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REVIEW ARTICLE

A Scoping Review of Economic Evaluations Alongside Randomised Controlled Trials of Home Monitoring in Chronic Disease Management

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Abstract Many countries have considered telemedicine and home monitoring of patients as a solution to the demographic challenges that health-care systems face. However, reviews of economic evaluations of telemedicine have identified methodological problems in many studies as they do not comply with guidelines. The aim of this study was to examine economic evaluations alongside randomised controlled trials of home monitoring in chronic disease management and hereby to explore the resources included in the programme costs, the types of health-care utilisation that change as a result of home monitoring and discuss the value of economic evaluation alongside randomised controlled trials of home monitoring on the basis of the studies identified. A scoping review of economic evaluations of home monitoring of patients with chronic disease based on randomised controlled trials and including information on the programme costs and the costs of equipment was carried out based on a Medline (PubMed) search. Nine studies met the inclusion criteria. All studies include both costs of equipment and use of staff, but there is large variation in the types of equipment and types of tasks for the staff included in the costs. Equipment costs constituted 16–73% of the total programme costs. In six of the nine studies, home monitoring resulted in a reduction in primary care or emergency contacts. However, in total, home monitoring resulted in increased average costs per patient in six studies and reduced costs in three of the nine studies. The review is limited by the small number of studies found and the restriction to randomised controlled trials, which can be problematic in this area due to lack of blinding of patients and healthcare professionals and the difficulty of implementing organisational changes in hospital departments for the limited period of a trial. Furthermore, our results may be based on assessments of older telemedicine interventions.

Key Points for Decision Makers

This review of economic evaluations alongside randomised controlled trials of home monitoring in chronic disease management describes nine studies and includes both costs of equipment and use of staff. Large variation was found in the types of equipment and types of tasks for the staff included in the costs. Equipment costs constituted 16–73% of the total programme costs.

Future studies should pay special attention to equipment costs and the possibilities for using the patient's own devices or other elements that could reduce the costs of telemedicine interventions.

1 Introduction

Many countries and international institutions have considered telemedicine and home monitoring of patients as a solution to the demographic challenges that healthcare systems face including an increasing number of patients

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with chronic disease [1]. Telemedicine is defined broadly here as the delivery of healthcare services through the use of information and communication technologies (ICT) in situations where the patients and the health professionals are in different locations. Home monitoring of patients via ICT is an important part of telemedicine interventions, and a number of studies have shown that it can reduce the number of bed days and emergency department visits for patients with chronic disease [2]. This has led to the hope that telemedicine and home monitoring can reduce the healthcare costs per patient [3].

However, reviews of economic evaluations of telemedicine and home monitoring do not provide a clear result. A 2002 systematic review of cost-effectiveness studies of telemedicine interventions [4] included 55 articles, but only 44% meet all the quality criteria applied in the review. Only 60% of the studies included equipment costs and many were small-scale and short-term, pragmatic studies. Therefore, the authors concluded that there was no solid evidence that telemedicine was cost effective.

Similarly, a 2009 systematic review [5] identified 33 economic evaluations of telemedicine and found that most lacked information on perspective and costing method. Few studies used sensitivity analysis and statistical analysis to assess the validity of the results and under half provided details on resources consumed in physical units and reported prices separately from quantities. The authors concluded that most of the economic evaluations had not been undertaken in accordance with standard evaluation techniques.

A 2012 systematic review that included 80 full economic evaluations of telemedicine, found that most studies had inadequate details about study design and methodology, including how costs were collected, calculated and reported [6]. The author thus found no further evidence that telemedicine interventions were cost effective. A 2014 review of nine published systematic reviews of cost-effectiveness analysis of telemedicine studies [7] also identified methodological flaws and joined the general consensus that most of the telemedicine studies do not follow the guidelines for economic evaluation.

Two other reviews from 2014 have found similar results from studies of telemedicine for specific patient groups. A review of six cost-effectiveness studies of telemedicine for patients suffering from chronic obstructive pulmonary disease (COPD) [8] found a potential for cost savings, but also noted the poor quality of the economic evidence and that decision makers seeking large-scale implementation of telemedicine in clinical practice should be cautious. A literature review of 32 cost-effectiveness studies of telemedicine intervention for patients with chronic heart failure [9] again concluded that most studies were not comprehensive economic evaluations (e.g. 72% did not include relevant costs, and many lacked information on investment costs). However, the few studies with a proper economic evaluation showed that telemedicine was cost saving and slightly improved effectiveness.

Most reviews of economic evaluations of telemedicine refer to the handbook on methods for economic evaluation of healthcare programmes [10] when assessing the economic evaluations. The handbook recommends economic evaluations to include estimation of the costs of organising and operating the programme (the programme costs) as well as the economic and health consequences. The programme costs should include both the variable costs (that vary with the level of outputs, e.g. supplies and health professionals' time) and the fixed costs (that do not vary with the quantity of output in the short term, e.g. 1 year). Typical examples of fixed costs are capital costs, which are the costs of purchasing the major capital assets required by the programme (e.g. equipment and buildings). Fixed costs typically represent investments at a single point in time, often at the beginning of the programme. The recommended method for estimating capital costs is to annuitise the initial capital outlay over the expected number of years of use of the asset and calculate the equivalent annual cost [10].

The handbook [10] also includes a 10-item check-list for assessing economic evaluations of healthcare programmes. According to the check-list economic evaluation should include all relevant costs and consequences including capital costs (item 4), information about costs and consequences should be measured accurately in appropriate physical units (item 5) and give a credible valuation of costs (i.e. prices) and consequences (item 6).

These items are often not included in the estimated costs of telemedicine. Their importance has been underlined, however, in a 2016 guideline on economic evaluation of health IT programmes [11] as considerable costs can be associated with health IT implementation, maintenance, required infrastructure and time spent on training in the use of the technology. A 2015 guideline for measuring costs and benefits of eHealth intervention [12] also noted that implementation of eHealth often incurs equipment costs that can be spread over the expected life time of the equipment.

Reviews of telemedicine evaluations have so far focused on scientific methods and study quality. However, researchers involved in assessment of telemedicine and home-monitoring programmes need information about which healthcare resources to include in the estimation of the programme costs of home monitoring and which types of use of healthcare that may change as a result of the use of home monitoring. Here, a review limited to health economic evaluations based on randomised controlled trials can be useful because randomised studies can be designed to include the information needed, and because randomised studies have the highest level of internal

validity. The aim of this study was to examine economic evaluations alongside randomised controlled trials of home monitoring in chronic disease management and hereby to explore the resources included in the programme costs, the types of healthcare utilisation that change as a result of home monitoring and to discuss the value of economic evaluation alongside randomised controlled trials of home monitoring on the basis of the studies identified.

2 Methods

The method used in this study is a scoping review, which is a rapid form of knowledge synthesis where the aim is to map the key concepts underpinning a research area and the main sources of evidence available [13]. This type of review can be done as a stand-alone project in a complex area with limited evidence, or it can be done prior to a systematic review. A scoping review differs from a systematic review as it addresses broader research questions, permits inclusion of different study designs, often does not assess the quality of the included studies, has a less structured data extraction, and typically uses a qualitative synthesis of the evidence [14]. The typical stages of a scoping review are: (1) identifying the research question, (2) identifying relevant studies, (3) study selection, (4) charting the data, and (5) collecting, summarising, and reporting the results [13]. We have identified our research question in the study aim above and describe the other stages in the following sections.

2.1 Identifying Relevant Studies

The review includes studies with the three following criteria: (1) economic evaluations based on randomised controlled trials (RCTs) of home monitoring; (2) for patients with one of the chronic diseases: asthma, COPD, diabetes, heart failure, hypertension; and (3) reporting the estimated costs per patient in the intervention and the control group, the home-monitoring programme costs and the costs per patient related to investment and use of home-monitoring equipment.

To identify studies, we used a search strategy inspired by a comprehensive review by Wootton [15] that included 141 RCTs of telemedicine in the management of chronic diseases (asthma, COPD, diabetes, heart failure, hypertension). One the basis of this review, the specific search terms were:

(Telemedicine OR telehealth OR tele monitoring OR home monitoring) AND (Costs OR cost-effectiveness OR cost-utility) AND (Asthma OR COPD OR diabetes OR heart failure OR hypertension). The search was limited regarding article type for RCTs, and only articles written in English were included.

2.2 Study Selection

Studies were selected in two steps. First, titles and abstracts identified from the Medline search were screened for their eligibility for inclusion. Then the full text of potentially relevant studies was obtained and examined to confirm that the studies included information on home monitoring, programme costs and types of costs (as this information was rarely available in the abstract). The two authors selected the studies independently, and any discrepancies were resolved through discussion.

2.3 Charting the Data

The following information from the selected studies (including appendices and online supplements) was entered into a data chart using the Microsoft Excel 2010:

- Authors
- Year of publication
- Country in which the study took place
- Study population
- Content of the home-monitoring intervention
- Perspective of the economic evaluation
- Types of costs included in the programme costs
- Types of costs included in the economic consequences of home monitoring (in addition to the programme costs)
- Number of subjects
- Mean cost per patient in the home-monitoring group
- Mean cost per patient in the control group
- Mean programme costs per patient of the home-monitoring intervention
- Mean cost of home-monitoring equipment per patient.

Equipment costs were defined as the costs of investment, leasing, or rental of home-monitoring equipment (e.g. spirometer, pulse oximeter, weight scale, heart rate and blood-pressure monitor, and other wireless technology) as well as the costs of submission and collection of information (e.g. use of telephone lines, broadband connection, web-based portal, etc.). Thus, costs related to use of healthcare professionals were not included in the costs of equipment.

To improve the comparability of results from the different studies, the estimated costs in the local currency was transferred into Euro (€) using the exchange rate of the year concerned [16]. We subsequently adjusted for inflation by taking into account changes in the consumer prices from the year of the study to 2016. This was done using the Harmonised Index of Consumer Prices for the European

Union estimated by Eurostat [17]. Our results are thus price level 2016.

2.4 Summarising and Reporting the Results

In summarising the identified studies, we first described the range of home-monitoring interventions, the patient groups, and the geographical distribution. We then compared the types of costs included in the estimated programme costs and the economic consequences of home monitoring. Two tables were made, one with information about the patients, the interventions and the included costs, and another with information about the estimated average costs per patient, the home-monitoring programme costs and the equipment costs. Our analysis was especially focused on differences in the types of costs included, costs of equipment and use of healthcare professionals, and the need for further research.

3 Results

3.1 Search Results

The Medline search was carried out June 20th 2017 and identified 630 publications. Based on screening of abstracts, 577 were excluded mainly because they were not based on RCTs or did not describe reviews of home monitoring. After assessing 53 full-text articles for eligibility, 44 articles were excluded, mostly because the articles did not describe the programme costs per patient or the costs of equipment (Fig. 1). The remaining nine articles [18–26] were included in the review.

3.2 General Characteristics of Included Studies

The nine studies were published between 2012 and 2017 (Table 1) and were mostly undertaken in Europe. The nine studies comprised the following: interventions for patients only with COPD ($n = 4$ studies), patients with hypertension (1), patients with diabetes (1), patients with chronic heart failure (1), patients with asthma (1) and one study included three patient groups. The intervention periods were 4–12 months and between one and six different devices were installed in the patients' homes. Data were submitted to a website or web-based portal, and the number of weekly readings varied between studies. Often, clinical teams assessed the data in monitoring teams and contacted the patients by phone based on alerts. Thus, although the home-monitoring interventions were similar, the studies differed in the specific devices used, the duration of the interventions, and the patient groups.

3.2.1 Resources Included in Programme Costs and Economic Consequences of Home Monitoring

As described in Table 1, there is variation in the types of equipment and types of tasks for the staff included in the estimated costs. For example, some studies include costs of hosting and installation in their estimated equipment costs, whereas others only included costs of hardware and peripherals. Similarly, some studies included costs of training of staff and patients, whereas others only included time used for monitoring of patients. Except for two studies [25, 26] all studies used the annuitisation method to estimate annual costs and assumed that the equipment would last for 3–5 years.

The different kinds of healthcare utilisation included in the estimated economic consequences of home monitoring are also described in Table 1. The perspective of the economic evaluations in all studies had a healthcare sector perspective, and seven studies included both patients' utilisation of hospital services, emergency department service, general practitioner (GP) and some form of primary care. The table also shows that the highest (percentage) cost reductions among the home-monitoring patients were found with regard to the patients' use of GP [20, 23, 25], district nursing [19, 22], emergency department [21], hospitalisations [18, 24] and drugs [26]. Thus, a reduction in the costs per patient was often found with regard to primary and acute care.

3.3 The Estimated Home-Monitoring Costs

The home-monitoring programme costs varied between €71 and €3,323 (Table 2). This reflects mainly the differences between the patient groups but also the differences in content and duration of the interventions and the types of costs included. Equipment costs varied between €16 and €1277 per patient (Table 2) and constituted 16–73% of the total programme costs. Equipment costs thus had a substantial impact on the total programme costs in most of the studies.

In three of the nine studies, the mean cost per patient using home monitoring was lower than the cost per patient in the control group, by €681 to €2765. In six studies, the mean costs were higher in the home-monitoring group, by €98 to €2718 per patient and in two of these six studies, this difference in the mean costs per patient between the telemedicine group and the control group was statistically significant [22, 25].

Table 2 also shows the home-monitoring programme costs. In five studies, home monitoring led to a reduction in other types of costs as the change in mean cost was less than the home-monitoring programme cost [18, 20, 24–26]. However, in four studies [19, 21–23] the costs of other

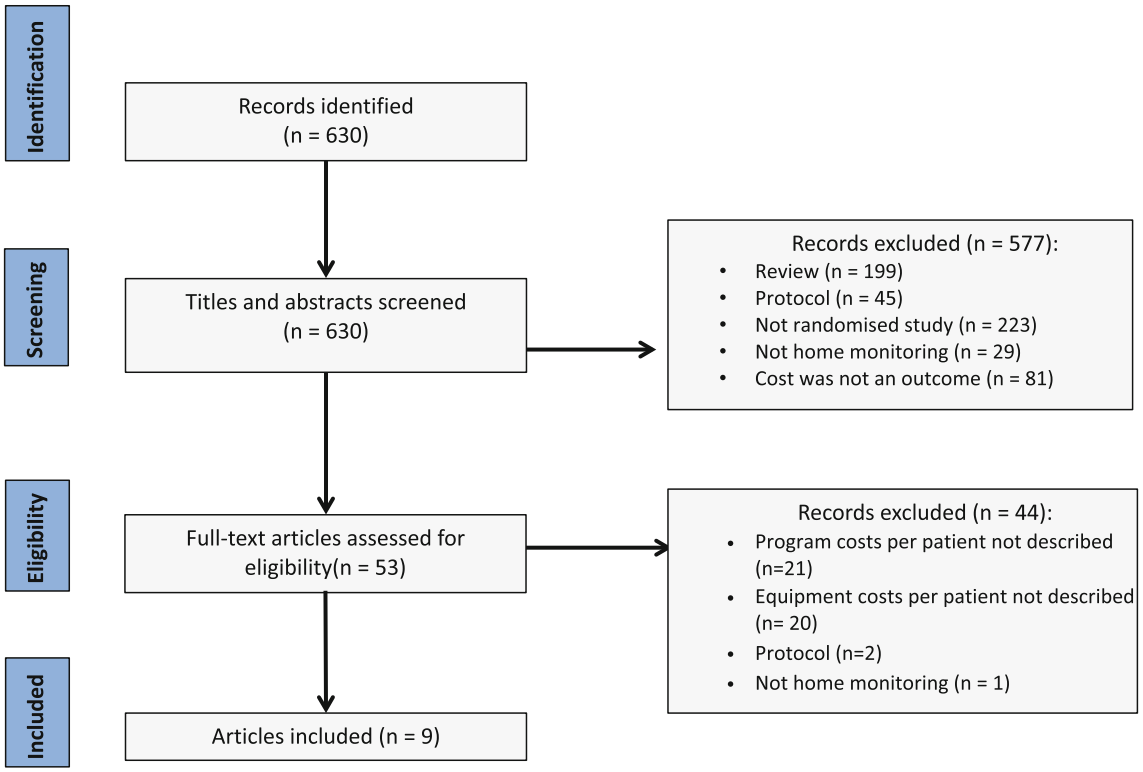

Fig. 1 Flow diagram of search and screening of articles

types of healthcare were increased, as the absolute change in mean cost was higher than the home-monitoring programme cost.

4 Discussion

This scoping review of nine economic evaluations based on RCTs has shown that there was large variation in the types of equipment and types of tasks for the staff included in the costs. Some studies include costs of hosting and installation of equipment, whereas others only included costs of hardware and peripherals. Similar, some studies included costs of training of staff and patients, whereas others only included time used for monitoring. Equipment costs constituted 16–73% of the total programme costs. In six of the nine studies home monitoring resulted in reduction in primary care or emergency contacts. However, in total, home monitoring resulted in increased average costs per patient in six of nine studies. The main reason seems to be that home monitoring may involve substantial programme costs (i.e. the costs of running the home-monitoring intervention), and it does not necessarily reduce other costs (e.g. hospital admission or primary care). Choice of hardware and devices is thus a crucial economic factor when implementing home monitoring for patients with chronic disease. It should also be noted that three studies found statistically significantly improved clinical outcomes [18, 22, 25]. Therefore, these studies could demonstrate that even though telemedicine is increasing the costs per patient, these technologies may be cost effective. Two of the studies concluded that this was the case [22, 25].

4.1 The Value of Economic Evaluation Alongside RCTs of Home Monitoring

A main advantage of the RCT design is the high level of internal validity as it minimises the risk of systematic error (bias) by ensuring that the intervention and the control groups have similar observed and unobserved characteristics [27]. In addition, RCTs allow collection of the data that is considered necessary at patient level. However, several critical issues have been raised against the use of RCTs in studies of telemedicine and digital health.

First, the cost-effective introduction of home monitoring may require organisational changes (e.g. within a clinical department), but these changes are unlikely to occur if the same department is going to offer conventional treatment for a control group and a telemedicine service for an intervention group over a time-limited trial period [28]. Cluster randomisation, as used in two of the nine studies [18, 23], or observational before-after studies may thus demonstrate more positive results at patient level than studies with randomisation at patient level if large

Table 1 Characteristics of the economic evaluations of home monitoring in chronic disease management

First author	Year	Diagnosis	Country	Duration (mo.)	Intervention	Perspective	Resources included in programme costs	Economic consequences included (the highest percentage cost reduction in bold)	Sample size
De San Miguel [20]	2013	COPD	Australia	12	Data were collected in a portable hub using thermometer, spirometer, pulse oximeter, weight, and a heart rate and blood pressure monitor, and submitted automatically via telephone to a website. Data were monitored daily by nurse who called the patient by phone if data triggered an alert. The patient's GP/specialist had access to the website	Healthcare system	Telehealth equipment. Nurse used for visits, daily monitoring calls. Travel	GP visits. Specialist visits. ED presentations. Hospital admissions	71
Jódar-Sánchez [21]	2014	COPD	Spain	4	Telemonitoring using a spirometer, pulse oximeter, and a heart rate and blood pressure monitor five times a week. Data were submitted via hub by the patient's telephone line. Data were submitted to a call centre and case manager	Healthcare system	Devices. Software. Time used by health professionals for handling alerts and for case management. Time used by technical staff for installation, technical incidents, travel	Hospitalisations. A&E departments. Specialised care	45
Stoddart [19]	2015	COPD	Scotland	12	Telemonitoring equipment and secure broadband link were installed in the patient's home. Patients completed a daily symptom and medication questionnaire on a touch-screen interface. Oxygen saturation and pulse rate were transmitted through Internet connection to the clinical team who contacted the patient by telephone in case of alert	NHS	Telemonitoring equipment. Broadband contract. Installation. Maintenance. Nurse time spent on patient training, monitoring of data, handling alerts. Travel	GP consultation. Practice nurse consultation. District nurse consultation. Emergency medication. Emergency visits. Day cases. Inpatient days. ICU days. HDU days	221
Udsen [23]	2017	COPD	Denmark	12	All patients receiving the same devices and peripherals. Standard Tablet (Samsung) with two apps that instruct patients in handling COPD during exacerbations. The tables collect and transmit data from Fingertip Pulse Oximeter, digital blood pressure monitor and a scale	Healthcare and social care	Hardware and peripherals. Project management. Installation. Maintenance and support. Training of staff. Patient training. Monitoring vital signs	Hospital admissions. Outpatient/ emergency visits. GP visits. Municipality care. Medicines	1225

Table 1 continued

First author	Year	Diagnosis	Country	Duration (mo.)	Intervention	Perspective	Resources included in programme costs	Economic consequences included (the highest percentage cost reduction in bold)	Sample size
Henderson [18]	2013	COPD, CHD, diabetes	England	12	Patients reported health status using home-monitoring systems and peripheral devices specific for the disease group. Patients took clinical readings up to 5 days per week. Monitoring centres were staffed by specialist nurses and community matrons	Health and social services	Telehealth equipment. Computer hardware, software and peripherals. Installation. Maintenance. Inhouse staff used for monitoring and responding to telehealth triggers, supervision, training of staff, training of patients. Administrative overheads	Hospitals costs. Primary care costs. Care home respite costs. Community care costs. Mental health care costs. Day care costs. Medication costs	969
Fasterholdt [24]	2016	Diabetic foot ulcer	Denmark	6	Telemedicine consultation of patients in their own home where home nurses uploaded screen image by smart phone to a homepage (pleje.net)	Healthcare sector	Telemedicine devices. Hardware licence. Technical infrastructure. Management, evaluation, meetings, administration. Staff training. Meetings with staff. IT support	Admissions. Outpatient visits. Home care nurse. Emergency visits GP visits	374
Stoddart [22]	2013	Hyper-tension	England	6	Self-monitoring of blood pressure four times daily for the first week and thereafter as desired. Data submitted via Bluetooth connection to a mobile phone to website for review by nurse/doctor with optional patient decision support by text or email	NHS	Telemonitoring equipment including devices and hosting. Time used by health professionals for monitoring of data, telephone helpline, training of patients	GP consultation. Practice nurse consultation. District nurse consultation. Medication. Emergency visits	256
Cui [26]	2013	CHF	Canada	12	Manitoba Health Lines offer 24-h service in which care and assessment is provided via telephone to patients. Self- monitoring tools are used by patients including blood pressure monitors and, bodyweight scales	Healthcare system	Equipment. Personnel. Technical assistance Travel (for staff). Administrative supports and supplies	Hospitalisation. Physician/ specialist visits	179
Ryan [25]	2012	Asthma	UK	6	A practice nurse contacted patient, who downloaded the t + Asthma app to their smartphone (or a loan). Twice daily recording and submission of symptoms, drug use and peak flow. Patients and clinician had access to patient data on website	NHS	Telemonitoring service. Trial nursing	GP consultations. Practice nurse consultations. Secondary care. Emergency services. Respiratory drugs	288

COPD chronic obstructive pulmonary disease, *NHS* National Health Services, *mo* months

Table 2 Estimated costs in economic evaluations of home monitoring in chronic disease management (€2016)

First author	Mean cost per telemedicine patient (SE)	Mean cost per control patient (SE)	Difference (negative implies reduced costs)	Home-monitoring programme costs per patient	Home-monitoring equipment costs (as percent of the programme costs)
De San Miguel [20]	12.706 [b]	15,471 [b]	−2765	3323	1277 (38%)
Jódar-Sánchez [21]	2304 (749.7)	1105 (453.1)	1199	237	104 (44%)
Stoddart [19]	14,486 (1521.7)	1177 (1163.9)	2718	570	365 (64%)
Udsen [23]	8793 (417.8)	7251 (412.1)	1542	705	335 (48%)
Henderson[a] [18]	8057 (111.8)	7015 (129.5)	1042	1852	848 (46%)
Fasterholdt [24]	12,641 (1019.8)	15 (1618.0)	−2086	586	199 (34%)
Stoddart [22]	363 (14.7)	225 (19.1)	138	71	16 (23%)
Cui [26]	5062 (911.1)	5735 (1958.1)	−681	1690	275 (16%)
Ryan [25]	441 (26.8)	344 (23.7)	98	131	96 (73%)

[a] The estimated costs reported in the study only include the costs for the first 3 months, but the duration of the intervention was 12 months. The costs in Table 2 were thus generated by multiplying by four to reflect the total cost of the 12-month intervention

[b] No information available

organisational changes are a condition for realising the full benefits of a telemedicine service.

Second, an RCT is also time-consuming when assessing clinical information systems, and this can be a problem in studies of rapidly developing IT applications. As an example, the RCT of home monitoring of patients with diabetic foot ulcer described in Table 1 [24], took 4 years to carry out. The duration of the RCT itself can lead to a less positive result in studies of telemedicine, but, as pointed out in a discussion of the pros and cons of RCT in clinical information systems, other designs such as prospective observational studies may also take several years [29].

Third, RCT guidelines state that blinding of patients and healthcare professionals is needed to avoid bias. This may be impossible in practice and may bias the results if both groups have positive expectations toward telemedicine and home monitoring [30]. The nine studies described in this review did not blind the patients. Studies of digital health interventions suggest that if a person who has sought help for a particular problem is randomised to the control group, he/she might find a digital solution online and thereby reduce the estimated impact of the intervention [27]. The lack of blinding may thus lead to positive or negative bias.

Finally, it is important to be aware that using RCTs in studies of home monitoring with the objective of minimising the risk of bias (and thereby ensuring internal validity) may be at the expense of a low degree of transferability or external validity [27]. For example, if only highly motivated patients are included in an RCT to ensure high compliance, the level of transferability of the results will be low. If expensive IT solutions are used to engage patients and health professionals and thereby increase the success of the trial, the home monitoring may also be more expensive than otherwise needed.

Based on these potential problems with RCTs, it has been argued that observational studies can provide valuable evidence on the cost effectiveness of interventions if RCTs are impractical [10]. Others have pointed out that although RCTs are an important part of the toolkit for evaluation of digital health interventions, they make up only one part [29]. Parallel to this, it has been suggested that RCTs should be undertaken only when the intervention has reached an acceptable degree of stability, the implementation of the intervention is expected to have a high degree of fidelity, and it is likely that clinical outcomes will be improved [27]. However, it should be noted that potential problems with the duration of a trial, the transferability of the results, and implementation problems can also occur in observational studies. Differences between results from RCTs and observational studies are an important evidence gap that needs to be considered in future studies of telemedicine and home monitoring.

4.2 Strengths and Limitations

The strength of this review is that it only includes studies based on RCTs that report information on both programme and equipment costs. Thus, we avoided a large number of potentially misleading economic evaluations based on studies with low levels of evidence or not reporting programme costs.

The inclusion of only nine studies may be considered a limitation because most of the existing economic evaluations have been excluded. Even with our highly selected sample of studies, few studies fully complied with the checklist for reporting of health-economic evaluations [10] and included detailed information about the resources used, prices for each resource, and the different types of costs. This review originally aimed to collect information about fixed costs, variable costs and capital costs from each study, but this level of detail was only available in six of the nine studies.

Assessment of eligibility of the articles was difficult because of a large variation in the reporting of the economic evaluations. Especially, assessment of whether the programme costs and the equipment costs are included in the estimated costs was difficult. As an example, two articles [31, 32] were not included because, even though the use of health professionals in the home monitoring for (e.g.) training of patients was described, the estimated programme costs did not include these costs. Similar, another randomised study [33] excluded the equipment costs, because both the intervention and the control group where implanted with the same device with the possibility to do home monitoring. Finally, a study [34] did not included device costs related to home monitoring because the equipment was provided free of charge, consequently, the study was not included in the review.

This review was limited to studies of home monitoring for patients with one of five different chronic diseases. A substantial part of the variation in the estimated costs per patient therefore could be explained by the differences between the patient groups and the interventions. Inclusion of other types of telemedicine, other patient groups, or other databases for the literature search may have altered the results. Furthermore, the studies included in the review were published in 2012–2017, with data collection starting before 2011 in seven of the nine studies. Moreover, the home-monitoring equipment was probably selected months before the studies started, and thus the results of this review may reflect the costs of older telemedicine technologies. The more recent technical developments may have reduced the prices and costs of telemedicine equipment.

5 Conclusion

This scoping review of economic evaluations alongside RCTs of home monitoring in chronic disease management has shown that there was large variation in the types of equipment and types of tasks for the staff included in the costs. Equipment costs constituted 16–73% of the total programme costs. The studies did demonstrate that the interventions resulted in reduction in, for example, primary care or emergency contacts; however, overall home monitoring resulted in increased average costs per patient in six of the nine studies. Those who design future studies of home monitoring should be aware of this risk of increased costs per patient, and special attention should be given to equipment costs. The use of the patient's own devices or other elements that may reduce costs should be considered when designing future interventions.

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Compliance with Ethical Standards

Conflict of interest The authors Kristian Kidholm and Mie Borch Dahl Kristensen declare that there is no conflict of interest.

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