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Systematic review

Effectiveness of physiotherapy with telerehabilitation in surgical patients: a systematic review and meta-analysis

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Abstract

Background Over the last few years, telerehabilitation services have developed rapidly, and patients value benefits such as reduced travelling barriers, flexible exercise hours, and the possibility to better integrate skills into daily life. However, the effects of physiotherapy with telerehabilitation on postoperative functional outcomes compared with usual care in surgical populations are still inconclusive.

Objectives To study the effectiveness of physiotherapy with telerehabilitation on postoperative functional outcomes and quality of life in surgical patients.

Data sources Relevant studies were obtained from MEDLINE, EMBASE, CINAHL, the Cochrane Library, PEDro, Google Scholar and the World Health Organization International Clinical Trials Registry Platform.

Study selection Randomised controlled trials, controlled clinical trials, quasi-randomised studies and quasi-experimental studies with comparative controls were included with no restrictions in terms of language or date of publication.

Data extraction and synthesis Methodological quality was assessed using the Cochrane risk of bias tool. Twenty-three records were included for qualitative synthesis. Seven studies were eligible for quantitative synthesis on quality of life, and the overall pooled standardised mean difference was 1.01 (95% confidence interval 0.18 to 1.84), indicating an increase in favour of telerehabilitation in surgical patients.

Limitations The variety in contents of intervention and outcome measures restricted the performance of a meta-analysis on all clinical outcome measures.

Conclusions Physiotherapy with telerehabilitation has the potential to increase quality of life, is feasible, and is at least equally effective as usual care in surgical populations. This may be sufficient reason to choose physiotherapy with telerehabilitation for surgical populations, although the overall effectiveness on physical outcomes remains unclear.

PROSPERO registration number: CRD42015017744.

Keywords: Telehealth; Telerehabilitation; Telemedicine; Functional status; Exercise; Surgery; Physiotherapy

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Introduction

Delayed postoperative recovery is one of the main problems after surgery [1]. Postoperative complications contribute highly to postoperative morbidity, and may lead to increased length of hospital stay and mortality, and reduced cost-effectiveness [2–4]. In surgical patients, handgrip strength, inspiratory muscle strength, physical activities and QoL are risk factors for postoperative complications and poor postoperative functional recovery [5,6].

Physiotherapists play an important role in reducing and preventing the decrease in physiological and functional capacity due to surgery by physical exercise training, and maintenance of physical activity levels over the pre- and postoperative course. These interventions are potentially effective for postoperative functioning [7]. Health systems are currently engaged in a process of innovation to improve efficacy and efficiency in healthcare services [8,9]. Telerehabilitation is one of these developments, defined as the delivery of rehabilitation services to patients at a distance using information and communication technologies [10]. Telerehabilitation may contain assessment, education, monitoring and exercise interventions [9,10]. Over the last few years, telerehabilitation services have developed rapidly, and have the potential to be a more cost-effective alternative for outpatient assessment and treatment in hospital due to the ability to reach people in remote areas or at home. Telerehabilitation interventions have been used with success in areas of preventive care and management of chronic diseases, where patients positively valued benefits such as reduced travelling barriers, flexible exercise hours and the possibility to better integrate skills into daily life. Telerehabilitation interventions decrease travelling costs, are significantly less time consuming and are generally more convenient [11]. People also have the opportunity to train more intensively than is possible at a healthcare institution. The feasibility and acceptability of such technology have demonstrated significant patient and clinician satisfaction and improvements in QoL [9,12,13]. Physiotherapy or exercise interventions can be streamed through telerehabilitation, and are valuable in the pre- and postoperative phase for surgical patients.

There is evidence showing the positive effects of physiotherapy with telerehabilitation on clinical outcomes in cancer patients, cardiac patients, and patients with musculoskeletal disorders and depression [14,15]. Moreover, the effects of telerehabilitation on QoL seem to be promising [16]. However, research that demonstrates the effects of physiotherapy with telerehabilitation on postoperative functional outcomes and QoL compared with conventional care in surgical populations is still inconclusive [16].

Therefore, this systematic review aimed to study the effectiveness of physiotherapy with telerehabilitation on postoperative functional outcomes and QoL in surgical patients. The secondary objective was to determine whether telerehabilitation in surgical patients increased patient satisfaction.

Methods

Data sources and searches

MEDLINE, EMBASE, CINAHL, the Cochrane Central Register of Controlled Trials (CENTRAL), PEDro (www.pedro.org.au), Google Scholar (http://scholar.google.com) and the World Health Organization International Clinical Trials Registry Platform (www.who.int/ictrp) were searched for eligible studies following the Cochrane Handbook for Systematic Reviews of Interventions [17]. Grey literature was searched using Open Grey (www.opengrey.eu). The following keywords and Medical Subject Headings (MeSH) combined with Boolean operators were used: 'Physical Therapy Modalities'[Mesh] OR 'Exercise Therapy'[Mesh] OR physiotherap*[tiab] OR exercise*[tiab] AND 'Telemedicine'[MAJR] OR 'Telecommunications'[MAJR] OR telehealth[tw] AND 'Surgical Procedures Operative'[MeSH] AND randomized controlled trial[pt] OR controlled clinical trial[pt]. All databases were searched from their inception to November 2016. Appendix A (see online supplementary material) shows the full electronic search.

The references of included studies were checked for other relevant publications in order not to miss any unpublished or ongoing trials. Also, the proceedings and developments of the American Telemedicine Association were followed with care.

Study selection

Randomised controlled trials, controlled clinical trials, quasi-randomised studies and quasi-experimental studies with comparative controls were included with no restrictions in terms of language or date of publication.

Adults aged >18 years with an indication for thoracic, upper abdominal or orthopaedic surgery were included in this review.

Studies on telerehabilitation were included if the intervention contained aspects of physical exercise or exercise therapy combined with health education or intentions to change health-related behaviour. All modalities of the pre- and postsurgical intervention (type, duration, frequency and intensity of the treatment strategies) were taken into consideration. The control intervention was considered as usual care, face-to-face contact or no care. Telerehabilitation that combined incidental face-to-face contact to clinically assess patients on aspects of functional status were included if the intervention was conducted with telerehabilitation.

Studies were excluded if the intervention did not contain physical exercise or exercise therapy via telerehabilitation.

The functional outcome measures were based on the International Classification of Functioning, Disability and Health (ICF) [18]. In this framework, health and health-related components are classified in domains, expressed as body functions and structures, activities and participation, and personal and environmental factors [19].

Studies in the different ICF domains that measured any postoperative functional outcome, which represent the effectiveness of telerehabilitation programmes, were included in this review. In the domain of body functions and structures, pain, fatigue, joint range of motion, muscle strength, coordination, stamina, and inspiratory and expiratory muscle strength were measured, whereas in the activity and participation domain, limitations in activities of daily living, mobility, employment, education, social and vocational activities, and any other patient-reported outcome measures were measured [20].

Measurements of QoL performed with questionnaires were also taken into account. Secondary outcome measures included patient satisfaction.

Data extraction and quality assessment

The titles and abstracts of articles identified by the search strategy were screened by two authors (ME and TV), and when there was insufficient information for inclusion, the full text article was obtained. If necessary, the corresponding authors were contacted for additional information. Reasons for exclusion were recorded.

Two authors (ME and TV) extracted study data independently and recorded them on a modified data extraction form for intervention studies according to the guidelines of the Cochrane Collaboration [21]. In cases of disagreement, a third author (MS) was consulted to make a final decision.

Two authors (ME and TV) assessed the risk of bias for each included study independently using the Cochrane Collaboration's tool for assessing the risk of bias (Fig. A, see online supplementary material) [22]. Discrepancies were resolved through discussion. In cases of disagreement, a third author (MS) was consulted to make a final decision.

Data synthesis and analysis

A meta-analysis was conducted using Cochrane Review Manager (RevMan) software if studies were similar in terms of included patients, intervention and outcome measures. The overall effect size was calculated using the standardised mean difference because the data of all included studies were continuous. Heterogeneity with the I^2 statistic was assessed, with a percentage $\leq 40\%$ representing no heterogeneity of importance and a percentage $\geq 75\%$ representing considerable heterogeneity [23]. A random effects model was used, taking into account the heterogeneity of patients across studies. If meta-analysis was not possible, a narrative overview of the findings was presented, including tabular summaries of extracted data.

Where data were missing, the authors attempted to contact the study authors. An intention-to-treat analysis was conducted where possible; otherwise, data were analysed as reported. Loss to follow-up information was documented and assessed as a source of potential bias.

Subgroup analysis has been executed on type of surgery, time of intervention (pre- or postoperatively), type and duration of intervention (mono- or multidisciplinary, consultation, monitoring, training), type of communication technology, the healthcare provider and the method of implementation (as new care for something that did not exist before or in addition to existing care). Due to the small number of studies included in each subgroup, heterogeneity was not assessed, and it was not possible to assess reporting bias using funnel plots. Selective outcome reporting was assessed using the Cochrane risk of bias tool [23].

Results

Study selection

The search strategy yielded 1031 results. After removing duplicates, 799 records remained and were initially screened. Fifty-five records were found to be eligible for full screening, of which 23 records were included for qualitative synthesis (Fig. 1). Full details of these studies can be found in Table 1. Nineteen of the included studies were randomised controlled trials [8,24–41], of which two were non-inferiority studies [33,34], two were pilot studies [25,38] and one was a feasibility study [31]. Two studies had quasi-experimental designs with comparative controls [42,43], one was a prospective controlled trial [16], and one was a multisite, two-group experimental study with repeated measures [44].

Study characteristics

This review included 3424 patients in total. Overall, 56% ($n = 1910$) were female. The lowest mean age reported in any of the included studies was 43.2 [standard deviation (SD) 8.5] years and the highest reported mean age was 83.0 (SD 8.0) years.

Among the 23 included studies, seven studies reported on cardiac surgery ($n = 1150$) [24,26–29,42], eight studies reported on orthopaedic surgery ($n = 878$) [8,30–35,43], and eight studies reported on oncological surgery in the abdominal, thoracic and cervical regions ($n = 1396$) [16,36–41,44].

A variety of inclusion and exclusion criteria have been reported. The majority of studies included patients who were discharged home or to short-term rehabilitation, who had a telephone or access to high-speed internet services, and had no communication disorders. Reported exclusion criteria were significant cognitive deficits and any concomitant medical conditions that influenced rehabilitation or precluded safe participation in exercises.

Table 1
Summary of study characteristics.

Study	Design	Objective	Participants			Intervention		Outcomes		Results[a]	Conclusion
			n (male/female)	*Characteristics*	I: *n* [age (SD)] C: *n* [age (SD)]	Treatment	Control	Primary	Secondary		
Cardiac surgery											
Arthur 2002 [24]	RCT	Effectiveness of a monitored, home-based programme	242 (197/45)	Patients after CABG surgery	I: 120 [64.2 (9.4)] C: 122 [62.5 (8.8)]	Home: exercise consultations and exercise training	Hospital: supervised exercise sessions	Peak oxygen uptake	• QoL (SF36) • Social support	• Peak VO_2 was not significant • Social support 6 months: 36.0 (SD 4.9) vs 34.6 (SD 6.4); P = 0.05. • QoL: 51.2 (SD 6.4) vs 48.6 (SD 7.1); $P = 0.004$	Low-risk CABG surgery patients may be served as well or better with a monitored, home-based exercise programme than with an institution-based programme
Barnason 2006 [25]	Pilot RCT	Effectiveness of a home communication intervention	50 (28/22)	Patients after CABG surgery	Not specified	Home health care plus communication intervention	Home health care	• Physiologic functioning • Psychosocial functioning (MOS-SF36)	Not specified	• General health function: F 8.41, $P \leq 0.01$ • Physical: F 9.42, $P \leq 0.001$ • Role-physical: F 5.74, $P < 0.05$ • Mental health function: F 7.97, $P < 0.001$	Findings demonstrate the potential benefit of using home communication intervention to augment outcomes of patients undergoing CABG

Hartford 2002 [26]	RCT	Effectiveness of a telephone-based intervention	131 (113/18)	Patients after CABG surgery and their partners	I: 63 [62.7 (9.1)] C: 68 [63.0 (8.2)]	Information and support by telephone	Usual care	Anxiety (BAI)	n/a	Greater than minimal anxiety: (39% vs 57%) ($Chi^2 = 4.174$, df = 1, $P < 0.041$)	The intervention effect is most present in the early period after discharge — the time most affected by reduced length of stay
Kortke 2006 [42]	Quasi-experimental design with comparative controls	Evaluation of a telemedically monitored intervention	170 (157/13)	Patients after cardiac surgery	I: 100 [57.6 (8.4)] C: 70 [55.2 (11.2)]	An ambulatory rehabilitation with telemedical monitoring	Regular conventional in-hospital rehabilitation	• Physical perfor-mance • QoL (SF36)	• Complication • Costs	All items had increased with statistical significance in favour of I	An ambulatory rehabilitation improves physical performance, quality of life, and is safe and cheap
Lee 2013 [27]	RCT	Effectiveness of home-based exercise with wireless monitoring	55 (44/11)	Patients with a diagnosis of ACS and having undergone PCI	I: 26 [54.3 (8.9)] C: 29 [57.8 (7.5)]	Wireless monitored home-based exercise training	Ordinary medical therapy, diet control and exercise at home on their own	• Exercise capacity • QoL (SF36)	Not specified	• Exercise capacity: increase in metabolic equivalent of the tasks (+2.47 vs +1.43, $P = 0.021$); maximal exercise time (+169.68 vs +88.31 second, $P = 0.012$) • QoL: +4.81 vs +0.89, $P = 0.022$	The finding that patients were able to reduce their anxiety by using the wireless monitoring equipment during exercise at home is considered clinically meaningful

Table 1 (*Continued*)

Study	Design	Objective	Participants			Intervention		Outcomes		Results[a]	Conclusion
			n (male/female)	*Characteristics*	I: *n* [age (SD)] C: *n* [age (SD)]	Treatment	Control	Primary	Secondary		
Tranmer 2004 [28]	RCT	Effectiveness of a telephone-based intervention	200 (152/48)	Patients after cardiac surgery	I: 102 [63.8 (38.7 to 87.1)]	Active and ongoing follow-up via telephone at home	Pre-operative and discharge preparation	• QoL (SF36) • Symptom distress (MSAS)	• Utilization of health care • Healthcare contacts • Home care use	• Physical component score: MD 0.04 (95% CI −1.99 to 2.08), $P = 0.97$ • Mental component score: MD–1.25 (95% CI −4.54 to 2.04), $P = 0.45$	The provision of a telephone-based intervention following cardiac surgery is feasible
					C: 98 [66.6 (41.9 to 82.6)]					There were no significant differences in QoL and symptom distress	
Rollman 2009 [29]	RCT	Effectiveness of a telephone-based intervention	302 (177/125)	Patients after CABG surgery with depression	I: 150 [64 (10.8)]	Telephone contact with a workbook	No treatment advice	Generic Mental QoL (SF36)	• Mood symptoms • Physical QoL • Functioning • Hospital re-admission	Generic Mental QoL: between-group difference: 3.2 (95% CI 0.5 to 6.0), $P = 0.02$	Telephone-delivered collaborative care for post-CABG depression can improve QoL, physical functioning and mood symptoms at 8-month follow-up
					C: 152 [64 (11.2)]						

Orthopaedic surgery											
Eriksson 2009 [43]	Quasi-experimental designs with comparative controls	Exploration of video communication in home rehabilitation	22 (5/17)	Patients after shoulder hemi-arthroplasty replacements	I: 10 [70 (53 to 85)] C: 12 [73 (50 to 86)]	Supervised telemedicine at home	Physiotherapy at the local treatment centre	• Shoulder pain (VAS) • ROM • Function (SRQ) • QoL (SF36)	n/a	• Shoulder pain: 7 (95% CI 3 to 10) vs 2 (95% CI −1 to 5), $P \leq 0.001$ • Shoulder function: 41 (95% CI 26 to 54) vs 11 (95% CI 3 to 22), $P < 0.001$	The telemedicine group improved significantly in terms of shoulder pain, mobility and function, as well as in QoL
Jones 2011 [30]	RCT	Efficacy of a telephone-based intervention	102 (40/62)	Patients after arthroscopy	I: 52 [45.9 (13.3)] C: 50 [47.1 (12.2)]	Intervention by telephone	Standard postoperative teaching	• Symptom distress (SDS) • Functional health (MOS-SF36)	Not specified	• Symptom distress: 1 week post surgery F = 7.2, $P < 0.0001$) • Functional health: - Physical health scores (F = 2.9, $P = 0.016$) - Mental health scores (F = 4.6, $P = 0.001$)	Telephone calls during the immediate postoperative period resulted in improved patient outcomes

Table 1 (*Continued*)

Study	Design	Objective	Participants			Intervention		Outcomes		Results[a]	Conclusion
			n (male/female)	*Characteristics*	I: *n* [age (SD)] C: *n* [age (SD)]	Treatment	Control	Primary	Secondary		
Langford 2015 [31]	Randomised controlled feasibility study	Feasibility of a telephone-based intervention	30 (11/19)	Community-dwelling adults after recent hip fracture	I: 15 [83 (8)] C: 15 [82 (10)]	Usual care plus an in-hospital educational session	Usual care plus an in-hospital educational session with educational manual and videos	• Recruitment rate • Participant retention	QoL (EQ5D-5L)	• EQ-VAS: 1.28 (95% CI −12.95 to 13.54)	This study highlights the feasibility of telephone coaching to improve adherence to mobility recovery goals
Latham 2014 [32]	RCT	Effectiveness of a telephone-based home exercise programme	232 (72/160)	Patients after hip fracture	I: 120 [77.2 (10.2)] C: 112 [78.9 (9.4)]	Home exercise programme with telephone calls	Nutrition education and telephone calls	Function (SPBB)	• Self-efficacy • Adverse events • Exercise adherence	• SPPB: score change from baseline at 6 months: 0.8 (95% CI 0.4 to 1.2), $P < 0.001$	The use of a home-based functionally oriented exercise programme resulted in modest improvement in physical function at 6 months after randomisation
Moffet 2015 [33]	Multicentre non-inferiority randomised clinical trial	Effectiveness of in-home telerehabilitation	205(100/105)	Patients with primary total knee arthroplasty	I: 104 [65 (8)] C: 101 [67 (8)]	Physical therapy intervention with telerehabilitation	Physical therapy with home visits	• Gain from baseline to follow-up (WOMAC)	• KOOS • Functional and strength tests • Knee range of motion	• WOMAC total score, adjusted for baseline: 22% (95% CI −6% to 2%)	The results demonstrated the non-inferiority of in-home telerehabilitation, and support its use as an effective alternative to face-to-face service after hospital discharge

Piqueras 2013 [8]	RCT	Effectiveness of interactive virtual telerehabilitation	181 (50/131)	Patients with primary total knee arthroplasty	I: 90 C: 91 I + C: 181 [73.3 (6.5)]	Interactive virtual telerehabilitation	Standard clinical protocol of TKA rehabilitation	Active range of knee movement	• Muscle strength • Walk speed • Pain • WOMAC	Change in baseline to 2 weeks: • Knee extension: 0.2 (SD 2.8) vs 0.9 (SD 3.7); *P* = 0.045 • Knee flexion: 8.53 (SD 6.56) vs 7.71 (SD 6.89); *P* = 0.298	The use of interactive virtual telerehabilitation is equally as effective as conventional treatment
Russell 2011 [34]	Non-inferiority RCT	Efficacy of internet-based telerehabilitation	65 (32/33)	Patients with primary total knee arthroplasty	I: 31 [66.2 (8.4)] C: 34 [69.6 (7.2)]	Internet-based telerehabilitation	Rehabilitation in an outpatient physical therapy department	• WOMAC • Pain • Stiffness • Function	PSFS, TUG, pain intensity, knee flexion and extension, quadriceps muscle strength, limb girth measurement, gait	Change in baseline to 6 weeks: • Global: 1.10 (95% CI 0.14 to 2.07), *P* = 0.08 • Pain: 0.78 (95% CI −0.26 to 1.83), P = 0.24 • Stiffness: 1.46 (95% CI 0.24 to 2.68), *P* = 0.04 • Function: 1.07 (95% CI −0.01 to 2.14), *P* = 0.18	Telerehabilitation intervention achieved physical and functional outcomes at 6 weeks that were not inferior to face-to-face therapy

Table 1 (*Continued*)

Study	Design	Objective	Participants			Intervention		Outcomes		Results[a]	Conclusion
			n (male/female)	*Characteristics*	I: *n* [age (SD)] C: *n* [age (SD)]	Treatment	Control	Primary	Secondary		
Tousignant 2011 [35]	RCT	Efficacy of telerehabilitation at home	41[b]	Patients with primary total knee arthroplasty	I: 21 [66 (10)] C: 20 [66 (13)]	Telerehabilitation with video-conferencing	Usual home care services	• WOMAC • QoL (SF36)	Not specified	• WOMAC: 8.1, ($P = 0.047$ in favour of C) • SF36: less bodily pain C > I, $P = 0.013$ Better physical functioning C > I, $P = 0.019$	Home telerehabilitation is as effective as usual care after 2 months of treatment
Oncological surgery											
van den Brink 2007 [16]	Prospective controlled trial	Effectiveness of telemedicine	163 (118/45)	Patients after surgery for head and neck cancer	I: 35 [59 (38 to 75)] C: 128 [61 (29 to 84)]	Electronic health information support	Standard care	QoL	Not specified	Change in baseline to 6 weeks • State anxiety: −4.53 (SD 1.82), $P = 0.01$ • Fear: −2.59 (SD 1.05), $P = 0.02$ • Physical self efficacy: 2.39 (SD 1.07), $P = 0.03$ • General physical complaints: −1.27 (SD 0.52), $P = 0.02$	The intervention improved some components of QoL more quickly than standard care, although they ultimately reached the same level of improvement

Coleman 2005 [44]	Multisite, two-group experimental study with repeated measures	Effectiveness of a telephone-based support intervention	106 (0/106)	Patients after breast cancer	I: 54 (age not specified)	Telephone social support and education	Telephone contact only	• Mood state (POMS) • Cancer-related worry • Relationships • Loneliness • Symptom experience	Not specified	No significant differences in outcomes were found at the end of any phase of the study	The mailed educational resource kit alone appeared to be as effective as the telephone social support in conjunction with the mailed resource kit
					C: 52 (age not specified)						
Eakin 2012 [36]	RCT	Effectiveness of a telephone-based exercise intervention	143 (0/143)	Patients after breast cancer	I: 73 [51.7 (9.0)]	Telephone calls	Participation in all study assessments but no intervention contacts	• QoL (FACT-B + 4) • Fatigue (FACIT) • Anxiety (STAI) • Function (DASH)	Patient satisfaction	Change in baseline to 6 months:	Results provide strong support for feasibility and modest support for efficacy of telephone-based interventions
					C: 70 [54.1.(8.7)]					• QoL: 1.5 (95% CI −3.6 to 6.6), $P = 0.549$ • Fatigue: 2.0 (95% CI −1.4 to 5.3), $P = 0.233$ • Anxiety: −0.3 (95% CI −5.2 to 4.6), $P = 0.891$ • Function: −0.21 (95% CI −3.7 to 3.3), $P = 0.902$	

Table 1 (*Continued*)

Study	Design	Objective	Participants			Intervention		Outcomes		Results[a]	Conclusion
			n (male/female)	*Characteristics*	I: *n* [age (SD)] C: *n* [age (SD)]	Treatment	Control	Primary	Secondary		
Hawkes 2013 [37]	A two-armed prospective RCT	Effectiveness of a telephone-based intervention	410 (221/189)	Patients after colorectal cancer	I: 205 [64.9 (10.8)] C: 205 [67.8 (9.2)]	Telephone-delivered healthcare sessions	Educational brochures	• Physical activities • QoL (SF36) • Cancer-related fatigue	• Weight management • Dietary intake	Change in baseline to 6 months: • MVPA: 11.5 (95% CI −18.8 to 41.9), $P = 0.457$ • Physical component summary: 0.0 (95% CI −1.8 to 1.8), $P = 0.991$ • Mental component summary: 0.7 (95% CI −1.1 to 2.5), $P = 0.455$	Telephone-delivered interventions are feasible and can improve some important health outcomes compared with usual care
Ligibel 2012 [38]	Multicentre pilot study, randomised 1:1 study	Feasibility of a telephone-based exercise intervention	121 (9/112)	Patients after breast, colon or rectal cancer	I: 61 [53.1 (10.8)] C: 60 [55.5 (10.6)]	Telephone-based intervention	Routine care	• Physical activity	• Fitness • Physical functioning • Fatigue • Exercise self-efficacy	Change in baseline to 16 weeks: • Physical activity: 54.5 (SD 142.0) vs 14.6 (SD 117.2), $P = 0.13$	A telephone-based exercise intervention has the ability to improve fitness and physical functioning

Pinto 2013 [39]	RCT	Effectiveness of a telephone-based intervention	192 (0/192)	Patients after breast cancer	I: 106 [56.1 (9.9)]	Healthcare advice plus telephone-counselling	Healthcare advice plus telephone calls	7-day Physical Activity Recall	• Motivational readiness for PA • MOS SF36 • FACT-F	Change in baseline to 6 months:	Healthcare advice plus telephone counselling improved PA among breast cancer patients at 3 and 6 months
					C: 86 [55.9 (9.9)]					• 7-day PAR: 32.16 (95% CI 3.06 to 61.26) • SF36: −0.35 (95% CI −0.46 to −0.23) • FACT-F: 1.89 (95% CI −0.54 to 4.33)	
Pinto 2013 [40]	RCT	Effectiveness of a telephone-based intervention	46 (20/26)	Patients after colorectal cancer	I: 20 [59.5 (11.2)]	Telephone-based physical activity exercise	Contact control to monitor problems	Effect on self-reported PA and fitness	• Motivational readiness for PA • Fatigue • Self-reported physical functioning • QoL (SF36)	Change in baseline to 6 months:	A telephone-mediated home-based intervention improved PA, motivational readiness and fitness levels
					C: 26 [55.6 (8.24)]					• 7-day PAR: 1.18 (95% CI 0.81 to 0.149) • SF-36: 0.08 (95% CI 0.24 to 0.731)	

Table 1 (*Continued*)

Study	Design	Objective	Participants			Intervention		Outcomes		Results[a]	Conclusion
			n (male/female)	*Characteristics*	I: *n* [age (SD)] C: *n* [age (SD)]	Treatment	Control	Primary	Secondary		
Vonk Noordegraaf 2014 [41]	RCT	Effectiveness of an eHealth intervention	215 (0/215)	Patients after hysterectomy and/or laparoscopic adnexal surgery	I: 110 [43.5 (7.8)] C: 105 [43.2 (8.5)]	eHealth programme	Access to a control website	Return to work	• QoL (SF36) • General recovery • Pain intensity	Return to work: HR 1.43 (95% CI 1.003 to 2.040), $P = 0.048$ • QoL: 1.43 (95% CI 1.003 to 2.040), $P = 0.048$	The use of the eHealth resulted in a faster return to work, with a higher QoL

CABG, coronary artery bypass graft; I, intervention; C, control; FU, follow-up; MD, mean difference; HR, hazard ratio; CI, confidence interval; ACS, acute coronary syndrome; PCI, percutaneous coronary intervention; CR, cardiac rehabilitation; APN, advance practice nurse; QoL, quality of life; TKA, total knee arthroplasty; MVPA, moderate-to-vigorous-intensity physical activity; PA, physical activity; MOS, Medical Outcomes Study; SF-36, Short Form health survey; BAI, Beck Anxiety Inventory; MSAS, Memorial Symptom Assessment Scale; VAS, Visual Analogue Scale; SRQ, Shoulder Rating Questionnaire; SDS, Symptom Distress Scale; SPBB, Short Physical Performance Battery; KOOS, Knee Injury and Osteoarthritis Outcome Score; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; 7-day PAR, 7-Day Physical Activity Recall; PSFS, Patient Specific Functional Scale; TUG, timed up and go; POMS, Profile Of Mood States; STAI, State-Trait Anxiety Inventory; DASH, disabilities of the arm, shoulder and hand; FACIT, Functional Assessment of Chronic Illness Therapy; 7-day PAR, 7-day Physical Activity Recall Scale; FACT-B + 4, Functional Assessment of Cancer Therapy-Breast; FACT-F, Functional Assessment of Cancer Therapy Scale-Fatigue; n/a, not applicable.

[a] Results are presented as interventions vs control, unless otherwise stated.

[b] This study did not specify the number of male/female participants.

Table 2
Details of the interventions.

Study reference	Type of technology	Pre/post surgery	Care provider	Intervention	Type	Duration	Frequency	Intensity	Outcome measurements
Arthur 2002 [24]	Telephone	Post	Exercise specialist	Exercise	New care module	6 months	1 call p/2w	5x p/w 1 hour	Baseline 3, 6 months FU
Barnason 2006 [25]	Communication device	Post	Physician/ nurse content expert	Education/ information/support	In addition to UC	12 weeks	1x p/d	10 minute	Baseline 6, 12 weeks FU
Coleman 2005 [44]	Telephone	Post	Oncology nurses	Education/ information/support	New care module	13 months	I:1x p/w II: 1x p/w III: 1x p/2w IV: 1x p/m	Not specified	Baseline 3, 5, 8 and 13 months FU
Eakin 2012 [36]	Telephone	Post	Exercise physiologist	Exercise	New care module	8 months	16 calls	15 to 30 minute	Baseline 6, 12 months FU
Eriksson 2009 [43]	Videoconferencing	Post	Physiotherapist	Exercise	New care module	8 weeks	2 to 3x p/w	Not specified	Baseline 8 weeks FU
Hartford 2002 [26]	Telephone	Post	Nurse	Education/ information/support	New care module	7 weeks	6 calls in total	20 to 60 minute	Baseline Day 3, week 4, 8 FU
Hawkes 2013 [37]	Telephone	Post	Health coaches	Education/ information/support	New care module	6 months	1 call p/2w	Not specified	Baseline 6, 12 months FU
Jones 2011 [30]	Telephone	Post	Nurse	Education/ information/support	New care module	72 h	1 call p/d	Not specified	Baseline 72 hour, 1 week FU
Kortke 2006 [42]	Telemedical monitoring: not specified	Post	Physician	Exercise	New care module	3 months	3x p/w	30 minute	Baseline 6, 12 months FU
Langford 2015 [31]	Telephone	Post	Physiotherapist	Education/ information/support	In addition to UC	4 months	5 calls	Not specified	Baseline 4 months FU
Latham 2014 [32]	Telephone	Post	Physiotherapist	Exercise	New care module	6 months	3x p/w	1 hour	Baseline 6, 9 months FU
Lee 2013 [27]	Telephone + wireless monitoring device	Post	Not specified	Exercise	New care module	12 weeks	1 call p/w	4 to 5x p/w 50 minute	Baseline 12 weeks FU
Ligibel 2012 [38]	Telephone	Post	Behavioural counsellors	Education/ information/support	New care module	16 weeks	10 to 11 calls in total	30 to 45 minute	Baseline 16 weeks FU

Table 2 (*Continued*)

Study reference	Type of technology	Pre/post surgery	Care provider	Intervention	Type	Duration	Frequency	Intensity	Outcome measurements
Moffet 2015 [33]	Internet	Post	Physiotherapist	Exercise	New care module	2 months	16	45 to 60 minute	Baseline 2, 4 months FU
Pinto 2013 [39]	Telephone	Post	Oncologists and surgeons	Education/ information/support	In addition to UC	12 weeks	2 to 5x p/w	10 to 30 minute	Baseline 3, 6 and 12 months FU
Pinto 2013 [40]	Telephone	Post	Research staff	Education/ information/support	In addition to UC	12 weeks	2 to 5x p/w	10 to 30 minute	Baseline 3, 6 and 12 months FU
Piqueras 2013 [8]	IVT	Post	Physiotherapist	Exercise	New care module	10 days	5 sessions in total	1 hour	Baseline 10 days, 3 months FU
Rollman 2009 [29]	Telephone	Post	Nurse care manager	Education/ information/support/	New care module	8 months	Not specified	Not specified	2 weeks 2, 4 and 8 months FU
Russell 2011 [34]	Videoconferencing	Post	Physiotherapist	Exercise	New care module	6 weeks	1x p/w	45 minute	Baseline 6 weeks FU
Tousignant 2011 [35]	Videoconferencing	Post	Physiotherapist	Exercise	New care module	2 months	2x p/w	Not specified	Baseline 2, 4 months FU
Tranmer 2004 [28]	Telephone	Post	Nurse	Education/ information/support	In addition to UC	5 weeks	6 calls in total	20 to 30 minute	Baseline 5 weeks FU
van den Brink 2007 [16]	Internet	Post	Not specified	Education/ information/support	In addition to UC	6 weeks	Not specified	Not specified	Baseline 6, 12 weeks FU
Vonk Noordegraaf 2014 [41]	Internet	Pre and post	Not specified	Education/ information/support	New care module	3 months	Not specified	Not specified	2, 6, 12 and 26 weeks FU

FU, follow-up; UC, usual care; IVT, interactive virtual telerehabilitation.

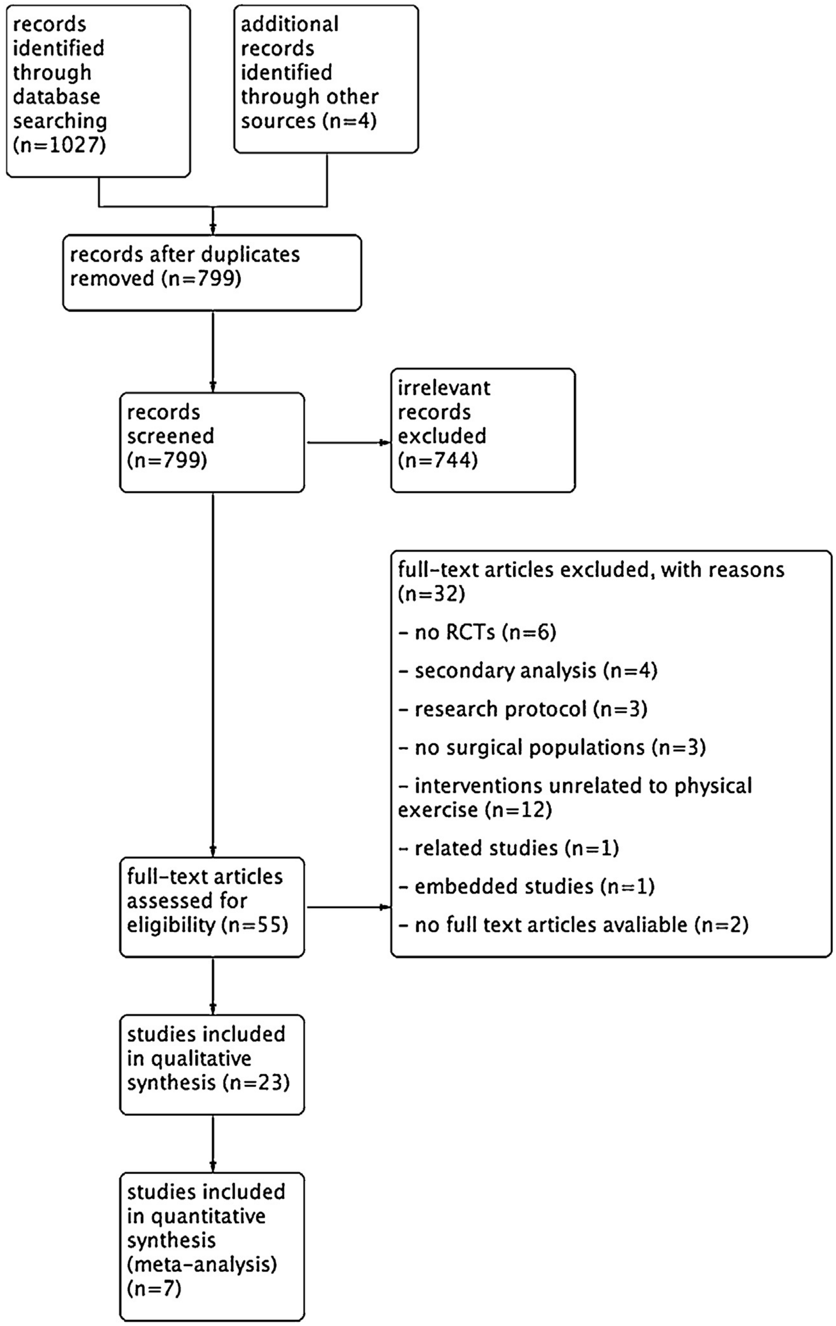

Fig. 1. PRISMA flowchart.

Type of interventions

The majority of studies implemented the intervention as a new care module for something that did not exist previously ($n = 17$) [8,24,26,27,29,30,32–36,37,38,41–44], and six studies implemented the intervention in addition to existing care. All interventions started after surgery, apart from the study by Vonk Noordegraaf *et al.* that started 4 weeks before surgery [41]. Interventions with telerehabilitation were aimed at physical exercise training ($n = 10$) or at education, information and support ($n = 13$). Physiotherapists, exercise specialists, exercise physiologists or physicians provided all interventions aimed at physical exercise, while interventions aimed at education, information and support were predominantly provided by nurses. The type of telerehabilitation technology used was a telephone in 14 studies, videoconferencing in three studies, the Internet in three studies, and a specific e-Health technology device in three studies. Considerable variation was seen in duration, type, frequency and intensity of the interventions. The duration ranged from 3 days to 13 months, with a mean of 3.71 (SD 2.97) months. The frequency of telerehabilitation sessions varied from once per day to once per month, with an intensity of 10 minute to 1 hour per session. All patients were measured at baseline before surgery and after the intervention, and many studies undertook one or two follow-up measurements to evaluate the intervention. Intervention details are shown in Table 2.

Types of outcome measures

The main findings from the included studies are described in Table 1.

Physical outcome measures

Physical outcome measures varied between studies and covered different domains of the ICF [18]. Outcome measures related to the ICF domain body functions and structures were related to the type of surgery: peak oxygen uptake [24], exercise capacity [45] and physical functioning [25,42] were frequently reported in cardiac surgery, whereas joint pain [34,43], range of motion [8,33,34] and stiffness were frequently reported in orthopaedic surgery. Outcome measures related to the ICF domain activities and participation were less dependent on type of surgery. Daily activity levels were often assessed with questionnaires such as the Short Physical Performance Battery [32], the 7-day Physical Activity Recall Scale [39] and Motivational Readiness for Physical Activities [39,40].

Psychological outcome measures

Outcome measures of interventions aimed at education, information and support were mainly assessed using questionnaires, such as depression (Hamilton Rating Scale for Depression) [29], illness-related fear and anxiety (Beck Anxiety Inventory) [46], social support, psychological functioning (Medical Outcomes Study Short Form Health Survey) [25,30,47], symptom distress (Memorial Symptom Assessment Scale) [28,30] and mood state (Profile of Mood State) [44].

Quality of life

QoL was investigated in 15 studies as a primary or secondary objective with the 36-item Short Form Survey (SF36) [24,25,28–30,35,37,39–41,43], the EQ5D-5L questionnaire [31] and the Functional Assessment of Cancer Therapy-Breast [36]. One study used a self-developed questionnaire for QoL [16], and the questionnaire was not specified in one study [27].

Patient satisfaction

Patient satisfaction was investigated in the study by Eakin *et al.* as a secondary objective. Patient satisfaction ratings were very high, although the exact numbers related to usual care were not reported [36].

Main outcomes

Evaluation of effects

Of all studies that investigated the effectiveness of physiotherapy with telerehabilitation on postoperative outcomes, 16 studies reported significant differences in favour of telerehabilitation for at least one functional outcome. Physical functioning measured with the Medical Outcomes Study Short Form health survey increased significantly in the telerehabilitation group in the studies by Barnason *et al.* [25], Jones *et al.* [30] and Pinto *et al.* [40].

Physical activities measured with the 7-day Physical Activity Recall scale increased significantly in the studies by Pinto *et al.* [39,40], while Ligibel *et al.* [38] and Hawkes *et al.* [37] were not able to find a difference.

Studies that investigated telerehabilitation in patients with orthopaedic surgery reported a significant increase in knee extension in favour of telerehabilitation [8], while Eriksson *et al.* found comparable improvements in shoulder function [43]. Tousignant *et al.* [35] reported a significant decrease in pain in the telerehabilitation group, contrary to Russell *et al.* who could not find a difference [34].

Mental health functions were positively affected by telerehabilitation in the studies by Barnason *et al.* [25] and Jones *et al.* [30], and Arthur *et al.* [24] reported a significant difference in social support.

All studies came to the conclusion that exercise interventions with telerehabilitation had the ability to improve at least one of the functional outcome measures reported. Studies reported that telerehabilitation was feasible [26,36–38], not inferior to usual care [33,35] or equally as effective as usual care [8,16,24,35,44].

QoL increased significantly in 10 studies [24,25,27,29,30,35,40–43] in favour of the intervention with telerehabilitation. Tranmer and Parry [28], van den Brink *et al.* [16] and Eakin *et al.* [36] did not find a difference in QoL between the intervention and control groups.

Meta-analysis

All included studies reported different types of interventions with telerehabilitation and different functional outcome measures, even after dividing the studies into three subgroups of patients (cardiac, orthopaedic and oncological). Therefore, a meta-analysis on these outcomes was not appropriate. The authors were able to perform a meta-analysis on QoL because telerehabilitation is believed to have an effect on QoL in general [16]. Data from seven studies were sufficient to include for meta-analysis [24,27,29–31,33,41]. The overall pooled standardised mean difference for QoL for seven studies was 1.01 (95% confidence interval 0.18 to 1.84), indicating that QoL increased with telerehabilitation compared with usual care (Fig. 2). The heterogeneity expressed with I^2 was high at 97%.

Study or Subgroup	Telerehabilitation Mean	SD	Total	Usual care Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
Arthur et al. 2002	51.2	6.4	120	48.6	7.1	122	14.7%	0.38 [0.13, 0.64]
Jones et al. 2011	82	21	52	73.8	17.7	50	14.4%	0.42 [0.03, 0.81]
Langford et al. 2015	75.72	16.14	15	77	17.09	15	13.4%	−0.07 [−0.79, 0.64]
Lee et al. 2013	61.12	5.91	26	56.31	5.67	29	13.9%	0.82 [0.27, 1.37]
Moffet et al. 2015	70.3	2	104	69.2	1.9	101	14.6%	0.56 [0.28, 0.84]
Rollman et al. 2009	44	0.8	150	41.4	0.8	152	14.5%	3.24 [2.90, 3.59]
Vonk Noordegraaf et al. 2014	660	17	110	630	19	105	14.6%	1.66 [1.35, 1.97]
Total (95% CI)			**577**			**574**	**100.0%**	**1.01 [0.18, 1.84]**

Heterogeneity: $Tau^2 = 1.21$; $Chi^2 = 228.57$, $df = 6$ ($P < 0.00001$); $I^2 = 97\%$
Test for overall effect: $Z = 2.39$ ($P = 0.02$)

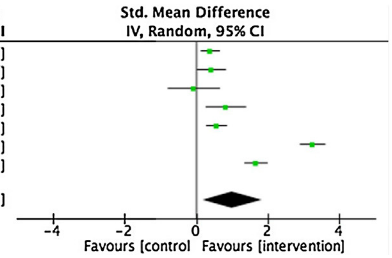

Fig. 2. Forest plot of telerehabilitation interventions vs usual care with quality-of-life (QoL) outcomes.
Meta-analysis of standardised mean difference comparing QoL of participants receiving an intervention with telerehabilitation with control participants receiving usual care. The left side of the Forest plot indicates higher QoL levels in favour of the control intervention; the right side of the Forest plot indicates higher QoL levels in favour of the telerehabiliation intervention. Participants undergoing the telerehabiliation intervention demonstrated significantly higher levels of QoL compared with usual care.

Methodological quality of included studies

Standards of reporting varied considerably between studies. Random sequence generation was performed in 14 studies [8,24,25,28–30,32–37,41,44] and was lacking in two studies [16,42]. Allocation concealment appeared to be unclear in 10 studies [8,25–28,32,36,38,40,41], and selection bias could be present in three studies [16,42,43]. The majority of studies reported on blinding of outcome assessment, suggesting a low risk of detection bias. Incomplete outcome data were detected in seven studies [8,25,33,35,37,38,43] and were unclear in another seven studies [24,26,27,34,39,42,44], suggesting attrition bias. Selective reporting appeared to be present in four studies [16,35,37,44], which may have induced reporting bias. Other biases were not found between studies. A risk of bias summary and full details of individual studies can be found in Figs. A and B (see online supplementary material).

Discussion

This systematic review shows that physiotherapy with telerehabilitation is feasible and improves QoL in surgical populations, although the overall effectiveness on functional outcomes could not be determined.

The risk of bias assessment of the included studies was often high or unclear, which is a potential limitation of this review. Standards of reporting were not optimal across all included studies, with incomplete outcome reporting in seven studies. These methodological shortcomings are one of the reasons why a comparison of effectiveness between studies was not possible.

The majority of included studies (78%) investigated the effectiveness of telerehabilitation on more than one functional outcome measure, and reported a significant positive effect on at least one measure. However, none of the studies detected a significant positive effect on all outcome measures in favour of telerehabilitation. This is in line with the results of previously published systematic reviews focusing on the effectiveness of telerehabilitation in non-surgical populations. Kairy *et al.* [48] reported that most of the clinical outcomes in their included studies improved after telerehabilitation, but stated that there is still a need for more methodologically sound research to confirm its effectiveness.

Wide variation was noted between the included studies in terms of type of intervention, duration, frequency and outcome measures. This heterogeneity made it inappropriate to pool data from different studies and investigate the overall pooled estimate of effect [23].

The lack of overall significant evidence in favour of telerehabilitation could also be due to the fact that many studies used questionnaires to quantify outcome. In a review on the effectiveness of telerehabilitation in stroke patients, Laver *et al.* [10] stated that questionnaires often contain subscales with significant differences between the intervention and control groups, whereas the overall score does not differ.

This is the first systematic literature review to demonstrate that interventions with telerehabilitation have the potential to increase QoL in surgical populations. Van den Brink *et al.* [16] reported that despite the rarity of studies investigating telerehabilitation with QoL as an outcome measure, the results looked promising. Despite the high heterogeneity between studies leading to effects with large variation, a meta-analysis was still considered to be appropriate because QoL was measured with the same questionnaire in the different studies, and is not directly related to the type of patients or intervention provided.

Telerehabilitation has been shown to be a valuable tool in managing postoperative outcomes and functional progress in surgical patients [32]. Patients often deal with a temporary loss of mobility directly after surgery, and are confronted by integrated care from multiple health providers. Telerehabilitation allows patients to perform their exercises more frequently without extra face-to-face visits [10,32,39,42,43]. Therefore, these patients might benefit from a relief in burden of care and increased efficiency by providing them with telerehabilitation at home instead of conventional 'face-to-face' rehabilitation, leading to an increased perception of QoL. Kairy *et al.* [48] stated that telerehabilitation in patients with physical disabilities could lead to similar clinical outcomes compared with usual care, with possible positive effects on areas of healthcare utilisation.

As restrictions in physical functioning of surgical patients are profound, physiotherapeutic interventions with telerehabilitation could be recommended to improve QoL after complex surgery.

On the basis of the secondary objective of this review, patient satisfaction was only reported in the feasibility study by Eakin *et al.* [36], where patient satisfaction ratings were high but exact numbers related to usual care were missing. This is in line with the significant outcomes of patient satisfaction with telerehabilitation illustrated in studies by Beaver *et al.* [11] and Cleeland *et al.* [49], where helpfulness in dealing with concerns at an appointment with telerehabilitation were reported as more helpful in meeting patient's needs. Although the populations in these studies were not exclusively surgical, and the interventions were not always exercise related, there is still sufficient indication for telerehabilitation interventions to be satisfactory in surgical patient groups, taking into account positive adherence and retention rates [11,31,32,49].

Study limitations and strengths

The main strength of this review is its extended search and detailed assessment of articles according to the Cochrane Collaboration's tool for assessing risk of bias [22]. This revealed considerable variation in standards of reporting across studies, but contributed to the interpretation of results.

A limitation of this study is the variety in contents of intervention and outcome measures that were used in studies. In order not to miss relevant articles, no restrictions were placed on these intervention and outcome parameters. However, this limits generalisation to specific surgical groups, and restricted the performance of a meta-analysis on clinical outcome measures. However, despite this variety, QoL was measured with the same questionnaire in all studies, and was therefore eligible to be pooled by means of a random effects model.

Second, patients' pre-operative functional status was not taken into account as an inclusion criterion. As the telerehabilitation intervention could have less impact in patients with a higher functional status prior to surgery compared with patients with a lower functional status, the results on effectiveness could be skewed. This was also illustrated by Barnason (2006), who found that the degree of functional status in patients undergoing coronary artery bypass surgery was related to survival after surgery [25]. This emphasised the importance of identifying and intervening in cases with poor functioning. Therefore, organising patients by functional status before surgery can be an important factor to consider when applying a telerehabilitation intervention or investigating its effectiveness.

Finally, only one study reported patient satisfaction. It may have been possible to collect more data on patient satisfaction if non-randomized feasibility studies had been included.

Clinical implications and conclusions

This systematic review found that physiotherapy with telerehabilitation is feasible in surgical patients, and is at least equally effective compared with usual care. This systematic review with meta-analysis showed that QoL in surgical populations increased with telerehabilitation. As the effectiveness of telerehabilitation compared with usual care on physical outcomes is considered to be at least equal, this may be an important reason to choose physiotherapy with telerehabilitation instead of usual care for surgical populations. Despite methodological shortcomings within the included studies, this review illustrates the feasibility of telerehabilitation in surgical patients, but research relating to the (cost-) effectiveness and patient satisfaction of telerehabilitation requires further exploration. As telerehabilitation is developing continuously, and technology changes and improves at a high rate, it is recommended that alternative trials should be designed that allow iterations of new releases of technology.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.physio.2018.04.004.

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