Early-stage feasibility of the "Copilot for COPD" app in healthcare providers' daily practice: a qualitative study

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ABSTRACT

Background: Improved exacerbation outcomes are found in COPD patients who recognize exacerbations early on and perform prompt and adequate actions. The recently developed 'Copilot for COPD' application is designed to increase these key self-management skills by early detection of symptom deterioration through self-monitoring, and performing adequate and prompt action through individualized action planning. Health care providers' (HCP) role is to install, personalize and evaluate the app with patients. Evaluating HCPs' perceptions regarding feasibility of the app within constraints of daily practice is important and will determine if the app is suitable for pilot testing with HCPs and patients.

Purpose: To evaluate the perceived feasibility of the Copilot app in HCPs' daily practice regarding acceptability, demand, implementation, practicality and integration

Methods: Qualitative study using observations, think aloud, semi-structured interviews with HCPs with a case-management role in COPD care (n=13), conducted in primary-, secondary- and tertiary health care settings in the Netherlands from February 2019 to June 2019. Data were analysed by thematic analysis.

Results: HCPs found the app acceptable and expressed interest to use the app. Perceived benefits included a enhancing self-management behavior; structure patient-HCP contact; provide direction in treatment; improve uniformity in exacerbation self-management support; and be used throughout and across healthcare settings. Potential risks included increased treatment burden and substituting HCP contact with app. Individual patient characteristics and fit with workflow and time were considered facilitators and or barriers. Conditions to be met included management support, training and instructions, WIFI, and app integration with local IT systems. Integrating the app into current care paths across settings was perceived feasible, considered a shared responsibility, and fits nurses role best. Finally, several usability problems were found.

Conclusions: Important conditions need to be met and usability issues resolved before further feasibility testing can be evaluated.

Keywords: COPD, exacerbations, self-management, mHealth, feasibility

SAMENVATTING

Achtergrond: Vroegtijdig een longaanval herkennen en adequate acties nemen zijn essentiële zelfmanagementvaardigheden voor COPD patiënten en tonen betere gezondheidsuitkomsten.. De "Copiloot voor COPD" app is ontwikkeld om patiënten te ondersteunen door het zelfmonitoren van symptomen en vroegtijdige herkenning van een longaanval, en het toepassen van snelle en juiste acties door individuele actieplanning. Hulpverleners met een casemanagement rol zijn belangrijk bij het installeren, personaliseren en evalueren van de app. Daarom is hun perspectief rondom haalbaarheid van de app binnen dagelijkse praktijk belangrijk en geeft richting aan vervolg stappen.

Doel: Het vroegtijdig evalueren van de haalbaarheid van de Copiloot app vanuit de perspectief van hulpverleners met een casemanagement rol in COPD zorg.

Methode: Een kwalitatieve studie met observaties, think-aloud en semigestructeerde interviews zijn gedaan met dertien hulpverleners uit eerstelijns-, tweedelijns-, en derdelijnszorg in Nederland van februari 2019 tot juni 2019. Data werd geanalyseerd middels thematische analyse.

Resultaten: Hulpverleners vonden de app acceptabel en toonden interesse de app te gebruiken. Potentiele voordelen waren zelfmanagement van patiënten verbeteren; contact tussen hulpverlener en patiënt versterken; richting aan behandeling geven; uniformiteit in werkwijze stimuleren; en toepasbaar binnen ketenzorg. Mogelijke risico's waren verhoogde behandellast en patiënten die hulpverleners vervangen voor de app. Eigenschappen van patiënten en de mogelijkheid tot inpassen in huidige werkprocessen en tijd kunnen werden gedacht implementatie te remmen of bevorderen. Daarnaast werden toestemming van management, training en instructies, WIFI en het integreren van de app in lokale ICT systemen als belangrijke voorwaarden genoemd. Tevens vonden hulpverleners integratie van de app in bestaande zorgpaden van de settingen haalbaar. Werken met de app werd als gezamenlijke verantwoordelijkheid gezien waarbij de verpleegkundige de belangrijkste rol heeft. Daarnaast werden er verschillende gebruikersproblemen gevonden.

Conclusie: Belangrijke voorwaarden en gebruikersproblemen moeten opgelost worden voordat lange termijn haalbaarheid wordt geëvalueerd bij patiënten en hulpverleners.

Steekwoorden: COPD, exacerbaties, zelfmanagement, haalbaarheid, mHealth

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INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD), globally a highly prevalent chronic disease, is associated with a significant burden in patients and society[1]. COPD is characterised by persistent respiratory symptoms and interrupted by exacerbations, described as, *"a sustained worsening of patients' respiratory symptoms that are beyond normal day-to-day variations and may warrant a change in regular medication in a patient with underlying COPD"*[2]. These exacerbations are associated with increased hospital admission and mortality rates[3], decline in lung function, health status, quality of life[4,5], and high healthcare utilization[1].

In COPD, early detection of an exacerbation and performing adequate and prompt actions are key self-management skills leading to improved exacerbation outcomes[6,7]. However, recognizing early warning signs can be difficult[8] and differ greatly between patients, resulting in late or incorrect treatment, and adverse short- and long term health outcomes[9,10]. A written action plan with ongoing support from health care providers (HCPs) have shown to increase patients' confidence and skills in identifying daily variations in symptoms and taking appropriate actions[11]. Although action plans decrease the acute impact of exacerbations on health status, decrease symptom intensity of exacerbations and accelerate recovery time[12], no robust clinical effects were found on exacerbation frequency, healthcare utilization[12] or health related quality of life[13]. This might be explained by the "one size fits all' approach of a paper action plan regarding design, health literacy, intensity and modes of delivery[12].

Recently, research has focused on utilizing mobile technology, or mHealth, for self-management purposes in pulmonary disease[14,15]. For COPD, mHealth provides opportunities to increase patients' commitment and sense of urgency for self-management behavior in exacerbation management through comprehensive and individualized strategies that fit patients' needs, perceptions and capabilities. MHealth allows patients to actively engage in and self-manage their condition[16] by using effective behavior change techniques such as tailoring[17], self-monitoring, feedback, rewards and action planning[18]. Although limited evidence exists for effectiveness of current mHealth, recent studies suggest patient outcomes may improve with mHealth interventions aimed at supporting self-management[14,19].

The 'Copilot for COPD' is a recently developed mHealth 'app' for COPD patients. The app targets early detection of symptom deterioration through self-monitoring, and performing adequate and prompt actions through individualized action planning. It consists of four components: 1) an individualized action plan; 2) symptom monitoring; 3) a calendar showing registered symptoms and undertaken actions; and 4) information on COPD and

exacerbations. The app is designed to be used by patients and their HCPs across healthcare settings. HCP's role is to help install the app, personalize the action plan, and evaluate the calendar with patients.

Evaluating the feasibility of the app within the constraints of HCPs' daily practice is important to determine if the app can work as intended. According to Bowen et al., acceptability, demand, implementation, practicality and integration are important feasibility parameters[20]. Acceptability focusses on how users react to innovations; demand looks at perceived estimated use of innovations in daily practice; implementation describes the extent and likelihood innovations can be implemented as planned into daily practice; practicality explores the perceived extent to which an innovation can be used within constraints of daily practice; and integration focusses on the level of system change needed to integrate the innovation into daily practice[20].

The aim of this early-feasibility study was to evaluate HCPs' perceptions regarding feasibility of the first prototype app within their daily practice. Considering HCPs' importance in helping patients to use the app, knowledge of HCPs' feasibility perceptions is a precondition for determining if the app can be feasible for patients. Furthermore, the outcome of this study will determine if the app is suitable for pilot testing with HCPs and patients.

OBJECTIVE

The objective of this study is to evaluate the perceived feasibility of the Copilot app in HCPs' daily practice by exploring acceptability, demand, implementation, practicality and integration.

METHOD

Study design
A generic qualitative study was conducted to evaluate HCPs' experiences and perceptions of feasibility, consisting of observations with think aloud (TA) and semi-structured interviews. Observations with TA were relevant in observing how HCPs interacted with the app while verbalizing initial perceptions and feelings regarding the app[21]. Semi-structured interviews reflected HCPs' perceptions concerning feasibility in daily practice[22,23].

Population and domain
A purposive sample of HCPs providing case management care to COPD patients in the Netherlands according to the Dutch Standard of Care[24] was selected from primary-,

secondary- , and tertiary care settings in the Netherlands. Case management was defined as providing ongoing, follow-up self-management support during patient consultations, provided by doctors and nurses[25]. Included were nurses (practice nurses, outpatient nurses, nurse practitioners) and doctors (general practitioners, pulmonologists, physician assistants) with minimal one-year experience regarding case management, and employed with current organization for minimal one year. The one-year cut-off point was considered relevant in providing meaningful insights into the study parameters. Maximum variation sampling in profession and work setting aimed to increase the likelihood of reflecting different perspectives in the findings[26].

Recruitment and informed consent

Participants were recruited by the researchers (T.Holtrop & Y.Korpershoek) by email or telephone. Four were approached based on interest expressed during a previous study. Others were recruited through local COPD networks. Potential participants received a letter of invitation and contacted within a week to determine interest in study participation. HCPs with expressed interest received an information letter and informed consent[27]. Recruitment started with five HCPs to initiate data analysis. Further recruitment was determined by ongoing data analysis and data saturation regarding acceptability, demand and implementation. Data collected on practicality and integration parameters varied greatly between organizations, not feasible to saturate, and only collected to provide a general direction in local contexts.

Data collection procedures

Data were collected during a single, one-hour session at the HCPs place of employment in four steps using the guideline in Table 1. Outcomes of interest and collection methods are described in Table 2.

Step 1 Explaining the study

HCPs were explained the aim of the app, the intended roles of HCP and patient in, developmental stage of the app and aim of the study and walked through the four components of the app.

Step 2 Conducting interactive session (Observation and TA)

HCPs used the paper fictional patient case[22] and corresponding tasks[22] in Table 3 to install the app on a 2018 Apple iPad; personalize the action plan; and evaluate the calendar[22]. The researcher observed the execution of tasks while HCPs verbalized their initial thoughts[28]. Usability issues that arose during the interactive session were collected.

Step 3 Conducting interview (Semi-structured interview)

The interview reflected on HCPs' perceptions of using the app in their daily practice according to the outcomes of interest in Table 2. The interview guide used (Table 4) was developed according to the feasibility parameters and outcomes of interest guided by Bowen et al.[20,26].

Step 4 Collecting participant characteristics (Questionnaire)

Important participant characteristics were collected using the form in Table 5.

Before starting data collection, two pilot sessions with independent experts were conducted to test data collection procedures for practicality and understandability. Findings of the pilot sessions were used to modify data collection procedures. Practical issues that arose during the study resulted in iterations in data collection guideline in Table 1[26]. All sessions were conducted by TH or YK. Observations and TA comments were written down in fieldnotes[26]. A video camera recorded the hand interaction with the app interfaces and audio recorded the interview[29]. In total, 13 sessions were conducted between February 2019 to May 2019. Eleven sessions were conducted by TH, MSc student and three sessions were conducted by YK, PhD candidate and supervisor.

Data analysis

Deductive thematic analysis according to Braun and Clarke were conducted to identify, analyze and report themes within the data[30]. Data were analyzed independently by TH and YK. After each session researchers noted initial ideas in memos[31]. Video recordings were reviewed for usability issues, and categorized according to type of problem. All think aloud, and interviews were transcribed verbatim[30]. Data analysis was supported by NVivo 11.0 software (QSR International Pty Ltd Version 11).

First, the two researchers read the transcripts to get an overall picture. Second, interviews were reread in more detail, initial codes were connected to meaningful paragraphs by both researchers and discussed afterwards to reach consensus. Next, identified codes were brought under potential themes and subsequently, reviewed for correspondence to the coded paragraphs. Last, potential themes were further defined and clear definitions were generated[30].

Credibility of the study was enhanced through data and researcher triangulation[31]. Visual recording of observations were evaluated and linked to think aloud and interviews. Peer debriefing occurred every two weeks between the two researchers in which findings were

discussed and consensus was reached. Furthermore, discussions with experts on the interpretation of the data (J.Trappenburg) contributed to the study's credibility.

RESULTS

A total of thirteen HCPs participated in this study consisting seven nurses, six medical professionals from four primary-, seven secondary-, and two tertiary care settings. Baseline characteristics are presented in Table 6. Eleven HCPs used paper plans in current practice and two HCPs gave oral instructions to patients instead of using paper plans. Ten HCPs currently worked with or had past experience in working with digital technology specifically for COPD care.

Themes are used to describe the results of this study and illustrated by quotes of the HCPs. (Q references in the text refer to quotes of specific themes described in the textboxes.)

Acceptance and demand of the app

To understand the level of acceptance and willingness to use the app in practice, HCPs were asked to describe their first impression of the app, their perceptions on fit with culture, and intention to use in daily practice. Overall, *high satisfaction* was expressed, rating satisfaction seven or higher on a ten-point numeric scale. Reasons included finding the app *easy to use (Q1)* due to design simplicity, lay-out of the app ,supporting pictographs and receiving positive feedback when using the app. Although HCPs needed time to accustom to the app, working with the app easy to learn. Also, most HCPs found the app *relevant to daily practice (Q2).* The calendar was considered most relevant by providing a compact, rapid and orderly overview of registered symptoms and actions. Particularly nurses found the app in line with current exacerbation-management support. However, *personalizing yellow and orange zone is mandatory* for all HCPs. Having the ability to add non-respiratory symptoms or highlighting frequently occurring symptoms was thought to further support patients recognizing symptom deterioration.

All HCPs expressed a *positive attitude towards mHealth (Q3)* due to opportunities to improve quality of care and satisfaction in patients and HCPs. Furthermore, implementing digital innovations were stimulated in many HCPs organizations and were believed to fit organizational culture. However, some organizations did not prioritize and facilitate digital innovations. When discussing their colleagues' attitudes towards mHealth, many believed doctors in general to be hesitant and resistant to change due to time issues.

The majority of HCPs had *high interest (Q4)* in using the app, scoring eight or higher on a ten-point numeric scale. Most HCPs had the *intention to use app in daily practice .* However, 2 doctors had little interest in using the app due lack of efficiency for their workflow.

Q1: *"I find it very useful, it is accurate and well-arranged and I find the lay-out very pleasant, actually. You're not distracted in the screen by small letters or something on the side edge. I think it's very clear."* (HCP10)

Q2: Interviewer: *"How relevant is the app to clinical practice?"* HCP: *"It's good. I think the methodology is good in regard to symptoms and symptom recognition. And that is can really help us as healthcare providers gain insight into how patients experience their symptoms.* Subsequently you get access into how the patient deals with increase in symptoms." (HCP 6)

Q3: *"I think these sort of initiatives for a large part have the future and…and that it can make it easier for people, and that it will help. So I am very,very enthusiastic."* (HCP5)

Q4: Interviewer: *"How interested are you in using the app and why?"* HCP: *"I think an 8 or 9. Also because currently, there is **nothing**. The culture is finally shifting as we discover, oh yes….the (CODP) patient has to do it. What we have been doing with patients with diabetics for years."* (HCP 11)

Perceived benefits and potential risks for using app in daily practice

Potential benefits and risks of using the app at the patient-, HCP-, and organizational level were discussed. HCPs mentioned many benefits and relatively few risks.

Regarding benefits, HCPs found the app a *useful tool for patients to apply effective self-management behavior (Q5).* It can help patients become aware of their symptoms during stable and deterioration phase and help take proper actions at the right moment. Nurses in particular felt this contributes to patient empowerment by increasing knowledge, skills and self-confidence, allowing patients to take charge of the disease by becoming less reliable on their HCP. Especially nurses found the app *useful to enhance and structure HCP-patient contact (Q6).* In HCPs experience, patients tend to underestimate or exaggerate their symptoms and often have trouble recalling past experienced symptoms and subsequent actions. The calendar supports patient's memory and prevents HCPs having to 'dig for information', thereby saving valuable time and increasing meaningful contact between HCP and patient. Subsequently, the *calendar can provide direction in treatment and support (Q7).* The calendar many be used by doctors to evaluate medication treatment and by nurses to better match specific patient needs with relevant HCP support. Also, nurses believed the *app can increase uniformity in exacerbation management support.* How exacerbation management support is provided is often inconsistent between HCPs within the same organization and or across settings. In some nurses opinion, the app increases consistency in work methods between HCPs within own organization and across settings. Furthermore, HCPS agreed *the app can be used throughout and across healthcare settings (Q8).* The app can be used by various HCPs within one setting and or across settings, including those without a case manager role. For example, physiotherapists and community health nurses

are considered important for providing regular support to patients. Furthermore, several nurses mentioned the app can replace transfer of nursing information between settings.

Most HCPs found no risks involved in using the app. However, patients *substituting HCP contact with app* was a concern mentioned by a GP. Patients may be less likely to involve their HCP because they have the app to guide them. Especially in a stable phase a patient may think HCP contact is redundant because their app indicates all is well. The app may also *contribute to an increase in treatment burden (Q9)* for patients in tertiary care. In pulmonary rehabilitation centers patients are treated in multidisciplinary teams with a variety of (digital) interventions in which a patient has to comply to. Adding another app could increase patients' treatment burden.

Q5: *"I think patients will be more equipped to say, 'These are my symptoms and if I have this then something really needs to be done' . And I think especially the orange zone going towards red and that they will be heard by HCPs, especially the ones they don't know well. A substitute GP or emergency doctor or so……It gives them confidence that they know."* (HCP10)

Q6: *"Now you have a specific topic to discuss. Usually it's small talk, but now patients will know in advance, 'okay, we will discuss **this**.' So also **they** will prepare in advance. So yes, I think it could be positive."* (HCP1)

Q7: *"Look, if someone's calendar is continuously 'green', you can say, 'well, that looks really good!, maybe we should cut back or adjust some medication. Let's see if that is possible' So that is all profit."* (HCP8)

Q8: "*You know, currently you have it on paper. And by having it on the phone you give the responsibility to the patient. And when he comes in contact with other HCPs….if I…look at us…look at the nurses in community care, we collaborate intensively with them, then you can say, 'Look, the patient has it on his phone!' And not only for us outpatient clinic but also for the nursing ward they can say, 'Hey, what has the patient done? What happened?'"* (HCP4)

Q9: *"If I put myself into the patients position, I think, 'Now I have an app for lung attack, and the food intake app and move monitor app. That is quite a lot.' That's the only thing that makes me hesitant, the treatment burden."* (HCP10)

Barriers and facilitators in daily practice

After identifying benefits and risks, HCPs discussed factors in daily practice that could facilitate or hinder using the app as intended.

All HCPs believed *patient skills, opportunity and motivation influences the use of app (Q10-11).* The proliferation of mobile device use, increased digital literacy skills and frequently carrying a smartphone was believed to facilitate the use of the app in a large population. However, low-literacy, confrontation with illness, forgetting the app during periods

of deteriorations or losing interest in using the app were described as barriers by many HCPs.

HCPs mentioned the *ability to fit the app within available time and workflow (Q12-13)*. Most HCPs believed the app fit nurses', but not doctors', available time and workflow. Several doctors felt using the app would result in even more work as they would be obligated to focus on issues that normally would not come to light.

Q10*: "We have a lot of older generations here. That could be complicated for them. But sometimes it takes me by surprise when someone of 90 has a tablet and iPhone. I am often surprised because you think, 'Oh, no they will not do that', and then all of the sudden, there is their phone!" (*HCP 4)

Q11: *"I do wonder if someone will actually work with it. Because there are also people that do not constantly want to be reminded and they prefer to hide it."* (HCP1)

Q12: "*The content, we also work with that when we make plans. So is in agreement with the work procedure we do without the app, what we do on paper now."* (HCP3)

Q13: *" Right now I am already thinking, for a doctor, for the consultation time available, this is too complicated, it takes too long. I am getting…I think, 'Shit, I have to continue. I don't have that much time.' Look, now I am not even talking with the patient. I am only…"* (HCP5)

Conditions to be met to integrate the app in daily practice

HCPs were asked to think about conditions currently not available but necessary in order to use the app in daily practice. Many insisted *management support is necessary (Q14)*. Having organizational mandate to implement the app was important for most HCPs and was seen to contribute to allocation of time and resources. Overall, larger organizations believed acquiring management support to be more difficult and time consuming than smaller organizations.

Nurses indicated *training and instructional material is necessary (Q15)*, including training sessions for HCPs, and a demonstration app to inform, instruct and practice with patients to determine patient skills and motivation. Supplemental written information may also be useful. To install the app during HCP consultation, *free and adequate WIFI provided by healthcare organization is mandatory (Q16)* to ensure rapid download of the app on patient's device. Currently, not all organizations provide free internet. Subsequently, *integrating the app with local IT systems is relevant (Q17-18),* particularly for doctors. Reducing administrative burden, preparing patient consultations, using app output for statistical purposes or

occasional HCP monitoring symptoms were frequently mentioned reasons by doctors. Integration of systems was less important for nurses. Some argued it could have an opposing effect and undermine or diminish patient's self-management behavior.

Q14: *"We have an agreement that new studies or implementations must be approved of by the management team. On the one hand it always costs a little bit of time, on the other hand, you know when its approved then everybody has to abide by it. Then it will be supported by all location managers."* (HCP7)

Q15*: "Of course training for HCPs is necessary, but also to show patients, look this is it. And that you have a dummy patient. And that you can show what you can do with it. Then the patient can decide if he want to or not. And yes.. an instructional flyer and preferably a example thing. Preferably on desktop. Or on mobile device, that will work most handy because that is what they will work with. If you put it on your desktop it's really large and its not a realistic image for patients."* (HCP2)

Q16: *"If it costs me 5 minutes to get the app on the phone then….that's a barrier, yes. Because then it costs too much time. Having the app rapidly available on the telephone is, I think, the most important!"* (HCP6)

Q17: *"Then you have the monitoring that automatically shoots in. It's a pity, but with diabetics it also works that way. The glucose monitor measures the curve, and I **still** have to fill out things on paper! That does not fit with this day and age. You should have the modality to automatically shoot it into the chronic care module. I believe that's where you differentiate yourself and then you have a really good system."* (HCP12)

Q18: *"No, no….then you actually affirm or emphasize the external locus of control. The patient becomes passive, 'I am being taken care of.' And that is what we don't want anymore!"* (HCP6)

Utilizing the app in daily practice

HCPs discussed how they perceived the app would most likely be used in their daily practice. Overall, HCPs regarded the *app a shared responsibility (Q19)* between nurses and doctors. All HCPs indicate working with the app, including installing, personalizing and evaluating the app, best fits nurses' role as this is in line with current nursing practice, and less suitable for doctors role due to lack of time and disrupting workflow. However, HCPs express doctors are important in prescribing and evaluating medication treatment. HCPs currently using paper plans *intended to replace paper plan for the app*. Nurses indicate patients often lose or forget their plan or become illegible. Nonetheless, patient preferences and skills will determine if the paper plan is replaced for the app. Furthermore, *selecting patients to use the app is HCPs responsibility (Q20).* Some HCPs would inform all patients, using interest and motivation to select patients. Others would preselect patients based on assumptions of suitability before introducing patients to the app. Moreover, HCPs perceived the app *feasible to integrate into existing paths of care (Q21).* This included annual COPD checkups in primary care; clinical

care paths, outpatient follow-up care and pulmonary rehabilitation programs in secondary care; clinical and outpatient pulmonary rehabilitation programs in tertiary care. However individual organizational factors will determine the specifics of how the app is to be integrated. Regarding time investment, nurses estimated 20 to 30 minutes to install and personalize the app and 15 minutes to evaluate the app.

Q19: *'Look what you also have is, the perspective of a doctor is different than that of a nurse. A doctor looks at the medical treatment and we (nurses) look at management and how to self-manage. That is a big difference, of course."* (HCP13)

Q20: *"I think we should select a category patients who we think is suitable. And then ask 'is this something you would be interested in?' Just like we do with the other program [telemonitoring] we currently use. But the advantage we have now is, you know you have to select well. Selection is sort of complicated. I would prefer to invite patients here. Currently we have a IT company that does the selection for the other program. I think doing it that way has some negative things."* Interviewer: *"You want to control it yourself?"* HCP: *"Yes, that way I can see that, **when** they do it, I can see **how** they do it."* (*HCP5)

Q21: *"Of course I see patients annually for their COPD'. One year we do lung tests and the other year we don't. Then it would be nice to use this app….You can fill it out together with the patient, because I think that could be an issue. Regarding medication, people don't know exactly which they had or forgot the name and then you can walk through with this together. We already do this on a yearly basis to check if they ordered medication too often or not often enough."* (HCP11)

App usability

Although not the focus of this study, several *usability problems* were observed while working in the action plan. Most frequently occurring problems were related to the medication interface and switching between various interfaces.

DISCUSSION

This early-feasibility study provides insight into the perceptions of HCPs with a case-management role in COPD care in the Netherlands towards using the Copilot app in daily practice. Overall, HCPs found the app acceptable and expressed interest in using the app in practice. Several benefits and few risks were mentioned for HCPs, patients and organizations, although nurses and patients are perceived to benefit more than doctors. This may be explained by HCPs perceptions that working with the app fits nurses time and workflow, is in line with nurses current practice, and therefore found to fit nurses' role best. Despite potential advantages, doctors are expected to play a marginal role in working with

the app due to constraints in time and workflow. Management support, WIFI, instructional material and system integration of the app were considered important conditions to be met for implementation. However, the level of importance of these conditions varied between contexts and professions and may be attributed to organizational factors or fundamental difference in needs between doctors and nurses. All HCPs found the app feasible to integrate into existing programs or care paths across the settings. Nevertheless, individual organizational factors will determine the specifics of how, when and by whom it will be integrated. Although not the focus of this study, HCPs experienced several usability problems. These were identical to problems identified in the usability evaluation conducted with the same prototype as used in this study.

The findings of this study are in line with other studies. A 2015 systematic review by Gagnon et al. evaluated facilitators and barriers regarding HCPs' adoption of mHealth and found usefulness and ease of use of mHealth important factors to facilitate or hinder the adoption of mHealth by HCPs. MHealth to support patient empowerment, interoperability with systems, management support of technology, training and human resources were frequently mentioned facilitators while disruption to workflow and increased workload were key adoption barriers[32]. In line with that study, Miller et al found lack of adequate electronic exchange between systems, initial physician time costs, uncertain financial benefits and physician attitudes as key doctor-related barriers[33]. These studies indicate that nurses may hold the key to successful implementation of the app due to their role, fit with workflow and time, and numerous advantages. Moreover, to increase the likelihood of using the app in practice, these studies strengthen our findings on the importance of meeting the implementation conditions. According to our results and literature, integrating the app with systems could facilitate the use of the app, especially for doctors. However, system integration was not mentioned by Korpershoek et al. who studied the needs of HCPS regarding mHealth intervention for CODP patients[34].

Strengths and limitations

A strength of this study was obtaining maximum variation in settings and HCPs, resulting in a broad range of perspectives, thereby increasing the applicability of our findings to similar settings in the Netherlands. The feasibility framework described by Bowen et al. ensured a wide range of feasibility parameters were collected to evaluate *if the app can work* within the constraints of daily practice[20]. Although not the focus of data saturation, data collected on integration and practicality give a general impression of contextual differences of how to integrate the app and which role is perceived to be most suited. Furthermore, methods used in this study gave rapid insight into influencing factors and conditions regarding feasibility; thereby allowing researchers to adapt the app by moving backwards or forward quickly.

Finally, the trustworthiness, credibility and conformability of this study was enhanced by using data and researcher triangulation[31].

   A limitation of this study was the inconsistency in conducting the sessions due to HCPs' unruly workflow and time issues; HCPs not having read the information letter prior to conducting the session; HCPs spending more time than intended on interacting with the app; and HCPs relatively large focus on usability issues. Subsequently, this led to less in depth interviews and not systematically collection information on parameters. We tried to intercept this by applying the guideline in Table 1.

Implications for further research

Before the app can be used in daily practice, conditions and usability problems need to be met and resolved. Once this has occurred, it is important to evaluate feasibility with HCPs and patients over a period of time focusing on '*will the app work at intended?"* These results also provide direction how to implement the app to fit the needs of individual settings and professionals. Furthermore, future research should creatively combine methodologies appropriate for fast paced digital innovations instead of following classical research pathways as may put the new innovation as risk as it is fragile to survive and positive results may be needed to sustain the innovation[35].

CONCLUSION

Overall, HCPs found the app acceptable, expressed interest in using the app, and found several benefits and few risks. The app is perceived feasible to integrate in existing care paths in primary-, secondary,- and tertiary care settings whereby using the app is considered a shared responsibility in which it fits nurses' role best. Nonetheless, usability problems and conditions to be met have to be resolved before feasibility over time with HCPs and patients can be evaluated.

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Table 1 Guideline how to conduct feasibility study with HCPs in practice

Introduction	

Describe aim of the study	• Evaluation of feasibility of the Copilot app in the daily practice of HCP
	• This is an early feasibility study (we want to know how the app fits your current practice)
	• Consists of:
	    ○ Interactive session→work with the app using a patient case;
	    ○ Interview→reflecting on the session; evaluating perceptions;
	    ○ Collecting participant characteristics
	• Time: approximately 20 minutes for session; 20 minutes for interview; 10 minutes for questionnaire and rounding off

Describe aim of video recording	
Collect informed consent/questions	
Questions to ask before starting session	• Experience with action plans • Experience with technology in care for COPD patients
Explain aim of Copilot app	
What is the intended use?	• Developed for patients • Helps patients recognize fluctuations in symptoms and if necessary helps take proper action at the right time • Contains a symptom diary, action plan, information of COPD and exacerbations (show components in app) • Contains a calendar: look back on registered symptoms and actions • To be used for self-monitoring for patients. It is not a monitoring system for professionals (this is the difference! Current systems focus on monitoring by HCPs)
Explain color zones in action plan	• Green = 'I feel well'. Present symptoms are 'normal'. The app specifically focusses on teaching the patient what are their 'normal' symptoms, their maintenance therapy and how they can stay in the green zone • Yellow = 'I feel less well'. There is an increase in one or more symptoms. This signals actions should be taken according to mutual agreements between patient and HCP • Orange = "I feel less well for 2 days'. Increased symptoms have been present for two days, or symptoms have increased in severity • Red = 'I need acute help'. Symptoms are life threatening
Scenario's: how to use the app	
1. Registration of app	During patient consultation, the HCP and/or patient download the app onto the mobile device of the patient and together they personalize the action plan

2. Intensive symptom monitoring	To determine what is 'normal', the patient intensively monitors his/her symptoms for two weeks by turning the on the 'symptom diary'
3. Action plan adjustment	After two weeks of daily symptom monitoring, the action plan can be adjusted. How and when adjustment of action plan takes place depends on individual context of HCP
4. Regular use	The patient is actively asked once per week how he/she feels. In addition the patient can register symptoms at any given time
5. Actions to be taken	The app helps the patient take the proper action when the patient indicates he/she feels less well
6. Evaluating app during consultation	Using the calendar, the registered symptoms and actions are evaluated during patient consultations. If necessary, a new period of intensive monitoring can be deployed

Explain role of patient and HCP	
Role patient	• Owner of the app, shows app to all relevant HCPs • Makes a personalized action plan in collaboration with HCP • Registers symptoms and taken actions in symptom diary • Uses the information component to search for information about COPD, exacerbations and self-management
Role HCP	• Focusses on personalizing the action plan in collaboration with the patient • Specifically focusses on the green zone: what symptoms are 'normal' for the patient • Evaluates the calendar with the patient during consultations→evaluation of registered symptoms and actions; if necessary, adjustment of action plan

Explain current developmental phase of app	
	• This is the first prototype • Currently working on integrating the app into local IT infrastructure • Usability testing with patients and HCPs have been completed. Observed usability issues have not been resolved in current prototype. Primary focus is evaluating perceptions and not usability.

Explain interactive session	
	• Use a fictional patient case consisting of baseline consultation and follow-up consultation • Conduct several tasks with the app using the patient case, tasks are in line with how you would do this in daily practice • Think aloud→feelings, thoughts, etc.

Part 1: initial consultation	Show patient case • Pretend that Mr. Janssen is sitting across from you for his first consultation. • A basis action plan is made based on mutual agreements described in the patient case
Part 2: follow-up consultation	Show patient case • Pretend Mr. Janssen returns to see you after several weeks. • Mr. Janssen has registered symptoms over this period of time • Based on registered symptoms the action plan is adjusted and personalized. Show calendar
Conduct interview	
Participant characteristics (Questionnaire)	
Give small present to participant	

Table 2 Definition, objectives, parameters, outcomes of interest, data collection method according to Brown et al[28]

Parameter Focus area	Definition	Outcomes of interest	Measurement method
Acceptability	"How the HCP reacts to the Copilot app."	Satisfaction with the Copilot app	Observation think aloud interview
		Appropriateness of Copilot app	Interview
		Perceived fit of Copilot app within the organizational culture	Interview
Demand	"To what extent is the Copilot app likely to be used by the HCP."	Perceived demand of Copilot app	Interview
		Expressed interest/intended use	Interview
Implementation	"The extent, likelihood and manner in which the Copilot app can be used by HCPs as planned and proposed."	Degree of execution of tasks using the Copilot app	Observation think aloud
		Success or failure of execution of tasks using the Copilot app	Observation think aloud
		Factors affecting implementation ease or difficulty	Interview
Practicality	"To what extent the copilot app can be used by HCPs in their routine daily practice considering the available resources."	Expected benefits and burden for HCPs using the Copilot app	Interview
		Ability of HCPs to carry out tasks in their routine daily practice	Interview

| Integration | "To what extent can the Copilot app be integrated in current collaboration between Dutch primary, secondary and tertiary care settings." | Perceived fit with local care infrastructure at patient and organizational level | Interview |
| | | Perceived sustainability at patient and organizational level | Interview |

Table 3 Fictional patient case and corresponding tasks

Tasks to conduct according to patient case 'Mr. Janssen'

1. **First consultation:**

   1) Read the information in the patient case.
   2) Register the Copilot app according to the onboarding conversation of the app.
   3) Individualize all color zones of the action plan according to the 'Mr Janssen' s case.

2. **Follow-up consultation:**

   1) Read the information in the patient case related to the follow-up consultation.
   2) Adjust Mr. Janssen's normal symptoms (green zone) [Show symptom diary]
   3) Adjust the medication in the green zone.
   4) Using the calendar, evaluate the registered symptoms and actions with Mr. Janssen.
   5) Take a look at the information component of the app. You can use this to explain give information about COPD, exacerbations and self-management to Mr. Janssen.

FIRST CONSULTATION
Aim: Installing and personalizing action plan with Mr. Janssen.

Information for baseline consultation:
- Mr. Janssen, 63 years of age, COPD GOLD II/D.
- Mr. Janssen has experienced frequent exacerbations during the past year, including being hospitalized four months ago.
- 'Normal' COPD symptoms include:
  - Shortness of breath (during light exertion)
  - Coughing (every now and then)
  - Sputum (a little)
  - Fatigue (light fatigue)
- Normal treatment (green zone):
  - Long working bronchodilator: Spiriva Respimat 1x 2 doses per day

        o   Anti-inflammatory inhaler: Foster doses aerosol 2 x 1 doses per day
- Actions to be taken when increase in symptoms occur (yellow zone):
  - Extra medication:
    - Atrovent doses aerosol 3-4 doses per day.
  - "I divide my energy/activities over the day".
  - "I conduct by breathing exercises".
  - 'In case of questions, I contact my HCP".
- Mutual agreements in orange zone:
  - Fill out the contact person.

FOLLOW-UP CONSULTATION AFTER SEVERAL WEEKS

Aim: Adjust action plan and evaluate registered symptoms/actions

Information for follow-up consultation:

Mr. Janssen has registered his symptoms every day for the past two weeks. He has also registered which actions he undertook at the moment he felt less well. Mr. Janssen is back to see you and to show you which symptoms he has experienced. After evaluating the calendar, you can tell the symptoms he experiences as 'normal' do not correspond to green zone you initially filled out together. At that time, Mr. Janssen did not really know what his normal symptoms were. The registered symptoms indicate Mr. Janssen frequently coughs (instead of coughing every now and then) and is very fatigued (instead of little fatigued). Mr. Janssen also experiences wheezing during breathing.

Based on this information, for the green zone, you advise Mr. Janssen to increase the dosage Foster from 2x1 to 2x2 daily.

Table 4 Interview guide

Acceptability	
	- What is your first impression of the app? - On a ten-point numeric scale, how satisfied are you working with the app? (Why? What needs to change in order to increase satisfaction?) - What is your perception of the clinical relevance of the app? Can you explain? - Would you advise colleagues to use the app? Why?
	- How usable is the app for your daily practice? - How usable is the app for your patients?
	- To what extent does using the app fit the culture of your organization? - To what extent is your organization willing to use an app to support self-management in COPD patients?
Demand	

	• How interested are you to use the app for your daily work on a ten-point numeric scale? Why? What needs to change to increase this? • To what extent does the app fit your wishes to improve COPD care? • What would it mean for your daily practice if you were to use the app?
	• How do you think you would use the app for your daily practice? • How do you think the app will be used in your organization? • Are there components of the app you would use more than others?
Implementation	
	• Were you able to individualize the action plan as you would normally do with the paper plan (depends on if someone uses paper plan)
	• What went well during execution of tasks in your opinion? • What went less well during execution of tasks in your opinion?
	• Which factors in your organization may facilitate the use of the app as intended? • Which factors in your organization may hinder the use of the app as intenden?
Practicality	
	• To what extent can the app currently be used in your practice considering the current resources available? • What are benefits of using the app in your opinion? (e.g. your work process, interaction with patients, organization) • What are risks of using the app in your opinion? (e.g. work process, interaction with patients, organization
	• To which extent would you be able to use the app in your consultations if the app was currently available? Are the condition currently in place to use the app? • Which conditions need to be met in order to use the app as intended? • What are possible positive and negative effects on your organization if you were to use the app? • How much time do you think is necessary to 1) personalize the app and 2) adjust and evaluate the app?
Integration	
	• To what extent does working with the app fit your daily workflow? • How can the app be integrated into you daily practice? • How can the app be integrated into the daily practice of your colleagues? • How can the app be integrated into your organization? • To what extent does the app fit into current collaboration between primary, secondary and tertiary care?

	• Which changes need to occur before the app can be integrated into your daily practice? In your organization? With your local collaboration partners. • To what extent is the app sustainable to use in your organization?

Table 5 Baseline characteristics participants

1 What date is it today?	

. . / . . / . . . .

2 What is your gender?

❑ Male ❑ Female

2 What is your date of birth?

. . / . . / 19 . .

3 What is your profession/job?

....

4 What type of organization do you work? (hospital, general practice, pulmonary rehabilitation center)

....

5 How many years of work experience do you have as a case manager in COPD care?

.....................year

6 How many years do you work for your current employer?

.....................year

7 How many people work in your organization?

❑ 10 or less
❑ 11-25
❑ 26-50
❑ 51-100
❑ 100-250
❑ 250-1000
❑ More than 1000

8 Which COPD patients do you see most often in your daily practice?

❑ Most patients have GOLD stadium 1-2
❑ Most patients have GOLD stadium 2-3

- [ ] Most patients have GOLD stadium 3-4
- [ ] I don't know

---

9 How many COPD case manager consultations do you conduct on average per week?

…………………consultations

---

10 How much time do you have on average for this consultation?

…………………minutes

---

11 Do you use an action plan in caring for COPD patients?

- [ ] Yes   - [ ] No

---

12 When do you make an action plan with the COPD patient?

……………………………………………………………….

---

13 How much time does it take to make an action plan?

…………………minutes

---

14 Do you use mHealth in COPD care?

- [ ] Yes   - [ ] No

---

15 Would you be willing to use the Copilot app for your COPD patients?

- [ ] Yes, I would use the app
- [ ] Yes, I would use the app only
  if:…………………………………………………………………………………………………..
- [ ] No, I would not use the app
  because:………………………………….…………………………………………
- [ ] I have doubts of using the app
  because:…………………………………………………………………………………

Table 6 Baseline characteristics of HCPs

ID	Age range	Sex	Profession	GOLD	Sett ing	Consults per week	Consults (minutes)	Work experience (years)	Size organization	Time for action plan (minutes)
HCP1	30-34	Female	N	3-4	2	20	30	3	250-1000	30
HCP2	50-54	Female	N	2-3	1	15	45	30	25-50	n/a
HCP3	55-59	Female	N	3-4	2	28	20	6	>1000	15
HCP4	45-49	Female	N	3-4	2	21	30	12	>1000	2x30
HCP5	30-34	Male	P	3-4	2	15	10	7	>1000	n/a
HCP6	55-59	Male	NP	3-4	2	70	20	20	>1000	10
HCP7	40-44	Female	GP	1-2	1	4	10	7	100-250	10
HCP8	60-64	Male	P	3-4	2	50	15	34	250-1000	20
HCP9	45-49	Female	P	3-4	3	25	20	2	250-1000	10
HCP10	55-59	Female	PA	3-4	3	10	30	30	250-1000	15
HCP11	50-54	Female	N	2-3	1	2	30	12	<10	10
HCP12	40-45	Male	GP	1-2	1	4	10	10	11-25	10
HCP13	60-64	Male	NP	2-3	2	20	30	14	>1000	30

Abbreviations: *GOLD* Global Initiative for Chronic Obstructive Lung Disease; classified by GOLD stage 1-2,2-3, and/or 3-4

N=nurse; P=pulmonologist; NP=nurse practitioner; GP=general practitioner; PA=physician assistant

Healthcare settings: 1=primary care; 2=secondary care; 3=tertiary care