


# eHealth for people with COPD in the Netherlands: a scoping review


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**Background:** In the Netherlands, almost 600,000 people had chronic obstructive pulmonary disease (COPD) in 2017. This decreases quality of life for many and each year, COPD leads to approximately 6,800 deaths and about one billion health care expenditures. It is expected that eHealth may improve access to care and reduce costs. However, there is no conclusive scientific evidence available of the added value of eHealth in COPD care. We conducted a scoping review into the use of eHealth in Dutch COPD care. The aim of the research was to provide an overview of all eHealth applications used in Dutch COPD care and to assess these applications on a number of relevant criteria.

**Methods:** In order to make an overview of all eHealth applications aimed at COPD patients in the Netherlands, literature was searched in the electronic databases PubMed and Google Scholar. In addition, Dutch health care websites were searched for applications that have been evaluated for effectiveness and reliability. The identified eHealth applications were assessed according to five relevant quality criteria, eg, whether research has been conducted on the effectiveness.

**Results:** Thirteen health care programs and patient platforms in COPD care have been found that use eHealth. In addition, 13 self-care and informative websites and 15 mobile apps were found that are available to citizens and patients. Five of 13 care programs and patient platforms were found to be effective in improving quality of life or reducing hospital admissions in small pilot studies. The effectiveness of these and the other eHealth applications should be established in larger studies in the future.

**Discussion:** More research into the effectiveness of eHealth applications for COPD patients is needed. We recommend to develop a nationwide open source platform where well-evaluated eHealth applications can be showcased for patients and health care providers to improve COPD care.

**Keywords:** COPD, eHealth, care programs, scoping review

## Introduction

In 2017, almost 600,000 people had chronic obstructive pulmonary disease (COPD) in the Netherlands.<sup>1</sup> Having COPD may reduce the quality of life and the burden of disease is high.<sup>2,3</sup> In addition, health care costs related to COPD were estimated to be around €1 billion in the Netherlands in 2015.<sup>1</sup>

Self-management may be important to improve well-being and quality of life of COPD patients, for example, by reducing exacerbations.<sup>4</sup> eHealth may be promising to improve self-management and health outcomes in people with somatic diseases, including COPD.<sup>5,6</sup> eHealth can be defined as the use of new information and communication technologies, in particular Internet technology, to support or

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improve health and health care.<sup>7</sup> Using eHealth applications in the care for patients with COPD is attractive because the number of patients is growing and this puts pressure on the quality, accessibility, and affordability of (COPD) care.<sup>8</sup> eHealth may reduce this pressure by making health care accessible from home or other places, affordable by decreasing costs, while the quality remains high when the effectiveness is established in research.

Meta-analyses and reviews have been conducted to investigate the effectiveness of eHealth interventions in COPD care outside the Netherlands. Most studies were conducted into telehealth, in which telecommunications and virtual technology are used to provide health care outside health care institutions.<sup>9</sup> A meta-review by Hanlon et al (2017)<sup>10</sup> summarized the evidence of eight previous reviews on the effectiveness of telehealth interventions for people with COPD. They concluded that no effect of telehealth was found on mortality and improved health outcomes. Sul et al (2018)<sup>11</sup> found similar results in their meta-analysis on telemonitoring. The results of another meta-analysis indicated that physical activity improved after telehealth, but no effect on dyspnea was found.<sup>12</sup> A meta-analysis of 10 studies into telecare for COPD<sup>13</sup> showed a decrease in the number of emergency room visits and hospital admissions, compared with control groups receiving regular care. However, no effect was found of telecare on quality of life. In recent reviews, also no effect on quality of life was found,<sup>14</sup> nor are there any negative effects of the use of telecare programs.<sup>10</sup> More research into this topic is needed, as results are not consistent and mostly telehealth was investigated in these studies.

Previous studies also examined for which COPD patients eHealth may be most effective. A recent review of the effect of telemedicine for COPD<sup>15</sup> shows that the programs with the most effective outcomes target elderly patients with severe COPD. Patients with frequent exacerbations and comorbidity may also benefit more. Furthermore, larger effects of telemedicine are found when patients live further away from regular care or have a limited social network and therefore have limited access to care. Although most studies have been conducted in the group of older patients with COPD, there is also evidence that COPD patients who are younger than 60 years may be the most cost-effective group.<sup>16</sup>

Many eHealth applications for COPD patients have been developed in the Netherlands. However, an overview of these applications and their scientific validation are, as

far as we know, lacking. This study provides an overview of all eHealth applications used in Dutch COPD care. In addition, the applications were assessed on a number of quality criteria, such as available scientific evidence of the effectiveness on quality of life.

## Methods

### Search strategy and selection of eHealth applications

Several strategies have been used to search for eHealth applications. First, the electronic databases PubMed and Google Scholar have been searched. We used the search terms COPD, eHealth, digital care, digital care program, telemedicine, telecare, telemonitoring, and teleconsultation. Second, the references of “Playbook The future of care requires action” (Playbook De Toekomst van de zorg vraagt om actie)<sup>17</sup> and the digital care guide COPD (digitale zorggids COPD)<sup>18</sup> were searched for eHealth applications. Third, the websites of Trimbos institute<sup>19</sup> (quit smoking) and GGD Appstore<sup>20</sup> (quit smoking, adherence to therapy and informative apps) were used for the selection of informative apps. These two organizations recommend apps that were proven to be effective and reliable by the organizations. Last, we used the snowball method to find eHealth applications, in which the references in one article are the source for finding other relevant articles. We searched for articles and eHealth applications in March and April 2018.

An inclusion criterion for an eHealth application for the review was that it should be a digital application for COPD patients within Dutch health care. eHealth applications that were included were health care programs, patient platforms, (self-) care websites, informative websites, and mobile apps. Teleconsultation and telemonitoring were included (eg, teleconsultation was often a part of health care programs), but telerehabilitation was not included. We will use the term eHealth applications as an umbrella term. If no information was provided by the owners of an application, the application was not included in the study. No restrictions regarding publication year were applied and articles in Dutch or English were included in the review.

### Assessment criteria

The included eHealth applications have been evaluated according to the criteria described below. Health care programs and patient platforms were assessed on all

criteria. Most websites and apps were available for everyone, so not specifically for COPD patients. Therefore, the websites and apps could not be evaluated on all criteria. For example, it was not possible to evaluate the availability in primary and secondary health care for most websites and apps. Websites and apps that did not specifically target COPD patients may provide accessible and useful information that can support self-management. Therefore, they are included in this scoping review. In [Table 1](#), the criteria and scoring are described in more detail.

### Integration into routine (national) care

This criterion involves the availability of the eHealth application for all COPD patients or for a specific group of patients. An application can only be available during a research period or it can be permanently implemented and thus accessible to a large group of patients. In the former case, this is usually for a limited group of patients and there is a chance that the application will no longer be used after the study has ended.

### Involvement of patients in the development of the eHealth application

This criterion concerns the extent to which patients were involved in the development of the eHealth application. When this so-called co-creation is applied, the wishes and needs of users are taken into account in the development. Implementation of eHealth applications could then be more successful.<sup>21</sup>

### Effectiveness on improving quality of life and reducing hospital admissions

It has been examined whether research has been conducted that shows that the eHealth application improves the quality of life of patients or that a reduction in the number of hospital admissions was found.

### Availability in primary and secondary health care

In this criterion, the extent to which the eHealth application is available for all general practitioners and pulmonologists/hospitals was examined. Some applications are only available for some health care professionals in primary or secondary health care, eg, because of an investigation. Other applications are only available for either primary or secondary health care, making cooperation between both difficult.

### Costs of the eHealth application

We assessed whether the patient and care provider had to pay for using the eHealth application. It was also

investigated whether the use of the application is covered by the health care package or otherwise reimbursed by the health insurer.

## Procedure

One author searched for articles and eHealth applications and screened them on eligibility. All owners of the identified eHealth applications were approached by e-mail with the request to participate in the study. Questions were asked regarding the assessment criteria (eg, integration into routine care and costs of the application). When parties did not respond to the first email, reminders were sent. The information received (mostly in writing, sometimes by telephone when owners requested this) were collected in an Excel database. Subsequently, each eHealth application in the database was assessed on each criterion with a green, yellow, red, or gray smiley. A green smiley means that the application met the criterion, a yellow smiley means that the criterion was partially met, a red smiley means that the criterion was not met, and a gray smiley means that there was not enough information to assess this criterion. In the end, there was an overall assessment for each eHealth application based on the number of green, yellow, red, and gray smileys. For example, when most criteria of an eHealth application received a green smiley, the overall assessment was also a green smiley.

The assessment was carried out independently by two assessors. In case of disagreement, the assessment was discussed. All disagreements could be solved this way, no third assessor was needed. No verification of the received information was conducted. We did not assign weighting to the different assessment criteria because of the nature of this scoping review.

## Results

### Included applications

A total of 47 eHealth applications were found that met the inclusion criteria. The owners of two care programs and four informative applications have not provided data. One of them stated no information could be provided because of the ongoing scientific research into their application. The other five parties did not respond to repeated requests for information. The 41 resulting eHealth applications were divided into 13 care programs<sup>22–28</sup> and patient platforms,<sup>29–34</sup> 13 informative eHealth applications,<sup>22,35–46</sup> and 15 apps,<sup>35,37,42,46–57</sup> which were assessed. The results of the assessment procedure will be described below and are included in [Table 2](#).

Table 1 Overview of assessment criteria and scoring

		Level of implementation within regular care					Level of patient participation		Scientific evidence		Involved actors		Costs / reimbursement options				
		Full implementation and the eHealth application is permanently available	Level of integration within regular (national) care	Is the eHealth application available for all patients with COPD?	Mild - Moderate COPD GOLD I/2	Severe - Very severe COPD GOLD 3/4	Are patients involved in development of the eHealth application?	Does the eHealth application support self-management of the patient?	Is there scientifically proven improvement in quality of life?	Is there a scientifically proven reduction in hospital admissions?	The eHealth application can be used in primary care	The eHealth application can be used in secondary care	Reimbursement of eHealth application by health insurer	Costs for the patient	Costs for the practitioner	Availability of app	
No information received / unknown	😞	No information received / unknown	No information received / unknown	No information received / unknown	These two indicators are solely informative; some eHealth applications only run in secondary care and are specific for severe patients		No information received / unknown	No information received / unknown	No information received / unknown	No information received / unknown	No information received / unknown	No information received / unknown	No information received / unknown	No information received / unknown	No information received / unknown	No information received / unknown	
Meets the criteria	😊	The eHealth application is permanently available, even after research has ended	For all healthcare providers in primary or secondary care available if desired	No specific inclusion criteria	For all patients regardless of the severity of COPD	For all patients regardless of the severity of COPD	Yes; patients are involved in the development process	Yes; the eHealth application aimed at self-management	Yes; this has been shown in research	Yes; this has been shown in research	Available for all primary care practices	Available for all secondary care practices	Full reimbursement of application and provided care	Full reimbursement of application and provided care	Full reimbursement of application and provided care	Available for iOS and Android	
Partly meets the criteria	😐	The eHealth application is available but not for everyone (eg due to IT problems or other impeding factors)	The eHealth application is only available for specific settings; eg after research has been stopped, there is no national implementation	The eHealth application is only available for specific settings; eg after research has been stopped, there is no national implementation	Only to be used for patients who are included in a study	Only to be used for patients who are included in a study	Patients are only involved at a later stage	Partial support for self-management	There is no improvement nor deterioration	There is no improvement nor deterioration	Only available for practices that participate in the ongoing research	Only available for practices that participate in the ongoing research	Partial reimbursement from the health insurance (reimbursement e-consultation)	Partial compensation; there is a personal contribution	Partial compensation: Purchase of the application is paid by practices but they receive compensation for the e-consultation	Available for iOS or for Android; not both	
Does not meet the criteria	😞	The eHealth application is a research project and is therefore not available to other parties	The eHealth application is part of a research project and is therefore not available to other parties	The eHealth application is part of a research project and is therefore not available to other parties	Not applicable to this group	Not applicable to this group	Patients were not involved in development of the eHealth application	The eHealth application is not focused on self-management	There are no proven effects	There are no proven effects	Not available for practices in primary care	Not available for practices in secondary care	No reimbursement from the health insurance	Patient must pay for use of the application	No reimbursement	The app can only be used by patients in the study	

Table 2 Overview of eHealth applications and results of the assessment procedure

Health applications	Study program?	Research setting	Level of implementation		Level of integration	Is the eHealth application suitable for all patients with COPD?	How often does the COPD eHealth app	Are patients involved in the eHealth application?	Is there a scientific evidence of the quality of life?	Is there a scientific evidence of the quality of life?	Is there a scientific evidence of the quality of life?	Is there a scientific evidence of the quality of life?	Is there a scientific evidence of the quality of life?	Is there a scientific evidence of the quality of life?	Is there a scientific evidence of the quality of life?	Is there a scientific evidence of the quality of life?	Is there a scientific evidence of the quality of life?	Is there a scientific evidence of the quality of life?	Is there a scientific evidence of the quality of life?	Is there a scientific evidence of the quality of life?	Is there a scientific evidence of the quality of life?	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Table 2 (Continued).

Health program?	Research setting	Only for research and the research population	Full implementation for all patients with permanently available	Level of implementation within regular (national) care	Is the already application available for all patients with COPD?	Mild Moderate COPD GOLD 1/2	Severe Very severe COPD GOLD 3/4	Level of patient participation development of the application support and health application?	Does the already implementation of the application support lead to improvement of the patient?	Scientific evidence Is there scientific evidence for improvement in quality of life?	Involved actors	The already application can be used in secondary care	The already application can be used in primary care	Reimbursement of application by health insurer?	Costs / reimbursement options	Costs for the participants in the intervention	Overall assessment
Enabling applications																	
	Yes																
	Yes																
	Yes																
Medication monitoring																	
	Yes																
	Yes																
	Yes																
Smoking cessation																	
	Yes																
	Yes																
	Yes																
Informational apps																	
	Yes																
	Yes																
	Yes																

No information received / unknown	Yes
Meets the criteria	Yes
Partly meets the criteria	Yes
Does not meet the criteria	Yes

## Assessment of care programs and patient platforms

Five<sup>23–26,30</sup> of 13 included care programs and patient platforms showed positive results in terms of improving quality of life or reducing hospital admissions based on small pilot studies. For most of the other programs and platforms, no information was available about the effectiveness (yet). In addition, the long-term effectiveness of the programs and platforms was not studied up to now.

The number of users of the different programs and platforms ranges from 20<sup>33</sup> to 2000.<sup>41</sup> Costs of the programs and platforms are usually not for the patient (12 out of 13 programs, 1 unclear<sup>31</sup>), but often for the care provider (11 out of 13, 1 unclear,<sup>31</sup> 1 without costs for the care provider<sup>32</sup>). This mainly concerns the development costs of a program or platform or the purchase thereof.

### Care programs

All care programs except one<sup>24</sup> are still part of ongoing research, mainly situated in secondary health care. This implies that especially patients with severe COPD which are treated by the pulmonologist are eligible for these eHealth care programs. Only three<sup>22,24,28</sup> of the seven care programs could be used in both primary care and secondary care. In the future, care programs may become more and more accessible to patients with a milder disease course and the cost-effectiveness compared to usual care may be more likely then. One program was found to be effective in improving quality of life and perceived quality of care compared to usual care in a randomized controlled trial (RCT), and it is used in both primary and secondary health care.<sup>24</sup>

### Patient platforms

The patient platforms focus mainly on implementation in primary care. The platforms that are linked to or are part of the chain information systems seem to have a greater scope than the platforms that are used alongside GP information systems.

## Assessment of self-care and informative websites

The self-care and informative websites that (partially) focus on patients with COPD are divided into three websites to promote medication adherence,<sup>35,40,41</sup> five informative websites,<sup>22,36,37,39,42</sup> and five websites focused on

smoking cessation.<sup>38,43–46</sup> For the majority of the various self-care and informative websites, there is no link with existing programs and no treatment relation between the patient and the care provider is necessary. The scientific evidence for the effectiveness of these applications is limited or completely absent. The uptake depends on the accessibility, advertising, and recommendation by individual care providers.

Two informative sites, although not integrated in care or chain programs, have an increasing uptake in primary care based on scientific effectiveness on quality of life<sup>22</sup> and health care usage.<sup>42</sup> However, one of these sites<sup>42</sup> is not only focused on COPD but on other diseases as well. The study does not show the effectiveness of the website specifically for people with COPD. Only one informative site<sup>22</sup> is publicly accessible, but also linked to one of the care programs. This program is part of a study and there are no results about the effectiveness of the program yet.

Two informative websites/self-care applications for smoking cessation<sup>44,45</sup> have been found where research into the effectiveness has been conducted. However, the effectiveness of the applications has been established for the general public or for specific groups; there is no evidence of the applications specifically for COPD patients.<sup>58,59</sup> There are usually no costs for the patient for using self-care and informative websites.

## Assessment of eHealth apps

Fifteen apps were found that focused on COPD care, medication adherence, smoking cessation, and information about COPD-related topics. The results of the assessment of apps are almost similar to the results of the assessment of self-care and informative websites. Six apps were found to be effective,<sup>42,46,47,51,52,56</sup> and most apps are available for all COPD patients and can be accessed via iOS and Android and are free for patients.

## Discussion

This study provides an overview of eHealth applications used in COPD care in the Netherlands. Thirteen health care programs and patient platforms have been found. In addition, 13 self-care and informative websites and 15 mobile apps were found that are available to citizens and patients. Five of the 13 care programs and patient platforms were scientifically investigated in small pilot studies, and positive effects were found on improving quality of life or reducing hospital admissions for COPD patients.

No evidence is available about the effectiveness of the other care programs and patient platforms yet, but research is ongoing for most of them. As self-care and informative websites and eHealth apps are available to everyone, the effectiveness of these applications specifically for COPD patients was not established yet. There are usually no costs for using the applications for patients. However, often care providers have to pay the development or purchase of a care program or patient platform.

As far as we know, this was the first review that summarized eHealth applications for COPD patients in the Netherlands. In previous research outside the Netherlands, mostly telehealth was studied and the results regarding the effectiveness were mixed.<sup>10–14</sup> This review adds other eHealth applications than telehealth and applications that are used and studied in the Netherlands. The effectiveness of many eHealth applications included in this review was not investigated yet. Therefore, more research in primary and secondary care is needed to draw any conclusions about the effectiveness of eHealth applications for COPD care in the Netherlands.

Despite the limited evidence of the effectiveness for eHealth in primary COPD care, it appears that a large proportion of general practitioners in the Netherlands offer or intend to offer eHealth services.<sup>60</sup> The patient platforms we found focus primarily on implementation in primary care and thus meet a demand from the field. The programs that are linked to or are part of the chain information systems seem to have a greater scope than the programs that have to be used separately in addition to the general practice information system. Therefore, we recommend to implement promising eHealth applications for COPD patients in primary care while studying their effectiveness.

Some limitations of this review should be mentioned. First, the study is a scoping review, which is by definition less comprehensive than a systematic review. Second, the search was conducted by one person (author CH), instead of two independent persons. Third, the owners of six eHealth applications did not provide data and therefore could not be included in the review. Fourth, most of the self-care and informative websites and eHealth apps are not specifically for COPD patients. Therefore, they could not be assessed on all criteria. Fifth, the included eHealth applications were quite diverse in terms of both purpose and form. Therefore, it was difficult to compare them on the assessment criteria.

For future research, we recommend to investigate the long-term effects of eHealth applications for COPD patients, in

addition to the short-term effects. Furthermore, the effectiveness of different eHealth applications may be studied in the future to find out which applications are the most effective. Thereafter, the implementation of the most effective applications may be facilitated in Dutch COPD care. We also recommend to improve collaboration between primary and secondary care. Most care programs are used in secondary care and most patient platforms are used in primary care. It would be valuable when this could be more integrated in order to improve care for COPD patients. Additionally, it may be relevant to conduct the current review also in other countries to enable international comparison. It may also be relevant to investigate which COPD patients use eHealth applications and which patients do not use it and why. Lastly, it is necessary to develop a nationwide open source platform for effective eHealth applications. This platform could possibly be modularly arranged to make links with other diseases. Well-evaluated eHealth applications can be displayed and found in this way by patients and health care providers.

## Conclusions

We can conclude that there are 47 eHealth applications used in Dutch COPD care. Five of the 13 care programs and patient platforms were found to be effective in improving quality of life or reducing hospital admissions in small pilot studies. More research into the effectiveness of eHealth applications is needed. Furthermore, usually patients do not have to pay for the use of these eHealth applications. However, the costs for care providers to develop or purchase care programs or patient platforms may be considerable, which is a barrier for implementation.

## Abbreviations list

COPD, Chronic Obstructive Pulmonary Disease; GGD, Gemeentelijke Gezondheidsdienst (municipal health service); GP, general practitioner; RCT, randomized controlled trial.

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## Disclosure

The authors work in research or practice with some of the included eHealth applications (E-Vita COPD, SARA, ziektelastmeter, Thuisarts, mijn luchtpunt 2, MonitAir). The present study was commissioned and funded by the National Health Care Institute, an independent

government body. Its outcomes will be used for collaborative, multistakeholder efforts to improve lung care in the Netherlands. Dr Hans C Ossebaard is an employee of the National Health Care Institute. Miss Sanne van Luenen conducts a study (mijnluchtpunt.nl) with Boehringer Ingelheim outside the submitted work. The authors report no other conflicts of interest in this work.

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