



Effectiveness of telemedicine: A systematic review of reviews

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ABSTRACT

Objectives: To conduct a review of reviews on the impacts and costs of telemedicine services. **Methods:** A review of systematic reviews of telemedicine interventions was conducted. Interventions included all e-health interventions, information and communication technologies for communication in health care, Internet based interventions for diagnosis and treatments, and social care if important part of health care and in collaboration with health care for patients with chronic conditions were considered relevant. Each potentially relevant systematic review was assessed in full text by one member of an external expert team, using a revised check list from EPOC (Cochrane Effective Practice and Organisation of Care Group) to assess quality. Qualitative analysis of the included reviews was informed by principles of realist review.

Results: In total 1593 titles/abstracts were identified. Following quality assessment, the review included 80 heterogeneous systematic reviews. Twenty-one reviews concluded that telemedicine is effective, 18 found that evidence is promising but incomplete and others that evidence is limited and inconsistent. Emerging themes are the particularly problematic nature of economic analyses of telemedicine, the benefits of telemedicine for patients, and telemedicine as complex and ongoing collaborative achievements in unpredictable processes.

Conclusions: The emergence of new topic areas in this dynamic field is notable and reviewers are starting to explore new questions beyond those of clinical and cost-effectiveness. Reviewers point to a continuing need for larger studies of telemedicine as controlled interventions, and more focus on patients' perspectives, economic analyses and on telemedicine innovations as complex processes and ongoing collaborative achievements. Formative assessments are emerging as an area of interest.

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1. Introduction

Previous reviews of telemedicine have concluded that irrefutable evidence regarding the positive impact of telemedicine on clinical outcomes still eludes us. One review [1] of more than 150 articles concluded that *potential* effectiveness could only be attributed to teleradiology, telepsychiatry, transmission of echocardiographic images and consultations between primary and secondary health providers. Another systematic review [2] that assessed more than 1300 papers making claims about telemedicine outcomes found only 46 publications that actually studied at least some clinical outcomes. A review that analyzed the suitability of telemedicine as an alternative to face-to-face care [3] concluded that establishing systems for patient care using telecommunications technologies is feasible; however, the studies provided inconclusive results regarding clinical benefits and outcomes. A report on peer-reviewed literature for telemedicine services that substituted face-to-face services with ICT-based services at home and in offices or hospitals [4] identified 97 articles that met the inclusion criteria for analysis. The authors concluded that telemedicine is being used even if the use is not supported by high quality evidence. Reviews on cost outcomes have fared similarly. A

study focused on cost-effectiveness interventions concluded that there is no good evidence that telemedicine is or is not a cost-effective means for delivering healthcare [5].

The quality of studies is a recurrent concern in these reviews [1,2,4–6]. There is also a debate about appropriate research methodologies. For example, economic analysis of telemedicine has not yet met accepted standards [5]; there is a relative lack of exploration of the socio-economic impact of telemedicine [7]; evidence on factors promoting uptake of telemedicine is lacking [8]; there is relatively undeveloped use, at the time, of qualitative methods [9]; many studies have not been well-designed [4,10]; and, considering perceived difficulties of building a robust evidence base for recent innovations, researchers have argued that simulation modelling needs further development [11].

The lack of consensus raises questions about the quality of research evidence in terms not only of the data collected and analysed, but also in terms of the approaches to evaluation, that is, the underlying methodologies used, which may not be capable of addressing the questions to which different stakeholders seek answers. Others have noted that evaluation traditions do not sufficiently collaborate to cross borders and that a common language for evaluation is missing [12].

This paper reports on research funded under EU SMART 2008/0064, which sought to review the evidence on the

effectiveness of telemedicine with particular reference to both outcomes and methodologies for evaluation. This paper focuses mainly on the evidence about effectiveness, and assesses the range of conclusions drawn by reviewers about the effectiveness of telemedicine and the gaps in the evidence base. A companion paper focuses on the methodological issues and recommendations [13].

2. Objectives

The objective of the work was to conduct a review of reviews on the impacts and costs of telemedicine services and consider qualitative and quantitative results, with the purpose of synthesizing evidence to date on the effectiveness of telemedicine. The key questions addressed were firstly, how are telemedicine services defined and described in terms of participants, interventions, comparisons and outcome measures; secondly, what are the reported effects of telemedicine; thirdly which methodologies were used to produce knowledge about telemedicine in studies included; fourthly, what are the strengths and weaknesses of these methodologies, including HTA methodologies; and finally what are the knowledge gaps and what methodologies can be recommended for future research? The present paper addresses the first two of these questions, and identifies assessments of the evidence base provided within the reviews and knowledge gaps in terms of outcomes.

3. Methods

An initial search identified systematic reviews of telemedicine published from 1998. A systematic review was defined as an overview with an explicit question and a method section with a clear description of the search strategy and the methods used to produce the systematic review. The review should also report and analyse empirical data. In addition, reviews which described or summarised methods used in assessing telemedicine were included. Because of the large number of reviews retrieved, a decision was taken to include only reviews published from 2005 and onwards in the final review.

3.1. Inclusion criteria

3.1.1. Population/participants

Systematic reviews on patients and consumers, health professionals and family caregivers, regardless of diagnoses or conditions, were included in the searches for systematic reviews.

3.1.2. Interventions

All e-health interventions, information and communication technologies (ICT) for communication in health care, Internet based interventions for diagnosis and treatments, and social care if an important part of health care and in collaboration with health care for patients with chronic conditions were considered relevant.

3.1.3. Comparisons

Reviews of studies comparing telemedicine to standard care or to another type of care, as well as reviews of studies comparing different e-health solutions were included.

3.1.4. Outcomes

Only reviews reporting relevant outcomes were included, specified as health related outcomes (morbidity, mortality, quality of life, patient' satisfaction), process outcomes (quality of care, professional practice, adherence to recommended practice, professional satisfaction) and costs or resource use. Systematic reviews reporting emerging issues, such as an unexpected finding or important new insights were also included.

3.1.5. Languages

No articles were excluded based on language, although the main focus of the project was telemedicine in Europe.

3.2. Exclusion criteria

3.2.1. Design

Reviews considered not systematic, including commentaries and editorials, were excluded. Systematic reviews with major limitations (low quality reviews) according to a revised checklist for systematic reviews from EPOC (Cochrane Effective Practice and Organisation of Care Group) were excluded.

If the same authors had produced several publications of the same review, the most updated and/or the full report of the review was selected, and other versions excluded. Dissertations, symposium proceedings, and irretrievable documents were excluded.

3.2.2. Participants

Studies with participants considered not relevant for the review, for instance studies on use of ICT on people outside health care were excluded. Animal studies were excluded.

3.2.3. Interventions considered not relevant for the review

Other exclusions were studies on interventions considered not relevant for the review, such as studies on Internet and other ICT media used for information seeking; quality of information on the Internet; Internet based education of students and health professionals, including use of games; medical technology in clinical practice in general, i.e. medical and surgical examinations and treatments based on computer technologies, except when used as remote diagnosis and treatment (telehealth); ordinary use of electronic patient records; use of telephone (including cell phones) only; e-health as only a very limited part of an intervention; use of Internet for surveys and research; online prescriptions; mass media interventions and veterinary medicine.

3.2.4. Outcomes

Articles without relevant outcomes, i.e. not on the list of outcomes specified above under inclusion criteria, were excluded.

3.3. Information sources

Literature searches of the following databases: ACM Digital Library (ACM – The Association for Computing Machinery), British Nursing Index, Cochrane library (including Cochrane database of systematic reviews (CDSR), Database of reviews of effects (DARE), Health Technology Assessment Database (HTA), CSA, Ovid Medline, Embase, Health Services/Technology Assessment Text (HSTAT), International Network of Agencies for Health Technology Assessment (INAHTA), PsycInfo, Pubmed, Telemedicine Information Exchange (TIE), Web of Science.

The main search was performed in February 2009, and an updated search was performed in July 2009.

3.4. Search

The search strategies are available on the website: (to be inserted).

3.5. Study selection

Based on the criteria for inclusion and exclusion, AGE and SF independently screened the lists of titles/abstracts identified through searches for systematic reviews. Any discrepancies were solved by discussion with the third member of the team, AB. The potentially relevant systematic reviews were retrieved in full text.

3.6. Data collection process

Data collection was carried out online using a data extraction form. Each potentially relevant systematic review was assessed in full text by one member of an expert panel of reviewers. A revised check list from EPOC (Cochrane Effective Practice and Organisation of Care Group) was used to assess the quality of the systematic reviews. The quality domains assessed according to this checklist were methods used to identify, include and critically appraise the studies in the review, methods used to analyse the findings and an overall assessment of the quality of the review. The review team (AGE, AB and SF) subsequently checked review reports for agreement regarding the inclusion and exclusion criteria.

3.7. Data items

Data on type of participants, interventions and outcomes included in the reviews were collected. Other data items were: geographical coverage of review, time frame of included studies, range of data collection methods used in studies included in the reviews, disciplines/areas covered and methodological traditions included in the review. The reviewers were also asked to indicate emerging issues identified by the authors of the reviews.

3.8. Quality of systematic reviews and risk of bias in individual studies

The members of the expert team assessed the quality of the systematic reviews, including questions regarding the degree

to which the systematic reviewers had assessed risk of bias in individual studies.

Systematic reviews with major limitations were excluded. We assessed the methodological quality of studies in the field of telemedicine based on the review authors' assessments of risk of bias in the primary studies they had included.

3.9. Summary measures and synthesis of results

The authors analysed the data collected by the members of the expert team. Due to the expected heterogeneity of studies, regarding participants, interventions, outcomes and study designs, a quantitative summary measure of the results was not planned. We did a qualitative and narrative summary of the results of the systematic reviews. The results of the literature review were presented and discussed in two workshops intending to validate results. In the first workshop different user groups took part and in the second workshop methodology experts participated. The analysis was inspired by principles of realist review [14], considered appropriate for complex interventions.

4. Results

We identified 1593 records through the searches and excluded 1419 following screening. We retrieved 174 potentially relevant articles in full text. We excluded 94 of these based on the pre-specified inclusion and exclusion criteria. The qualitative synthesis below relate to 73 of the 80 included articles.

The results of the 80 systematic reviews included are summarised in seven tables in [Appendix 1](#). Tables one through six list populations, interventions, outcomes, results and conclusions for the reviews cited in this paper, according to the headlines presented in the discussion below. [Table 7](#) list the seven included reviews not cited in this paper.

5. Telemedicine is effective

Twenty reviews ([Table 1](#)) concluded that telemedicine works and has positive effects. These include therapeutic effects, increased efficiencies in the health services, and technical usability.

Types of interventions that were found to be therapeutically effective include online psychological interventions [15]; programmes for chronic heart failure that include remote monitoring [16]; home telemonitoring of respiratory conditions [17]; web and computer-based smoking cessation programmes [18]; telehealth approaches to secondary prevention of coronary heart disease [19]; telepsychiatry [20]; virtual reality exposure therapy (VRET) for anxiety disorders [21]; robot-aided therapy of the proximal upper limb [22]; internet and computer-based cognitive behavioural therapy for the treatment of anxiety [23,24]; home telehealth for diabetes, heart disease and chronic obstructive pulmonary disease [25]; and internet based physical activity interventions [26]. A review comparing telepsychiatry and face-to-face work [27] found no differences between the two, and suggested that

telepsychiatry will increase in use, particularly where it is more practical.

Interventions that are effective in reducing health service use include vital signs monitoring at home with telephone follow-up by nurses [28]; computerised asthma patient education programs [29]; and home monitoring of diabetes patients [30].

Technical effectiveness and reliability are reported in respect of remote interpretation of patient data [31]; smart home technologies [32]; and home monitoring of heart failure patients [33].

One review concluded that home based ICT interventions in general give comprehensive positive outcomes for chronic disease management, despite only identifying a small number of heterogeneous studies [34].

6. Telemedicine is promising

Nineteen reviews (Table 2) were less confident about the effectiveness of telemedicine, suggesting that it is promising, or has potential, but that more research is required before it is possible to draw firm conclusions. In some cases, in which the same conditions and interventions are discussed, these more tentative conclusions must temper those of authors who find conclusive evidence.

One review [35] for example found internet-delivered CBT to be a ‘promising’ and ‘complementary’ development, but did not provide the endorsements that others [23,24] did for CBT for the more specific conditions of anxiety and depression. Similarly psychotherapy using remote communication technologies was seen as promising [36], but still requiring more evidence.

Areas in which review authors agreed that telemedicine shows therapeutic promise, but still requires further research, include virtual reality in stroke rehabilitation [37,38]; improving symptoms and behaviour associated with and knowledge about specific mental disorders and related conditions [39]; diabetes [40,83]; weight loss intervention and possibly weight loss maintenance [41]; and alcohol abuse [88].

Other authors found promise in terms of health service utilisation. One review [42] for example suggested that asynchronous telehealth developments could result in shorter waiting times, fewer unnecessary referrals, high levels of patient and provider satisfaction, and equivalent (or better) diagnostic accuracy. Another [43] found that home telehealth has a positive impact on the use of many health services as well as glycaemic control of patients with diabetes.

Positive patient experiences were highlighted as promising in relation to home telemonitoring for respiratory conditions [17]. There is potential for using Internet/web-based services for cancer patients in rural areas [44], and telemonitoring can empower patients with chronic conditions [45].

Promising impacts on service delivery were identified [46,47] in use of electronic decision support systems and telemedicine consultations promise to support improved delivery of tPA in patients with stroke (a treatment which requires to be administered within 3h) [48]. Computer reminders to professionals at the point of care show ‘small to modest improvements’ in professional behaviour, but studies

are heterogeneous and interventions complex, making these difficult to understand [49].

7. Evidence is limited and inconsistent

Twenty-two reviews (Table 3) however concluded that the evidence for the effectiveness of telemedicine is still limited and inconsistent, across a wide range of fields.

In terms of therapeutic effectiveness, there is some limited evidence regarding telemonitoring for heart failure [50]; despite reviewers suggesting that electronic transfer of self-monitored results has been found to be feasible and acceptable in diabetes care, they find only weak evidence for improvements in HbA1c or other aspects of diabetes management [51]; others found only weak evidence of benefit relating to informatics applications in asthma care [52]; and no evidence of improvement in clinical outcomes following teleconsultation and video-conferences in diabetes care [53].

Frequently, these reviewers call for further research, notably in the form of RCTs. Examples include calls relating to web-based alcohol cessation interventions [54]; and virtual reality in stroke therapy, despite this being found [37] to be ‘potentially exciting and safe’. More work on telemonitoring in heart failure is called for [55]; on e-therapy for mental health problems [56]; on smart home technologies [57]; and on technological support for carers of people with dementia [58]. Others [28] underlined that lack of evidence does not imply lack of effectiveness, and that in many cases interventions are simply ‘unproven’. Caution is also urged by reviewers [59] who identified small numbers of heterogeneous studies in relation to chronic disease management. One review [60] found it impossible to draw any significant conclusions about the impact of interventions to promote ICT use by health care personnel.

Several reviewers found that research has been somewhat narrowly focused and suggested further research which takes a broader perspective or a different one. They suggested that telemedicine researchers have not yet asked all the important questions, or conducted research in appropriate ways. For example, in the cases of dermatology, wound care and ophthalmology, it was argued that evaluation has explored ICT-based asynchronous services for efficacy, but outcomes or access issues have not been considered [61]. In a similar vein, although most of the studies of smart homes found technical feasibility, there remain certain topics that require further research, notably, ‘technical, ethical, legal, clinical, economical and organisational implications and challenges’ [32]. Others [44], whilst seeing significant potential for teleoncology, especially in rural areas, suggested that local studies may be needed to confirm this. A further contribution to the debates about CBT (see above), found that whilst it appears to be effective for panic disorders, social phobia and depression, its effects on obsessive-compulsive disorder and anxiety and depression combined remain insufficiently clear [62]. Causal pathways in HbA1c decline in diabetes care remain unclear, and this conclusion can be linked with the variations in programme designs [63]. Whilst smoking cessation programmes appear to be effective across a range of studies, nevertheless the mechanisms of action are not well understood [64].

Telemedicine is a dynamic field, and new studies and new systematic reviews are rapidly being published. As telemedicine extends into new clinical areas, it is unsurprising that reviewers give renewed accounts of limited evidence. Some examples of new areas from our review include little research on health promotion provided through the Internet [65]; a Cochrane review that found no studies of smart homes that met their inclusion criteria [57]; a review of studies on spiritual care that found little systematic research in this area [66]; and a review concluding that formative evaluation is needed for remote monitoring in hypertension [90].

8. Economic analysis

An important emerging issue from our review is the lack of knowledge and understanding of the costs of telemedicine (Table 4).

Several reviewers suggested that telemedicine seemed to be cost-effective, but few draw firm conclusions. One review found that 91% of the studies showed telehomecare to be cost-effective, in that it reduced use of hospitals, improved patient compliance, satisfaction and quality of life [67]. This was the clearest conclusion, with others being much more cautious: telemedicine was found to be cost-effective for chronic disease management, but the authors cautioned that studies were few and heterogeneous [34]. A comparison of the costs of telemonitoring and usual care for heart failure patients found that telemonitoring could reduce travel time and hospital admissions, whilst noting that benefits are likely to be realised in the long term [68]. Others found home telehealth for chronic conditions to be cost saving, though underlining that studies were generally of low quality [25]. One review found remote interpretation in medical encounters to be more expensive than its alternatives [31].

Other reviewers did not find good evidence about cost-effectiveness; the cost-effectiveness of home telecare for older people and people with chronic conditions is uncertain [28]; there is a lack of consistent results regarding costs of synchronous telehealth in primary care [69]; there is little evidence for the economic viability of home respiratory monitoring [17]; the cost-effectiveness of IT in diabetes care is undetermined [40]; one review was able to identify only one study of the costs of CBT, with significant weaknesses [70], with another finding little evidence in the same area [62].

A particular limitation identified in terms of costs concerns the wider social and organisational costs of telemedicine. One review found that a societal perspective on costs has not yet been developed for home telehealth [71] and another highlighted the need to consider not only costs to health services of interventions, but also costs to service users and their social networks [72].

9. Is telemedicine good for patients?

A second emerging issue concerns patient satisfaction with telemedicine, and indications that telemedicine may alter the relationships between patients and health professionals (Table 5).

One review found that health service users with ICT used in support, education and virtual consultation feel more confident and empowered, with better knowledge and improved health outcomes, as well as experiencing better nurse-patient relationships [73]. The reviewers call for more research on the mechanisms for these changes. Generally there is evidence of high patient satisfaction ratings for telerehabilitation, but reviewers argue that more process research, case studies and qualitative studies are needed to improve our understanding of these outcomes [74]. Interactive health communication applications (IHCAs) for people with chronic disease appear to give benefit in terms of improved support, better knowledge and improved health outcomes, but the authors asked for more larger studies to be conducted [75].

Others found no consistent results regarding user experiences, though suggested that access can be improved [69]. Alongside development of technologies which aim to benefit patients and citizens as well as professionals, we need research on the impacts of technologies for these groups [76]. An example is that information websites relating to dementia are geared more to carers than to people with dementia themselves, and that the websites do not usually offer personalised information [77].

10. Asking new questions

We have already noted the emergence of new topic areas in this dynamic and complex field. The focus on patient benefits however indicates a more basic development, namely that reviewers are starting to explore new questions beyond those of clinical and cost-effectiveness. Our review produced two key examples (Table 6). Firstly, a review that identified gender differences in computer-mediated communications relating to online support groups for people with cancer cautioned that studies are limited and heterogeneous [78]. Nevertheless, the authors suggested that this issue needs to be considered by those designing interventions of this kind. This implies a consideration that telemedicine is an ongoing intervention where users influence its development and hence that effectiveness of outcome is a complex collaborative achievement. Secondly, a review focusing on stroke thrombolysis service configurations, their potential impact and ways of recording data to inform which configuration could be most suitable for a particular situation, highlighted the need to consider a wider range of service delivery issues [79]. Similarly, it was argued that in post-stroke patients, the consideration of caregivers' mental health and high levels of patient satisfaction should be an integral element of studies [80].

Furthermore, some of the papers included in the review explored issues which can inform the future development of telemedicine, that is, they provide formative assessments. Examples include a review of 104 definitions of telemedicine [81] which, in identifying four broad types of definitions, suggested how stakeholder interests can alter perceptions of priorities in telemedicine interventions, such that some may focus on delivering healthcare over a distance and others on the potential of technology per se; and work arguing that clinical and technical guidelines can inform the

future development of telemedicine and facilitate evaluation [20,82].

11. Reflections on the methodology of our study

Our study is a review of systematic reviews. There are some inherent weaknesses in this approach. In general we have to rely on the information in the included reviews. The quality of the reviews may vary; the reviews may have done a poor job in specifying their inclusion and exclusion criteria, the searches may not be comprehensive, the review authors may not have assessed or extracted data from the primary studies adequately, nor analysed and synthesised the findings across the studies properly. But even using high quality reviews, we necessarily lose information and details that we can only find if we go back to the primary studies.

Although we did a thorough job in developing the search strategy and identified a vast amount of reviews on the effects of telemedicine, we might have missed relevant systematic reviews.

Some of the included reviews are probably outdated. Studies that are published after the search date in the reviews are not included. Ideally we could have supplemented the review with more recent primary studies not included in the reviews, but we did not have the resources to do this.

We did not check whether reviews included the same references. Several reviews have studied similar or overlapping topics, and have at least partially included the same studies. It may therefore be that evidence is counted twice, or that different interpretations of effectiveness are given by review authors. We have not analysed the degree to which there are discrepancies in the analyses of similar studies, nor the reasons for different interpretations of the same findings, for instance did we not analyse the heterogeneity of the results among the reviews based on the quality of the reviews.

The data collection and assessment of each included review was accomplished by one external expert, while two is considered to be optimal in order to reduce risk of bias. We did not train the data extractors, and we did not pilot the data extraction form. The experts were not completely consistent in their judgments. This limitation was partly due to the resources and organisation of the project, in that two workshops were held, intending to validate results. In addition, the review team made a quality check of the reviews by comparing the reported data with information in the full text papers. Any unclear themes were discussed in the team to reach consensus.

We have limited information regarding effect sizes and the strength of evidence for the outcomes that we have studied.

We have however demonstrated that it is possible to make such a large overview in quite a short time, involving both methodology and content experts. We have used systematic methods in the literature searches and the assessment of the reviews, and we have excluded reviews of low methodological quality.

In combining rigorous and systematic methods with a pragmatic approach we have produced a relevant and rich overview of the field.

Summary points

“What was already known on this topic”

- Evidence regarding the effectiveness of telemedicine is patchy and incomplete.
- The quality of much of the research conducted is poor.

“What this study added to our knowledge”

- The evidence base is accumulating robust knowledge about the effectiveness of telemedicine.
- As the field is rapidly evolving however, new knowledge is constantly needed.
- Continuing areas of weakness but also of great interest include economic analyses, understandings of patient perspectives, of effectiveness and outcomes as complex and ongoing collaborative achievements, and formative assessments.

12. Conclusions

Despite large number of studies and systematic reviews on the effects of telemedicine, high quality evidence to inform policy decisions on how best to use telemedicine in health care is still lacking. Large studies with rigorous designs are needed to get better evidence on the effects of telemedicine interventions on health, satisfaction with care and costs. As the field is rapidly evolving, different kinds of knowledge are also in demand, e.g. a stronger focus on economic analyses of telemedicine, on patients' perspectives and on the understanding of telemedicine as complex development processes, and effectiveness and outcome as ongoing collaborative achievements. Hence formative assessments are also pointed out as an area of weakness and interest.

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Appendix 1.

In Tables 1–7, columns listing results and conclusions quote from the authors' work. Where a review appears in more than one table, this reflects the range of evidence produced. Full access to a searchable database of abstracts of items included in the review will be available on the MethoTelemed website, which also includes guidance for evaluating telemedicine. www.telemed.no/MethoTelemed.

Table 1 – Systematic reviews reporting that telemedicine is effective.

Reference	Conditions included	Geographic area	Service/ intervention	Outcome	Authors' summary of results	Authors' conclusions
Barak et al. [15]	Mental health	Not stated	Internet based psychotherapy	Behavioural, Health, Perception/satisfaction, Social	Sixty-four studies included covering 94 services. The overall mean weighted effect size was 0.53, similar to the average effect size of traditional, face-to-face therapy. Comparison between face-to-face and Internet intervention across 14 studies showed no differences in effectiveness. Fourteen studies (RCTs) included. Four evaluated telemonitoring, nine structured telephone support, and one both. Remote monitoring programmes reduced the rates of admission to hospital for chronic heart failure by 21% and all cause mortality by 20%. Three studies reported quality of life improvements and four, reduced cost, one found no gain in cost-effectiveness.	Internet based intervention is as effective as face-to-face intervention.
Clark et al. [16]	Cardio-vascular (CHF)	All countries	Remote monitoring, telephone support	Behavioural, Cost/economic, Health	Twenty-three studies included. Good levels of data validity and reliability were reported. However, little quantitative evidence exists about the effect of remote monitoring on patient medical condition and utilization of health services. Positive effects on patient behaviour were consistently reported. Only two studies performed a detailed cost analysis.	Programmes for chronic heart failure that include remote monitoring have a positive effect on clinical outcomes in community dwelling patients with chronic heart failure.
Jaana et al. [17]	Respiratory conditions	USA, Europe, Israel, Taiwan	Remote monitoring	Behavioural, Cost/economic, Feasibility/pilot, Health, Perception/satisfaction	Home telemonitoring of respiratory conditions results in early identification of deteriorations in patient condition and symptom control. Positive patient attitude and receptiveness of this approach are promising. However, evidence on the magnitude of clinical and structural effects remains preliminary, with variations in study approaches and an absence of robust study designs and formal evaluations.	
Myung et al. [18]	Smoking cessation	Worldwide	Web and computer-based programmes	Behavioural	Twenty-two studies included (RCTs). In a random-effects meta-analysis of all 22 trials, the intervention had a significant effect on smoking cessation. Similar findings were observed in nine trials using a Web-based intervention, (and in 13 trials using a computer-based intervention Subgroup analyses revealed similar findings for different levels of methodological rigor, stand-alone versus supplemental interventions, type of abstinence rates employed, and duration of follow-up period, but not for adolescent populations.	The meta-analysis of RCTs indicates that there is sufficient clinical evidence to support the use of Web- and computer-based smoking cessation programs for adult smokers.

Table 1 (Continued)

Reference	Conditions included	Geographic area	Service/ intervention	Outcome	Authors' summary of results	Authors' conclusions
Neubeck et al. [19]	Cardio-vascular (CHD)	USA (3 studies), Norway (1), Canada (3), Australia (3), Germany (1)	Communication using ICT, patient-professional	Behavioural, Health, psychosocial state, quality of life	Eleven studies included (RCTs). Telehealth interventions were associated with non-significant lower all-cause mortality than controls. These interventions showed a significantly lower weighted mean difference at medium long-term follow-up than controls for total cholesterol, systolic blood pressure, and fewer smokers. Significant favourable changes at follow-up were also found in high-density lipoprotein and low-density lipoprotein.	Telehealth interventions provide effective risk factor reduction and secondary prevention. Provision of telehealth models could help increase uptake of a formal secondary prevention by those who do not access cardiac rehabilitation and narrow the current evidence-practice gap.
Pineau et al. [20]	Psychiatric conditions (adult and paediatric)	Focus on Canada and USA	Telepsychiatry	Cost/economic, Ethical issues, Legal, Organizational, Technology related, clinical guidelines and technical standards	'About 60' studies included. The authors argue that definition of clinical guidelines and technological standards aimed at standardising telepsychiatric practice will promote its large scale implementation.	The review concludes that telepsychiatry should be implemented in Québec and provides detailed clinical and technical guidelines for implementation. They add that taking into account human and organizational aspects plays a part in ensuring the success of this type of activity; that legal and ethical aspects must also be considered; and that a detailed economic analysis should be carried out prior to any large investment in telepsychiatry. Finally, implementation of psychiatry should be subjected to rigorous downstream assessment in order to improve management and performance.
Powers and Emmelkamp [21]	Anxiety (especially phobias)	Not stated	Virtual reality exposure therapy	Behavioural, Perception/satisfaction, Psychophysiology, perceived control over phobias	Thirteen studies included. VRET (Virtual reality exposure therapy) is highly effective in treating phobias and more so than inactive control conditions. VRET is slightly, but significantly more effective than exposure in vivo, the gold standard in the field. Advantages of VRET: can be conducted in the therapist's office, rather than in vivo situations, the possibility of generating more gradual assignments and of creating idiosyncratic exposure. VRET is cost-effective.	Given the advantages and the efficacy of VRET supported by this meta-analysis a broader application in clinical practice seems justified.

Prange et al. [22]	Stroke	USA	Rehabilitation (robots)	Health	Eleven studies included. Robot-aided therapy of the proximal upper limb improves short and long-term motor control of the paretic shoulder and elbow: however, there is no consistent influence on functional abilities.	This systematic review indicates that robot-aided therapy of the proximal upper limb can improve short and long-term motor control of the paretic shoulder and elbow. Robot-aided therapy appears to improve motor control more than conventional therapy.
Reger and Gahm [23]	Mental health problems (anxiety)	Not stated	Internet/computer-based treatment	Behavioural, Health	Nineteen studies included (RCTs). Meta-analysis showed that ICT was superior to waitlist and placebo assignment across outcome measures. The effects of ICT were equal to therapist-delivered treatment across anxiety disorders. Conclusions were limited by small sample sizes, the rare use of placebo controls, and other methodological problems. The number of available studies limited the opportunity to conduct analyses by diagnostic group.	The results of this meta-analysis provide preliminary support for the use of Internet and computer-based CBT for the treatment of anxiety.
Spek et al. [24]	Mental health (depression and anxiety)	Global	CBT via internet	Health	Twelve studies included (RCTs). Authors concluded that eCBT was effective, but noted that there was only a small number of studies and significant heterogeneity.	Despite study limitations, eCBT seemed to be effective.
Tran et al. [25]	Diabetes, heart failure, COPD and other chronic diseases	Canada focused, but international publications included	Home telehealth	Cost/economic, Health, Perception/satisfaction	Seventy-nine studies included. Of the included studies, 26 pertained to diabetes, 35 to CHF, nine to COPD, and eight to mixed chronic diseases. The comparator “no care” was not identified in any of the included studies, so usual care was used as the comparator throughout the clinical review. Home telehealth appeared generally clinically effective and no patient adverse effects were reported. Evidence on health service utilization was more limited, but promising. The economic review suggested cost-effectiveness, but the quality of studies was low.	Conclusions relate to the potential for home telehealth in Canada which is seen as positive. However, more research, such as multicentre RCTs, is warranted to accurately measure the clinical and economic impact of home telehealth for chronic disease management to support Canadian policy makers in making informed decisions.
van den Berg et al. [26]	Internet based physical activity interventions	Not mentioned other than language limitations	Physical activity	Behavioural, Health	Ten studies included. The analysis focused on the methodological quality of the studies, which showed variation in study populations and interventions making generalization difficult.	There is indicative evidence that internet based physical activity interventions are more effective than a waiting list strategy.

Table 1 (Continued)

Reference	Conditions included	Geographic area	Service/ intervention	Outcome	Authors' summary of results	Authors' conclusions
Hylar et al. [27]	Mental health	France, Australia, Canada, Japan, UK and US	Telepsychiatry	Feasibility/pilot, Perception/satisfaction, Quality of different instruments used for consultations	Fourteen studies included. Telepsychiatry was found to be similar to In person for studies using objective assessments. Bandwidth was a moderator. Heterogeneous effect sizes for different moderators (bandwidth) High bandwidth was slightly superior for assessments requiring detailed observation of patients.	Only a handful studies have attempted to compare telepsychiatry with in-person psychiatry (IP) directly, using standardised assessment instruments to permit meaningful comparison. According to the meta-analysis, there was no difference in accuracy or satisfaction between the two modalities. Telepsychiatry is expected to replace IP in certain research and clinical situations.
Barlow et al. [28]	Elderly people, chronic diseases	Worldwide	Home telecare	Behavioural, Health, Organisational, Safety	Sixty-eight RCTs and 30 observational studies with 80 or more participants included. Results show that the most effective telecare interventions appear to be automated vital signs monitoring (for reducing health service use) and telephone follow-up by nurses (for improving clinical indicators and reducing health service use). Evidence on cost-effectiveness is less clear, and on safety and security alert systems insufficient.	Having identified where there is evidence of effectiveness, and where it is lacking, the authors conclude that insufficient evidence does not amount to lack of effectiveness: more research is needed.
Bussey-Smith and Rossen [29]	Asthma	USA, Hawaii, Sweden	Computer-based patient education programmes (CAPEPs)	Behavioural, Cost/economic, Health, Perception/satisfaction, Social	Nine studies included. One study each showed reduced hospitalizations, acute care visits, or rescue inhaler use. Two reported lung function improvements. Four showed improved asthma knowledge, and five showed improvements in symptoms.	Although interactive CAPEPs may improve patient asthma knowledge and symptoms, their effect on objective clinical outcomes is less consistent
Jaana et al.[30]	Diabetes	North America, Europe and Asia	Remote monitoring	Behavioural, Health, Technology related, Structural	Seventeen studies included. Most studies reported overall positive results in Diabetes mellitus type 2, and found that IT based interventions improved health care utilisation, behaviour attitudes and skills.	Positive effects are reported, but there is variation in patient characteristics (background, ability, medical condition) sample selection and approach for treatment of control groups.
Azarmina and Wallace [31]	All	All countries	Remote interpretation in medical encounters	Cost/economic, Feasibility/pilot, Health, Organisational, Perception/satisfaction, Safety	Nine studies included. Results showed that time between encounters was reduced, but evidence on consultation length was not consistent. Good client and doctor satisfaction was shown, but those interpreting data preferred to do so face to face. Costs of these interventions are high, but efficiency gains are possible.	The review suggests that remote interpretation is an acceptable and accurate alternative to traditional methods, despite the higher associated costs.

Demiris and Hensel [32]	Older people, people with disabilities	Europe, USA, Asia	Smart home	Behavioural, Health, Safety, Social, Physiological and functional	Twenty-one projects included (drawing on 114 publications). A table is presented with their technologies, target audience, technologies and different outcome. A lack of evidence on clinical outcomes is identified.	Most of the studies demonstrated the feasibility of the technological solution. Technical, ethical, legal, clinical, economical and organisational implications and challenges need to be studied in-depth for the field to grow further.
Martinez et al. [33]	Heart failure	All countries	Remote monitoring (home)	Behavioural, Cost/economic, Feasibility/pilot, Health, Legal, Organizational, Perception/satisfaction, Safety, Social, Technology related	Forty-two studies included. (1) Remote monitoring for cardiac heart failure appears to be technically effective for following the patient remotely; (2) it appears to be easy to use, and it is widely accepted by patients and health professionals; and (3) it appears to be economically viable.	Evaluating the articles showed that home monitoring in patients with heart failure is viable.
Gaikwad and Warren [34]	Chronic disease	Not stated	Home based ICT interventions	Behavioural, Cost/economic, Health, Perception/satisfaction	Twenty-seven studies included. These systems can improve functional and cognitive patient outcomes in chronic disease and reduce costs. However, the research is not yet sufficiently robust.	Telecare, telehealth etc. have positive clinical and cost outcomes – although studies are few in number and heterogeneous. Better evidence-based outcome measures are needed, especially regarding costs and physician perspectives.

Table 2 – Systematic reviews reporting that telemedicine is promising.

Reference	Conditions included	Geographic area	Service/ intervention	Outcome	Authors' summary of results	Authors' conclusions
Cuijpers et al. [35]	Pain and other health problems	Global	CBT via internet	Health	Twelve studies included (RCTs). Three studies focused on pain, three on headache, and six on other health problems. Effects found for Internet interventions targeting pain and headache were comparable to effects found for face-to-face treatments, and the same was true for interventions aimed at headache. Other interventions also showed some effects, which differed across target conditions.	Internet-delivered cognitive behavioural interventions are a promising addition and complement to existing treatments. The Internet will most likely assume a major role in the future delivery of cognitive behavioural interventions to patients with health problems. More research on eCBT is needed.
Bee et al. [36]	Anxiety and depression	Not stated	Psychotherapy mediated by remote communication technology	Behavioural outcomes	Thirteen studies included. Pooled effect sizes for remote vs. conventional services were 0.44 for depression and 1.15 for anxiety related disorders. Few studies compare remote and face-to-face psychotherapy. Data suggest that good effects may not be dependent on patient and therapist being co-located, but the evidence is limited.	Remote therapy has the potential to overcome some of the barriers to conventional psychological therapy services, but large scale trials are needed.
Crosbie et al. [37]	Stroke	Not stated	Virtual reality (VR) in stroke rehabilitation	Behavioural, Health, Safety	Eleven studies included. Five cover upper limb rehabilitation, three, gait and balance, two cognitive interventions, and one both upper and lower limb rehabilitation. Three were AACPD Level I/Weak, two Level III/Weak, three Level IV/Weak and three Level V quality of evidence. Three RCTs obtained statistical significance, and eight studies found VR based therapy to be beneficial. None reported any significant adverse effects.	VR is a potentially exciting and safe tool for stroke rehabilitation but its evidence base is too limited by design and power issues to permit a definitive assessment of its value. Thus, while the findings of this review are generally positive, the level of evidence is still weak to moderate, in terms of research quality. Further study in the form of rigorous controlled studies is warranted.
Henderson et al. [38]	Stroke	Global	Virtual reality (VR) in stroke rehabilitation	Health	Six studies included. The results of the reviewed studies suggest that immersive VR may have an advantage over no therapy in the rehabilitation of the upper limb in patients with stroke, but the results are still questionable.	Current evidence on the effectiveness of VR in the rehabilitation of upper limb in patients with stroke is limited but sufficiently encouraging to justify further research in this area.

Griffiths and Christensen [39]	Mental health	Global	Internet interventions	Behavioural, Health, Perception/satisfaction	Sixteen papers included (reporting 15 RCTs). The review demonstrates that Internet interventions show promise as a means of improving symptoms and behaviour associated with and knowledge about specific mental disorders and related conditions.	Most interventions were reported to be effective in reducing risk factors or improving symptoms, although many of the studies had methodological limitations. Three of the interventions that reported positive outcomes are available without charges to the public. There is growing evidence that emerging IT may improve diabetes care. Future research should characterize benefits in the long term, establish methods to evaluate clinical outcomes, and determine the cost-effectiveness. Patients benefitted from web-based diabetes management, through savings in time and cost. Major obstacles to wider implementation are patient computer skills, adherence to the technology, architectural and technical design and the need to reimburse providers for their care. Preliminary studies suggest that the internet may be an adequate vehicle for weight loss intervention and possibly for programs directed at weight loss maintenance.
Jackson et al. [40]	Diabetes	Not stated	Computer assisted interactive IT	Behavioural, Cost/economic, Health	Twenty-seven papers included (reporting 26 studies) Significant impacts on behavioural, clinical and structural levels.	
Azar and Gabbay [83]	Diabetes	Not stated	Web-based management of glucose uploads	Clinical, Health, Behavioural	Eight studies on type 1 diabetes seven papers on type 2 (or mixed populations). The type 1 studies tended to show equivalent HbA1c improvements in intervention and control groups. For type 2 patients, there were statistically significant differences for HbA1c between intervention and control groups.	
Weinstein [41]	Obesity	USA	Internet based programmes	Health	Eight studies included. All studies examining weight loss via Internet programs reported positive results, except one investigating a commercial program. Results from the three weight loss maintenance programs conducted on the Internet were equivocal. Because the subjects of all these studies were predominately white, educated women, generalisability of findings is limited.	

Table 2 (Continued)

Reference	Conditions included	Geographic area	Service/ intervention	Outcome	Authors' summary of results	Authors' conclusions
Elliott et al. [88]	Alcohol abuse	Mostly US studies	Computer-based treatment	Behavioural, Health, Perception/satisfaction, Social	Seventeen studies included (RCTs). The e-interventions emerge as more effective than no treatment, and approximately equivalent to alternative intervention approaches. E-interventions appear to be superior to assessment-only (AO) control conditions. In addition, possible moderators (e.g. baseline drinking patterns) and mediators (e.g. corrected drinking norms) have emerged.	These studies compared the effectiveness of e-interventions with other commonly used techniques, reading materials, and assessment-only control conditions. Overall, findings provide some support for such programs, especially in comparison with assessment-only control conditions.
Deshpande et al. (asynchronous telehealth) [42]	All, but especially dermatological conditions	World	Store and forward of clinically important digital samples for assessment at a convenient time	Cost/economic, Health, Organisational, Safety, Social	Fifty-two studies included (16 of good quality). An environmental scan found 39 organisations using both real time and asynchronous services. Overall study quality is poor, evidence suggests shorter waiting times, fewer unnecessary referrals, high levels of patient and provider satisfaction, and equivalent (or better) diagnostic accuracy when compared with face-to-face consultations. It is unknown whether the benefits that have been shown in small local studies could be realized after wide-scale implementation.	Pragmatic objectives for implementation and evaluation are needed, involving policy makers, specifically in Canada. Standardisation procedures are already in progress and are likely to improve collaboration between providers.
Polisena et al. (diabetes) [43]	Diabetes	Worldwide	Home telehealth	Health	Twenty-six studies included. Study results indicated that home telehealth helps to reduce the number of patients hospitalised, hospitalizations and bed days of care. Home telehealth was similar or favourable to UC across studies for quality-of-life and patient satisfaction outcomes.	In general, home telehealth had a positive impact on the use of numerous health services and glycaemic control. More studies of higher methodological quality are required to give more precise insights into the potential clinical effectiveness of home telehealth interventions.
Holland et al. [89]	Heart failure	Europe, USA, Australia, New Zealand, Argentina	Remote monitoring, telephone support	Health	Thirty studies included (RCTs). Sensitivity analysis of combined data from 30 interventions showed reduction in hospital admission and reduction in all-cause mortality. Comparison of interventions in different settings indicated that effective interventions were delivered at least partly at home.	Results suggest that multidisciplinary interventions for patients with heart failure reduce hospital admissions and mortality. Interventions include telemedicine, but there is limited evidence in this area.

Jaana et al. [17]	Respiratory conditions	USA, Europe, Israel, Taiwan English-language publications in peer-reviewed journals	Remote monitoring	Behavioural, Cost/economic, Feasibility/pilot, Health, Perception/satisfaction	Twenty-three studies included. Good levels of data validity and reliability were reported. However, little quantitative evidence exists about the effect of remote monitoring on patient medical condition and utilization of health services. Positive effects on patient behaviour were consistently reported. Only two studies performed a detailed cost analysis.	Home telemonitoring of respiratory conditions results in early identification of deteriorations in patient condition and symptom control. Positive patient attitude and receptiveness of this approach are promising. However, evidence on the magnitude of clinical and structural effects remains preliminary, with variations in study approaches and an absence of robust study designs and formal evaluations.
Hailey et al. [44]	Cancer	United States, Canada, Denmark, Finland, Spain, UK	Comparing a wide range of interventions	Cost/economic, Health, Perception/satisfaction, Social	Fifty-four studies included. Positive findings from higher-quality studies suggested that telephone-based technology was effective for promoting mammography and colposcopy in specific populations, for increasing fruit and vegetable consumption, and as an alternative to in-person support groups for women with breast cancer. Eight economic assessments provided some indications of cost advantages in diagnosis and treatment, and in palliative care. 20 papers reported patient and family satisfaction. However, the significance and generalisability of these findings appears limited.	From the perspective of the Alberta Cancer Board, the literature suggests some useful possibilities for developing new services using internet or web-based, telephone-based, and video-based technologies for cancer patients in rural areas. However, it seems likely that these applications would need validation with suitable local studies.
Pare et al. [45]	Chronic disease	US, Canada, Europe, Asia	Remote monitoring	Behavioural, Health, Organisational, Policy, Technology related	Sixty-five studies included. The magnitude and significance of the effect of (automated) telemonitoring of patients with four chronic conditions (hypertension, diabetes, COPD and cardiac failure) remains inconclusive. Patients' compliance is high, The clinical effectiveness (e.g. less frequent hospitalisation) is more consistent in cardiac and pulmonary studies than in diabetes and hypertension. Economic viability was poorly evidenced.	Telemonitoring seems to be a promising approach to chronic patient management. Technology is reliable. It empowers patients, and potentially improves clinical conditions.

Table 2 (Continued)

Reference	Conditions included	Geographic area	Service/ intervention	Outcome	Authors' summary of results	Authors' conclusions
Nannings and Abu-Hanna [46]	All (especially chronic)	Not mentioned	Decision support models for professional use	Technology related, Conceptual models	Sixty-five studies included. The objectives were to define the term DSTS, to propose a general DSTS model, and to propose model-based templates to aid DSTS development for three medical tasks. The definition, general model and model-based templates are based on a systematic literature search. The applicability of the templates to new DSTSs found in a separate limited literature search was tested. A definition of DSTSs is provided, a conceptual model for understanding DSTSs is proposed and a set of reusable templates, and examples for using them are provided.	The conceptual model and the reusable modelling templates are demonstrated to be useful in understanding and modelling DSTSs during the early stages of their development.
Sintchenko et al. [47]	Diabetes, heart failure, and chronic obstructive pulmonary disease (COPD). Other chronic diseases that could be managed by using home telehealth	Not stated	Home telehealth	Clinical outcomes; health service use, QoL, Patient satisfaction	Twenty-four studies included. The authors feel they have shown that EDSS improves prescribing practices and treatment outcomes of patients with acute illnesses, but are less effective in primary care.	The authors state that further research is needed to quantify the range of benefits of EDSS, and to explore new measurement metrics and enhance the appropriate clinical use of electronic decision support.
Wu and Langhorne [48]	Stroke	Found studies only from Germany, US, France	Acute medicine	Cost/economic, Feasibility/pilot, Health, Perception/satisfaction, Safety	Seventeen studies included. Studies reported that telemedicine systems were feasible and acceptable. Inter-rater reliability was excellent for global clinical assessments and decisions on radiological exclusion criteria although agreement for individual assessment items was more variable. Telemedicine systems were associated with increased use of tPA.	Although there is limited reliable evidence, observational studies have indicated that telemedicine systems can be feasible, acceptable, and reliable in acute-stroke management. In addition, telemedicine consultations were associated with improved delivery of tPA.
Shojania et al. [49]	Medication, vaccination and tests (various conditions unspecified)	Worldwide	Decision support for clinicians	Health	Twenty-eight studies included. The studies tested reminders to prescribe specific medications, to warn about drug interactions, to provide vaccinations, or to order tests. The review found small to moderate benefits. The reminders improved physician practices by a median of 4%. In eight of the studies, patients' health improved by a median of 3%.	Point of care computer reminders generally achieve small to modest improvements in provider behaviour. A minority of interventions showed larger effects, but no specific reminder or contextual features were significantly associated with effect magnitude.

Table 3 – Systematic reviews reporting that evidence on telemedicine is limited and inconsistent.

Reference	Conditions included	Geographic area	Service/ intervention	Outcome	Authors' summary of results	Authors' conclusions
Chaudhry et al. [50]	Heart failure	Telephone-based monitoring: Argentina (1 study), USA 4 studies. Automated monitoring USA 1 study. Automated physiologic monitoring USA 1 study. Comparisons of two or more methods of telemonitoring: Germany/the Netherlands and UK: one study, USA 1 study	Remote monitoring	Cost/economic, Health	Nine studies included. Six suggested reduction in all-cause and heart failure hospitalisations with telemonitoring. Of the three negative studies, two enrolled low-risk patients and patients with access to high quality care, and one enrolled a very high-risk Hispanic population. Studies comparing forms of telemonitoring demonstrated similar effectiveness. Intervention costs were higher with more complex programs.	The evidence base for telemonitoring in heart failure is currently quite limited. Based on the available data, telemonitoring may be an effective strategy for disease management in high-risk heart failure patients.
Farmer et al. [51]	Diabetes	Not stated	Self-monitoring, Data transfer	Cost/economic, Feasibility/pilot, Health, Organizational, Perception/satisfaction	Twenty-six studies included. Electronic transfer of glucose results appears feasible in a clinical setting. Only two of the RCTs included more than 100 patients, and only three extended to one year. Only one study was designed to show that telemedicine interventions might replace clinic interventions without deterioration in HbA. Results pooled from the nine RCTs with reported data did not provide evidence that the interventions were effective in reducing HbA to 0.04% (p. 1372).	Telemedicine solutions for diabetes care are feasible and acceptable, but evidence for their effectiveness in improving HbA or reducing costs while maintaining HbA levels, or improving other aspects of diabetes management is not strong. Further research should seek to understand how telemedicine might enhance educational and self-management interventions and RCTs are required to examine cost-effectiveness.
Sanders and Aronsky [52]	Asthma	USA	Diagnostics, prevention and monitoring, decision support tools, patient-centred education tools	Behavioural, Health, Social	Sixty-four studies included, but only 21 prospective trials. The mean quality score was 6.6 (range: 3–10). None of the studies reported on allocation concealment. Of the 13 studies that reported a clinical outcome, seven reported a positive effect of the computerised intervention and six reported no significant change. Of the eight studies reporting a non-clinical outcome, seven reported a statistically significant positive effect of the computerised intervention.	Most studies took place in the outpatient clinic environment, with minimal study of the emergency department or inpatient settings. Few studies demonstrated evidence of computerised applications improving clinical outcomes.

Table 3 (Continued)

Reference	Conditions included	Geographic area	Service/ intervention	Outcome	Authors' summary of results	Authors' conclusions
Verhoeven et al. [53]	Diabetes	Worldwide	Teleconsultation and video-conferencing	Cost/economic, Health, Perception/satisfaction, Technology related	Thirty-nine studies included. They found no significant statistical heterogeneity among the pooled randomised controlled trials that they identified within this group. Most of the improvements found concerned (a) satisfaction with technology, (b) improved metabolic control or (c) cost savings. No significant benefits were found in relation to (a) quality of life, (b) transparency, or (c) better access to care.	The study did not support any conclusion that these interventions improved clinical values (e.g. blood pressure). The authors argued that diversity in design of the studies meant that strong conclusions were premature.
Bewick et al. [54]	Alcohol abuse	Worldwide	Web-based interventions	Behavioural, Cost/economic	Ten studies included. Five gave process evaluations and five, some pre- and post-intervention results. Only one study was an RCT, and the studies scored low on quality criteria.	There is inconsistent evidence on the effectiveness of electronic screening and brief intervention (eSBI) for alcohol use. Process research suggests that web-based interventions are generally well received. However further controlled trials are needed to fully investigate their efficacy, to determine which elements are keys to outcome and to understand if different elements are required in order to engage low and high-risk drinkers.
Crosbie et al. [37]	Stroke	Not stated	Virtual reality in stroke rehabilitation	Behavioural, Health, Safety	Eleven studies included. Five cover upper limb rehabilitation, three, gait and balance, two cognitive interventions, and one both upper and lower limb rehabilitation. Three were AACPD Level I/Weak, two Level III/Weak, three Level IV/Weak and three Level V quality of evidence. Three RCTs obtained statistical significance, and eight studies found VR based therapy to be beneficial. None reported any significant adverse effects.	VR is a potentially exciting and safe tool for stroke rehabilitation but its evidence base is too limited by design and power issues to permit a definitive assessment of its value. Thus, while the findings of this review are generally positive, the level of evidence is still weak to moderate, in terms of research quality. Further study in the form of rigorous controlled studies is warranted.
Maric et al. [55]	Heart failure	Not stated	Remote monitoring	Cost/economic, Feasibility/pilot, Health, Organisational	Fifty-six papers included. Many of the identified papers on telemonitoring of heart failure (HF) patients demonstrate at least some benefit. There is a general trend towards improvement associated with the use of most modalities. However inconsistent evidence between trials for the same modality and difference between modalities make a definitive conclusion difficult. Evidence of benefit from video consultation alone is lacking. The majority of papers reported trials that are non-randomised and many papers had small sample sizes.	This study reviewed studies conducted in HF telemonitoring, to describe the nature of the modality, the methods and the results. Telemonitoring appeared to be an acceptable method for monitoring HF patients. Controlled, randomized studies directly comparing different modalities and evaluating their success and feasibility when used as routine clinical care are now required.

Postel et al. [56].	Mental health problems	North American and European	E-therapy	Health	Fourteen studies included. E-therapy seems to be promising but study results are still based only on small groups.	More research is needed, and should be better reported.
Martin et al. [57]	Physical disability, cognitive impairment, learning disability	Not explicitly mentioned	Smart home	Cost/economic, health, organizational, social and technology issues	No study identified met the inclusion criteria.	The review does not provide sufficient evidence to support or refute the integration of smart home technologies into health and social care. RCTs should be adopted. International descriptive terminology is needed. The rate of abandonment by individuals of the technologies needs investigation. Further evaluation is needed in robust trials with good follow-up.
Powell et al. [58]	Dementia (carers' stress and depression)	North America	Five specific technological interventions	Behavioural, Cost/economic, knowledge	Fifteen studies included. They describe five interventions: ComputerLink, AlzOnline, Caring for Others and two studies from the REACH project (TLC and CTIS). The interventions reviewed were multifaceted with elements of networked peer support. Outcomes were inconsistent but suggested that the interventions had moderate effects on improving carer stress and depression. Treatment effects were found to vary with caregiver characteristics such as ethnic groups, formal support and baseline burden.	
Barlow et al. [28]	Elderly people, chronic diseases	Worldwide	Home telecare	Behavioural, Health, Organisational, Safety	Sixty-eight RCTs and 30 observational studies with 80 or more participants included. Results show that the most effective telecare interventions appear to be automated vital signs monitoring (for reducing health service use) and telephone follow-up by nurses (for improving clinical indicators and reducing health service use). Evidence on cost-effectiveness is less clear, and on safety and security alert systems insufficient.	Having identified where there is evidence of effectiveness, and where it is lacking, the authors conclude that insufficient evidence does not amount to lack of effectiveness: more research is needed.

Table 3 (Continued)

Reference	Conditions included	Geographic area	Service/ intervention	Outcome	Authors' summary of results	Authors' conclusions
Garcia-Lizana and Sarria-Santamera [59]	Chronic disease	Nations around the world	Management, control and prevention	Health, Perception/satisfaction, Safety	Twenty-four studies included. Improvements in clinical outcomes were not shown, though no adverse effects were identified. In the detection and follow-up of cardio-vascular diseases however, ICTs provided better clinical outcomes, mortality reduction and lower health services utilization. Systems used for improving education and social support were also shown to be effective.	Although some positive results were identified, at present the evidence about the clinical benefits of ICTs for managing chronic disease is limited.
Gagnon et al. [60]	None (implementation issues)	Not stated	Educational	Behavioural, Cost/economic	Twenty-seven references listed. The authors find very little data on interventions to promote ICT use, and argue that more studies are needed.	Too few studies, which are too heterogeneous, make it impossible to draw any significant conclusions about the impact of interventions to promote ICT use by HCPs.
Hersh et al. [4]	Various conditions (Medicare population)	USA, UK, Australia, Europe	Comparing store and forward, home based, office-hospital-based services	Health, Organisational, Concordance studies, diagnosis and management, access	Ninety-seven studies included. Store and forward services have been studied in many specialties, especially dermatology, wound care, and ophthalmology. The evidence for their efficacy is mixed, and in most areas, there are not corresponding studies on outcomes or improved access to care. Several limited studies showed benefits of home based telemedicine interventions in chronic diseases. These interventions appear to enhance communication with providers and provide closer monitoring of general health, but the studies were conducted in settings requiring additional resources and dedicated staff. Studies of office/hospital-based telemedicine suggest that telemedicine is most effective for verbal interactions, e.g. videoconferencing for diagnosis and treatment neurology and psychiatry.	Outside of a small number of clinical specialties, the evidence base for the efficacy of telemedicine is weak. Further well-designed and targeted research that provides high quality data will provide a strong contribution to understanding how best to deploy technological resources in health care.

Demiris and Hensel [32]	Older people, people with disabilities	Europe, USA, Asia	Smart home	Behavioural, Health, Safety, Social, Physiological and functional	Twenty-one projects included (drawing on 114 publications). A table is presented with their technologies, target audience, technologies and different outcome. A lack of evidence on clinical outcomes is identified.	Most of the studies demonstrate the feasibility of the technological solution. Technical, ethical, legal, clinical, economical and organisational implications and challenges need to be studied in-depth for the field to grow further.
Hailey et al. [44]	Cancer	United States, Canada, Denmark, Finland, Spain, UK	Comparing a wide range of interventions	Cost/economic, Health, Perception/satisfaction, Social	Fifty-four studies included. Positive findings from higher-quality studies suggested that telephone-based technology was effective for promoting mammography and colposcopy in specific populations, for increasing fruit and vegetable consumption, and as an alternative to in-person support groups for women with breast cancer. Eight economic assessments provided some indications of cost advantages in diagnosis and treatment, and in palliative care. 20 papers reported patient and family satisfaction. However, the significance and generalisability of these findings appears limited.	From the perspective of the Alberta Cancer Board, the literature suggests some useful possibilities for developing new services using internet or web-based, telephone-based, and video-based technologies for cancer patients in rural areas. However, it seems likely that these applications would need validation with suitable local studies.
Linton [62]	Anxiety and depression	Not specified	Computer-based cognitive behavioural therapy (CBT)	Behavioural, Cost/economic, Ethical issues, Health, Perception/satisfaction, self-assessment	Twelve studies included. The paper investigates what effects and costs are associated with computer-based CBT in treating adult patients with anxiety disorders or depression.	There is limited scientific evidence indicating that computer-based CBT has favourable, short-term effects on symptoms in the treatment of panic disorder, social phobia, and depression. The scientific evidence is insufficient to assess the effects of treatment on obsessive-compulsive disorder and mixed anxiety/depression. The scientific evidence is insufficient to assess the cost-effectiveness of the method.

Table 3 (Continued)

Reference	Conditions included	Geographic area	Service/ intervention	Outcome	Authors' summary of results	Authors' conclusions
Mathur et al. [63]	Diabetes	Not stated	Evaluation	Feasibility/pilot, Health	Fourteen studies included. Marked variability in operational design of programs and poor rationalization of choice of outcome metrics with program components found.	Causal pathways in decline of HbA1c remain unclear, even though 11 of 14 studies showed decline. The authors recommend a standardized methodology for analyzing communications technology use in diabetes care.
Walters et al. [64]	Smoking cessation	Worldwide	Web and computer-based programmes	Behavioural	Nineteen studies included. 47% of included studies reported statistically significant or improved outcomes at the longest follow-up, relative to a comparison group.	Few patterns emerged in terms of subject, design or intervention characteristics that led to positive outcomes. The 'first generation' format, where participants were mailed computer-generated feedback reports, was the modal intervention format and the one most consistently associated with improved outcomes.
Lintonen et al. [65]	Promotion of health	Global	Emerging information and communications technology, especially the internet	Classified uses of IT generally	Fifty-six papers included. Using the papers studied, the authors classified IT in health promotion: IT as an intervention medium; IT as a research focus; IT as a research instrument and IT for professional development.	IT in health promotion is only just emerging. While a lot of health promotion information is provided over internet, little published research exists on its use and usefulness.
Van Nooten et al. [66]	All	Not stated	Spiritual care	Information, assessments, theories of role of spiritual care and interventions	Eighteen studies included (17 articles and one book). There are very few systematic studies on use of Internet for spiritual care as e-health. Four different categories of spiritual and religious care are identified: information search, assessments, theories and interventions.	No systematic studies were found on how ICTs are being used to integrate religious and spiritual care into healthcare.
Jaana et al. [90]	Cardio-vascular (hypertension)	USA, Europe, Japan, Israel, Malaysia	Remote monitoring	Behavioural, Cost/economic, Feasibility/pilot, Blood pressure control	Fourteen studies included. The studies present evidence on the positive impacts of telemonitoring on patients and their condition: significant BP control, better medication adherence, changes in patient lifestyle and attitudes. The studies were considered limited because of study designs. Little is known on the effects of telemonitoring on services utilization. Only one study demonstrated a detailed cost-effectiveness analysis.	Preliminary evidence exists on benefits. However, limited information exists on effects of utilization and economic viability. Future studies should include both RCT's and research to understand processual conditions and mechanisms through which BP control is achieved. (Formative evaluations).

Table 4 – Emerging issue 1: economic analysis.

Reference	Conditions included	Geographic area	Service/intervention	Outcome	Authors' summary of results	Authors' conclusions
Rojas and Gagnon [67]	All	Worldwide	Telehomecare (THC)	Cost/economic, Health, Perception/satisfaction	Twenty-three studies included. THC was found to be a cost-effective alternative to traditional approaches in 91% of the studies. Main benefits included decreased hospital utilisation; improved patient compliance with treatment plans; improved patient satisfaction with health services and improved quality of life.	The authors argue that one of the major disadvantage is of THC studies has been the failure to adopt a set of common indicators to calibrate their cost-effectiveness.
Gaikwad and Warren [34]	Chronic disease	Not stated	Home based ICT interventions	Behavioural, Cost/economic, Health, Perception/satisfaction	Twenty-seven studies included. These systems can improve functional and cognitive patient outcomes in chronic disease and reduce costs. However, the research is not yet sufficiently robust.	Telecare, telehealth etc. have positive clinical and cost outcomes – although studies are few in number and heterogeneous. Better evidence-based outcome measures are needed, especially regarding costs and physician perspectives.
Seto [68]	Heart failure	Worldwide	Remote monitoring	Cost/economic	Eleven studies included. The author considered a variety of direct and indirect cost categories including costs to the health system and costs to the patient. These are described.	Telemonitoring has a positive role to play in reducing costs by reducing re-hospitalisation and travel costs.
Tran et al. [25]	Diabetes, heart failure, COPD and other chronic diseases	Canada focused, but international publications included	Home telehealth	Cost/economic, Health, Perception/satisfaction	Seventy-nine studies included. Of the included studies, 26 pertained to diabetes, 35 to chronic heart failure, nine to COPD, and eight to mixed chronic diseases. The comparator “no care” was not identified in any of the included studies, so usual care was used as the comparator throughout the clinical review. Home telehealth appeared generally clinically effective and no patient adverse effects were reported. Evidence on health service utilization was more limited, but promising. The economic review suggested cost-effectiveness, but the quality of studies was low.	Conclusions relate to the potential for home telehealth in Canada which is seen as positive. However, more research, such as multicentre RCTs, is warranted to accurately measure the clinical and economic impact of home telehealth for chronic disease management to support Canadian policy makers in making informed decisions.

Table 4 (Continued)

Reference	Conditions included	Geographic area	Service/intervention	Outcome	Authors' summary of results	Authors' conclusions
Azarmina and Wallace [31]	All	All countries	Remote interpretation in medical encounters	Cost/economic Feasibility/pilot, Health, Organizational, Perception/satisfaction, Safety	Nine studies included. Results showed that time between encounters was reduced, but evidence on consultation length was not consistent. Good client and doctor satisfaction was shown, but those interpreting data preferred to do so face to face. Costs of these interventions are high, but efficiency gains are possible.	The review suggests that remote interpretation is an acceptable and accurate alternative to traditional methods, despite the higher associated costs.
Barlow et al. [28]	Elderly people, chronic diseases	Worldwide	Home telecare	Behavioural, Health, Organizational, Safety	Sixty-eight RCTs and 30 observational studies with 80 or more participants included. Results show that the most effective telecare interventions appear to be automated vital signs monitoring (for reducing health service use) and telephone follow-up by nurses (for improving clinical indicators and reducing health service use). Evidence on cost-effectiveness is less clear, and on safety and security alert systems insufficient.	Having identified where there is evidence of effectiveness, and where it is lacking, the authors conclude that insufficient evidence does not amount to lack of effectiveness: more research is needed.
Deshpande et al. (synchronous telehealth) [69]	Chronic disease, CHF, psychological and neurological problems	All countries	Home telehealth, in real time	Behavioural, Cost/economic, Feasibility/pilot, Health, Perception/satisfaction, Safety, Social, Technology related	Thirty-one systematic reviews included (11 of high quality). Most reviews and most of the studies they review are low quality. The authors suggest that this illustrates the resource constraints for researchers and policy makers. Nevertheless, weak evidence that real-time telehealth can improve service access, user satisfaction and resource utilization is found. For patients with psychiatric and neurological conditions in remote areas, evidence of benefit is stronger.	Evidence is generally weak and studies of poor quality, but telehealth is nevertheless promising, especially in a Canadian context over a large geographical area.

Barak et al. [15]	Mental health	Not stated	Internet based psychotherapy	Behavioural, Health, Perception/satisfaction, Social	Sixty-four studies included services. The overall mean weighted effect size was 0.53 (medium effect), similar to the average effect size of traditional, face-to-face therapy. Comparison between face-to-face and Internet intervention across 14 studies showed no differences in effectiveness.	Internet based intervention as effective as face-to-face intervention.
Jackson et al. [40]	Diabetes	Not stated	Computer assisted interactive IT	Behavioural, Cost/economic, Health	Twenty-seven papers included (reporting 26 studies) Significant impacts on behavioural, clinical and structural levels.	There is growing evidence that emerging IT may improve diabetes care. Future research should characterize benefits in the long term, establish methods to evaluate clinical outcomes, and determine the cost-effectiveness.
Kaltenthaler et al. [70]	Mental health (depression and anxiety)	Worldwide	Computerised cognitive behavioural therapy (CCBT)	Cost/economic, Health, Perception/satisfaction, Safety	Twenty-four CCBT studies and one economic analysis included. There is some evidence for positive effects of CCBT, and of cost-effectiveness compared with usual care. The authors identify 'significant uncertainty' regarding whether the treatments should be adopted.	The authors identify a long list of needs for further research, including access to CBT, comparing CCBT with other interventions, CCBT via the internet, more RCT type studies, patient preferences, studies in GP settings and studies of co-morbidities.

Table 4 (Continued)

Reference	Conditions included	Geographic area	Service/intervention	Outcome	Authors' summary of results	Authors' conclusions
Linton [62]	Anxiety and depression	Not specified	Computer-based CBT	Behavioural, Cost/economic, Ethical issues, Health, Perception/satisfaction, Self-assessment	Twelve studies included. The paper investigates what effects and costs are associated with computer-based CBT in treating adult patients with anxiety disorders or depression.	There is limited scientific evidence (indicating that computer-based CBT has favourable, short-term effects on symptoms in the treatment of panic disorder, social phobia, and depression. The scientific evidence is insufficient to assess the effects of treatment on obsessive-compulsive disorder and mixed anxiety/depression. The scientific evidence is insufficient to assess the cost-effectiveness of the method.
Polisena et al. (chronic disease) [71]	Chronic disease	Worldwide	Home telehealth	Cost/economic	Twenty-two studies included. Home telehealth was found to be cost saving from the healthcare system and insurance provider perspectives in all but two studies, but the quality of the studies was generally low. An evaluative framework was developed which provides a basis to improve the quality of future studies to facilitate improved healthcare decision-making and an application of the framework is illustrated using data from an existing programme evaluation of a home telehealth program.	Current evidence suggests that home telehealth has the potential to reduce costs, but its impact from a societal perspective remains uncertain until higher-quality studies become available.
Griffiths et al. [72]	Many conditions – all involving the intervention	Sweden, United States, Australia, Canada, UK, Spain, Denmark, Italy, Netherlands, Japan	Internet delivery of healthcare interventions	Reasons for use, reflections	Thirty-seven studies included. These covered a range of health conditions. Reasons for Internet delivery included low cost and resource implications due to the nature of the technology; reducing cost and increasing convenience for users; reduction of health service costs; overcoming isolation of users; the need for timely information; stigma reduction; and increased user and supplier control of the intervention.	Internet delivery may have unintended consequences. It may overcome isolation by time, mobility, and geography, but it may not be a substitute for face-to-face contact. Costs to service users and their social networks as well as providers need to be considered. Reasons for choosing internet delivery must be made clear. Internet delivery needs to be compared with other modes of delivery.

Table 5 – Emerging issue 2: is telemedicine good for patients?

Reference	Conditions included	Geographic area	Service/ Intervention	Outcome	Authors' summary of results	Authors' conclusions
Akesson et al. [73]	All	Worldwide	Support, education/ information/ virtual consultation	Behavioural, Feasibility/pilot, Health, Perception/satisfaction, Quality of life	Twelve studies included. Three themes identified: support and help, education and information, and telecommunication instead of on-site visiting. Findings show consumers feeling more confident and empowered, with increased knowledge and improved health status due to the ICT resources. Lack of face-to-face meetings or privacy did not appear to be a problem.	ICT can improve the nurse-patient relationship and augment well-being for consumers. More research is needed to measure consumers' experiences and factors that influence it.
Kairy et al. [74]	Physical disabilities	Not stated	Telerehabilitation	Behavioural, Cost/economic, Health, Perception/satisfaction, Social	Twenty-eight studies included. Clinical outcomes were generally improved; clinical process outcomes were high; consultation time was longer; patient satisfaction ratings were high. Healthcare utilization evidence was unclear. There is some evidence of potential cost savings.	While evidence is mounting concerning the efficacy and effectiveness of telerehabilitation, high quality evidence regarding impact on resource allocation and costs is still needed to support clinical and policy decision-making.
Murray et al. [75]	Chronic disease	Not stated	Interactive health communication Applications (IHCA)	Behavioural, Health	Twenty-four studies included (RCTs). Computer-based programmes ('Interactive Health Communication Applications') for people with chronic disease had a significant positive effect on knowledge, social support, and clinical outcomes. Results suggest it is more likely than not that IHCAs have a positive effect on self-efficacy. IHCAs had a significant positive effect on continuous behavioural outcomes. Binary behavioural outcomes also showed a positive effect for IHCAs, although this result was not statistically significant. It was not possible to determine the effects of IHCAs on emotional or economic outcomes.	IHCAs appear to have largely positive effects on users, in that users tend to become more knowledgeable, feel better socially supported, and may have improved behavioural and clinical outcomes compared to non-users. There is a need for more high quality studies with large sample sizes to confirm these preliminary findings, to determine the best type and best way to deliver IHCAs, and to establish how IHCAs have their effects for different groups of people with chronic illness.

Table 5 (Continued)

Reference	Conditions included	Geographic area	Service/ Intervention	Outcome	Authors' summary of results	Authors' conclusions
Deshpande et al. (syn-chronous telehealth) [69]	Chronic disease	All countries	Home telehealth, in real time	Behavioural, Cost/economic, Feasibility/pilot, Health, Perception/satisfaction, Safety, Social, Technology related	Thirty-one systematic reviews included (11 of high quality). Most reviews and most of the studies they review are low quality. The authors suggest that this illustrates the resource constraints for researchers and policy makers. Nevertheless, weak evidence that real-time telehealth can improve service access, user satisfaction and resource utilization is found. For patients with psychiatric and neurological conditions in remote areas, evidence of benefit is stronger.	Evidence is generally weak and studies of poor quality, but telehealth is nevertheless promising, especially in a Canadian context over a large geographical area.
Koch [76]	Chronic diseases, elderly population, paediatrics	Country and no of publications: USA 238; UK 52; Japan 39; Germany 31; Greece 22; Australia 20; Canada 18; France 17; Spain 17; China 14; Italy 14; Sweden 13; Finland 6; other 77	Home telehealth	Cost/economic, Perception/satisfaction, Feasibility/pilot, Health, Organizational, Technology related	Five hundred and seventy-eight studies included. 44% of publications come from the United States, followed by UK and Japan. Most cover vital sign parameter (VSP) measurement and audio/video consultations. Publications about IT tools for improved information access and communication as well as decision support for staff, patients and relatives are relatively sparse. Clinical application domains are mainly chronic diseases, the elderly population and paediatrics.	Internationally, we observe a trend towards tools and services not only for professionals but also for patients and citizens. However, their impact on the patient—provider relationship and their design for special user groups, such as elderly and/or disabled needs to be further explored. In general, evaluation studies are rare and further research is critical to determine the impacts and benefits, and limitations, of potential solutions and to overcome a number of hindrances and restrictions, such as the lack of standards to combine incompatible information systems; the lack of an evaluation framework considering legal, ethical, organisational, clinical, usability and technical aspects; the lack of proper guidelines for practical implementation of home telehealth solutions.
Lauriks et al. [77]	Dementia	No limits	ICT-based interventions	Health, Perception/satisfaction, Social, Technology related	Forty-six publications and 22 websites included. Needs identified are generalized and personalized information; support with regard to symptoms of dementia; social contact and company; health monitoring and perceived safety.	Information is generally not personalised and is not attuned to the person with dementia; ICT solutions aimed at compensating for disabilities demonstrate that people with mild to moderate dementia can handle simple electronic equipment and can benefit from it. Instrumental ICT-support for coping with behavioural and psychological changes in dementia is relatively disregarded as yet, while support for social contact can be effectively realised through, for example, simplified (mobile) phones. GPS technology and monitoring systems are proven to result in enhanced feelings of safety and less fear and anxiety.

Table 6 – Asking new questions.

Reference	Conditions included	Geographic area	Service/ intervention	Outcome	Authors' summary of results	Authors' conclusions
Mo et al. [78]	All	Not stated	Online support groups	Behavioural, Health, Outcome of posted messages used to categorise gender differences	Twelve studies included. Half of the studies examined gender differences by comparing male and female cancer discussion boards. Some gender differences were observed in these studies. However, for studies that analysed mixed-gender communities, gender differences were less evident.	Results seemed to reveal gender differences in communications in single-sex online health support groups, and similarities in communication patterns in mixed-sex online health support groups. However, findings should be treated with caution due to the diversity in studies and methodological issues highlighted in the present review.
Price et al. [79]	Stroke	Oceania, Asia, Europe, North America, Europe	Service configurations	Safety, Activity level and response times for thrombolysis treatment	Fifty-four studies included. Local service configuration provides less thrombolysis activity than wider collaborations and report as many protocol violations despite their simpler design. Local variations in population density, geography, experts and activity and safety data reporting formats makes it difficult to compare service configurations. Reporting of activity and safety in a standardised format is urged.	Stroke services should continue to publish thrombolysis activity and safety data in a recommended format in order to determine the most suitable configuration for different settings.
Deshpande et al. (stroke management) [80]	Stroke	US, Canada, Germany, Italy, Netherlands, China	Acute medicine	Cost/economic, Feasibility/pilot, Health, Perception/satisfaction, Technology related	Twenty-two studies included (eight of high quality). Results showed improved access to thrombolysis, acceptable times between hospital arrival and thrombolysis, and decreased need to transfer patients across institutions. Mortality rates, and three and six month functional outcomes were comparable with those of face-to-face stroke care. Mortality rates were also similar. Patients and provider satisfaction was high, though not assessed in detail.	Although it is difficult to draw conclusions from this small sample of studies, the trend suggests that in post-stroke patients, telehealth led to improvements in caregivers' mental health and high levels of patient satisfaction. There was minimal evidence regarding the impact on resource utilization.

Table 6 (Continued)

Reference	Conditions included	Geographic area	Service/ intervention	Outcome	Authors' summary of results	Authors' conclusions
Sood et al. [81]	All	Not stated	All	Definitions of telemedicine	Hundred and four studies included, which generate 104 definitions. The authors identify four types of definition: (1) Medical: mention of “providing healthcare services”. (2) Technological: indication of technology's role. (3) Spatial: “geographical separation of patient and doctor” pertains to or involves nature of space/distance. (4) Benefits: medical care is brought to people when it is not feasible to get people to medical care.	The article provides formative evaluation by classifying the different approaches to defining telemedicine and their underlying theoretical assumptions.
Pineau et al. (telepsychiatry) [20]	Psychiatric conditions (adult and pediatric)	Not stated Focus on Canada and USA	Telepsychiatry	Cost/economic, Ethical issues, Legal, Organizational, Technology related, clinical guidelines and technical standards	‘About 60’ studies included. The authors argue that definition of clinical guidelines and technological standards aimed at standardizing telepsychiatric practice will promote its large scale implementation.	The review concludes that telepsychiatry should be implemented in Québec and provides detailed clinical and technical guidelines for implementation. They add that taking into account human and organizational aspects plays a part in ensuring the success of this type of activity; that legal and ethical aspects must also be considered; and that a detailed economic analysis should be carried out prior to any large investment in telepsychiatry. Finally, implementation of psychiatry should be subjected to rigorous downstream assessment in order to improve management and performance.
Pineau et al. [82]	Multiple conditions	References in English. Focus on Canada and USA	Telerehabilitation	Cost/economic, Ethical issues, Legal, Organizational, Technology related, clinical guidelines and technical standards	Unspecified number of studies included. The review offers clinical and technical guidelines for telerehabilitation implementation.	The review concludes that telerehabilitation should be implemented in Québec and provides detailed clinical and technical guidelines for implementation. They add that taking into account human and organizational aspects plays a part in ensuring the success of this type of activity; that legal and ethical aspects must also be considered; and that a detailed economic analysis should be carried out prior to any large investment in telerehabilitation. Finally, implementation of telerehabilitation should be subjected to rigorous downstream assessment in order to improve management and performance.

Table 7 – Included reviews not cited in the paper.

Reference	Conditions included	Geographic area	Service/ intervention	Outcome	Authors' summary of results	Authors' conclusions
Bonacina et al. [84]	Telecardiology	No mention	Systematic review (methodology paper)	Methodology development	Sixty-one studies included. Most literature related to pilot projects, feasibility studies and short-term outcomes. The analysis is used to develop a method of classifying scientific publications to assess the evidence they contain so that it can be used.	This is a methodological study suggesting a framework for evaluation of literature on telemedicine.
Christensen et al. [85]	Anxiety and depression	Not mentioned	Open access websites which deliver cognitive and behavioural interventions	Behavioural outcomes	Twenty-three studies included. All were RCTs. Data included dropout and adherence, predictors of adherence and reasons for dropout. Relative to reported rates of dropout from open access sites, the study found that the rates of attrition in randomized controlled trials were lower, ranging from approximately 1–50%. Predictors of adherence included disease severity, treatment length, and chronicity. Few studies formally examined reasons for dropout, and most failed to use appropriate techniques to analyze missing data.	Dropout rates from randomized controlled trials of Web interventions are low relative to dropout from open access websites. The development of theoretical models of adherence is as important in the area of Internet intervention research as it is in the behavioural health literature.
Clarke and Thiyagara-jan [86]	None (technical)	Not described	Evaluation	Technology related	Forty-seven studies included. The analysis was unable to identify a 'definitive, standards based telemedicine technical evaluation framework.	Work needs to be done to address the deficiency identified.
Demiris [87]	Many conditions (also professional groups)	USA, UK, Scandinavia	Not about interventions – focus is development of electronic communities	Ethical issues, Policy, Defining features of a complex intervention	Forty-seven studies included. Virtual communities in health care cover a wide range of clinical specialties, technologies and stakeholders. They include peer-to-peer networks, virtual health care delivery and research teams. Ethical challenges include identity and deception, privacy and confidentiality. Technical issues include sociability and usability.	Virtual communities may empower patients and enhance coordination of care services; however, there is not sufficient systematic evidence of the effectiveness of virtual communities on clinical outcomes or patient empowerment. Researchers need to address issues, such as sample sizes and experimental design to further the research field in this domain.

Table 7 (Continued)

Reference	Conditions included	Geographic area	Service/ intervention	Outcome	Authors' summary of results	Authors' conclusions
Marziali et al. [91]	Older people with unspecified conditions	North America and Europe	Home telehealth (ethical issues)	Ethical issues	Hundred and seven studies included. Studies show lack of information about ethics and professional practice. Where these issues are explored, this is done to a limited extent. Peer-reviewed work is more likely to consider these issues.	That studies of telemedicine have addressed issues of ethics and professional practice to a limited extent and that these are not well documented.
Oh et al. [92]	All	No mention	Evaluation (definitions)	Organizational, Perception/satisfaction, Policy, Technology related, Definitions of eHealth	Thousand two hundred and nine abstracts scanned, 430 citations reviewed, 1158 Google sites reviewed. 51 unique definitions were retrieved, showing a wide range of themes, but no clear consensus about the meaning of the term eHealth. Two universal themes (health and technology) were identified and six less general (commerce, activities, stakeholders, outcomes, place, and perspectives).	The widespread use of the term eHealth suggests that it is an important concept, and that there is a tacit understanding of its meaning. This compendium of proposed definitions may improve communication among the many individuals and organizations that use the term.
Scott et al. [93]	All	Canada, USA, New Zealand, Europe	All (focus is on identifying agreed outcome indicators)	Behavioural, Cost/economic, Ethical issues, Health, Legal, Organizational, Perception/satisfaction, Policy, Safety, Social, These were grouped	Two hundred and eighteen studies included. A key objective of the NTOIP was to identify and describe outcome indicators that had been used to evaluate telehealth projects for quality, access, acceptability and cost. The findings show that the situation is complex and confusing, but that recommendations can be made.	The study was not considered as an end in itself, but rather the beginning of a continuing process of telehealth evaluation and research in Canada and elsewhere. That is, the ongoing quest for identification of a small number of appropriate outcome indicators (as well as their related outcome measures and outcome tools), their consistent description and their consistent application in future evaluations. This initiative suggests that the importance of evaluation and of consistent use of indicators is understood.

Appendix B. Supplementary data

Supplementary data associated with this article can be found, in the online version, at [doi:10.1016/j.ijmedinf.2010.08.006](https://doi.org/10.1016/j.ijmedinf.2010.08.006).

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