motor impairment due to ischemic stroke randomized to usual care or telemedicine group.	A very small pilot study. The statistical comparison is unrealistic, given sample size and reported findings (% improvement higher for control than intervention, similar Z statistics, no between -group comparison).	7 = Poor to fair	Authors report that in motor performance the telemedicine-VR group improved SS while the usual care VR group did not.	Preliminary study indicating that both the VR and the FTF approaches gave improvements in motor deficits of the upper arm.
Finlayson M. 2005 ²³ Observational pre-post intervention design	To modify and pilot test a FTF group energy conservation education program for delivery by group telephone teleconference to people with MS.	Teleconference course (modified from an existing FTF energy conservation program) delivered by an occupational therapist. Treatment in six sessions.	29 community dwelling individuals with MS in USA.	Small pilot study with no control group.	6.5 = Poor to fair	SS reductions in fatigue severity, fatigue impact, and improvements in the following aspects of QoL: bodily pain and general health. Average effect size was 0.31 (moderate).	Preliminary study suggesting promise of this approach and justification for further work in this area.

Neurology (cont'd)

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Bell et al. 2005 ⁷ RCT	To measure the effectiveness of a scheduled telephone intervention offering counseling and education to people with TBI on behavioral outcomes compared with standard follow-up at 1 year post-injury	Intervention group received 30-45 min telephone calls at 2 and 4 weeks and 2, 3, 5, 7, and 9 months after discharge. The calls consisted of brief motivational interviewing, counseling, and education, plus facilitating usual care.	171 patients with a primary diagnosis of TBI randomly assigned to telephone intervention (N=85, 78 participated) or to standard follow-up (N=86, 76 participated) at discharge from an acute rehabilitation unit in Seattle, WA, USA.	Generalizability of results questionable as all subjects were recruited from those sent to inpatient rehabilitation after acute medical treatment (only 10% of patients with TBI). Other possible treatments or interventions not controlled for.	14 = High	At 1-year those who had received scheduled telephone intervention fared SS better on the primary composite outcome index. In addition, this group fared better on specific composites such as functional status and quality of well-being. There were no SS differences on vocational status or community integration status.	Good evidence that telephone intervention produced significant benefit for this type of patient at the unit. Generalizability to other settings and application of the composite outcome might need further consideration.
Egner et al. 2003 ²¹ RCT	To study the impact of a TRH intervention on people with mobility declines due to advanced MS	Structured in-home education and counseling session delivered via telephone or video by a rehabilitation nurse. Individual rehabilitation education sessions scheduled weekly for a period of five weeks, then once every two weeks for one month.	27 severely mobility impaired patients with advanced MS having received rehabilitation at a facility in Atlanta, GA, USA and experiencing increased risk of pressure ulcer development randomized to video (N=9), telephone (N=11), or usual care group (N=7).	Small sample size. Authors note that, anecdotally, participants did not regard the intervention as particularly helpful to them, as an add on to well-established patterns of care.	9 = Fair to good	For the video group HRQOL scores trended higher and fatigue and depression scores lower for 24 months. Fatigue scores were SS lower for the video group at months 6, 12, and 18.	Benefit of the TRH interventions for this patient group was not established by this study.

Neurology (cont'd)

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Grant et al. 2002 ²⁸ RCT	To quantify the impact of social problem-solving telephone partnerships on primary family caregiver outcomes after stroke survivors are discharged home from a rehabilitation facility	Intervention consisting of initial 3-hour home visit to begin problem-solving skill training. Initial session followed by weekly (first month) and biweekly (second and third month) telephone contacts.	74 stroke survivors from two rehabilitation facilities in Southeastern USA with an admitting diagnosis of ischemic stroke and their primary family caregivers were entered into the study. Participants randomized into intervention, sham intervention and usual care groups.	Limited information concerning number of subjects in each group and baseline characteristics of the groups.	8.5 = Fair to good	Compared with the sham intervention and control groups, family caregivers who participated in the problem-solving telephone partnership intervention had better problem-solving skills; greater caregiver preparedness; less depression; and SS improvement in measures of vitality, social functioning, mental health, and role limitations related to emotional problems. There were no SS differences among the groups in caregiver burden.	Evidence that intervention produced significant benefits for caregivers of stroke survivors.
Phillips et al. 2001 ⁴⁷ RCT	To study the effect of a telehealth intervention to reduce the incidence of secondary conditions among SCI patients	A 9 week video-based intervention or a 9 week telephone-based intervention consisting of individual educational rehabilitation sessions with a nurse over 9 weeks (seven sessions).	Patients with newly acquired SCI recruited during their initial stay at a rehabilitation facility in Atlanta, GA, USA and randomized to video (N=36), telephone (N=36) or standard care group (N=39). Follow up to 1 year.	Preliminary findings of a small study. Only 42% patient enrolled for 1 year.	9 = Fair to good	HRQoL did not differ SS between the groups at the end of the intervention. Mean annual hospital days were 3.00 for the video group, 5.22 for the telephone group and 7.95 for the standard care group. Telehealth intervention may be cost-saving.	Preliminary evidence suggests the intervention could be effective.

Neurology (cont'd)

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Salazar et al. 2000 ⁵⁶ & Warden et al. 2000 ⁷¹ RCT	To evaluate the efficacy of inpatient cognitive rehabilitation for patients with TBI	Intensive standardized, 8 week, in-hospital cognitive rehabilitation compared with limited home rehabilitation with weekly telephone support from a master's-level psychiatric nurse.	120 military personnel having been treated at an Army Medical Center in Washington DC, USA for moderate-to-severe closed head injury randomly assigned to in-hospital cognitive rehabilitation (N=67) or to limited home rehabilitation with weekly telephone support (N=53).	Some small baseline differences between the groups.	13.5 = High	At 1-year follow-up no SS difference between the groups in return to employment (90% vs 94%) or fitness for duty (73% vs 66%). The overall benefit of home rehabilitation with telephone support was similar to that of in-hospital cognitive rehabilitation. Cost data suggest that the home – based intervention may be cost – saving.	Good evidence that the telephone based home intervention gave similar outcomes to in–hospital treatment and is a suitable alternative for rehabilitation of this patient group.
Brown et al. 1999 ¹⁴ Prospective non - randomized	To evaluate the impact of telephone caregiver groups, compared with traditional FTF, on-site caregiver groups	Both types of groups met weekly for 9–10 weeks and were led by either social work or psychology professionals. The telephone groups met using teleconference technology.	Caregivers of an adult person with a brain injury having been treated at a rehabilitation hospital in Alberta, Canada, placed in either one of 10 telephone groups (N=52) or one of 10 on-site groups (N=39).	Relatively small sample size and no randomization (caregivers allocated to groups based on proximity to the hospital). Missing questionnaires for one or more of the measurement periods reducing the number of caregivers available for analysis.	9.5 = Good	Similar amounts of improvement for the outcomes in both groups. In both types of groups, participants showed a SS improvement in Profile of Moods States and a trend toward improvement in Caregiver Burden Inventory, and the McMaster Model Family Assessment Device results.	Evidence that telephone groups offer a method of providing support and education to rural caregivers that is as effective as in person – site (FTF) groups. Means of improving access of rural caregivers to specialist advice.
Boter H. 2004 ¹⁰ Multicentre RCT	To assess the effectiveness of an outreach nursing care program for recently discharged stroke patients	Outreach care consisted of three telephone calls and one home visit within 5 months after discharge by 1 of 13 stroke nurses.	536 stroke patients from 12 hospitals in the Amsterdam and Utrecht districts in the Netherlands randomized at discharge to standard care (N=273) or standard care plus outreach care (N=263).	Number of patients completing outcome questionnaires lower than planned, consequently, study slightly underpowered (from 80% to 77%). Lower response rate among outreach care patients than in controls.	14 = High	Outreach care patients had better scores on the SF-36 domain "Role Emotional" than controls. No SS differences on other primary outcome measures. For secondary outcomes, no SS differences, except that intervention patients used fewer rehabilitation services and had lower anxiety scores.	The outreach intervention was not effective for this group of patients.

Neurology (cont'd)

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Bourgeois et al. 2007 ¹¹ RCT	To evaluate the effects of an errorless training approach, Spaced Retrieval training delivered by telephone, on the reported everyday memory problems of adults with chronic TBI	Participants received either Spaced Retrieval training or didactic strategy instruction, both by telephone. Participants in both groups identified three memory-related goals and were paired to receive the same total telephone contact time. Four to 5 x 30 minute sessions per week, average 11.8 sessions. One month follow up.	23 patients and their caregivers from Florida and 15 from Wisconsin, USA, recruited from local support groups, advertising, other ways. n = 22 patient – caregiver pairs in intervention group, 16 in controls (used stratified pairing based on race and sex).	Only short term outcomes were obtained. Some missing data on behaviour related to selected goals. Other tools might be more appropriate for measuring QoL.	8.5 = Fair to good	Spaced Retrieval group participants reported SS more treatment goal mastery/strategy use, and everyday use of treatment behaviours than those in the didactic strategy instruction group, at 1-month post-training. Both groups reported some generalized strategy use to other non-targeted behaviours and decreased frequency of reported memory problems. NSD between groups in reported memory problems. No change in perceived quality of life in either group (using Community Integration Questionnaire).	Both telephone based approaches provided some improvement in memory problems, neither had an influence on quality of life. Spaced Retrieval approach offered some additional benefits over didactic training.
Georgeadis 2004 ²⁵ Randomized crossover study	To determine whether performance on assessment and feedback from adults with acquired brain injury differed between FTF and VC settings	Participants asked to retell stories from the Story Retell Procedure in both telemedicine and FTF settings. Their performance was scored using a standardized scoring metric.	N = 40 with recent brain injury (12 TBI, 14 L cerebrovascular accident, 14 with R cerebrovascular accident). Rehabilitation hospital, Washington DC, USA.	Timing of crossover unclear, potential for carry over.	7.5 = Fair - good	There was NSD in story telling performance between the two settings.	Indication that telemedicine (VC) is an alternative to FTF treatment for survivors of TBI and stroke with communication disorders.

Neurology (cont'd)

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Schoenberg et al. 2008 ⁶⁰ Retrospective comparative	To compare outcomes between patients receiving computer-based cognitive rehabilitation teletherapy program and those receiving FTF outpatient speech–language therapy	Participant data collected from a retrospective chart review. Compared with data for patients using home PC with Internet connection and those having FTF outpatient program. 24.4 weeks in therapy for PC group, 9.8 weeks for FTF group.	Persons with TBI who had been patients at a large rehabilitation hospital in Oklahoma, USA. N=19 in telemedicine group, N=20 FTF.	SS difference between groups in time between injury and initiation of rehabilitation. Time of therapy for PC group based on self-reporting Various assumptions, omissions in cost estimates.	7.5 = Fair to Good	NSD between groups in proportion of patients living independently, driving independently, or working/ studying ≥ 31 hours/week. Also NSD in total treatment cost.	Weak evidence that teletherapy intervention and FTF rehabilitation provide similar outcomes at a similar total cost.
Vauth et al. 2008 ⁷⁰ Prospective comparative	To examine the efficacy of linguistic telepractice in post-stroke patients, using additional process of treatment for aphasic patients to bridge a gap of therapy after hospitalization	Synchrotel therapy where the therapist and patient are in different rooms and both have two screens (one for therapy material, the other to see the therapist/patient). Therapy three times a week for 60 minutes, 2 – 3 months.	17 patients with chronic, severe non-fluent aphasia divided into intervention (N=8) and usual care (N=8) groups (one patient dropped out). Germany.	Small study	7 = Poor to fair	No differences between telepractice and conventionally treated patients.	Efficacy of this TRH approach was not established.

Cancer

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Gotay et al. 2007 ²⁷ RCT	To evaluate the effectiveness of a brief telephone intervention in patients with first breast cancer recurrence	Intervention of 4 – 8 telephone calls following a standard curriculum and delivered over 1 month by trained peer counsellors at a breast cancer advocacy organization.	305 women from multiple institutions in the USA experiencing a first recurrence of breast cancer randomly assigned to standard care (N=153) or intervention (N=152).	No significant limitations.	13 = High	No differences between the groups in distress or depressive symptoms at 3 months; at 3 months, 70% of controls and 66% of intervention patients reported psychosocial distress; 40% of controls and 47% of intervention patients exhibited depressive symptoms.	Intervention was not effective for improving psychosocial outcomes.
Pinto et al. 2005 ⁴⁸	To evaluate the efficacy of a home-based physical activity (PA) intervention for early-stage breast cancer patients	Intervention group received 12 weeks of PA counselling via telephone, and weekly exercise tip sheets. Controls asked not to change current level of activity during the 12 weeks. Received weekly phone calls, to match frequency of contact with the PA group. Assessments at baseline, 12 weeks, and 6 and 9 months.	N= 86 sedentary women who had completed treatment for stage 0 to II breast cancer. N=43 each group, 4 dropouts in PA group. Recruitment by various methods in Providence and Smithfield, RI, USA.	Authors note relatively high exclusion rate may limit the generalizability of the findings.	11.5 = High	PA group reported SS more PA, higher energy expenditure per week than controls. Also, had better performance on a field test of fitness and reduction in fatigue. Changes in PA were not reflected in objective activity monitoring. NSD in body mass index and percent body fat.	Indications of success in increasing PA, fitness and specific aspects of psychological well-being among early-stage breast cancer patients.

Speech disorders

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Tindall et al. 2008 ⁶⁵ Observational study	To compare the outcomes of Lee Silverman Voice Treatment (LSVT®) delivered via videophones to the outcomes of traditional treatment delivered FTF	Treatment delivered by certified clinicians over videophone following the standards for LSVT® Outcomes compared to those from a similar FTF study. 4 weeks treatment, measures after further week.	24 patients with idiopathic Parkinson's disease and hypokinetic dysarthria in Kentucky, USA.	No control group. Costs to provider and logistics of placing videophones in patients' homes not considered.	7 = Poor to fair	Post-treatment improvements in vocal intensity. Compared to results of earlier FTF study, magnitude of treatment effects were similar except for SS smaller post-test change in intensity during the monologue. From the patient perspective, intervention would be cost saving compared to FTF treatment.	Relatively weak evidence that the intervention is effective in treatment of this patient group. Potentially, it would provide an alternative approach to delivery of speech pathology services.
Mashima et al. 2003 ⁴¹ RCT	To determine whether voice therapy can be delivered effectively remotely	Vocal rehabilitation protocol delivered under two conditions: patient and clinician in the same room (conventional group) and in separate rooms, interacting in real time via video camera and monitor (VC group). Post-treatment data collected at discharge, mean 9 weeks.	72 patients with voice disorders from an Army Medical Center, in Hawaii, USA randomly assigned to conventional (N=36) or remote video teleconference group (N=36). 71% completed the vocal rehabilitation protocol.	Full outcome data obtained only in a limited number of participants.	10 = Good	No differences in outcome measures between the conventional group and the remote VC group (voice quality, acoustic analysis, laryngoscopy findings). Participants in both groups showed positive changes on all outcome measures after completing the vocal rehabilitation protocol.	Evidence that the telemedicine approach gave similar findings to FTF treatment, and that it would be an alternative approach to delivery of voice therapy services.

Urology

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Moore et al. 2008 ⁴³ Multicentre RCT	To test the effectiveness of weekly postoperative pelvic floor muscle training (PFMT) versus supportive telephone contact by a urology nurse for men at 4 weeks after radical prostatectomy	The treatment group followed standardized daily home routine, had weekly 30-minute biofeedback-assisted PFMT for a maximum of 24 weeks. Control group contacted weekly by research nurse, received information on PFMT, encouraged to follow directions (10 to 12 PFM exercises at three times per day).	216 men from three Canadian centres. Ninety-nine randomized to control group and 106 to treatment group. Patients in study for 12 months.	Control group participants may have been influenced by study participation, the regular contact with the research nurse, and the ability to contact the nurse at any time and may therefore have adhered to home PFMT more than non-research men might have done.	12.5 = High	There were no SS differences between groups at any time point for continence and other outcome variables. Verbal instruction and written information with telephone support seemed to be as effective as intensive PFMT. Less-intense therapy may be more cost-effective.	Evidence that the telephone – based home support for this patient group is as effective as focused physiotherapy.
Hui et al. 2006 ³³ RCT	To compare telemedicine with a conventional outpatient continence service in older women with urge or stress urinary incontinence	Group behavioural training provided by a nurse specialist via VC, with the support of a research assistant at the patients' end. All components of training similar in the two groups with the exception of pelvic floor contraction feedback available only in the FTF group. Duration 8 weeks.	Community-dwelling older women in Hong Kong, PRC, randomized to conventional continence service (N=31) or a telemedicine continence program (N=27).	Possible selection bias due to recruitment of patients by advertisements. Some baseline differences between the groups. Small number of subjects and more drop-outs in the telemedicine group.	10 = Good	Participants in both groups experienced SS symptom improvement and improvement in pelvic floor muscle strength. NSD between the groups.	Indication that training using VC is a suitable alternative to FTF training.

Rheumatology

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Rau et al. 2008 ⁵² Quasi-randomized controlled trial	To evaluate the effectiveness of brief motivational interviewing by telephone for pain-related self-efficacy, cognitive and behavioral coping with pain, and pain-related psychological strain over a period of 9 months	The intervention group participants received three motivational telephone calls at intervals of 2 months with a follow-up time of 9 months after first study admission.	147 patients at a rehabilitation clinic in Bad Eilsen Germany (fibromyalgia syndrome, RA, ankylosing spondylitis) enrolled. At the end of the study 91 (47 in the intervention and 44 in the control group) were available for analysis (drop out rate 38%).	Quasi-randomization. Possible selection bias in the allocation of patients to the study groups with more emotionally disturbed patients in the intervention group. High drop out rate.	9 = Fair to good	SS positive effects in the intervention group for cognitive coping and for coping with emotional strains of chronic pain. No SS effects for self-efficacy expectations and behavioral coping with pain.	Evidence of some benefit (coping) from the intervention, but no effect on other aspects of chronic pain management.
Lorig et al. 2008 ³⁹ RCT	To determine the efficacy of an Internet-based Arthritis Self-Management Program (ASMP) as a resource for arthritis patients unable or unwilling to attend small-group ASMPs	Internet ASMP consisting of password protected, interactive, Web-based instruction, Web-based bulletin board discussion, tools such as exercise logs, medication diaries, and tailored exercise programs, and the Arthritis Helpbook (6-week intervention, 12 months follow up).	California, USA 855 patients with RA, osteoarthritis, or fibromyalgia and Internet and e-mail access randomized to an intervention (N=433) or usual care (no intervention) control (N=422) group.	Heterogeneous study population. Participants could not be blinded to the intervention, thus the possibility of an attention effect can not be ruled out. High attrition rate in both groups. Drop outs tended to be more severely disabled. Authors state that intervention viable alternative to the small-group (FTF) ASMP, but the FTF approach was not included in the study.	12.5 = High	The Internet-based ASMP proved effective in improving 4 of 6 health status measures at 1 year. There was NSD in health behaviours or in health care utilization.	The intervention appears to be effective in reducing the effects of arthritis over 1 year, though there was no difference to usual care in some aspects. Patients with only fibromyalgia had fewer benefits from the program.

Rheumatology (cont'd)

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
van den Berg et al. 2006 ⁶⁷ RCT	To compare the effectiveness of two Internet-based physical activity interventions for patients with rheumatoid arthritis (RA)	Internet-based physical activity program with individual guidance, a bicycle ergometer, and group contacts (individualized training group) and an Internet-based program providing only general information on exercises and physical activity (general training group). Measurement over 12 months.	160 physically inactive patients with RA recruited from rheumatology outpatient clinics in The Netherlands. Randomly assigned to individualized training group (N=82) or to general training group (N=78).	No significant limitations	14.5 = High	Proportion of physically active patients SS greater in the individualized training group at 6 (38% versus 22%) and 9 months (35% versus 11%) regarding a moderate and a vigorous intensity level. However, NSD regarding changes in physical activity as measured with an activity monitor, functional ability, QoL, or disease activity.	Good evidence that individualized training intervention more effective in promoting physical activity than a general training intervention. Both interventions associated with improvements in functional activity, QoL, as well as in level of physical activity.
Pariser et al. 2005 ⁴⁶ RCT and qualitative study	To examine the effects of a telephone intervention on self efficacy depression, pain, and fatigue in older adults with arthritis	RCT over 6 weeks. Both groups received information and developed action plans. Intervention group also received a telephone support including instruction on managing arthritis, encouragement to pursue their goal. Quantitative and qualitative data analysis.	85 adults > 55y with rheumatoid or osteoarthritis from two clinics in New Orleans, USA. Control group did not receive the telephone intervention.	Sizes of groups, method of randomization not specified. Sparse details on data analysis, qualitative methodology.	8 = Fair to good (Qualitative = Fair)	SS increase in self efficacy and decrease in depression and pain for both groups. However, NSD between groups for any measure. Themes from qualitative analysis were intervention helping set goals, facilitate access to care, adhere to action plans, increase knowledge of arthritis and its management.	Only weak evidence from qualitative study that telephone intervention offers improvement over non – telephone approach.

Pulmonary disease

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Nguyen et al. 2008 ⁴⁵ RCT	To test the efficacy of two 6-month dyspnea self-management programs, Internet-based and FTF, on dyspnea with ADL in people living with chronic obstructive pulmonary disease (COPD)	Content of both programs similar, focusing on education, skills training, and ongoing support for dyspnea self-management, including independent exercise. Measurement over 6 months. Only difference in the mode (Internet/personal digital assistant [PDA] or FTF) in which the education sessions, reinforcement contacts, and peer interactions took place.	50 participants in San Francisco and Seattle, USA, with moderate to severe COPD who were current Internet users randomized to Internet-based (N=26) or FTF (N=24) dyspnea self-management program.	Study stopped early, before reaching sample target, due to significant technical and usability challenges. 22% of participants dropped out after randomization. Changes in 6MWD and some HRQoL measures were less than MCIDs.	10.5 = Good	Both programs showed similar clinically meaningful changes in dyspnea with ADL from baseline to 3 months and sustained these improvements at 6 months. Self-reported endurance exercise time, physical functioning, and self-efficacy for managing dyspnea showed positive improvements over time in both groups with no SS differences with respect to program modality. However, no improvements in a more objective indicator—distance covered during a 6-minute walk test.	Preliminary indication that Internet-based and FTF programs gave similar outcomes. Overall effectiveness of both programs would need further study.
Wewel et al. 2008 ⁷³ Observational before-after study	To study whether a short-term intervention by regular phone calls causes an increase in activity at home in COPD patients and whether this results in a gain in exercise capacity	During a 2-week period phone calls every other day to raise home-based activity. During the study, patients wore an actograph plus pedometer and kept a diary.	21 former in-patients of the Grosshansdorf hospital, Germany, with stable severe COPD (GOLD III/IV).	No control group. Short observational periods.	7.5 = Fair to good	Compared to baseline actograph counts higher after intervention. An increase in 6MWD and HRQoL scores between initial and final visit. In patients with stable severe COPD, it was possible to increase activity by regular phone calls without performing previous rehabilitation.	Study showed that over a short time period telephone calls to COPD patients in their homes results in increased activity and improvements in exercise capacity and HRQoL. Longer, controlled studies needed to establish effectiveness of intervention.

Pulmonary disease (cont'd)

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Ries et al. 2003 ⁵³ RCT	To evaluate a telephone-based maintenance program after pulmonary rehabilitation	12-month maintenance intervention with weekly telephone contacts employing a semistructured interview and monthly supervised reinforcement sessions.	Pulmonary rehabilitation graduates from San Diego, CA, USA, randomized to intervention (N=87) or usual care (N=85).	No important limitations. Pulmonary rehabilitation had produced relatively modest improvements, e.g. mean change in 6MWD was < MCID.	12.5 = High	Both groups showed similar improvements after rehabilitation. During the intervention, exercise tolerance and overall health status ratings were better maintained in the experimental group. There were no between group differences for self efficacy or generic and disease-specific HRQoL. By 24 months no SS differences between the groups, and patients had returned to levels that were close to pre-rehabilitation measures.	The maintenance program produced only modest improvements in the maintenance of benefits after rehabilitation.

Chronic pain

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Brattberg, 2006 ¹³ & 2007 ¹² RCT	To study the utilization of the Internet in the rehabilitation of people on long-term sick leave with chronic pain and/or burnout	A 20-week CBT program, based on 19 films on different themes, and supplemented with written material and an Internet meeting every week.	60 people from Southern Sweden randomly assigned to two groups: a treatment group (that participated in a rehabilitation course over the Internet, 27 patients) completed the intervention) and a waiting list group (28 patients completed post-study protocol).	No concurrent control group. Participants had a range of diagnoses.	11 = Good	On completion of TRH, SS improvements in treatment group vs controls for depression, pain, vitality, social function, performance problems involving work or other activities due to physical illness and presence of stress symptoms. Fifty-seven percent also increased their work capacity. At 1 year no SS group differences regarding stress or health but a SS increased work capacity in the intervention group compared to controls.	Evidence that the intervention had a significant long term effect on work capacity, considered an important outcome for individuals with complex, long term problems. However, other benefits seen on completion of the intervention were not maintained at 1 year.
Appel et al. 2002 ³ RCT	To test efficacy of behavioural telemedicine interventions to teach self-regulation skills to chronic pain patients	Three group design, CCTV vs speaker phone vs FTF, all N = 9. Muscle relaxation-based exercise and hypno-suggestive imagery based pain reduction technique. Measures before and immediately after the intervention.	N = 27 subjects recruited by newspaper advert, Washington DC, USA. Mean pain level 4.85/10, mean duration 12.9 years.	Lowest point in range of pain levels was 1. Authors note that a single experienced therapist provided all the interventions, so that generalizability to other therapists not known.	9.5 = Good	Little difference in outcomes between treatment methods, NSD for pain scale, discomfort scale, physical and cognitive tension, physical assessment.	Indication that both telemedicine methods give similar outcomes to FTF in self regulation training for chronic pain management. Longer term studies with other groups needed to confirm effectiveness, generalizability.

Mobility impairment

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Sanford et al. 2006 ⁵⁸ & 2007 ⁵⁷ RCT	To examine the effect on mobility self-efficacy of a multifactorial, individualized, occupational/ physical therapy intervention delivered via teletechnology or in-home visits	Patients in the intervention groups received 1-hour therapy sessions for four consecutive weeks focusing on three transfer tasks and three mobility tasks. The intervention included an exercise component and an adaptive strategy component. Usual care group received no therapy. Follow up at 6 weeks.	65 community-dwelling adults with new mobility devices (patients at hospitals in Decatur, GA or Durham, NC, USA). N= 33 randomized to UC group, 32 to intervention group. In intervention group a therapist delivered the intervention in the traditional home setting (trad group N=16) or remotely via teletechnology (tele group N=16).	Small sample size. Heterogeneous patient population. Drop-out rate 20%.	9 = Fair to good	In intervention group SS greater increase in overall self-efficacy than in the usual care group. Intervention group exhibited positive changes in self-efficacy for all tasks and greater positive change than the UC group on all items except getting in and out of a chair. NSD between intervention groups in the number of problems identified, recommendations made, or number of recommendations implemented for 5 of 6 tasks. The SS difference for the other task, moving from room to room, is likely attributable to the nature of the protocol.	Preliminary indication that TRH approach gives similar outcomes to a FTF intervention and may be an acceptable alternative approach for delivery of services. Authors make point that further study would be needed to establish efficacy and cost – effectiveness in routine use.

Orthopedics

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Eriksson et al. 2009 ²² Controlled prospective study	To explore the benefit of video communication in home rehabilitation after shoulder joint replacement	Telemedicine patients exercised at home and were supervised at a distance by a physiotherapist using VC. Eight weeks of supervised physiotherapy.	22 patients from Northern Sweden divided into telemedicine (N=10) and conventional rehabilitation groups (N=12).	Small sample size, no randomization. Treatments were not delivered by the same therapist.	8 = Fair to good	Telemedicine group received greater number of treatments compared to controls. Telemedicine group improved SS more in three self-reported measures and in terms of decrease in pain and vitality.	Indication that the telemedicine intervention is effective in home rehabilitation of this group of patients. Some of the treatment effect may have been due to the considerably larger number of sessions provided to the intervention group.
Wong et al. 2005 ⁷⁴ Observational study	To explore the efficacy of an exercise program for elderly people with knee pain conducted via VC	A 12-week exercise program, including strengthening and balance training, was given via VC, in conjunction with a home-based exercise program.	22 community-dwelling subjects aged ≥ 60 years with knee pain recruited from two community centers in Hong Kong, PRC.	Small pilot study without a control group. Uneven sex distribution of participants (18 females, two males completed study).	7 = Poor to fair	SS improvements in all domains of the Western Ontario and McMaster Universities Osteoarthritis index. In secondary outcomes SS improvements in muscle strength, functional performance, 2 of 8 domains of the SF-36, NSD in rotation of knee.	A preliminary study indicating short term improvements for elderly people through use of a VC– based approach.
Russell et al. 2003 ⁵⁵ RCT	To assess the efficacy of an Internet-based TRH program in patients with total knee arthroplasty	VC and specially developed motion analysis tools enabling remote assessment of physical measures.	21 patients who had undergone total knee arthroplasty in Brisbane, Australia and receiving a 6-week rehabilitation program randomized to a TRH (N=10) or a FTF group (N=11).	Small pilot study in which both interventions were delivered in the hospital (although by means of VC in the TRH group).	9 = Fair to good	Physical and functional improvements similar in both groups.	Preliminary study showing the feasibility of using a VC approach in rehabilitation of this patient group.

Orthopedics (cont'd)

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Weinberger et al. 1989 ⁷² RCT	To study whether the improvement in joint pain and physical function associated with monthly telephone contact by lay personnel is contingent on intensified medical treatment	a) Monthly telephone counselling reviewing medication, pain, gastrointestinal symptoms, early warning signs, outpatient visits, general practitioner call centre and barriers to attending clinic appointments; b) same intervention delivered FTF at clinic appointment; c) both FTF and telephone d) usual care control group.	Patients with osteoarthritis receiving care from General Medical Practice of a university – affiliated hospital in Indianapolis, USA. Randomized to a) N = 112, b) N =109, c) N=109, d) N= 109. Patients counselled for 11 months following enrolment.	10% attrition at 11 month follow up interviews.	12.5 = High	Physical health improved, pain was reduced, and psychological health improved marginally in patients contacted by telephone, compared with those not contacted by telephone. In those contacted only at the clinic, physical health worsened, but neither pain nor psychological health differed from values in patients not contacted. The intervention did not enhance social support, morale, or medication compliance.	Evidence that the TRH intervention gave improvement in physical health compared with FTF counseling, usual care. SS differences in the effects on other outcomes were not demonstrated.
Eberl R. 2006 ²⁰ RCT	Effectiveness of televisits following elbow arthroplasty	Televisit (Internet) used for 6 weeks after discharge, subjects followed as outpatients for 6 months, including a physical examination.	Patients after arthroplasty following posttraumatic contracture of the elbow in Bochum, Germany. Randomized to televisits (N=11) or usual care (N=12).	Small study. Fairly high drop -out rate.	7 = Poor to fair	Intervention group had shorter stay in hospital and lower hospital costs. NSD in functional outcomes.	Preliminary study giving some evidence of benefits to health care utilization from use of the TRH method, but none to functional outcomes.

Childhood obesity

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/conclusion	Implications for decision making
Van Egmond-Fröhlich, 2006 ⁶⁹ RCT	Evaluation of follow up care for obese children and adolescents following inpatient rehabilitation	12 x 0.5 hour outpatient consultations with primary care physicians using a modular guideline and Internet – based training program. Controls had standard care. Measurements at beginning and end of inpatient rehabilitation and at 6 months and 12 months after discharge.	N = 521 children and adolescents who received rehabilitation (5.9 weeks) at 7 facilities in Germany. Randomized to intervention (N=250) or control group (N=271).	22.4% drop out rate already after the first consultation. The study may have been underpowered to detect small differences because of the low utilization of the intervention.	14 = High	On intention to treat analysis, NSD between intervention and control groups. Intervention utilized by only 50% of eligible participants.	Intervention not shown to improve longer term effectiveness of inpatient rehabilitation.

Elderly with various morbidities

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Courtney et al. 2009 ¹⁸ RCT	To evaluate the effect of an exercise-based model of hospital and in-home follow-up care for older people at risk of hospital readmission on emergency health service utilization and QoL	Nursing and physiotherapy assessment and individualized program of exercise strategies, nurse-conducted home visit and telephone follow-up continuing for 24 weeks after discharge.	128 patients with an acute medical admission to a tertiary referral hospital in Brisbane Australia, aged ≥ 65 and with at least one risk factor for readmission randomized to intervention or control group.	Withdrawals in the intervention group may have biased results. 28% of the intervention group patients not compliant with exercise program.	14.5 = High	SS fewer emergency hospital readmissions (22% vs. 47%) and emergency GP visits (25% vs. 67%) in the intervention group. SS greater improvements in QoL in the intervention group, with changes in scores for intervention group > MCID	Good evidence that, following discharge, the intervention produces benefits for patients aged ≥ 65 who are cognitively intact and able to walk independently, but who are at risk of hospital readmission.
Bendixen et al. 2009 ⁸ Retrospective matched comparison	To examine the effects of a TRH program (Low Activities of Daily Living Monitoring Program – LAMP) on healthcare costs	LAMP patients received adaptive equipment and environmental modifications focusing of self care and safety within home. Care coordinators remotely monitored patients' vital signs and provided education. Study investigated health-related costs. Estimates of these at 1 year post-enrolment.	115 elderly patients living at home and with at least two functional deficits in at least two ADL. 115 matched controls from participants in Veterans Large Health Study, USA.	No randomization. Matching performed retrospectively. Other than Veterans Administration costs not included in the analyses. No long-term follow-up. Authors comment that residual scores for the regression equation indicated a large error component for the model used. Also that important differences between groups were unaccounted for in the model.	8 = Fair to good	No SS differences in post-enrolment costs between LAMP and usual care. LAMP patients had more clinic-visits post intervention but less hospital and nursing home stays.	Effectiveness of the TRH program is uncertain, on the basis of the data presented. Stronger study design and more meaningful outcomes data would be needed to resolve this difficulty.
Nakamura et al. 1999 ⁴⁴ Observational controlled study	To evaluate the effectiveness (in improving independence) of adding services using videophones to conventional home health care services	An intervention group of home healthcare cases were provided with videophones, and it was compared to a reference group of regular healthcare cases. Study was over 3 months.	Five pairs of males and 11 pairs of females from Tokyo, Japan, with cerebral hemorrhage, cerebral infarction, osteoporosis, or Parkinson's disease analyzed.	No randomization. Case matching not successful.	6.5 = Poor to fair	SS greater improvements in ADL communication, and social communication independence in the intervention group.	Preliminary evidence that intervention is effective in promoting independent living for patients with different types of disability.

Elderly with various morbidities (cont'd)

Study, study design	Objectives	Approach	Setting and subjects	Limitations	Quality scores	Results/Conclusion	Implications for decision making
Chumbler et al. 2004 ¹⁷ Case-control study	To compare health-related outcomes for frail elders receiving care coordination via distance monitoring with those receiving no intervention	Intervention participants were given one of three forms of distance monitoring technology with care coordinators monitoring the health status of the participants daily or weekly depending on group assignment. Follow up to 12 months.	Chronically ill veterans with hypertension, diabetes, respiratory disease, or heart disease enrolled in a Veterans Health Administration demonstration project in Florida, USA. One hundred eleven patients in the intervention group, 115 in the control group.	No randomization. Intervention participants divided into three groups using different kinds of technologies. High proportion of participants did not complete functional independence follow up. Patient disposition over the 12 months is not clear.	5.5 = Poor to fair	Over 1 year, the intervention group improved SS more in instrumental ADL points and Functional Independence Measure motor and cognitive scores.	Weak evidence suggesting that a home-telehealth technology, linked to care coordination, has the potential to improve the functional and cognitive status of frail older individuals.
Zerth EO. 2008 ⁷⁶ RCT + prospective comparative study	Assessment of telehealth intervention for rural caregivers and patients following discharge from a medical rehabilitation setting	Participants assigned to 8 week, multicomponent telephone-based intervention, a Helpline telephone-based intervention or usual care. (6 month follow up).	N = 43 rural, informal caregivers of older adult rehabilitation inpatients in Illinois, USA, recruited from two medical rehabilitation centres. Seven dropouts to end of intervention, further 13 at follow up.	Only pre- and post-intervention data considered because of low response rates for follow up measurements. Allocation of subjects to control group was not randomized.	8.5 = Fair to good	NSD in caregiver outcomes between the two intervention groups. Control group caregivers did not experience SS improvement in outcomes but perceived a decline in social support. Care recipients of caregivers participating in the multi-component intervention had improved subjective physical functioning (SF 36); NSS improvements for the helpline or control groups.	Weak evidence of efficacy for both telemedicine interventions.

This review considers the evidence of benefit from use of telerehabilitation (TRH) from studies that had clinical or administrative outcomes.



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