Adverse Effects of eHealth Applications Replacing or Complementing Healthcare Contacts: A Scoping Review

Abstract

Background: The use of eHealth has increased tremendously in recent years. eHealth is generally considered to have a positive effect on healthcare quality and to be a promising alternative for face-to-face healthcare contacts. Surprisingly little is known about possible adverse effects of eHealth applications.

Objective: We conducted a scoping review on empirical research into adverse effects of eHealth applications that aim to deliver healthcare on a distance. We investigated if adverse effects were reported and the nature and quality of research into these possible adverse effects.

Methods: For this scoping review, we followed the five steps of Arksey and O’Malley’s scoping review methodology. We examined the literature between December 2012 and August 2017 in the following databases: PubMed, CINAHL, Web of Science and the Cochrane Library. Each paper was independently screened by at least two authors; differences were resolved through consensus development. Study characteristics were extracted. The methodological quality of the studies was assessed using the Critical Appraisal Skills Programme (CASP) lists. Results related to the research question were described and categorized.

Results: Our search identified 79 papers that were potentially relevant; 11 studies met our inclusion criteria after screening. These studies differed in many ways and the majority was characterized by small research populations and low study quality. Despite the shortage of solid research, we found some indications of possible adverse effects.

Conclusions: There is a lack of high-quality empirical research on adverse effects of eHealth applications replacing or complementing face-to-face care. While the development of eHealth applications is ongoing, the knowledge with regard to possible adverse effects is limited. The available research focuses often on efficacy, added value, implementation issues, use and satisfaction, whereas adverse effects are underexposed. A better understanding of possible adverse effects might be a starting point to improve the positive impact of eHealth-based health care delivery.

Keywords: eHealth, adverse effects, scoping review

Introduction
The use of e-health has increased considerably in recent years. eHealth comprises all kinds of information and communication technologies, such as websites and apps for screening, assessment and self-monitoring, health promotion, physical training, and social support (e.g., video-chat sessions with a therapist, moderated bulletin boards, chat rooms, social media)\[1,2\]. eHealth is generally considered to have a positive effect on healthcare quality and to be a promising alternative for face-to-face healthcare contacts [3]. Moreover, the use of eHealth applications is expected to reduce healthcare consumption and healthcare costs [4]. Also, eHealth is supposed to contribute to the fast availability of updated medical information, as well as to the provision of tailored care, independent of place and time [5]. In addition, although research in the field is not conclusive, eHealth may improve self-management, health literacy and healthy behaviour [6,7].

In line with these high expectations large companies and healthcare organisations invest many millions in the development of eHealth applications [8,9]. Given the large investments for eHealth, it is remarkable that there is a lack of information with regard to possible unfavourable outcomes of eHealth interventions. The limited number of studies in this field report adverse events such as patients' anxiety caused by monitoring vital signs.[10] Other publications mention professionals who get overwhelmed by the amount of data, workload and workarounds [11].

We conducted a scoping review on empirical studies into adverse effects of eHealth applications that aim to deliver healthcare on a distance. A better understanding of what is known about possible adverse effects will help to improve use of eHealth.

**Methods**

**Scoping Review Methodology**

For this scoping review, we followed the five steps according to Arksey and O'Malley's scoping review methodology, supplemented with recommendations by Levac et al and Daudt et al [12–14]. We used this method because the aim of a scoping review is to assess the available research literature in order to chart the nature, range and extent of the research evidence and to identify gaps in the existing literature [15].

**Step 1 Identifying the research question**

In our study we defined eHealth as the use of information and communication technologies to support or improve health care (delivery) [16,17]. We searched specifically for studies into eHealth applications replacing or complementing the face-to-face contact between a health professional and a patient in the context of treatment, health monitoring, supporting self-management or their communication [18].

An adverse effect was defined as any unfavourable outcome on the patient or the quality of care that occurred as a result of the use of an eHealth intervention [19].

The following research questions were formulated:

1. Which adverse effects of eHealth applications are reported in empirical studies?
2. What is the nature and quality of the research into the adverse effects of eHealth applications?
Step 2 identifying relevant studies

Between December 2012 and August 2017 we examined the literature in the following databases: PubMed, CINAHL, Web of Science and the Cochrane Library. We used Refworks 2.0, a web-based bibliographic manager, to import all citations. After an initial broad search and consultations with a librarian, the final search query was composed, for which we used the set of comprehensive Medical SubHeadings (MeSH) and free text search terms ‘eHealth’ or its synonyms and ‘adverse effects’ or its synonyms. To find as many relevant articles as possible we decided to add “quality of care” and “risks” as title words, because both appeared to be related to articles on adverse effects (see appendix 1 for search query).

Step 3: Selecting studies

The primary search resulted in 6010 records. After removing duplicates, 5523 titles and abstracts were screened for relevance and for the in- and exclusion criteria by two researchers independently (WS and MG). Studies were included when eHealth and adverse effect were mentioned in title or abstract and empirical data (qualitative or quantitative) on adverse effects were provided. Except for mental health conditions, all other health conditions, ages and sample sizes were included. The papers had to be written in English and published between January 2012 and August 2017. We did not use studies in the field of public health, on electronic health records (EHRs) or electronic medical records (EMRs), as well as studies on education or surgical technology. We also excluded adverse effects that related to security and privacy of data storage and transmission were.

Prior to inclusion, two of the authors (WS and MG) verified agreement in applying the inclusion criteria. Disagreement was solved by discussion. In case no consensus was reached, a third expert (RS) was consulted. This resulted in 78 studies meeting the in- and exclusion criteria.

The two authors (WS and MG) subsequently screened the full-text of the selected articles independently for information on adverse events. The screening results were compared and any discrepancies were resolved by discussion. If the outcome was unclear, two other authors (LB and RS) of the research team arbitrated. For the final synthesis, we excluded 68 studies that did not met the inclusion criteria, leaving 11 studies for final synthesis (Figure 1). Study quality was independently evaluated by two researchers (WS and MG) and disagreements were resolved through discussion in order to reach final study quality ratings.
Figure 1 Study selecting Process

Step 4 Charting the data

We extracted and summarized author, year, geographic area, title, name and function of the intervention, study population, study design, outcome and measurements, results and conclusion of adverse effects. All articles were assessed and data were extracted independently by WS and MG.

We used the methodological quality the Critical Appraisal Skills Programme (CASP) Qualitative Research Checklist and Randomised Controlled Trial Checklist for appraisal [20,21]. WS and MG assessed the studies independently and any disagreement was resolved by discussion. Scores were displayed as the proportion number items filled in with ‘yes’ in relation to the total number of items. (see appendix 2 for overview)
Step 5 Collating, Summarizing, and Reporting the Results

In this phase results related to adverse effects were discussed by the WS, MG and the experts RS, LB and WA. Results were categorized following the six domains of quality as formulated by the Agency for Healthcare Research and Quality (AHRQ): safety, effectiveness, patient-centeredness, timeliness, efficiency, and equitability [22,23].

Results

We found eleven studies that met our inclusion criteria. The characteristics of included studies are summarized in Multimedia Appendix 3.

General characteristics

eHealth terminology and functions

Different terms were used for the eHealth application: Telerehabilitation [24], Telecare [25,26], Telemonitoring [27], Telemedicine consultation [28], Video Telehealth [29], Video Teleconsultation[30], Internetintervention [31], eVisit [32], mobile health [33] and digital communication [34]. These various applications served different functions: supporting exercise [24,25,33] (video)consultation [26,28,30,34], supporting self-management [26,27,31], triage [29], and primary care [32].

Study participants

Study participants were patients [24,28,30–33], healthcare professionals [26] or a mix of patients and healthcare professionals [25,27,29,34]. Eight studies involved an intervention targeting patients with a chronic health problem [24–27,30,31,33,34].

Study design and quality

Eight studies had a quantitative design, of which two studies were randomised controlled trials (RCTs). The appendix shows an overview of the quality appraisal.

Study quality was in general (very) low. The sample size in the studies varied from 2 [29] to 564 [32]. There were two studies that a priori and explicitly used adverse effects as a primary outcome measure.

Adverse effects

Table 1 shows study results about adverse effects categorized following the six domains of quality.

Table 1: Reported results about adverse effects

<table>
<thead>
<tr>
<th>Adverse effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
</tr>
</tbody>
</table>
No study-related adverse events [24]

No serious adverse advents are found related to the mode of the consultation [28]

Communication failures
Failure to record the content of the communication
Failure to consult the patient’s notes prior to engaging in communication [34]

**Effectiveness**

No difference in re-referrals [28]
Reduction SBP greater in control group at 12 weeks and similar at 52 weeks [33]

**Patient-centredness**

A new perceptual distance between patients and therapists [25]

Sense of losing privacy
Stigmatization
Poor cooperation of the patient [26]

Loss of trust
Lack of human face to face contact
Lack of willingness [31]

Concerns about promoting the sick role
Creates dependence on telemonitoring and professionals[27]

Lack of physical contact causes concerns about long term complications of diabetes [30]

**Timeliness**

- 

**Efficiency**

New time-consuming work routines
Responsibilities less transparent [25]
Mean consultation duration not different [28]

Increased triage time [29]

Less likely to order UTI relevant tests
No difference for follow-up visits
Overprescribing of antibiotics
Less likely to order preventive care [32]

**Equity**
Safety
Griffiths et al performed a study into the use of text messages, email and social media in the communication between young people and a clinical team. They found an increased risk of communication failures, failure to record the content of the communication and failure to consult the patient’s notes prior to engaging in communication [34]. Furthermore in the studies of Benvenutti et al and Buvik et al safety was part of the outcome. In both studies the eHealth intervention was judged as safe, because no study-related adverse events were observed among or reported by study participants [24,28].

Effectiveness
eHealth applications may not have better health outcomes. In a RCT of Petrella et al an online exercise program for people with metabolic risk was used. After 12 weeks this program resulted in a lower systolic blood pressure (SBP) in the active control group compared to the eHealth group. By 52 weeks the reduction in SBP was similar in both groups [33].

Patient-centeredness
The study of Bodker et al showed that when eHealth interventions aimed to support patients in doing their physical exercise at home, responsibilities between health professional and patient became less transparent [25].

Three articles reported a lack of human face-to-face contact between health professional and patient or reported on the impossibility for physical examination, leading to “… a new perceptual distance between patients and therapists” [25,30,31]. eHealth applications that support self-management cause patients expressing sense of losing privacy and stigmatization [26], loss of trust by patients [31], or poor cooperation or lack of willingness of patients [26,31]. Fairbrother et al explored patient and professional views on self-management in the context of telemonitoring. They reported that professionals expressed concerns about promoting the sick role and creating dependence on telemonitoring and professionals [27].

Efficiency
In the study of Bodker et al healthcare professionals mentioned new time-consuming work routines, i.e. a significant amount of coordination tasks [25]. Cady et al investigated triage nurse workflow before and after the implementation of video telehealth. They found an increased triage time [29]. Buvik et al however, found no differences in consultation duration in their RCT into video-assisted remote orthopaedic consultations in an orthopaedic outpatient clinic. [28]. In a study of Mehrotra et al on a comparison of care at eVisits and physician office visits physicians using eHealth were less likely to order relevant tests or order preventive care and they established overprescribing of antibiotics [32].
**Timeliness and Equity**

Adverse effects related to timeliness and equity were not reported in the selected studies.

**Discussion**

**Principal Results**

Our scoping review shows that there is a clear lack of empirical research on adverse effects of eHealth applications replacing or complementing face-to-face care. After a broad search for empirical studies we were only able to include eleven studies. And these studies differed not only in the function (e.g. monitoring or assessment) of the eHealth intervention, but also in study population, methodology and outcome. Thereby the majority of the studies entailed small research populations and low study quality. Adverse effects are rarely subject to systematic scientific research. So far information on real adverse effects is mainly limited to incidental reporting or as a by-catch from qualitative (pilot) studies. The heterogeneity and the low quality among studies in our scoping review do not provide a good understanding of the nature and size of these possible adverse effects.

Despite this shortage of solid research, we suggest that eHealth may have a negative impact on the transparency of the relationship between health professionals and patient regarding their responsibilities [25]. Furthermore, because there is in some applications no nonverbal communication and no ability to perform a physical examination, health professionals have worries about the effect of eHealth on the quality of the communication affecting the quality of care. Confidentiality issues and potential negative feelings can arise as a result from this changing relationship [29]. Patients may overemphasize the impact of their condition by getting ‘fixed’ on readings and the monitoring of data. This can lead to dependence on telemonitoring and professionals [27,34].

Thereby complex programmes of therapeutic exercises delivered by technology had limited success in engaging people in chronic pain. Patients showed a lack of willingness and engagement because they missed some help and face to face acknowledgement, or the content seemed not very relevant for them [31]. Furthermore, our findings show that eHealth may have an adverse effect on efficiency, because of new time-consuming work routines [25,29]. Bodker et al reported subtle transformations of work activities such as recruiting patients, conducting home visits to give personalized advice on home-training and invisible work necessary to uphold the telerehabilitation infrastructure.

In the study of Cady et al time spent on video triage activities was significantly longer than the time spent on equivalent telephone triage. Their workflow analysis revealed that new activities were added, such as preparing video telehealth, troubleshooting and the possibility for the physician participating in the session. Also the possibility to interact not only with the parent(s) but also with the child during the video telehealth assessment caused an increased workflow [29].
Limitations
Various limitations of this scoping review need to be considered. Some articles may have been missed when undertaken the search. Due to the research question we only searched for empirical studies that primarily focused on adverse effects. In the title or the abstract, studies may not be explicit about their findings related to adverse effects, as it may not be the main goal of the study. Also alternative terminology is used, such as “unintended consequences” or “negative effects” or “quality of care” to report relevant findings, which makes this review may not be inclusive of all papers that have reported relevant results.
Furthermore we searched specific for eHealth applications delivering healthcare at a distance. It is possible that we missed studies that did not meet the inclusion criteria, but present value to understanding the phenomenon of adverse effects of eHealth. Our findings address different eHealth applications, goals, and implementation contexts; different users, communities, and countries; and different chronic conditions. Due to the small number of, often poorly qualitative studies and the heterogeneity of the applications examined, we believe that our findings cannot apply to ehealth in general.

Comparison with other literature
The concept ‘eHealth’ is a relatively new way of providing care and is used for different applications, technologies and care processes. Although the number of articles reporting on eHealth interventions has increased in the past ten years, it is still a relatively new field of research. Most eHealth interventions are now at a pilot phase and as their implementation is often halted by organizational, cultural or financial barriers, most studies focus on implementation and organizational issues.
In an overview of systematic reviews of studies into the impact of telehealthcare on the quality and safety of care in 2013, McLean et. al. report: “it was not clear whether adverse events did not occur or whether there was a lack of reporting”. They did not come across any studies that explicitly examined impacts of telehealthcare on patient safety [35]. Our findings confirm that we still hardly know if there are adverse effects or that the issue of adverse effects is simply not addressed.
Research on the risks of eHealth have mostly focussed on factors such as infrastructure, technological issues, implementation issues, lower adherence. Unfavourable patient outcomes are rarely mentioned [11,35,36].

Recommendations for future Design and Research
While this scoping review highlights few adverse effects of eHealth interventions, there remains a gap in empirical research that should be addressed within future. Researchers need to consider and to anticipate these adverse effects of eHealth interventions. The changing relationship and responsibilities between health professional and patient, greater dependence of patient on healthcare and potential negative feelings and new time-consuming work routines, are important subjects for research in future.

Conclusion
Health may contribute to better accessible and more efficient health care. So far, possible negative effects are hardly investigated. The little research that has been done suggests that they do exist. Given the rapid expansion of eHealth there is an urgent need for further research on this issue.
Acknowledgements

Funding for this study was provided by HAN University of Applied Sciences, the Netherlands. The funders had no role in the study design, data collection, and analysis; decision to publish; or preparation of the manuscript. The authors gratefully thank Thomas Pelgrim and Alice Tillema, the medical information specialists, for their help and advice on search strategies in scientific databases.

Conflicts of Interest

None declared

References

19. Critical Appraisal Skills Program. CASP, Qualitative research checklist. Dept Gen Pract Univ Glas [Internet]


