Patients and healthcare practitioners' perspective on the development of a digital interprofessional intervention for COPD

Natacha Biset[1] (iD), Amélie Rosière[1], Victoria Lartigue[1], Stéphanie Pochet[1]
and Carine De Vriese[1] (iD)

Abstract

Background: Chronic obstructive pulmonary disease (COPD) patients often have poor health literacy, leading to non-adherence to treatment and poor inhalation technique. Technological solutions can help manage COPD, but adherence tends to be low due to various factors.

Objectives and Methods: We conducted a qualitative study to determine the needs of COPD patients and healthcare practitioners (HCPs) towards a mobile application and a web platform. We also aimed to identify potential barriers or facilitators to the use of such digital tools and their potential impact, and to assess the current state of collaboration between healthcare practitioners.

Results: Our study found that COPD patients face difficulties in managing the disease and treatments, lack information and need easier contact with caregivers. Patients' needs include access to reliable information about COPD, its medical treatments and smoking cessation, help in maintaining good physical condition through adapted exercises, incentives and reminders, and crisis management protocols or a logbook. As patient needs can differ, it would be ideal if the mobile application could be customized. HCPs cite patient adherence, correct intake of the treatment, communication and lack of patient motivation as challenges. In particular, they would like to have access to information on patient follow-up and logbooks, as well as scientific documentation. They believe that interprofessional collaboration is essential for good patient care. However, lack of time is a major hurdle in optimizing this collaboration.

Conclusion: Our study showed that most patients and HCPs view a technological platform positively to support the care of COPD patients and promote interprofessional collaboration.

Introduction

Chronic obstructive pulmonary disease (COPD) is the third leading cause of death worldwide. Despite international guidelines for its management, COPD is the seventh leading cause of poor health worldwide.[1] It involves adapting the patient's lifestyle, such as smoking cessation, exercise, a suitable diet and pulmonary rehabilitation. These adaptations enable patients to maintain a good quality of life but require their involvement, which is not always easy.[2]

COPD patients often come from a low socio-economic background and have a low level of education.[3] As a

---

[1]Department of Pharmacotherapy and Pharmaceutics, Faculté de Pharmacie, Université libre de Bruxelles (ULB), Brussels, Belgium

Corresponding author:
Carine De Vriese, Department of Pharmacotherapy and Pharmaceutics, Faculté de Pharmacie, Université libre de Bruxelles (ULB), Brussels 1050, Belgium.
Email: carine.de.vriese@ulb.be

result, they are more likely to have poor health literacy, which may explain the main problems encountered in their care. These include non-adherence to pharmacological and non-pharmacological treatment and poor inhalation technique, which can lead to exacerbations – a major complication in COPD patients.[3,4]

Healthcare practitioners face challenges in managing COPD patients due to comorbidities and multidisciplinary requirements.[5] Interprofessional collaboration defined as 'the process in which different professional groups work together to positively impact health care', is essential for the management of these patients.[6]

Over the years, several technological solutions have been created to enhance the management of chronic diseases such as COPD. The use of technology by COPD patients can be influenced by various factors, including age, education, experience with electronic devices, cognitive or motor skills and the people around them. Nevertheless, adherence to these technological interventions tends to be low.[7,8]

Comunicare is a digital platform developed in Belgium that aims to be a helpful companion throughout the entire care pathway. It comes in the form of a mobile application for the patients and a dashboard/web platform for the caregivers. Comunicare stands out from other platforms due to its innovative ability to personalize information on the care pathway and its intelligent patient–professional interaction.[9]

The purpose of this study was to determine the expectations of both patients and healthcare practitioners about a mobile application and a web platform such as Comunicare and to identify any potential barriers or facilitators to the use of such digital tools. Additionally, we aimed to assess the current state of collaboration between healthcare practitioners and assess the impact of a technological tool.

Methods

Study design

This exploratory qualitative study using semi-structured interviews was carried out in two stages: (1) a consultation of COPD patients and (2) a consultation of HCPs involved in COPD patient follow-up. Implementation science is defined as 'the study of methods to promote the adoption and the integration of evidence-based practices, interventions and policies into routine health care and public health settings'.[10] The RE-AIM framework was developed by Glasgow et al. in 1999 to assess the transferability of interventions developed by researchers and their impact on public health and is widely used in the literature.[11] It guides the planning and evaluation of programs according to the five key RE-AIM outcomes: reach, effectiveness, adoption, implementation and maintenance. The interview grids were developed and adapted from the RE-AIM

framework (Appendix 1).[12] Considering the context and objectives of our study, we specifically focused on the three following dimensions: reach, adoption and implementation. Additionally, we incorporated another dimension regarding the communication between patients and HCPs, which was crucial for the focus of this study. The themes discussed, classified according to the dimension and illustrated by verbatims, are detailed in Appendix 2 for patients (Table A3) and HCPs (Table A4). The consolidated criteria for reporting qualitative research (COREQ) checklist was used and is attached in Appendix 3.

Recruitment

Patients were recruited through the two partner hospitals Erasme Hospital and CHU Saint-Pierre, with the help of pulmonologists and physiotherapists treating COPD patients. There were posters and flyers available in waiting rooms, physician's offices and pulmonary rehabilitation (PR) units. HCPs were recruited through either of the partner hospitals. Given the limited number of responses, the snowball sampling method was used to disseminate the study on social networks and professional groups. In compliance with GDPR requirements, the comments section was disabled. Instead, motivated participants were invited to contact the research team privately using the provided contact details. Eligible patients included those with COPD diagnosis at any stage, while the targeted HCPs were pulmonologists, general practitioners, community pharmacists, physiotherapists and nurses.

Data collection

Two researchers conducted semi-structured interviews exclusively by phone for patients (NB, PhD student and AR, pharmacy student new to qualitative research) or in person for HCPs (NB and VL, pharmacy student new to qualitative research). Before the interviews, the study objectives and ethical considerations were explained. The patient was reminded that they could withdraw from the study at any time. Due to COVID-19 sanitary restrictions, interviews were conducted by phone, and verbal informed consent was obtained from all study participants in line with the approval granted by the Erasme Hospital Ethics Committee in December 2020 (P2020/372 / B406202000 0187). This consent was audio-recorded in accordance with the committee's approval. Additionally, written notes were made during the interviews. Interviews were conducted until thematic saturation, meaning no new codes or themes were emerging from the data during the last interview.[13] The main objectives were to identify the future beneficiaries of the tool; the difficulties encountered and the role of the tool in decreasing them; necessary features in a mobile application (patients) or a dashboard/ web platform (HCPs); and facilitators and barriers to

using the tool. We also assessed the state of communication between patients and HCPs, and between HCPs themselves. Finally, we identified the facilitators and barriers to collaboration between HCPs, as well as the potential impact of the proposed tool on patient care and interprofessional collaboration.

Analysis

Semi-structured interviews were transcribed verbatim and anonymized. Each patient and HCP was assigned an ID number, and any information that would allow identity to be traced was not transcribed. Transcriptions were inductively coded by two investigators independently with Nvivo software (versions 12.5.0.815 and 20.7.1.1534). The codes were then compared, and any discrepancies were discussed. Finally, the codes were classified into themes, which were grouped into outcomes and within one of the following dimensions: reach, adoption, implementation or communication.

Results

Patient consultation

Between January and March 2021, 21 patients meeting the inclusion criteria were enrolled (13 women and 8 men, median age was 56 years). Interviews lasted an average of 20–40 min. Details of the themes that were identified in the analysis, and illustrative quotes, can be found in Appendix 2 (Tables A3 and A4).

Reach. Motivation and utility. Patients participated in our study for various reasons. Some wished to contribute to the research, while others wanted to break their solitude or improve their quality of life through the intervention. They also hoped to raise awareness about their disease. Patients believed that a mobile application could be useful in reassuring them in certain situations, ensuring better follow-up or improving their quality of life. However, a few of them felt that a mobile application would not be helpful for them but believed that it could benefit other patients.

Adoption. Main difficulties in managing the disease. Most patients suffering from COPD reported experiencing difficulty managing their disease, symptoms and medications. Some patients mentioned that finding the right treatment took several years, while others struggled with remembering to take their medication. Patients also reported having difficulty managing side effects and the inhalation technique. They found it complex to obtain clear information about the disease, treatment options, life expectancy and how to adapt to their everyday activities. Many patients felt isolated and lonely because those around them did not understand the disease and its implications. Coping with the diagnosis, staying motivated to take medication, exercising regularly and quitting smoking were also significant challenges. Only two patients reported no difficulty in dealing with COPD.

Implementation. Needs in a mobile application. Patients with COPD expressed their need for more information on their condition, including details on the causes, prevalence, progression, prevention, crisis management, benefits of oxygen therapy and pulmonary rehabilitation. However, they found it difficult to find reliable information online or have been confronted with very fearful and pessimistic information. Additionally, some patients wanted to know more about available treatments and how they are chosen by doctors, as well as updates on new drugs.

To help manage their condition, patients suggested a crisis management protocol, reminders to take their medication, instructions on inhalation techniques, information on side effects and financial assistance. They also emphasized the importance of personalized information that considers their individual needs and preferences.

Patients expressed a desire for easier communication with HCPs, including the ability to ask questions about their symptoms and medication, and to quickly schedule appointments when necessary. They would also like to connect with other COPD patients to share experiences and provide mutual support.

Moreover, patients would appreciate a mobile application that provides personalized physical exercise recommendations based on their respiratory capacity. They would also like to receive encouragement to engage in physical activity and quit smoking, as well as advice on nutrition and relearning daily gestures based on gesture economy. Finally, patients expressed the need for a logbook to record their condition and feelings between visits and for the application to centralize their data and share it with different healthcare professionals.

Barriers to the use of a mobile application. The main barrier mentioned was related to smartphones or tablets. Some patients did not own a smartphone or tablet, did not know how to use it or did not want a mobile application cluttering up their phones. Some older patients might have trouble using a smartphone, which could also be a barrier. Patients also wanted guarantees about the management of their data. They thought that HCPs, who are already overworked, could not handle an application on top of their current workload. Without a response to the messages sent via the application, patients expressed that they would lose interest in it. However, patients also expressed their fear that this tool could replace a medical consultation. For them, it should be complementary, and it is essential to maintain consultations. Finally, a third of patients said that they had no barrier to using a mobile application that contained the functionalities they needed.

Facilitators to the use of a mobile application. Patients thought that reminders or notifications would encourage the use of the application. They also emphasized the importance of the application's ease of use. According to their feedback, the app should be easy to connect to, have a simple and visually appealing design, avoid overwhelming them with too much information, and most importantly, enable them to easily find what they are looking for. Some patients who already use a mobile app for another disease mentioned that it would be easy for them to adopt another one. Lastly, patients suggested that the promotion of the application by HCPs could be helpful.

Communication with healthcare practitioners.
Most patients reported effective communication with their HCPs, including general practitioners (GPs), pharmacists, physiotherapists and respiratory specialists. Communication usually occurred during consultations, pharmacy visits or by telephone, with email being used less frequently. The majority of patients reported consulting their respiratory specialist annually or every 6 months. For the other professionals mentioned, contact seemed more frequent. However, some patients expressed a lack of communication with HCPs feeling that doctors did not have enough time to provide sufficient information. They highlighted the interest and importance of pulmonary rehabilitation programs where nurses and physiotherapists took the time to give advice.

Patients also reported that it was challenging to reach HCPs directly over the phone or that it took a considerable amount of time to schedule an appointment. Therefore, some patients felt that a mobile application could improve communication between them and their HCPs.

Healthcare practitioner consultation

Between November 2022 and January 2023, a total of 24 HCPs were interviewed to saturation point for all professions combined. These HCPs belonged to five different professions, namely 7 community pharmacists, 5 physiotherapists, 3 GPs, 3 nurses and 6 pulmonologists. Out of the 24 HCPs, 13 were women and 11 were men, with a median age of 41 years. The physiotherapists interviewed worked in a hospital within a PR unit, in another service or outside the hospital. The nurses and respiratory medicine physicians were employed in different hospitals.

Reach. *Motivation, utility and targeted patients.* HCPs who participated in our study were motivated by their interest in the project, a desire to help patients and contribute to research, and their enjoyment of clinical studies. They emphasized the importance of developing a tool that could help COPD patients better understand their disease and treatments while also empowering and supporting them. HCPs believed that a digital intervention could improve collaboration and communication among healthcare providers.

Regarding the target audience for a digital tool in the form of a mobile application, HCPs had varying opinions. Some believed that age remained a significant barrier, while others noted that an increasing number of older patients have become capable of using smartphones since the COVID-19 epidemic. Some HCPs expressed concerns about patients' ability to afford a smartphone or their level of literacy to use one.

Finally, professionals raised concerns about patients' adherence to the tool, with the stage of the disease being a key factor. They suggested that patients should be introduced to the tool as early as possible so they can become familiar with it. This would make it easier for them to use the tool when they are at more advanced stages of the disease and are receiving more regular follow-up and interventions from different professionals. However, some suggested that patients who are already familiar with their disease may have little interest in using the tool.

Adoption. *Main difficulties encountered in the management of COPD patients.* HCPs face challenges in managing COPD patients, particularly regarding adherence to drug treatments and physiotherapy or PR. Pharmacists have observed that some patients tend to consume large quantities of crisis treatment but not enough chronic treatment. Similarly, physiotherapists have reported that patients often drop out of PR sessions, with only 35–40% attending regularly, according to them. The lack of adherence to medication and physical therapy is compounded by patients' difficulties in taking their inhaled treatment correctly, whether related to inhalation technique or dosing regimen.HCPs have also noted that patients' lack of health literacy makes it difficult for them to receive and comprehend information about their diagnosis and disease. Communication between HCPs can also be challenging. Furthermore, patients' general lack of motivation contributes to several of the difficulties discussed, such as smoking cessation, non-adherence to pharmacological treatments and physical activity. HCPs also face challenges in managing patients with comorbidities, exacerbations, depression and isolation. It is worth noting that a few HCPs reported no difficulties in managing COPD patients.

Implementation. *Needs in a mobile application and web platform.* The most commonly mentioned need among healthcare professionals is access to patient follow-up information. Pharmacists would like access to the doctors' diagnoses and any changes in treatment or dosage. Pulmonologists, on the other hand, would prefer better documentation of the context and follow-up of exacerbations, including single or multiple episodes, dates, nebulized treatment, antibiotic therapy, oral corticosteroids, hospitalization required or not, etc. They also suggest an updated list of patient treatments, monitoring of

vaccinations and better documentation of inhalation techniques through video capsules for themselves and patients.

Additionally, healthcare professionals believe that patients should have access to a logbook where they can record information such as how they feel, the occurrence of exacerbations, physical activity and the associated feelings. They also suggest reminders for medication, appointments and vaccinations, as well as an address book including HCPs and the patient's entourage. Some HCPs also recommend sharing certain data with family members or close confidants/carers. Finally, a crisis protocol including instructions in the event of patient deterioration seems relevant. Several professionals believe that a digital tool as a means of communication between HCPs would be beneficial for continuity of care.

HCPs have suggested that patients need to be encouraged to engage in physical activity or exercise that is tailored to their respiratory and other capabilities. Additionally, they believe that smoking cessation should be emphasized, and patients should be provided with information about tobaccologists and where to find them. To motivate patients, HCPs suggest sending them encouraging messages.

Some HCPs have requested access to up-to-date, high-quality documentation that includes guidelines, drug treatments and new developments, such as combinations of molecules and new devices. Finally, a few HCPs have mentioned that it would be useful to be able to use the application/platform offline, to send questionnaires to patients or to communicate with them through the application.

Facilitators for the use of a mobile application/web platform. HCPs agreed that the main facilitator for patients using a mobile application would be accompanying and training them on how to use it. However, they differed on which professionals should conduct this training. Physiotherapists and nurses seemed more willing to take on this task.

All professionals unanimously agreed that the application must be simple, intuitive and easy to use for patients. They emphasized that the interface must be welcoming to make patients want to use it. Additionally, it should be accessible to as many people as possible, including those with limited cognitive abilities, by using plain language or images. Moreover, it would be helpful if the application were available in multiple languages and free of charge. According to HCPs, patients already using smartphone applications will be more inclined to use a mobile app for their disease.

Some professionals noted that an advertising campaign aimed at HCPs and patients would be relevant. They believed that this tool could be prescribed, and if the patient initiated the request to use the application, they would be more willing to do so. They suggested that the web platform designed for them should be integrated into the software they already use.

According to healthcare professionals, the ability for patients to talk about their disease, its day-to-day management, any difficulties they may be experiencing or simply to break some of the isolation through the mobile application could encourage patients to use it.

Barriers to the use of a mobile application/web platform. As mentioned earlier, the main barrier for most HCPs was the age of the patients. With the COPD population being largely older, the use of mobile applications could be challenging for some patients. However, some HCPs noted that some older patients are very comfortable with technology. They also mentioned literacy issues with patients not always being able to read and write. Some professionals expressed concern about non-French-speaking patients' comprehension.

Another obstacle cited was related to the smartphone. Firstly, the patient must have the financial means to own a smartphone. Secondly, the patient must have sufficient skills to use the smartphone and the application correctly. Moreover, some professionals mentioned the patient's lack of involvement as a barrier that they had already noticed with smoking cessation. In addition, they believe that patients may be hesitant to share their personal information with the different HCPs who follow them.

For a third of HCPs, another barrier mentioned was time to dedicate to this application, given that they are already short of it daily. Finally, a physiotherapist expressed concern about this tool replacing certain consultations.

Communication. Means of communication between HCPs and patients. Most healthcare professionals communicate with their patients orally and through direct contact during consultations or phone calls. They may also provide written communication by labeling medication boxes with dosage information or using visual aids to demonstrate the correct use of inhalation devices. Some professionals use email or a liaison book to monitor certain patients at home. Occasionally, they may communicate through a third party.

Communication between HCPs. When it comes to communication between HCPs, there are differences depending on their specialty and place of work. Out-hospital professionals have limited communication with other HCPs. Communication between pharmacists and doctors mainly occurs through prescriptions or occasional phone contacts with GPs to resolve problems and even less frequently with specialists, mainly because of the difficulty of reaching them. Communication between physiotherapists and doctors is also through prescriptions or sometimes via a liaison book for certain patients. GPs usually receive reports from specialists. On the other hand, HCPs working in hospitals, specifically in a multidisciplinary PR unit, have frequent communication between professionals in the form of formal or informal meetings.

Collaboration and impact of the platform. Healthcare professionals feel that communication between professionals is fragile and needs strengthening. They believe that effective collaboration would make it easier for them to exchange information, when necessary, ultimately improving patient care. They think that a digital platform could help improve this collaboration by enabling information to be shared more easily. Frontline professionals could collect useful information to enrich the patient's history and prevent diagnoses based on incomplete or obsolete information. According to several HCPs, there is a lack of a liaison/coordinating professional to gather all relevant information and help patients manage their disease.

All HCPs agree that GPs are the first point of contact for patients with COPD. They detect the initial signs of the disease, refer patients to respiratory specialists, monitor the patient's condition and manage exacerbations. GPs also coordinate care for patients with comorbidities.

According to HCPs, respiratory specialists initiate treatment based on functional tests, perform annual reviews and adjust treatment if necessary. Physiotherapists are responsible for muscle strengthening, exercise training and helping patients with bronchial drainage and decongestion during exacerbations. They can also play a role in detecting deterioration because they see the patient regularly. If they visit the patient's home, they may have important information about the patient's lifestyle, such as passive smoking and sanitation.

Pharmacists check for drug interactions, provide instructions for proper medication use, ensure correct dosages and monitor treatment adherence. Nurses give medication and prepare aerosols for hospitalized patients. Like physiotherapists, they can also play a role in detecting deterioration. If they visit the patient's home, they may have important information about the patient's lifestyle. Psychologists can help COPD patients who are prone to anxiety or depression. Dietitians take care of dietary follow-up for patients who need to gain or lose weight and help patients with comorbidities like diabetes. Tobaccologists support patients in smoking cessation and can be from various professions such as physicians, pharmacists, physiotherapists or nurses. Specialist physicians are involved in the follow-up of patients with multiple comorbidities. Social workers set up a network of paramedics and help patients with administrative procedures such as obtaining home oxygen. Occupational therapists increase patients' quality of life by teaching them how to conserve their strength and manage their dyspnea. Home carers can detect deterioration because they visit patients regularly, while emergency doctors manage patients with exacerbations in the emergency room. Finally, language therapists can help with swallowing problems.

Facilitators to collaboration. The main facilitator of collaboration among professionals was through face-to-face meetings, such as informational evenings or interdisciplinary continuing education events. Some professionals found that communication by email was not always effective, as they did not always receive a response. They believed that face-to-face meetings were more helpful in establishing contact and encouraging further communication. Although some professionals already attended multidisciplinary meetings (such as a local multidisciplinary network or local medical assessment group), these initiatives were not specific to COPD and did not include all professions.

Some professionals believed that easier information sharing would make collaboration simpler. While sharing already existed through correspondence or platforms such as e-Health (a Belgian federal public institution promoting mutual electronic exchange between HCPs[14]), they felt that this was not enough. This need was also expressed in the functionalities to be integrated into the digital platform.

Other professionals explained that the personalities of their colleagues were important in facilitating collaboration – those who were willing to collaborate and available were easier to work with. Finally, a liaison professional and a patient's motivation were also seen as collaboration facilitators.

Barriers to collaboration. The main obstacle to collaboration among HCPs is the lack of time. Sometimes, it becomes challenging to contact another HCP, particularly when they are not easily reachable. Although information sharing was considered a facilitator in the past, it is currently a barrier for some professionals, possibly due to incompatible tools or data protection policies that prevent some HCPs from accessing patient data. Furthermore, sharing personal data is a sensitive matter, and some patients refuse to share their information. Finally, while some professionals' personalities or investments may facilitate collaboration, they may also act as a barrier for some, as reported by three professionals.

Discussion

According to our study, most healthcare professionals and patients have a favourable view of a digital platform, such as a mobile or web application, as a supportive tool for COPD patients' follow-up and interprofessional collaboration. However, some patients did not find the app useful, though they believed it could be helpful for other patients. These patients were usually at an advanced stage of the disease and had been living with it for some time. This suggests that the app may be more beneficial for newly diagnosed patients. However, in addition to health literacy, it is crucial to consider digital literacy. Digital literacy encompasses the varying abilities to utilize digital technologies and comprehend their associated risks. This concept extends beyond mere technical skills required for internet use and encompasses the capacity to critically and confidently engage with the online environment. In an

increasingly digitized healthcare landscape, low literacy can exacerbate health disparities. Patients who do not know how to utilize digital health tools usually fail to recognize their significance.[15] Therefore, it is possible that patients in our study may not understand the benefits of the app until they have tried it. Therefore, they must understand how this innovation can help them and that it is not too complicated to use so that it can be adopted effectively by the target population.[16]

Difficulties and needs in the management of COPD patients

In our study, healthcare professionals and patients alike recognize that COPD patients often lack health literacy, which can lead to difficulties in managing the disease and adhering to its treatments. Studies have shown that COPD patients tend to have lower levels of health literacy than expected. This lack of understanding appears to be associated with lower levels of education and income, and patients with lower levels of health literacy are at a greater risk of experiencing severe forms of COPD.[17] HCPs interviewed often struggle to effectively communicate the necessary information to COPD patients. Although there is a significant amount of information that needs to be conveyed to them, patients included in the study often feel that they do not receive enough information. This can be due to patients' lack of health literacy, because of either low literacy levels or language barriers, which can impede their understanding of the information provided. As a result, patients may not follow their medical recommendations, leading to an increased risk of hospitalization.[18]

Research has shown that patients tend to forget between 40% and 80% of the medical information provided by HCPs. The percentage of forgotten information increases as the amount of information given to the patient increases. Out of the information retained, nearly half is usually incorrect. Patients are more likely to remember verbal information related to diagnosis than drug treatment, and the percentage of information retained depends on the patient's level of health literacy. Written information seems to be better retained. Factors such as inappropriate terminology, mode of transmission, and patient-specific factors like education level can affect the retention of medical information.[19,20] Therefore, disease management can be complicated, which poses challenges for both patients and healthcare practitioners. Patients may fail to comprehend the benefits of drug treatments or use them incorrectly. This may be due to a lack of understanding about when to take the medication or how to inhale it properly, leading to complications like exacerbations. A study has shown that using visual aids like pictograms to explain drug treatments can help patients with low health literacy understand better.[21] In COPD patients, using a mobile application seems to improve

health literacy.[22] According to our study, it would be beneficial to have a mobile application that includes a collection of popularized educational documents and videos about COPD. This material would cover everything from the causes of the disease, its symptoms, pharmacological and non-pharmacological treatments, inhalation techniques, the importance of physical exercise, a protocol for managing exacerbations and how to assess their severity. Interviewed HCPs suggested that having this information available in multiple languages would be interesting. Particularly, the use of videos, instead of written instructions, has a positive impact on inhalation techniques, which are one of the main difficulties participants face.[23]

Additionally, while almost half of the patients who participated express the need to communicate with HCPs through an app, the latter do not feel the same way. This lack of communication was mentioned by a third of the patients interviewed, and some highlighted the unavailability of professionals. These mixed perceptions of the need for communication through an app between patients and HCPs in our study are probably linked to the shortage of time mentioned by professionals who cannot fathom adding another communication platform. Indeed, there are already several means of communication in use: in addition to face-to-face meetings, most professionals are available by telephone or email. This is likely due to professionals feeling overwhelmed and not having enough time to add another communication platform to their schedule. The eHealth Enhanced Chronic Care Model (eCCM) is a well-established, validated and adaptable model for e-healthcare. It is based on a global approach to patient care, focusing on interactions between patients and healthcare professionals. This framework demonstrates that by improving patient–healthcare professional communication, a significant increase in patient self-management and clinical and behavioural outcomes is observed.[24] Currently, the healthcare professionals interviewed are available for face-to-face meetings, phone calls and emails. In view of the current overwork, it seems difficult for them to imagine adopting live communication through a digital tool. However, such communication would be possible provided it was asynchronous. Indeed, asynchronous communication still appears to have a positive impact on health outcomes and seems to be a more feasible option, according to our healthcare professionals. Patients may express a need for communication as a way to become more involved in their care.[25] Often, they feel like they do not have enough information, and this may be related to the low retention rate of information provided by healthcare practitioners. One approach to improving this is by increasing health literacy, which is the main objective of this intervention.

HCPs we interviewed have noted that patients often lack motivation, which can make it challenging for them to quit smoking, maintain physical activity or adhere to pharmacological or non-pharmacological treatments. This lack of

motivation may be related to anxiety and/or depression, which are common comorbidities of COPD. These difficulties can also contribute to a sense of isolation, particularly in the later stages of the disease when patients may feel stigmatized.[26] Participating in this study was even mentioned as a way for some patients to overcome their loneliness. According to a review, up to a third of COPD patients with depression are not treated for it.[27] The anxiety may cause patients to use the application and its documentation less frequently, especially if they are apprehensive about their disease progression.[28] In addition to anxiety and depression, COPD patients often suffer from other comorbidities that make their treatment more complicated. Almost 90% of COPD patients have at least one other condition, while nearly 50% have three or more. The most common comorbidities are cardiovascular disease, metabolic disorders, anxiety, depression, osteoporosis or lung cancer.[29] These conditions can lower the quality of life and increase the risk of exacerbation, hospitalization and death. Therefore, it is highly recommended to screen for these comorbidities regularly, as early management is crucial. Additionally, these comorbidities represent a significant cost to society, apart from affecting the patient's condition.[5,30–32] To increase awareness about the significance of screening for comorbidities, it would be beneficial to incorporate information on these conditions into the documentation that is shared with patients through the mobile application. If a patient's comorbidities have already been identified, adding them to the app can help healthcare professionals obtain a better understanding of the patient's overall health status. Furthermore, as we discussed with our participants, allowing patients to discuss their disease and daily challenges through a mobile application could help alleviate the isolation some patients experience. This could facilitate day-to-day management, which has been suggested to improve compliance and adherence among patients[33] as well as their quality of life.[34]

Maintaining good physical condition is essential for patients with COPD. However, due to the pathophysiology of the disease, physical exertion can cause dyspnoea, which can lead to patients consciously or unconsciously reducing their efforts and experiencing physical deconditioning. This can limit their ability to perform routine activities and affect their independence.[35] To help manage this, there are fitness applications available, but these may not be suitable for COPD patients. Instead, they require tailored physical exercise programs that can help reduce respiratory symptoms, improve their physical condition, and promote psychosocial well-being. Pulmonary rehabilitation programs have been developed specifically for COPD patients and are customized for each patient based on their age, disease stage, general health and specific test results. A multidisciplinary team consisting of doctors, physiotherapists, occupational therapists, psychologists, dieticians and social workers supervises the program to ensure the best possible outcome for the patients.[36] Despite the undeniable benefits of pulmonary rehabilitation, patients often fail to maintain exercise after completion.[37,38] To address this, a mobile application can be used to transmit tailored exercises to patients who do not qualify for revalidation or to maintain their abilities after revalidation. These exercises would be provided in the form of images or videos, and a system can be set up to motivate or challenge patients to perform them regularly.[39] Telerehabilitation has shown similar results to traditional in-centre rehabilitation. Furthermore, if these telerehabilitation programs are tailored specifically to the patient's needs and expectations, evidence shows that they further improve acceptance and encourage telerehabilitation maintenance.[39]

Both patients and healthcare practitioners included in the study agree that incorporating reminders and notifications in a mobile application can be beneficial. However, users should not receive too many messages, and they should not be overwhelmed by other reminders. This approach seems to work well in increasing adherence in the short term, but there are mixed opinions when it comes to the long term. In the long run, reminders may be seen as more negative.[40] It would be helpful to allow users to customize the reminder frequency.[41] Additionally, it would be important to be able to customize the various elements of an application according to the patient's profile. For instance, treatment details should be tailored to show only the medication prescribed to the patient. Similarly, smoking cessation information should be displayed only for smokers. This would minimize irrelevant information and help patients focus on the information most relevant to them. Enabling personalization and customization of the application can also increase patient adherence.[8]

The adoption of technology in healthcare is often hindered by the age of patients. The low level of digital adoption may be attributed to limited access to computer hardware or the internet, as well as physical and cognitive changes associated with ageing.[42] In our study, healthcare practitioners consider the patients' age to be the primary obstacle, while only two patients mentioned it. Some studies have shown that even older patients can participate in technology-based projects. Of course, the patients involved are likely to be those who are already comfortable with technology and use it frequently. Nevertheless, this suggests that the age barrier is not insurmountable.[25] According to a report by Statbel, the Belgian statistics office, in 2022, 70% of the population aged between 65 and 74 used the internet almost every day. They primarily accessed it through their smartphones, computers or tablets. Unfortunately, no data were available for those over 75 years of age.[43] The COVID-19 epidemic seems to have increased the use of technology among older persons.[44] Since the outbreak, there has been a significant increase in smartphone ownership among older patients as well as internet use among those over 75, according to a

Canadian study.[45] The issue of age can be seen as temporary because today's young people will become tomorrow's older patients. However, the studies conducted so far do not specifically focus on people with COPD, who have unique characteristics. Healthcare practitioners are particularly concerned about the limitations of certain patients due to their reduced cognitive abilities. Additionally, since this population often has a low socio-economic status, acquiring a high-performance smartphone could be an added challenge. It would be beneficial if the application could function without requiring an expensive smartphone. Therefore, addressing socio-technical barriers faced by older adults can only be beneficial in the adoption of digital interventions, thus increasing access to care, which is indirectly linked to better self-management of the disease, fewer exacerbations and lower mortality.[39]

Moreover, while some seniors can learn on their own or with assistance from those around them, it is essential to provide them with proper training to use technology effectively.[46,47] Providing technical support to patients is considered crucial by HCPs we interviewed. This would not only help in training patients but also increase their acceptance of new technologies.[46] However, finding the right professionals to provide this training is challenging. In our study, Some HCPs mentioned that they lacked sufficient time to provide this support and suggested that other professions could take up this responsibility, with nurses and physiotherapists being the most likely to accept. Hiring more staff to train patients and assist in coordinating their care could be a potential solution. Respiratory specialists interviewed have highlighted a lack of dedicated care coordination professionals in Belgium, which is particularly important for managing advanced COPD patients with a multidisciplinary approach. While GPs act as coordinators, they have limited time for this task. The developed platform could serve as support for care coordination by providing all professionals with up-to-date patient information, which has been expressed as a need by healthcare practitioners. This would ensure better continuity of care for patients.[2]

Both patients and healthcare practitioners participating in the study agree that the design of the mobile application should receive special attention. It should be simple, uncluttered and easy to navigate making it accessible to as many patients as possible, including those with limited cognitive abilities. A study conducted on COPD patients revealed that an interface without a keyboard, with videos and images, helped in the effective transmission of information.[7] Additionally, using visual elements such as pictograms can increase adherence.[20] In a 2023 review of apps for chronic lung disease, the issue of accessibility was also addressed by allowing users to increase font size.[48]

In addition to a user-friendly application, patients in our study also require assurance about data sharing. Most of them are willing to encrypt their data as long as the application adheres to data regulations. Transparency of the data management policy is crucial in the adoption of an app, and it should be as clear as possible.[48] It would be interesting if patients could also choose with whom they share this data, meeting the needs of some patients to inform those around them.

HCPs would like the integration of the platform into their software as it would make it easier to use and avoid having too many sources of information.[49] Additionally, digital platforms can save time, which is a significant concern for almost 30% of professionals. To further reduce the time needed to use the application, a logbook where patients can enter information on their symptoms, feelings, PR, exacerbations or hospitalizations can be integrated into it. This would provide healthcare practitioners with precise information that can be accessed quickly, without relying solely on the patient's memory. Such a feature could be useful in assessing treatment efficacy or helping doctors monitor exacerbations.

In our study, one professional raised an important point regarding the cost of the intervention for COPD patients, who tend to have a low socio-economic status. If the patient has to pay for the digital tool, a significant portion of the target population may not be able to access it. A review has shown that the cost of interventions is a significant barrier to the adoption of telemedicine.[50] To overcome this barrier, the platform could be reimbursed by the social security system. In Belgium, mobile applications can receive recognition at various levels. To achieve the first level, the application must obtain the CE marking as a medical device, notify the Federal Agency for Medicines and Health Products (FAMHP) and comply with personal data protection regulations. To achieve the second level, the application should also demonstrate its connectivity with the basic services of the e-Health platform. It is a federal public institution whose mission is to support the provision of services and promote the mutual electronic exchange of information between all players in the healthcare sector. All this while guaranteeing the security of information, the protection of the privacy of patients and providers, and the respect of medical confidentiality.[14] To reach the third level and apply for NIHDI reimbursement, the application needs to demonstrate socio-economic added value and 'enable a healthcare practitioner to diagnose, apply therapy or monitor a patient remotely via a medical device designed to be used by the patient in their environment'.[51,52] So far, no applications in Belgium have achieved this level of recognition. We based our study on Comunicare model – one of the 14 mobile applications that achieved the second level.[53]

Patients interviewed do not wish to receive information through an app to replace consultations with healthcare practitioners. Instead, they want to use the app to ask questions on any topic related to their health and receive accurate information tailored to their specific needs. It is important to note that patients in our study have different preferences for information they want or need. Some patients want to know everything from the moment of diagnosis, while others do not. Patients

who are at a more advanced stage of the disease and those who have previously undergone PR seem to be better informed following their numerous encounters with various healthcare professionals. However, PR is not accessible to all patients, and it would be useful to communicate certain information to patients as early as possible. For example, information related to smoking, its link with the disease and the impact of smoking cessation on the disease is crucial. Nevertheless, it is estimated that around 35% of COPD patients continue to smoke despite the risks.[54,55] Regular messaging through applications, combined with support from professionals, can have a positive effect on smoking cessation. Therefore, therapeutic education is a key factor in achieving success.[55]

Collaboration among healthcare practitioners

Communication between healthcare practitioners appears to be limited, except for those working in hospitals, especially in PR units. Face-to-face appointments have been identified as an important facilitator of collaboration, according to professionals working outside hospitals. In Belgium, various initiatives have been launched to improve collaboration among healthcare practitioners. Local multidisciplinary networks have been established to bring doctors together for proper coordination and monitoring of disease progression, especially for diabetic patients and those with chronic renal failure.[56,57] To encourage collaboration between doctors in the same hospital, there is the local medical assessment group (LMAG).[58] Another project has been initiated to encourage collaboration between doctors and pharmacists. This project is called medical-pharmaceutical consultations, with the main purpose of enhancing patient care by improving the management of drug interactions, medication adherence, rational drug prescribing and care for patients who are taking multiple medications.[59] These examples demonstrate the existing initiatives in Belgium to improve collaboration among healthcare professionals. However, these efforts are not solely focused on COPD and do not involve all healthcare professions. Nevertheless, face-to-face meetings have been proved valuable for pharmacists and GPs to work together, helping to overcome prejudices and facilitate teamwork.[60] A review found that trust and interdependence are crucial for GP–community pharmacist collaboration. It is important to identify perceptions and expectations about other HCPs, their skills, interest in collaboration, role definition and communication.[61] Not knowing other professionals personally is a barrier to communication, which these initiatives would help to remove.[62] Meeting face-to-face seems crucial for professionals.

Collaborative initiatives in healthcare require significant investment in terms of time, effort and resources. However, official recognition of these initiatives can lead to financial support from NIHDI. While financial incentives are essential, their success alone cannot guarantee the successful implementation of a new service. Customized implementation strategies, along with financial incentives, can significantly increase the likelihood of success.[63]

Due to time constraints, HCPs may only collaborate when it is necessary. A study showed that pharmacists and general practitioners prefer to communicate through telephone when faced with an urgent problem, as written communication takes up more time.[62] This can make it challenging to contact healthcare practitioners, especially during emergencies. Therefore, incorporating an address book within a digital tool that lists the contact information of professionals nearby, along with emergency contacts, can be useful. However, it is essential to ensure that the sharing of this information is compliant with regulations, and the patient's consent must be obtained. Patients should have the option to choose whom they want to share their information with given the sensitivity of some of the data. This tool could facilitate secure information sharing, thereby solving the accessibility problems faced by pharmacists.

Strengths and weaknesses

In order to recruit patients for our study, we first sent out information to two hospitals – Erasme and CHU Saint-Pierre. However, not many people responded this way, so we decided to use snowball sampling and spread the word about the study through social media. We also tried to reach out to healthcare professionals through similar channels and professional associations. The restricted distribution and the use of snowball sampling may have resulted in a selection bias. However, we reached saturation point, that is, the interviews we conducted were no longer yielding new information, which meant that the sample was sufficient. The questionnaires used in this study were specifically developed for this research. They were designed based on the RE-AIM model to identify the crucial factors necessary for maximizing the likelihood of successful implementation. Although the questionnaires were not pilot-tested, each question was reviewed by the research team and the researchers conducted semi-structured interviews, which allowed for the rephrasing of questions if they were not clearly understood by the participants.

The patients we interviewed were those who showed interest in the study after learning about it through our outreach efforts. This means that they may already be familiar with the technologies we are studying. Nonetheless, we believe that it is important to involve both patients and professionals, who are the potential users of the digital tool, in order to create an intervention that addresses real needs in the field and increases engagement.

Conclusion

Managing COPD and taking care of COPD patients can be challenging. Only a very small proportion of participants report having no difficulties. One of the main reasons for

this is a lack of health literacy, which leads to issues in understanding, retaining information and adherence to both pharmacological and non-pharmacological treatments.

This study showed that most patients and professionals view a platform favourably as a way to support COPD patients' follow-up care and promoting interprofessional collaboration. Patients would benefit from access to high-quality information on COPD, its medical treatments and smoking cessation. They also need help maintaining their physical condition with tailored exercises, incentives and reminders, as well as access to crisis management protocols or a logbook. Since patients' needs may vary, it would be ideal for the mobile application to be customizable. The platform, developed according to the results of this study, would aim to enhance the management of COPD patients and improve the transmission of information at all levels, improving their quality of life.

It is essential to involve patients and professionals in the further development process, as they are the primary users. Further studies are needed to develop and implement the platform.

ORCID iDs: Natacha Biset 🆔 https://orcid.org/0000-0003-3465-4566
Carine De Vriese 🆔 https://orcid.org/0000-0002-6595-1742

Supplemental material: Supplemental material for this article is available online

References

1. Chronic obstructive pulmonary disease (COPD). https://www.who.int/news-room/fact-sheets/detail/chronic-obstructive-pulmonary-disease-(copd) (accessed 21 October 2023).

2. Fromer L. Implementing chronic care for COPD: planned visits, care coordination, and patient empowerment for improved outcomes. *Int J Chron Obstruct Pulmon Dis* 2011; 6: 5.

3. Eisner MD, Blanc PD, Omachi TA, et al. Socioeconomic status, race and COPD health outcomes. *J Epidemiol Community Health (1978)* 2011; 65: 26–34.

4. Rosas-Salazar C, Apter AJ, Canino G, et al. Health literacy and asthma. *J Allergy Clin Immunol* 2012; 129: 935–942.

5. Negewo NA, Gibson PG and McDonald VM. COPD and its comorbidities: impact, measurement and mechanisms. *Respirology* 2015; 20: 1160–1171.

6. Reeves S, Pelone F, Harrison R, et al. Interprofessional collaboration to improve professional practice and healthcare outcomes. *Cochrane Database Syst Rev* 2017; 6. DOI: 10.1002/14651858.CD000072.PUB3

7. Velardo C, Shah SA, Gibson O, et al. Digital health system for personalised COPD long-term management. *BMC Med Inform Decis Mak* 2017; 17: 1–13.

8. Barbosa MT, Sousa CS, Morais-Almeida M, et al. Telemedicine in COPD: an overview by topics. *COPD: J Chronic Obstructive Pulmonary Dis* 2020; 17: 601–617.

9. Comunicare | Compagnon du parcours de soins. https://www.comunicare.be/ (accessed 24 October 2023).

10. Kilbourne AM, Elwy AR, Sales AE, et al. Accelerating research impact in a learning health care system: vA's quality enhancement research initiative in the choice act era. *Med Care* 2017; 55: S4–S12.

11. Glasgow RE, Harden SM, Gaglio B, et al. RE-AIM planning and evaluation framework: adapting to new science and practice with a 20-year review. *Front Public Health* 2019; 7: 64.

12. Holtrop JS, Rabin BA and Glasgow RE. Qualitative approaches to use of the RE-AIM framework: rationale and methods. *BMC Health Serv Res* 2018; 18: 1–10.

13. Sebele-Mpofu FY. Saturation controversy in qualitative research: complexities and underlying assumptions. A literature review. *Cogent Soc Sci* 2020; 6. DOI: 10.1080/23311886.2020.1838706

14. e-Health. eHealth - Accès direct à la documentation. https://www.ehealth.fgov.be/ehealthplatform/fr (accessed 2 November 2023).

15. Arias López MP, Ong BA, Borrat Frigola X, et al. Digital literacy as a new determinant of health: a scoping review. *PLOS Digital Health* 2023; 2: e0000279.

16. Klaic M, Kapp S, Hudson P, et al. Implementability of healthcare interventions: an overview of reviews and development of a conceptual framework. *Implement Sci* 2022; 17: 1–20.

17. Azkan Ture D, Bhattacharya S, Demirci H, et al. Health literacy and health outcomes in chronic obstructive pulmonary disease patients: an explorative study. *Front Public Health* 2022; 10. DOI: 10.3389/fpubh.2022.846768

18. Sadeghi S, Brooks D, Stagg-Peterson S, et al. Growing awareness of the importance of health literacy in individuals with COPD. *COPD: J Chronic Obstruct Pulm Dis* 2013; 10: 72–78.

19. Kessels RPC. Patients' memory for medical information. *J R Soc Med* 2003; 96: 219–222.

20. Barros IMC, Alcântara TS, Mesquita AR, et al. The use of pictograms in the health care: a literature review. *Res Social Adm Pharm* 2014; 10: 704–719.

21. Choi J. Literature review: using pictographs in discharge instructions for older adults with low-literacy skills. *J Clin Nurs* 2011; 20: 2984–2996.

22. Alharbey R and Chatterjee S. An mHealth assistive system "MyLung" to empower patients with chronic obstructive pulmonary disease: design science research. *JMIR Form Res* 2019; 3. DOI: 10.2196/12489

23. Shah RF and Gupta RM. Video instruction is more effective than written instruction in improving inhaler technique. 2017:46:16–19. DOI: 10.1016/j.pupt.2017.08.005

24. Gee PM, Greenwood DA, Paterniti DA, et al. The eHealth enhanced chronic care model: a theory derivation approach. *J Med Internet Res* 2015; 17. DOI: 10.2196/jmir.4067

25. De Jong CC, Ros WJG and Schrijvers G. The effects on health behavior and health outcomes of internet-based asynchronous communication between health providers and patients with a chronic condition: a systematic review. *J Med Internet Res* 2014; 16. DOI: 10.2196/jmir.3000

26. Volpato E, Toniolo S, Pagnini F, et al. The relationship between anxiety, depression and treatment adherence in chronic obstructive pulmonary disease: a systematic review. *Int J Chron Obstruct Pulmon Dis* 2021; 16: 2001.

27. Yohannes AM and Alexopoulos GS. Depression and anxiety in patients with COPD. *Eur Respir Rev* 2014; 23: 345.

28. Marklund S, Tistad M, Lundell S, et al. Experiences and factors affecting usage of an eHealth tool for self-management among people with chronic obstructive pulmonary disease: qualitative study. *J Med Internet Res* 2021; 23. DOI: 10.2196/25672

29. Kahnert K, Jörres RA, Behr J, et al. The diagnosis and treatment of COPD and its comorbidities. *Dtsch Arztebl Int* 2023; 120: 434.

30. Smith MC and Wrobel JP. Epidemiology and clinical impact of major comorbidities in patients with COPD. *Int J COPD* 2014; 2014: 9–871.

31. Global Initiative for Chronic Obstructive Lung Disease. *Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease (2023 REPORT)*, www.goldcopd.org. 2023.

32. Barnes PJ. Inflammatory mechanisms in patients with chronic obstructive pulmonary disease. *J Allergy Clin Immunol* 2016; 138: 16–27.

33. Mccabe C, Mccann M and Brady AM. Computer and mobile technology interventions for self-management in chronic obstructive pulmonary disease. *Cochrane Database Syst Rev* 2017. DOI: 10.1002/14651858.CD011425.pub2

34. Janjua S, Pike KC, Carr R, et al. Interventions to improve adherence to pharmacological therapy for chronic obstructive pulmonary disease (COPD). *Cochrane Database Syst Rev* 2021. DOI: 10.1002/14651858.CD013381.PUB2/INFORMATION/EN

35. Giacomini M, DeJean D, Simeonov D, et al. Experiences of living and dying with COPD: a systematic review and synthesis of the qualitative empirical literature. *Ont Health Technol Assess Ser* 2012; 12: 1.

36. INAMI. Affections respiratoires chroniques graves : intervention dans le coût d'une rééducation fonctionnelle dans un centre spécialisé, https://www.inami.fgov.be/fr/themes/cout-rembourse ment/maladies/respiratoires/Pages/affections-respiratoires-chroniques-graves-intervention-cout-reeducation-fonctionnelle-centre-specialise.aspx (accessed 20 October 2023).

37. Mccarthy B, Casey D, Devane D, et al. Pulmonary rehabilitation for chronic obstructive pulmonary disease. *Cochrane Database Syst Rev* 2015. DOI: 10.1002/14651858.CD003793.pub3

38. Busby AK, Reese RL and Simon SR. Pulmonary rehabilitation maintenance interventions: a systematic review. *Am J Health Behav* 2014; 38: 321–330.

39. Siu DCH and Gafni-Lachter L. Addressing barriers to chronic obstructive pulmonary disease (COPD) care: three innovative evidence-based approaches: a review. *Int J Chron Obstruct Pulmon Dis* 2024; 19: 331–341.

40. Maureen G. Adherence in asthma and COPD: new strategies for an old problem. *Respir Care* 2018; 63. DOI: 10.4187/respcare.05905

41. Dennison L, Morrison L, Conway G, et al. Opportunities and challenges for smartphone applications in supporting health behavior change: qualitative study. *J Med Internet Res* 2018; 15, e86. DOI: 10.2196/JMIR.2583

42. Wagner N, Hassanein K and Head M. Computer use by older adults: a multi-disciplinary review. *Comput Human Behav* 2010; 26: 870–882.

43. Utilisation des TIC auprès des ménages | Statbel. https://statbel.fgov.be/fr/themes/menages/utilisation-des-tic-aupres-des-menages#news (accessed 19 October 2023).

44. Ungar R, Wu L, MacLeod S, et al. The impact of COVID-19 on older adults: results from an annual survey. *Geriatr Nurs (Minneap)* 2022; 44: 131–136.

45. Sixsmith A, Horst BR, Simeonov D, et al. Older people's use of digital technology during the COVID-19 pandemic. *Bull Sci Technol Soc* 2022; 42: 19–24.

46. Fong BYF, Yee HHL, Ng TKC, et al. The use of technology for online learning among older adults in Hong Kong. *Int Rev Educ* 2022; 68: 389–407.

47. Dong Q, Liu T, Liu R, et al. Effectiveness of digital health literacy interventions in older adults: single-arm meta-analysis. *J Med Internet Res* 2023; 25. DOI: 10.2196/48166

48. Quach S, Michaelchuk W, Benoit A, et al. Mobile heath applications for self-management in chronic lung disease: a systematic review. *Netw Model Anal Health Inform Bioinform* 2023; 12: 25.

49. Watson A and Wilkinson TMA. Digital healthcare in COPD management: a narrative review on the advantages, pitfalls, and need for further research. *Ther Adv Respir Dis* 2022; 16. DOI: 10.1177/17534666221075493

50. Scott Kruse C, Karem P, Shifflett K, et al. Evaluating barriers to adopting telemedicine worldwide: a systematic review. *J Telemed Telecare* 2018; 24: 4–12.

51. INAMI. Applications mobiles médicales : Introduire votre demande - INAMI, https://www.riziv.fgov.be/fr/professionnels/autres/fabricants-implants/Pages/fabricants-distributeurs-applications-mobiles-medicales-notifiez.aspx (accessed 18 October 2023).

52. mHealthBelgium. Pyramide de validation - mHealthBELGIUM, https://mhealthbelgium.be/fr/pyramide-de-validation (accessed 18 October 2023).

53. mHealthBelgium. Toutes les apps - mHealthBELGIUM, https://mhealthbelgium.be/fr/toutes-les-apps (accessed 18 October 2023).

54. Terzikhan N, Verhamme KMC, Hofman A, et al. Prevalence and incidence of COPD in smokers and non-smokers: the Rotterdam study. *Eur J Epidemiol* 2016; 31: 785.

55. Antoniu SA, Buculei I, Mihaltan F, et al. Pharmacological strategies for smoking cessation in patients with chronic obstructive pulmonary disease: a pragmatic review. *Expert Opin Pharmacother* 2021; 22: 835–847.

56. Trajets de soins « diabète de type 2 » et « insuffisance rénale chronique » : Votre rôle en tant que médecin - INAMI, https://www.inami.fgov.be/fr/professionnels/sante/medecins/qualite/trajets-de-soins/Pages/default.aspx (accessed 23 October 2023).

57. Réseaux locaux multidisciplinaires | AVIQ. https://www.aviq.be/fr/soins-de-sante/soins-ambulatoires/reseaux-locaux-multidisciplinaires (accessed 23 October 2023).

58. Règles de fonctionnement d'un Glem - INAMI. https://www.inami.fgov.be/fr/professionnels/sante/medecins/qualite/accreditation/Pages/medecins-accreditation-glem-fonctionnement.aspx (accessed 23 October 2023).

59. Concertation médico-pharmaceutique - INAMI. https://www.inami.fgov.be/fr/themes/qualite-soins/medicaments/concertation-medico-pharmaceutique/Pages/default.aspx (accessed 23 October 2023).

60. Rubio-Valera M, Jové AM, Hughes CM, et al. Factors affecting collaboration between general practitioners and community pharmacists: a qualitative study. *BMC Health Serv Res* 2012; 12: 1–10.

61. Bardet JD, Vo TH, Bedouch P, et al. Physicians and community pharmacists collaboration in primary care: a review of specific models. *Res Soc Administrative Pharm* 2015; 11: 602–622.

62. Weissenborn M, Haefeli WE, Peters-Klimm F, et al. Interprofessional communication between community pharmacists and general practitioners: a qualitative study. *Int J Clin Pharm* 2017; 39: 495–506.

63. Stafford R, Thomas J, Payakachat N, et al. Using an array of implementation strategies to improve success rates of pharmacist-initiated medication therapy management services in community pharmacies. *Res Soc Administrative Pharm* 2017. DOI: 10.1016/j.sapharm.2017.04.006

Appendix 1

Table A1. Questionnaire used for patients' interviews.

Phase	Questions
Motivation	Why did you decide to take part in this project?
Usefulness	How do you cope with your illness and treatment on a daily basis? What difficulties do you face?
	How do you think this tool could help you?
Needs	What would you need in a mobile application to help you manage your condition?
	What kind of information would be interesting or useful to receive through such an application?
	What kind of information would be interesting to share with caregivers through such an application?
Feasibility	How would you use this application on a day-to-day basis?
Facilitators	What would help you to use this application in your routine?
Barriers	For example, do you want to receive notifications, reminders, …?
	On the contrary, what are the factors that could slow down this use?
Relations between healthcare practitioners and patients	How do you currently communicate with the professionals around you (doctors, nurses, physiotherapists, pharmacists)?
	Is this communication important to you? Why or why not?
	How do you think this application could improve your communication with them?

Table A2. Questionnaire used for healthcare practitioners' interviews.

Phase	Questions
Presentation of the project and objectives	
Motivation	Why did you decide to take part in this project?
Usefulness – needs	What do you think about this project?
	What difficulties are encountered with COPD patients?
	What do you need to ensure optimum care for these patients?
	What functionalities would you need in a WEB platform to help you care your COPD patients?
Patient recruitment	What type of patients would you suggest participating in this project?
Feasibility (facilitators – barriers)	What do you think would facilitate the use of this kind of tool by patients? And for you?
	On the contrary, what factors could hinder the use of this tool?
Healthcare practitioner–patient relations	How do you currently communicate with your patients?
	How do you think this tool could influence professional–patient relations?
Relations between healthcare practitioners	In your opinion, what are the different professionals involved in the care of a COPD patient? What are their respective roles?
	How do you currently communicate with these professionals?
Feasibility (facilitators – barriers)	What do you think would make it easier for professionals to work in collaboration?
	On the contrary, what are the factors that could impede or hinder this collaboration?
Healthcare practitioner–patient relations	How do you think this collaboration could influence relations between professionals and patients?
	How do you think this tool/app could improve interprofessional collaboration?

Appendix 2

Table A3. Main themes discussed during patient interviews.

Dimensions	Outcome	Themes	Illustrative quotes
Reach	Identification of motivations to participate in the interview	Loneliness	'I think it is good because we feel a bit lonely'.
		Improving quality of life	'If a mobile application can help us to manage our disease in a better way, then that is great'.
		Highlight the disease	'Because people do not talk about COPD as much as they do other diseases'.
	Identification of future users	Targeted patients	'There are people who are 70 years old and still capable. I think there are still many who could benefit from what you have to offer'.
Adoption	Identification of the difficulties encountered	Difficulties in managing the disease and its treatments	'It is hard, it is difficult. Well, I am managing since we are forced to breathe, we have to carry on living as if there were nothing...'
		Lack of information	'We are so poorly informed that we do not know what to expect'.
		Lack of understanding from relatives	'When you are not feeling well, no one can understand what you are feeling except for someone else who has the same disease'.
	Perceived utility of the tool	Educate and reassure	'Maybe the app would help me to avoid calling my doctor every hour or every day in case of anxiety or stress'.
		Improve follow-up	'The doctors tell you this is what the treatment is and that is it. Then you go home, and you do not know what to do'.
Implementation	Main necessary features in a tool such as a mobile application for patients	Information on the disease ant treatments	'Information about the disease, the effect that revalidation can have, the effect that the medication can have, and why this medication rather than another'.
		Contact with HCPs	'It would be good to have exchanges and opinions from doctors about certain situations (...) when there are all these different symptoms that arise following treatment. Send it to them and ask them if it's normal'.
		Contact with other COPD patients	'If there are other patients who need to know about an experience, it might be a good idea to share opinions, how we manage ourselves, how we deal with problems, and so on'.
		Tailored fitness plan	'I would really like more sports-related information based on the functional test and spirometry I do every year'.

(continued)

Table A3. Continued.

Dimensions	Outcome	Themes	Illustrative quotes
		Crisis management protocol	'When I have an exacerbation, it would be good to remind myself of things so that I don't panic. For people close to me, we could read the information and instructions'.
	Identification of facilitators to the use of the tool	Reminders and notifications	'Alarms and reminders because I take my aerosols in the morning. But sometimes I just think I've taken it when in fact it was yesterday'.
		Ease of use	'It really needs to be super easy to access visually'.
		Already using an app	'I already use an application for my diabetes, so if there is an app for COPD I will use it'.
	Identification of barriers to the use of the tool	Related to the smartphone	'It is cluttering up my phone and I am anti-smartphone'.
			'I do not have a smartphone (...) I am too old and I do not understand'.
		Data sharing	'I'm not in favor of data sharing. I am willing to share my experiences, but personal data, that sort of thing, no'.
		Replacement of medical consultation	'It is always good to have real contact with the doctor'.
			'It cannot replace a medical consultation'.
Communication	Communication with HCPs	Effective communication through medical consultations, phone or email	'The doctor refills my prescriptions by email'.
			I' have a lung specialist who sees me every 6 months, but if I have a problem, he can see me without an appointment'.
			'I have regular visits to my GP'.
			'If I'm really unwell and I have a prescription, I call the pharmacist and email him the prescription'.
		Lack of communication with HCP and other COPD patients	'We have no communication with other people: we go to the pneumologist, wait for the results, take the treatment and that's it'.
			'When we phone, we get a response, but it's mainly the secretariat because they're not there and that's a problem'.
		Unavailability of professionals	'The doctor doesn't have time: he only sees one knee or one toe and doesn't see the whole picture'.
		Positive impact of an app	'With my GP, when I don't know or have questions, I'm sometimes afraid of bothering him. That's why an app would be good'.

Table A4. Main themes discussed during HCP interviews.

Dimensions	Outcome	Themes	Illustrative quotes
Reach	Identification of motivations to participate in the interview	Interest in the project	'We are moving more and more towards maintaining patients at home, as much as possible. I think it could be very useful in this context'. (Nurse)
		To help patients and research	'The tool seems really interesting, and it would be great to develop it to make life easier for patients and the carers around them'. (Physiotherapist)
			'I am interested in improving the quality of care and seeing how we can enhance the value of our profession'. (Pharmacist)
	Identification of future users		'I would suggest it to any COPD patient, in fact open the door and see who takes it'. (Pharmacist)
			'I would say for the first three stages, but for the fourth they are already familiar with all that'. (Nurse)
			'Patients in the advanced stages with a very negative impact on their lives would be very keen to have this kind of tool'. (Pulmonologist)
Adoption	Identification of the difficulties encountered	Adherence issues	'Treatment for a symptom is easy, but when patients do not feel anything, getting them to adhere to the treatment is more complicated'. (GP)
		Improper use of the treatment	'People find it hard to understand that a corticosteroid works, that it's a chronic treatment, whereas Ventolin works so well as soon as they take it'. (Pharmacist)
		Lack of patient health literacy	'Sometimes they don't even know they are ill and have a serious lung problem'. (GP)
			'I think some patients do not always understand everything they are told or what their medication or treatment is for'. (Pulmonologist)
		Complicated information transmission	'When I see another device arrive, I wonder (...) did the doctor make a mistake? Was there a change? Has the situation deteriorated?' (Pharmacist)

(continued)

Table A4. Continued.

Dimensions	Outcome	Themes	Illustrative quotes
Implementation	Main necessary features in a tool such as a mobile application (patients) and a dashboard/web platform (HCPs)	Have access to patient follow-up information	'If the patient has an exacerbation, has he been hospitalized, has he had antibiotics or cortisone, what are the comorbidities? And to have an up-to-date list of treatments'. (Pulmonologist)
			'Having access to the results of functional tests' (Physiotherapist)
		Basic information for patients (disease, treatment, ...)	'Short videos that explain the disease and can be referred to' (GP)
			'General information about the disease: its causes, course and prognosis, possible means of prevention, dietary advice, etc.' (Pulmonologist)
		Patient logbook	'Get a quick overview of how the patient has spent the last 6 months without necessarily using their memory' (Pulmonologist)
		Reminders for patients	'Reminders, either about taking medication or about medical appointments' (Nurse)
		Contact book	'Have the contact details of the GP, the specialist who initiated the treatment, have a list of physiotherapists specialized in respiratory physiotherapy, ...' (Pharmacist)
	Identification of facilitators to the use of the tool	Training to the use of the tool	'For example, someone explaining the application at the outset; I think that's compulsory'. (Physiotherapist)
		Design of the app	'Something that's easy to use and accessible to as many people as possible' (Pharmacist)
			'An ultra-intuitive interface with drawings and buttons' (Pulmonologist)
		Advertisement	'Advertise to HCPs so that they can pass on the information and usefulness of the tool to patients' (GP)
	Identification of barriers to the use of the tool	Patient's age	'We are targeting relatively old people who may not be very comfortable using a smartphone or an application'. (Nurse)
		Patient literacy level	'The level of understanding and education, because we still have some patients who are illiterate' (Physiotherapist)
		Time	'If professionals do not have the time, they won't do it because it is just one more thing to handle'. (Pulmonologist)

Table A4. Continued.

Dimensions	Outcome	Themes	Illustrative quotes
			'Let's face it, there's so much to do already'. (GP)
Communication	Communication with patients	Communication orally medical consultations, phone or email	'Mainly consultations, especially for COPD patients, where I like to see them frequently' (GP)
			'Simply when they come to the pharmacy for dispensing' (Pharmacist)
			'It could be a phone call, because I'm not necessarily going to bring the patient back into the practice'. (GP)
	Collaboration between HCPs	State of communication	'Better cooperation between HCPs, especially doctors, specialists and GP could have a positive impact by promoting our professions'. (Pharmacist)
			'I believe that cooperation between doctors and pharmacists is essential'. (Pharmacist)
			'It's still a GP–pharmacist duo that remains fragile in the field, despite an improvement'. (GP)
	Barriers to collaboration	Lack of time and lack of availability of other HCPs	'Some doctors are relatively accessible, and some are not at all'. (Physiotherapist)
			'Time, really time, it takes time to call'. (GP)
			'I can't afford to spend 3*20 min on hold on the phone during the day'. (Pharmacist)
		Information sharing	'The doctor, nurse and other professionals have access to the patient's medical file, but the pharmacist does not have access to it. (...). Between what the doctor said, the words he used and what the patient understood, what he told me and what I concluded from it...' (Pharmacist)
		Lack of funding	'And as well as time, it's also about money and profitability'. (GP)
		Personality	'You don't necessarily get on with everyone in the same way (...) so you don't necessarily want to have contact with everyone'. (GP)
	Collaboration facilitators	Meetings between HCPs	'Information evenings, multidisciplinary evenings' (Pharmacist)
			'Continuing education for younger generations too (...) open to multidisciplinary'' (GP)

Table A4. Continued.

Dimensions	Outcome	Themes	Illustrative quotes
		Good sharing of information	'In other words, the pharmacist now knows much better what we have prescribed and what the patient is taking (...) this connectivity is better (...) it makes things easier'. (GP)
		Personality	'The character of the professionals is the most important thing. If you have a professional opposite, you who is open to discussion, it obviously makes things easier on both sides'. (GP)
		Availability of other HCPs	'Availability facilitates collaboration: the pharmacist will be easier to contact than the pulmonologist, who is not always available in the hospital'. (GP)
		Professional liaison officer	'If there was a nurse coordinator, that would be a good link, who could take the time'. (Pulmonologist)
			'This person is the liaison nurse or the liaison physiotherapist. These are staff who need to be financed and there is no funding for this in Belgium now'. (Pulmonologist)

Appendix 3

See Supplemental file.