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Remote Care Technology: A Systematic Review of Reviews and Meta-Analyses †

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Abstract: Objectives—To identify the technologies that are being used in the remote care of patients with chronic conditions, and their most relevant outcomes. Methods—A systematic review of reviews and meta-analyses. Results—Fifty-one systematic reviews and meta-analyses related to diabetes, congestive heart failure, chronic obstructive pulmonary disease, mental and behavioral diseases, cancer, hypertension, asthma, multiple sclerosis, chronic renal disease, and obesity were retrieved; these studies compared the use of remote care technology with usual care. Conclusion—Remote care technology has positive effects in various health-related outcomes, but further research is required to allow its use in clinical practice.

Keywords: remote care technology; home monitoring; chronic diseases

1. Introduction

Researchers and practitioners are challenged to find efficient and effective technological solutions to meet the needs of citizens and promote healthcare reorganization [1], which are the aims of concepts such as medicine 2.0 [2], connected health [3], and holistic health [4,5]. In particular, remote care technology might promote healthcare personalization and the self-management of patients with chronic conditions.

A broad analysis of the state-of-the-art of remote care technology is useful to advise patients and their relatives, practitioners, and researchers. Therefore, the study reported in this article—a secondary analysis of the results reported in Queirós et al. [6], consisting of a systematic review of reviews and meta-analyses aiming to systematize current evidence on remote care technology—was informed by the following research question: what technologies and applications are being used in the remote care of chronic patients, and what are their most relevant outcomes?

2. Methods

To identify systematic reviews and meta-analyses related to technological solutions that can be used to support patients living with chronic conditions (i.e., inclusion criteria), two general databases (i.e., Web of Science and Scopus) and two specific databases (i.e., PubMed, a medical sciences database, and IEEE Explorer, a technological database) were searched. Moreover, the performed queries intended to include [6]: (i) all of the reviews where any of the keywords 'telecare', 'telehealth', 'telemedicine', 'homecare', 'telemonitoring', 'home monitoring', 'remote monitoring´, ehealth´, 'telerehabilitation', 'mobile health', 'mhealth', or 'assisted living' were presented in the title or abstract; and (ii) all of the reviews where any of the keywords 'technology-based', 'information technology', 'information and communication', 'internet-based', 'web-based', 'on-line', 'smartphones', 'mobile apps', 'mobile phone', 'monitoring devices', or 'consumer health information' were presented in the title or abstract together with any of the keywords 'healthcare', 'health care', 'patient', 'chronic disease', 'older', or 'elderly'. The search was performed on 30 April 2016, and included reviews published during the preceding 10 years.

Considering the exclusion criteria, the authors excluded systematic reviews or meta-analyses not publish in English, or reporting solutions that: (i) targeted long-term health conditions not related to adult patients (e.g., pediatric conditions); (ii) did not target the patients (i.e., studies that are clinician-focused or are intended primary to deal with the problems of caregivers rather than the patients); (iii) were designed to be used in an institutional environment, rather than the domicile of the patients; and (iv) were not relevant for the objective of this study.

After the removal of duplicates and articles not published in English, the analysis of the remainder articles was performed by two authors in three steps: (i) first, the authors assessed all of the titles for relevance, and those clearly not meeting the inclusion criteria were removed; (ii) afterwards, the abstracts of the retrieved articles were assessed against the inclusion and exclusion criteria; and (iii) finally, authors assessed the full text of the articles according to the outlined inclusion and exclusion criteria. In each of these three steps, any disagreement between the two authors was discussed and resolved by consensus.

The following characteristics of the retrieved articles were extracted: (i) authors, title, and year of publication; (ii) aims of the review or meta-analysis; iii) target chronic disease; (iv) technologies used; (v) search strategy; (vi) inclusion and exclusion criteria; (vii) quality assessment; (viii) data extraction procedure; (ix) total number of primary studies; (x) total number of random clinical trials (RCT); (xi) total number of participants; (xii) primary outcomes; (xiii) secondary outcomes; (xiv) author's interpretations; and (xv) author's conclusions. The relevant data were extracted and recorded independently by two authors. Once more, any disagreement between the two authors was discussed and resolved by consensus.

3. Results

A total of 2681 articles was retrieved from the initial searches on PubMed (822 articles), Web of Science (1263 articles), Scopus (550 articles), and IEEE Explorer (46 articles). The initial screening yielded 1429 articles by removing the duplicates (1210 articles), or the articles without abstracts or without the names of the authors (42 articles). After exclusions based on title alone, 563 articles were retrieved. Additionally, 315 articles were eliminated based upon review of their abstracts. The full texts of the 248 remaining articles were assessed against the inclusion and exclusion criteria, and 197 articles were removed. Fifty-one systematic reviews and meta-analyses were retrieved for this systematic review, and their scope and number of RCT versus number of primary studies are presented in Table 1.

Table 1. Scope of included systematic reviews and number of random clinical trials (RCT) versus the number of primary studies of the retrieved studies (RCT/*n*).

Ref.	Scope	RCT/*n*
[7]	Determination of how emerging interactive information technology has been used to enhance care for patients with type 2 diabetes.	14/26
[8]	Assessment of the value of home monitoring for congestive heart failure patients.	13/42
[9]	Examination of home monitoring interventions for congestive heart failure patients.	9/9
[10]	Determination of whether home monitoring without regular clinic or home visits improves outcomes for patients with congestive heart failure.	14/14

Table 1. *Cont.*

Ref.	Scope	RCT/*n*
[11]	Determination of whether interactive technologies and videotapes for the education of congestive heart failure patient improves knowledge, satisfaction, or other outcomes.	9/9
[12]	Assessment of the effects of home monitoring of patients with diabetes at informational, clinical, behavioral, structural, and economical levels.	9/9
[13]	Determination of benefits and deficiencies of teleconsultation and videoconferencing regarding clinical, behavioral, and care coordination outcomes of diabetes care.	39/39
[14]	Assessment of home monitoring of congestive heart failure patients.	9/9
[15]	Analysis of the efficiency of telemedicine use in the management of depression.	10/10
[16]	Comparison of home telehealth with the usual care of patients with chronic obstructive pulmonary disease.	10/10
[17]	Comparison of home monitoring with the usual care of congestive heart failure patients.	9/9
[18]	Assessment of a treatment's efficiency via videoconferencing of patients with psychosis.	0/25
[19]	Determination of the benefits of using computer-based interventions to provide health education to patients with hypertension.	4/6
[20]	Assessment of a treatment's efficiency via videoconferencing of patients with psychosis.	2/6
[21]	Discussion of web-based behavioral interventions for the management of type 2 diabetes.	8/13
[22]	Assessment of the clinical effectiveness of mobile-based applications that allow1 patients to record and send their blood glucose readings.	24/24
[23]	Assessment of the effect of behavioral telehealth interventions in type 2 diabetes on glycemic control and self-management.	13/13
[24]	Analysis of computerized cognitive behavioral therapy's efficiency for insomnia.	6/533
[25]	Examination of whether the putative benefits of telehealth (i.e., improvements in clinical outcomes and quality of life) are mediated by increases in knowledge, self-efficacy, and the self-care behavior of congestive heart failure patients.	7/12
[26]	Assessment of the use of smartphone technology for the management of patients with type 2 diabetes.	7/7
[27]	Assessment of the interventions employing mobile technology for overweight and obese patients.	21/21
[28]	Assessment of the effectiveness of information technology to promote physical activity in people with type 2 diabetes.	15/15
[29]	Assessment of how information technology has been used to improve self-management for patients with diabetes.	60/104
[30]	Assessment of the effectiveness, cost-effectiveness, and feasibility of using smartphones and tablets to facilitate the self-management of patients with asthma.	2/2
[31]	Assessment of the effects on health status and quality of life of computer-based diabetes self-management interventions for patients with type 2 diabetes.	17/17
[32]	Assessment of the effects of self-management health information technology for glycemic control in patients with diabetes.	58/58
[33]	Assessment of behavioral change techniques in web-based self-management programs for type 2 diabetes patients.	13/13
[34]	Analysis of the evidence on the acceptability, feasibility, safety, and benefits of online and mobile-based interventions for psychosis.	0/12
[35]	Assessment of the effect of specific technologies on congestive heart failure management.	25/25
[36]	Assessment of the cost-effectiveness of telehealth interventions for congestive heart failure patients.	21/32

Table 1. *Cont.*

Ref.	Scope	RCT/*n*
[37]	Analysis of the efficiency of information technology for reminiscence therapy of patients with dementia.	0/44
[38]	Assessment of the effectiveness of remote care monitoring of congestive heart failure patients.	13/13
[39]	Assessment of whether the use of consumer health information technology improves outcomes in patient self-management of diabetes.	67/67
[40]	Understanding the ability of mobile health tools to offer glycemic control for patients with type 1 diabetes.	1/14
[41]	Assessment of the effect of supportive telehealth interventions on pain, depression, and the quality of life of patients with cancer.	20/20
[42]	Analysis of the effectiveness of telerehabilitation interventions in patients with multiple sclerosis.	10/12
[43]	Assessment of whether dietary mobile apps improve dietary intake and clinical outcomes in patients with chronic renal disease.	5/5
[44]	Assessment of the role of technology-enabled interventions to improve or enhance self-management among individuals with hypertension.	0/12
[45]	Assessment of the impact of interventions promoting the monitoring of medication use and brief messaging to support medication adherence in patients with type 2 diabetes.	11/11
[46]	Assessment of the effectiveness of mobile health interventions for diabetes.	0/1479
[47]	Definition of the conceptual components of information technology applications to empower cancer survivors.	3/26
[48]	Assessment of the effects of telecare intervention in patients with type 2 diabetes and inadequate glycemic control.	18/18
[49]	Assessment of the types of technology being used to facilitate type 2 diabetes self-management.	9/14
[50]	Determination of the general characteristics of web based self-management support interventions in cancer care.	34/37
[51]	Assessment of the effects of telehealthcare on physical activity level, physical capacity, and dyspnoea of patients with chronic obstructive pulmonary disease.	9/9
[52]	Assessment of the effectiveness of telemedicine in reducing adverse clinical outcomes of patients with chronic obstructive pulmonary disease.	12/12
[53]	Analysis of the evidence for using information technology to manage diabetes.	52/67
[54]	Assessment of computer-based psychological treatment's efficiency for depression.	19/40
[55]	Assessment of the effectiveness of glucose monitoring systems to facilitate regular healthcare provision to type 1 and type 2 diabetes patients.	22/22
[56]	Assessment of the effectiveness of interventions to change lifestyle behavior delivered via automated brief messaging in patients with type 2 diabetes.	13/13
[57]	Assessment of the effect of game-based interventions on HbA1c, diabetes-related knowledge, and physical outcomes in the rehabilitation of diabetes patients.	4/4

In general, the systematic reviews and meta-analyses compare remote care supported by technological solutions with usual care, and several clinical conditions were identified: diabetes, congestive heart failure, chronic obstructive pulmonary disease, mental and behavioral diseases, cancer, hypertension, asthma, multiple sclerosis, chronic renal disease, and obesity. For diabetes, congestive heart failure, chronic obstructive pulmonary disease, and hypertension, home monitoring is complemented with applications to empower the patients, while for the remainder of the pathologies, the studies mainly report applications to empower the patients without the home monitoring component.

3.1. Diabetes

Of the retrieved articles, 22 dealt with patients with diabetes and their aims are to evaluate whether remote care technology can increase patient adherence to best practice recommendations (e.g., glycemic control, dietary management, or physical activity). A significant number of articles focus on both type 1 and type 2 diabetes [12,13,22,29,32,33,39,46,48,53,55,57]. Other articles focus on type 2 diabetes [7,21,23,26,28,31,45,49,56]. Only one of the retrieved articles focused exclusively on type 1 diabetes [40].

Usually, the measurement of physiological parameters (e.g., glucose level or vital signs) are complemented with other information, such as weight, symptoms (e.g., episodes of hypoglycemia), or behaviors (e.g., pedometers and accelerometers to measure walking distances and other physical activities) [58].

Concerning the supporting technologies, monitoring devices are being used together with telephone calls, videoconferencing, interactive web-based applications, computer-based applications (i.e., computer-based management systems and computer-based education systems), smartphone applications, social media, and gaming applications:

- Structured phone calls: self-care education calls and the feedback of self-monitored information and automated telephone disease management calls to supplement nurses' follow-up calls [7,12,22,23,33,40,48,53].
- Videoconference: video conferencing of patients with clinicians to receive feedback of uploading physiological information [7,13,29,40].
- Interactive web applications: to support automated information transmission from monitoring devices or allow the patients to record and transmit their measurements and report symptoms and behaviors, as well as provide a learning course about diabetes management, comprehensive patient-specific diabetes summary status, individualized plans (e.g., exercise, medication, or healthy eating), nutrition and exercise logs, insulin records, or motivational messages (e.g., messages that highlight the benefits of exercise) [7,21,22,28,29,32,33,40,48,49,53,55].
- Computer-based management systems: to allow the uploading of monitoring information together with the feedback of clinical staff, electronic practice guidelines, goal-setting plans, and reminder messages [7,12,28,29,31,33,53].
- Computer-based education systems: multimedia interventions on diabetes self-management, including video stories, quizzes, and feedback [28].
- Public kiosks, such as kiosks installed in the waiting room area with audio/video sequences to communicate information, provide psychological support, and promote diabetes self-management skills without extensive text or complex navigation [39].
- Smartphone applications: to support self-care activities, namely by providing reminders (e.g., short text messages or 30–60 s video messages on diabetes self-care topics), the acquisition of clinical information (e.g., integrating glucometers with mobile devices for automatic glucose level upload), the acquisition of complementary information (e.g., symptoms, alarms medication, or diet counseling), or physical activity tracked by built-in motion sensors or accelerometers [12,22,23,26,28,29,39,40,45,46,48,49,53].
- Social media: to provide peer support and education online, mostly through moderated forums [29].
- Gaming applications: to promote changing behavior (e.g., physical activity) [57].

In general, the studies dealing with diabetes mentioned glycosylated haemoglobin (HbA1c) as an outcome measure. Other clinical outcomes include weight, anxiety, or depression (e.g., PHQ-9 questionnaire scores), episodes of hypoglycemia, and quality of life. In parallel with clinical outcomes, there are other outcomes being considered, namely: care knowledge, self-management efficacy, patient self-motivation, behavior outcomes (e.g., prescribed medication adherence, diet and healthy eating, or physical activity) and care coordination (e.g., patient–clinician communication, cost-effectiveness, transparency of services provision, or equity of care access) [13,21,23,26,28,29,33,45,46,49,53,56,57].

Most of the studies reported a moderate to large reduction of HbA1c when compared with usual care, but computer-based self-management interventions appear to have small beneficial effects [31]. The retrieved articles also report that remote care technology is linked to positive outcomes for self-efficacy and health behavior changes, particularly in terms of the promotion of physical activity [28].

3.2. Congestive Heart Failure

Nine of the 51 retrieved articles reported on studies related to congestive heart failure [8–10,14,17,25,35,36,38]. The typical clinical parameters being measured (usually in a daily basis) were blood pressure, weight, heart rate, and oxygen saturation. However, other parameters were also considered in specific studies [25,58]: dyspnoea, asthenia, oedema, blood urea nitrogen, creatinine, sodium, potassium, and bilirubin.

The studies reported different types of technologies to collect and transmit clinical parameters, which might be complemented with additional information related to symptoms and behaviors. These technologies include:

- Monitoring devices.
- Structured phone calls to collect physiological information and symptoms [9,10,25,36].
- Interactive voice response [25] to help the patient record the relevant information.
- Videoconference to allow communication between patients and clinical staff [25].
- Computer-based applications for the measurement and automated transmission of body weight, arterial blood pressure, and heart rating, together with recording the answers to questionnaires about systems and behaviors [8].
- Interactive web applications allowing the automatic transmission of monitoring information, as well as the patients entering clinical information measurements, and additional information to be reviewed by clinicians at a later time [9,14,25,36,38].

In addition, there are studies reporting some form of health education [36], which is usually delivered by telephone calls, videoconferencing, computer-based applications, and interactive web-based applications.

The main concerns related to the clinical outcomes are the impact of remote care technology in heart failure-related hospitalizations and all-cause mortality when compared with usual care. However, several secondary outcomes are also considered, such as quality of life, perception of isolation, improvement in therapy, self-care behavior (e.g., adherence to prescribed medication, daily weighing, or adherence to exercise recommendations) and structural outcomes (e.g., acceptability by patients and health professionals, or impact in organizations and healthcare costs).

According to the retrieved articles, remote care technology has a positive effect on the clinical outcomes of congestive heart failure: it reduces mortality when compared with usual care, and it also helps to lower both the number of hospitalizations and the use of other healthcare services. Furthermore, there are also evidence that rapid-intervention models (those where healthcare practitioners are actively involved in patient monitoring) can enhance the efficacy of remote care [38]. However, there is a difficulty in capturing all of the consequences and effects of remote care interventions in congestive heart failure, and full economic analyses of cost-effectiveness are required [36].

3.3. Chronic Obstructive Pulmonary Disease

All of the retrieved articles dealing with chronic obstructive pulmonary disease analyze RCT primary studies [16,20,51,52]. In particular, three of them considered RCT as one of the inclusion criteria [16,20,52]. The retrieved articles dealing with chronic obstructive pulmonary disease report that remote care is supported by devices that are able to measure and transmit different types of information (e.g., weight, temperature, blood pressure, oxygen saturation, spirometry parameters, symptoms, medication usage, or steps in a six-minute walking distance) [58]. In some cases, the automatic information acquisition is complemented by clinical staff using questionnaires in telephone interviews, and videoconferencing can also be used to provide feedback to the patients. Two studies reported the use of videoconferencing [51,52]; one study reported the use of computer-based applications [51], and four studies reported the use of smartphone applications [16,20,51,52].

In terms of clinical outcomes, remote care is compared with usual care, considering mortality, admissions to hospital, or other healthcare utilization outcomes. Additional outcomes include, among others, quality of life, patient satisfaction, physical capacity, and dyspnoea. In terms of results, remote care was found to reduce rates of hospitalization and emergency department visits, while the findings related to hospital bed days of care varied between studies [16,20,52]. However, one study [16] reported greater mortality rates in a telephone-support group compared with usual care. Additionally, there is evidence that remote care has a positive effect on physical capacity and dyspnoea [51], and it is similar or better than usual care in terms of quality of life and patient satisfaction outcomes [16].

The evidence systematized by the articles of the category related to chronic obstructive pulmonary disease does not allow drawing definite conclusions, as the studies are small. The benefit of remote care for patients with chronic obstructive pulmonary disease is not yet proven, and further research is required before wide-scale implementation can be supported.

3.4. Mental and Behavioral Disorders

Concerning mental and behavioral disorders, six studies were retrieved: two studies [18,34] reported on the use of videoconferencing [18] and interactive web-based applications [34] to support people with psychosis; two studies [15,54] reported on the use of videoconferencing [15], interactive web-based applications [15], and computer-based applications [54] to support patients with depression; one study reported on the use of computer-based applications [24] to support patients with insomnia, and another study reported on the use of interactive web-based applications and computer-based applications [37] to support patients with dementia.

In respect of the use of interactive web-based applications, the participation of patients with psychosis for the purposes of social networking varied across studies [34,59]. Concerning the use of videoconference to treat patients with psychosis, findings generally indicated that clinical rating scales, psychiatric interviews, and diagnostic assessments could be reliably conducted using videoconferencing, and are generally equivalent to those performed face-to-face [18].

In terms of patients with depression, there is evidence that supports the effectiveness of different treatments for depression and highlights participant satisfaction, but there is insufficient evidence regarding the effectiveness of self-help computer-based and interactive web-based applications to help the management of depression [15,54].

When dealing with patients with insomnia, the respective study reported significant effects on sleep quality, sleep efficiency, the number of awakenings, sleep onset latency, the Insomnia Severity Index, and treatment adherence rate [24].

Finally, one study report on the use interactive web-based applications and computer based applications to support people with dementia, and promote their participation and social interactions (e.g., to take ownership of conversations) [37]. However, the high variability of the primary studies' design and respective aims made a quantitative determination of how different aspects of might contribute very difficult [37].

3.5. Cancer

The empowerment of patients with cancer can contribute to them being autonomous, having knowledge or psychosocial and behavioral skills, and receiving support from their community, family, and friends [47,59]. In this respect, the retrieved reviews dealing with cancer [11,41,47,50] reported on the use of technological solutions to support knowledge transmission (e.g., electronic survivorship care plans, patient-to-patient and patient-to-caregiver communication, and electronic patient-reported outcomes [47]), to promote illness education (e.g., facilitating the selection of treatment options), and to facilitate the control of symptoms such as pain, fatigue, anxiety, and depression.

Technological solutions such as telephone calls [11,41,47,50], videotapes, computer-based applications, interactive web-based applications, and smartphone applications are being used for symptoms monitoring (e.g., keeping a diary or asking questions to clinicians), counseling, educational services to provide information related to treatment (e.g., helping to cope with symptoms or improving decision-making), management services to order medication and keep appointments, as well as online groups or bulletin boards to promote patient-to-patient support (e.g., to share experiences).

The adoption of remote care technology was found to be effective in different healthcare outcomes, namely, pain, depression, anxiety, quality of life, knowledge, and satisfaction. However, the findings suggest that the application of remote care technology in cancer care is still at a very early stage, and is mostly utilized in developed countries [41].

3.6. Hypertension

Two articles [19,44] reported on the use of remote care technology to support patients with hypertension. Usually, the patients measure their blood pressure at home, which might be transmitted using different types of technologies (which can also be used for education):

- Telephone-based or videoconference telemonitoring and education [44].
- Computer-based applications and computer-based education interventions to promote knowledge, self-efficacy, and healthy behaviors [19].
- Internet-based telemonitoring and education [44].
- Kiosks with monitoring devices [44].

Several outcomes are being considered, namely: the burden of high blood pressure (systolic and diastolic), mean 24-h systolic and diastolic blood pressure, daytime and nocturnal systolic and diastolic blood pressure, fasting blood glucose, fasting lipid levels, depression, medications, weight, dietary, physical activity, quality of life, satisfaction with care, knowledge, and self-efficacy. The retrieved articles reported on an improvement in the proportion of participants with controlled blood pressure compared with those who received usual care, but more interventions are required, and the cost-effectiveness of the intervention should also be assessed [19,44].

3.7. Other Chronic Conditions

The use of technological solutions to support patients with asthma, multiple sclerosis, chronic renal disease, and obesity was also the object of systematic reviews and meta-analyses.

One study considered that remote interventions, including the use of smartphone applications designed for smartphones and tablets, are well-accepted for the care of patients with asthma, and increase their self-care behaviors [30]. A second study, related to the use of interactive web-based applications and videoconferencing for the telerehabilitation of people with multiple sclerosis [42], highlighted the lack of methodologically robust trials. A third article showed the potential clinical benefits of dietary interventions based on smartphone applications for chronic renal patients, although there is a need for additional robust trials [43]. Finally, a fourth article aimed to analyze the impact of smartphone applications targeting overweight or obese people, and concluded that when exclusively considering the use of mobile technologies (21 RCT), a significant reduction in weight was observed [27].

4. Discussion and Conclusions

According to the findings of the systematic reviews reported in this article, diabetes, congestive heart failure, chronic obstructive pulmonary disease, mental and behavioral disorders, and cancer are the most relevant chronic diseases in regard to the use of remote care technology.

Diabetes requires the constant monitoring of glucose levels and patient adherence to best practice recommendations, as well as engagement and participation [36]. Congestive heart failure has a high rate of hospital readmission [60]. Key aspects of the natural history of the chronic obstructive pulmonary disease are episodes of acute exacerbations [61]. Efficient contacts between patients and clinical staff are essential when dealing with mental and behavioral disorders, and patients undergoing cancer treatment may experience many undesirable side effects that can negatively affect their quality of life. Therefore, the results of the systematic reviews reported in this article are in line with the current strong motivation for using technological solutions as a way to monitor patients with chronic diseases at home and promote an increasing compliance to self-care.

The retrieved studies synthesize evidence related to the use of several monitoring devices to measure a wide range of physiological outcomes, including: vital signs (e.g., body temperature, blood pressure, heart rate, respiratory rate, and pulse oximetry), glucose level, weight, physical activity (e.g., pedometers), and foot skin temperature. Additionally, the use of an electronic stethoscope is reported in Jackson et al. [7].

In some studies, the monitoring devices automatically transmitted the information they collected, while in other studies, the patients or their informal caregivers communicated the information collected by the measurement devices. The information collected by the monitoring devices is sometimes complemented with information related to symptoms and behaviors. For instance, recording answers to structured questionnaires allowed the reporting of symptoms such as poor glycemic control, foot problems, chest pain, breathing problems, or different types of behaviors, including medication adherence, diet, or physical activity. In addition, the majority of the studies also reported on some form of health education.

In terms of what technologies are being used for in relation to the remote care of chronic patients (i.e., the research question of the study reported in the present article), the results show that there is a widespread use of information technologies:

- Monitoring devices.
- Telephone (e.g., structured phone calls, interactive voice response, or short message service).
- Videoconference.
- Videotapes.
- Interactive web-based applications (e.g., social media or gaming systems).
- Computer-based applications (e.g., management systems, education systems, clinical decision support systems, or gaming systems).
- Public kiosks.
- Smartphone applications (e.g., social media, short message service, prompts, or gaming systems).

Some technologies have received more attention than others. Particularly, smartphone applications such as applications to deliver periodic prompts and reminders were reported by a considerable number of systematic reviews. In this respect, the portability of smartphones enables users to have access to it 24 h a day, making the long-term management and reinforcement of health behaviors possible. This seems to promote the focus of the participants and their adherence to the programs.

Despite a high level of technological innovation and implementation, one of the findings is that telephone calls are still an important channel for the communication between patients and care providers.

Furthermore, it seems that important aspects are neglected during the technological developments, since there are reports of usability drawbacks, as well as reports of the need for more comprehensive solutions, including the provision of real-time feedback and the integration of the electronic health records systems being used by the care providers [29].

Therefore, the results show that not only disruptive technological solutions have a key role; practical and robust solutions are also required, which means that the integration and the interoperability of existing technologies assume great importance [62].

In general, the systematic reviews and meta-analyses included in the present study compared remote care with usual care, and the primary outcomes depended on the type of patients being considered (e.g., glycemic control for patients with diabetes, patients' readmissions and mortality for patients with congestive heart failure or chronic obstructive pulmonary disease, therapy improvement for patients with mental and behavioral disorders, or disease management for patients with cancer).

Secondary outcomes were quite diverse; they included anxiety or depression, weight, perceptions of isolation, pain, fatigue, physical capacity, episodes of hypoglycemia, dyspnoea, quality of life, patient satisfaction, care knowledge, self-management efficacy, patient self-motivation, behavioral outcomes (e.g., prescribed medication adherence, daily weighing, diet and healthy eating, or physical activity), and care coordination outcomes (e.g., improvement in therapy, patient–clinician communication, cost-effectiveness, transparency of the services provision, or equity of care access).

Independently of the outcomes being measured, the retrieved systematic reviews show that the usage of remote care technology has positive effects with moderate to large improvements in different outcomes when compared with conventional practices.

The technologies used in the experiments significantly evolved over the years. In parallel to the development of technologies, there was also advancement in the type of transmitted information using these technologies, which allowed the capture of more parameters, including information about the patient's symptoms and lifestyle events (e.g., meal portions and diet) [12].

One of the problems that emerged from the study reported in the present article is related to the outcomes being considered. Besides their diversity, it is important to consider that different measurement methods were being applied. This is an important difficulty when aggregating and studying data from different trials, which is essential in order to achieve the statistical and clinical significance that is required to incorporate new services in the clinical practice. Moreover, studies with longer follow-ups are needed in order to determine the long-term impact on health outcomes, and look for evidence of harm. Therefore, further research, including large-scale randomized controlled trials with consistent primary and secondary outcomes, and robust analysis about cost-effectiveness and the long-term sustainability of different types of remote care interventions, is required in order to allow the full incorporation of remote care technology in the clinical practice [60].

Despite the huge research effort related to remote care technology, there is an insufficient number of successful interventions that have been translated beyond the research setting and broadly adopted. Potential reasons for this lack of translation should be deeply studied. In particular, it is essential to identify which populations and sub-populations benefit from remote care technology.

Although the review selection and the data extraction were rigorous, this study has limitations, namely the ones resulting from the dependency on the keywords and the databases selected, and that a review of reviews tends to sacrifice detail. Despite these limitations, the systematically collected evidence contributes to the understanding of the use of remote care technology to support patients with chronic diseases.

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