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Cough Reduction Using A Mobile App:

Case Studies from CoughPro's Cough Management Feature

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February 2025

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Executive Summary

Chronic cough represents a significant yet often overlooked medical challenge, affecting approximately 5-10% of adults and substantially affecting quality of life. This white paper looks at early data from an innovative digital health solution - [CoughPro](#) - a health and wellness app that leverages cognitive behavioral cough management intervention techniques to address the complex therapeutic landscape of chronic cough management. Specifically, we used a convenience sampling approach to describe the effectiveness of digital cough management (Cough Management) tools within the CoughPro app, highlighting reductions in cough frequency as well as additional insights for users engaging with this feature. Through descriptive analysis and three case studies , we demonstrate promising trends in cough reduction attributable to the use of CoughPro, offering insights into the potential of science-based digitally delivered content for managing chronic cough. Taken together, these promising early results demonstrate the potential value in digital therapeutic (DTx) for chronic cough management, as well as the need for, and design of, further rigorous studies.

Background and Clinical Context

Chronic Cough

Cough has long been recognized as a symptom of many common conditions such as asthma, reflux, and post nasal drip (also known as upper airway cough syndrome (UACS), as well as illnesses such as lung cancer and chronic obstructive pulmonary disease (COPD). More recently it has become apparent that in many instances chronic cough is itself a disease, cough hypersensitivity syndrome. Chronic cough,

defined as a persistent cough lasting eight weeks or longer in adults, is more than a mere medical inconvenience. It represents a complex physiological condition with profound medical and psychosocial consequences. It is a condition that affects approximately 5-10% of adults worldwide and significantly impacts quality of life. It can lead to physical complications such as fatigue, sleep disruption, urinary incontinence, and even rib fractures. The condition is not only physically debilitating but also socially isolating, as frequent coughing can lead to anxiety, depression, and misinterpretation as a sign of contagious illness.

Current Treatment Landscape: Limitations and Gaps

Current chronic cough management strategies focus on empirically treating underlying causes like upper airway cough syndrome (UACS), asthma, or gastroesophageal reflux disease (GERD). However, the effectiveness of these empiric approaches varies greatly, with many patients experiencing only partial relief or no improvement in cough at all. Effective cough suppressing medications would be of great help to many patients, however, there has been little progress in developing novel antitussive drugs. In fact, the last drug approved by the US Food and Drug Administration for cough suppression was Tesalon Perls, in 1958. Furthermore, a most recent new drug submitted to the FDA was not approved for sale in the US. This therapeutic gap highlights an urgent need for innovative solutions in cough care.

Scientifically driven cognitive-behavioral interventions, such as speech-language pathologist-led behavioral cough suppression therapy, have demonstrated significant promise in rigorous randomized controlled trials. A recent meta-analysis concluded that behavioral cough suppression techniques significantly improved patient-reported outcomes, including the Leicester Cough Questionnaire (LCQ), and

reduced objectively measured cough frequency. Additional measures of cough symptoms, such as symptom scores, Visual Analog Scale (VAS) scores, and Cough Severity Index (CSI), also demonstrated notable improvements.

However, access to these behavioural techniques and treatments remains limited, as only a small number of specialists practice cough suppression techniques. Furthermore, many primary care physicians treating patients with chronic cough are unaware of appropriate and available referral options.

What is CoughPro?

Platform Overview

CoughPro is a smartphone wellness app that helps coughers detect and monitor their cough continuously that provides users an improved understanding of their cough. It runs Hyfe's state-of-the art cough detection models conveniently packaged for a broader audience. These are the same models used by leading researchers in more than 50 research studies all over the world.[1] Key Features
One of CoughPro's key features is its ability to monitor cough continuously. Once installed on your smartphone, CoughPro runs in the background, requiring no additional action from the user. Its powerful models detect cough with high accuracy and run directly on the phone, ensuring complete privacy preservation. Each individual cough is noted with precise timestamps, which facilitate cough pattern and trend analysis.

Behavioral Intervention Modules

Digital Therapeutics (DTx) is a fast growing field for chronic conditions, such as anxiety, insomnia, and diabetes. Coughpro also offers insights

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[1] You can read more about Hyfe's Research and Publications here.

into users' cough patterns as well as exclusive content and custom exercises based on a scientifically proven approach to behavioral cough reduction. CoughPro has the promise of being a powerful tool to address the treatment gap in chronic cough, described above, leveraging accessible, scalable solutions to deliver evidence-based interventions such as Behavioral Cough Suppression Therapy (BCST). This approach holds great promise for improving outcomes for chronic cough sufferers where traditional treatments have failed, in particular, for refractory chronic cough (RCC) and unexplained chronic cough (UCC) patients. Research studies of BCST demonstrate that, for those with an unproductive cough and cough hypersensitivity syndrome, consistently suppressing cough with specific techniques not only reduces coughing but actually diminishes the urge to cough itself. Based on the success of in-person treatment with BCST, [Cough Management](#) is a tool within CoughPro that subscribers can use to learn about and help leverage cough suppression techniques to manage their problematic cough.

Cough Management is a novel and experimental feature within CoughPro, rolled out in mid-2024. Currently, there are three sections within Cough Management:

1. <u>Education</u> - provides the basic information necessary to understand cough hypersensitivity syndrome, urge to cough, and BCST needed for using the subsequent features.

2. <u>Techniques</u> - includes detailed instruction on how to perform 3 science-backed cough suppression techniques when the urge to cough is identified, which can be applied in daily life.

3. <u>Triggers</u> - lets users explore possible cough triggers and how to manage the resulting urge to cough by using BCST techniques.

Each section includes audio, text, and/or video lessons that must be completed sequentially to help users anticipate cough triggers and develop suppression skills. Experience with BCST demonstrates that, over time, the urge to cough decreases. Once all sections are

completed, they can be revisited as needed. Meanwhile, objective cough monitoring runs in the background, providing users with data trends to highlight which techniques most effectively reduce cough frequency and how their cough patterns evolve after learning and practicing BCST.

In order to use CoughManagement, CoughPro users must answer "no" to the following eligibility questions to ensure Cough Management techniques are safe for them:

1. Is your cough usually productive (produces mucus that you need to spit out or swallow)?
2. Do you have difficulty swallowing on a regular basis?
3. Have you been diagnosed with a pulmonary disease such as COPD or lung cancer?
4. Does your current cough condition cause you to cough up blood?
5. Do you actively smoke or vape any substance?

Methodology

1. Data Overview
   a. Data was sourced from CoughPro users that have engaged with CoughPro's Cough Management feature, passed the above mentioned eligibility questionnaire, provided informed consent for anonymous use of their data and who met the inclusion criteria described below.. The data is anonymized and we know nothing about the identity of these users or their profile - we looked strictly at cough frequency data, expressed in precise cough timestamps, as generated by the Hyfe's cough detection model running inside CoughPro.
   b. <u>Inclusion criteria</u>:
      i. At least 18 hours of tracking

ii. Engagement with key Cough Management events inside the CoughPro app

iii. Cough frequency data both pre-cough management exposure and after it

2. Analysis

The metrics looked at through the analysis include:

- Hourly cough rate (coughs per hour, "CpH") - This is the mean number of coughs per hour across a given time period, a day, a week, or a month.
- The average number of cough bursts in 24h. A burst is any cluster of four or more coughs, none of which are separated by five seconds or more.
- For the purpose of consistency we have removed the day of the event (ie, day 0), since the event may have taken place at 11:52PM or at 2:00AM and we are looking only at days that have more than 18 hours of tracking time (i.e. monitoring as uninterrupted as possible). We are also looking at hourly cough rates (ie, 24 coughs in 18 hours = 1.25 coughs per hour) rather than hourly cough counts.

3. Limitations

- This is an **early observational study** and as such only presents case reports, statistics and resulting hypotheses from a very small number of selected users. Consequently, caution should be taken in generalizing from these anecdotes unless confirmed in future studies.
- Bias from uncontrolled / unknown variables, since we do not have any insights into other treatments or lifestyle changes that

the users may have undergone while monitoring their cough. Future studies will need to collect and analyse these variables.

- Adherence to cough monitoring can be impacted by the smartphone-based approach, as the device with CoughPro may not always be in close proximity to the user's mouth, reducing its effectiveness as a monitoring tool. Future studies should be conducted using wearable devices that are better suited for continuous monitoring due to their consistent proximity to the user.

Data Context and Definition of Events

Data Context and Definition of Events

Table 1 shows the breakdown of the userbase we selected from.

Criteria	Users	Records[2]
All CP users	6,386	90,456
Tracked >=12 hours in a day	2,889	56,795
Tracked >=12 hours + Finished education	51	2,878
Tracked >=12 hours + Finished technique	22	1,954
Chosen individuals for Case Study	3	347

Table 1 – Breakdown of the userbase the three cases studies were selected from

We chose the 3 users in these case studies for a larger community of users of the CoughPro app. To better understand how Cough Management works inside the CoughPro app, it is important to define the 4 different "events" inside the app.

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[2] A "Record" is a data entry representing the total cough-tracking data collected for any user on a specific calendar day. For example, if User A tracks their cough for three consecutive days and User B tracks theirs for seven consecutive days, the dataset comprises 10 records, corresponding to the daily data points for these two users.

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Event 1: Play Cough Management Education Video

The Education module of Cough Management provides users with an overview of the physiological mechanism of cough, cough reflex sensitivity, and the condition of cough hypersensitivity that is the cause of much unexplained and refractory chronic cough. This section educates users to gain awareness of the likely cause of their cough and sets them up for success in managing it. The material is presented in text and audio formats, enabling users to choose how they wish to receive the information. The app event is considered valid when a user listens to audio or reads the text described above.

Here is an aggregate look at all users that have completed this event comparing before vs after. From this early, small sample, there appears to be some short-term reduction in cough frequency, though it may not be sustainable without further steps. Given the significant data limitations and the fact that we do not know anything else about these users, it provides only limited insights on the general impact of the education content on cough frequency. However, it raises the testable hypothesis that education alone imparts an increased awareness of one's cough and leads to a reduction in cough frequency.
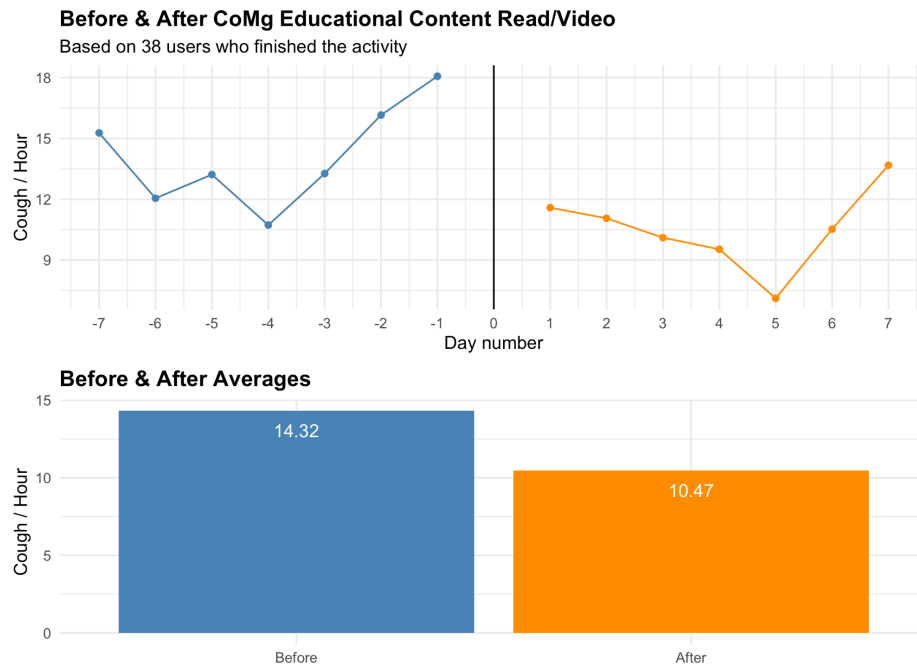
Before & After CoMg Educational Content Read/Video
Based on 38 users who finished the activity

Before & After Averages

Figure 1. Aggregated cough frequency data showing before and after exposure to educational content inside CoughPro app.

Event 2: Play Cough Management Techniques Video

This event means that the user has played at least one video related to specific techniques used to suppress the coughing reflex. As mentioned above, CoughPro contains educational content as well as interactive lessons and practical exercises designed to help users better understand their cough and take proactive steps for its management. The event analyzed in this section refers specifically to listening to audio or watching videos describing techniques to suppress cough. Future studies could address the hypothesis that video is superior to simple written text.
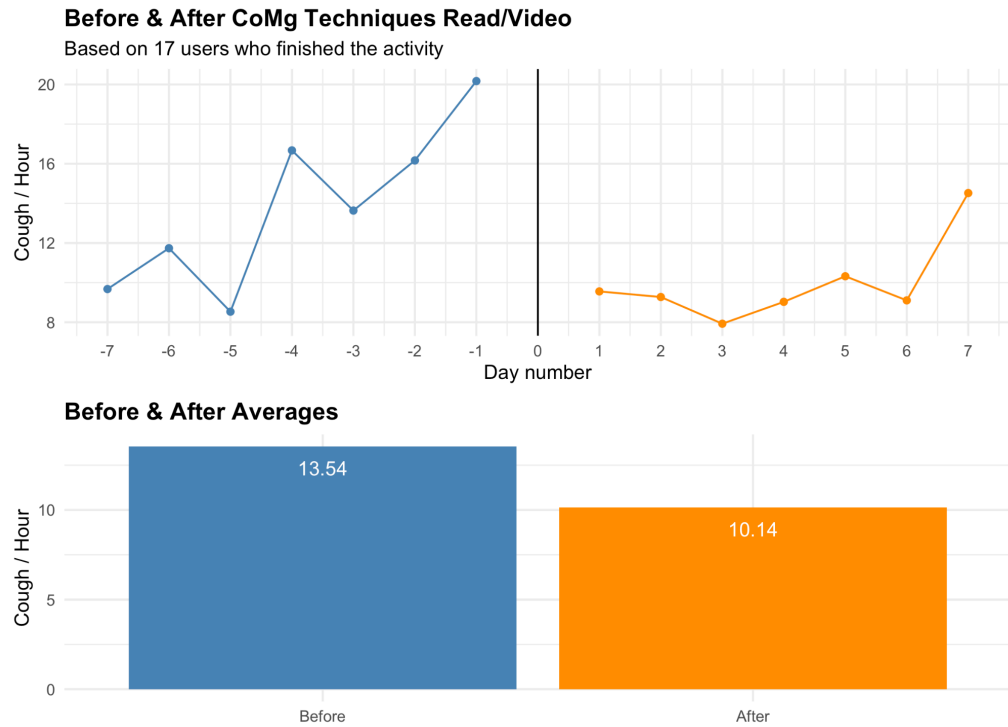
Before & After CoMg Techniques Read/Video

Based on 17 users who finished the activity

Before & After Averages

Figure 2. Aggregated cough frequency data showing before and after exposure to cough suppression techniques content inside CoughPro app

Event 3: Selecting a Trigger

One of the activities in the Cough Management section calls for users to identify a stimulus or activity that typically triggers their cough. We should not read too much into the apparent instant decrease in cough frequency after this event as the sample size is very small. Also, it is possible that users that made use of the trigger tracking feature are the most likely to have spent more time on the cough suppression techniques. However the case studies that we looked at would justify follow-up analysis with additional users and a structured study.[3]

The Case Studies

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[3] Hyfe is conducting a series of studies in Q1-2 of 2025 to rigorously measure the effect of Cough Management.

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User One

Background

This user had a relatively high baseline of hourly coughs (CpH) of up to 90 coughs / hour. This user has been using CoughPro for years and their historic cough frequency has been fairly consistent over time. They are clearly a chronic cougher with a severe, potentially debilitating cough.

Engagement with Cough Management

User 1 completed the Cough Management education content on Aug 27, 2024. They spent an average of 1 minute on each section / exercise inside the CoughPro App. Once they completed educational modules, on Aug 28 (a day later), they transitioned to cough suppression techniques:

1. Tongue-out swallow (9AM)
2. Effortful swallow (11AM)
3. Cough Control Breathing (11AM)
4. Additionally, in-app activity shows user 1 spent time reading materials on cough-control breathing

Results

User 1 demonstrated a sustained reduction in cough frequency CpH after using cough suppression techniques, with stabilization observed.
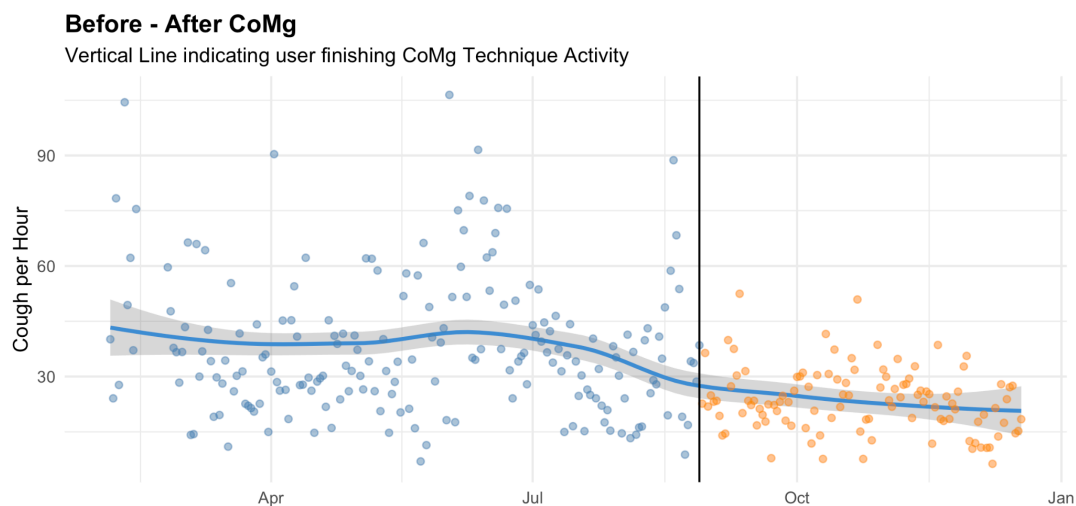
Before - After CoMg
Vertical Line indicating user finishing CoMg Technique Activity

Figure 3. User 1's cough frequency before (blue) and after (orange) finishing the Cough Management module inside the CoughPro app.

User Two

Background

User 2 is a relatively new CoughPro user. While their tracking has not been as consistent as User 1, when they joined CoughPro, their daily cough rate was extremely high, at 70 coughs / hour, though the number of hours monitored is relatively small.

Engagement with Cough Management

On October 18, 2024, User 2 completed the Cough Management education module as well as all cough suppression techniques on the same day October 18th.

Results

User 2 demonstrated an apparent drop in cough frequency, though limited follow-up data inhibits long-term conclusions.
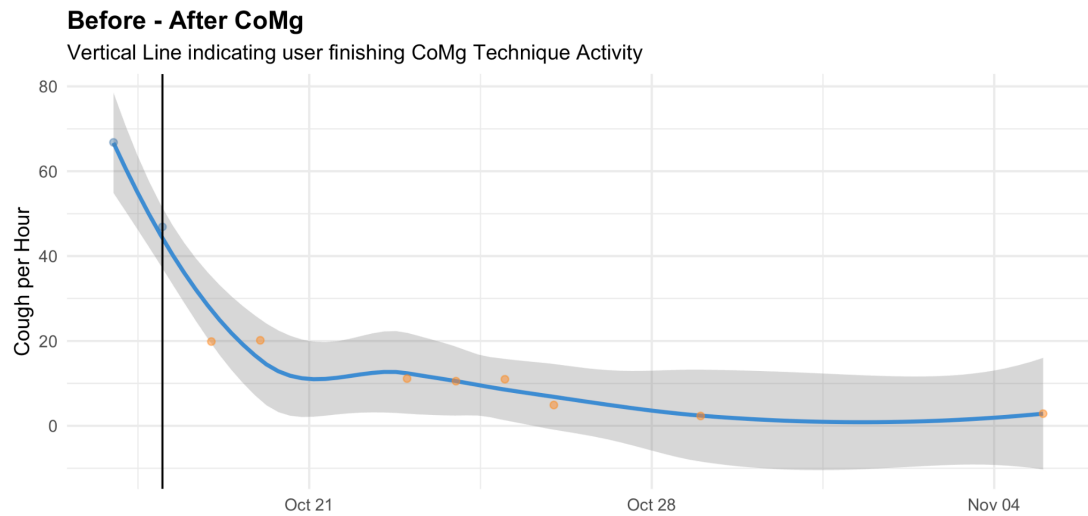
Before - After CoMg
Vertical Line indicating user finishing CoMg Technique Activity

Figure 4. User 2's cough frequency before and after finishing the Cough Management module inside the CoughPro app.

User Three

Background

User 3 had a moderate baseline cough frequency and they reported a specific trigger: *voice use*. This means that speaking, singing, or shouting triggers their cough.

Engagement with Cough Management

This user started engaging with Cough Management features on September 18, 2024 and according to in-app engagement data they seem to have spent more time than typical on each of the activities and techniques. They returned for a second session to finish the rest of the cough suppression techniques on September 20th.

Results

User 3 demonstrated a visible drop in cough frequency. However, this drop was followed by a gradual rebound, highlighting the need for continued intervention. Even with the partial rebound of their cough frequency, User 3's percentage decrease in cough rate is over 50%, better than results for leading pharmacological interventions.
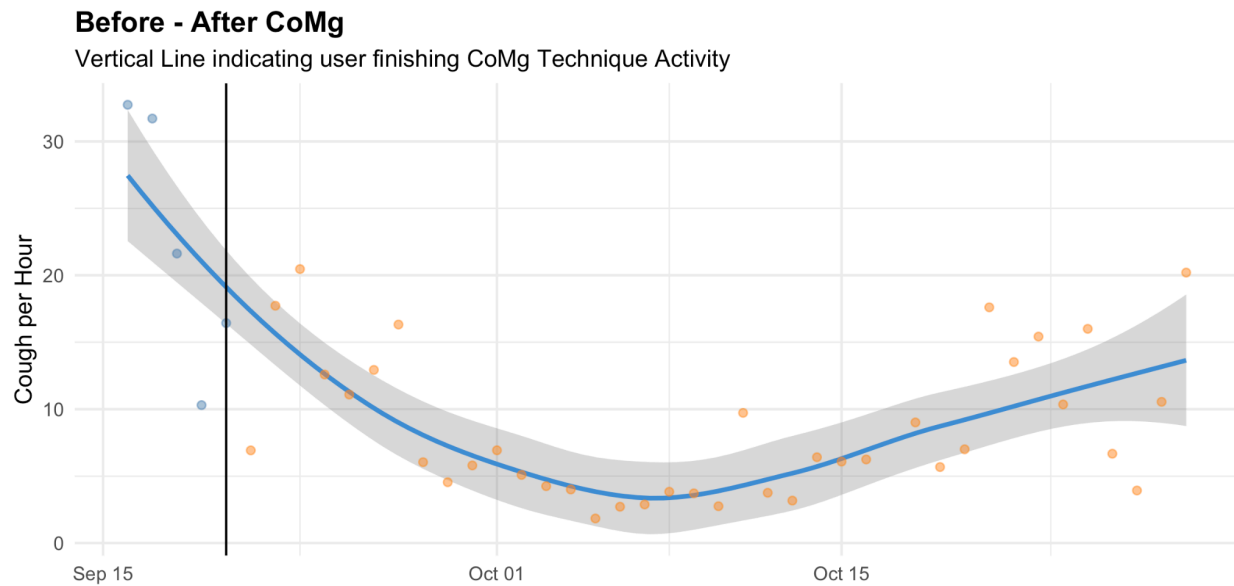

Before - After CoMg
Vertical Line indicating user finishing CoMg Technique Activity

Figure 5. User 3's cough frequency before (blue) and after (orange) finishing the Cough Management module inside CoughPro app.

Discussion

This whitepaper describes the results of a small and observational analysis of users of CoughPro focusing on three selected users. However, even this anecdata suggests the potential for digital delivery methods to achieve therapeutic outcomes in those suffering with chronic cough, derived from scientifically driven in-person Behavioral Cough Suppression Therapy (BCST). Consistent with data from randomized controlled trials (RCTs) for cough suppression therapy, where high engagement with the approach and a commitment to

practicing cough suppression techniques correlates with a reduction in cough frequency, early data from CoughPro suggests a similar trend: these users who actively engage with the app's educational and technique-based content experience meaningful reductions in cough frequency.

These case studies indicate that BCST, embedded in digital platforms such as CoughPro, might serve as effective interventions by themselves, or as a complement to traditional interventions and the use of new drugs as they become available for chronic cough patients. It also reinforces that behavioral changes can have a significant impact on cough and should be considered in the design and execution of clinical studies of new antitussives.

However, caution is warranted. In addition to the small sample size and variability in tracking data, it remains difficult to distinguish the app's effects from placebo effects or external influences, such as concurrent treatments or lifestyle changes. This whitepaper also has implications for the design and conduct of future studies of digitally delivered BCST. For example, future research currently in the planning stage, will need to be conducted prospectively with larger numbers of participants, collect potentially confounding clinical information and be conducted over longer time periods as described below.

Implications

The adoption of digital cough management tools like CoughPro has potentially significant implications for the future of chronic cough management. For patients who experience adverse events from traditional therapies or populations who may have limited access to speech-language pathologists or specialized healthcare, digital solutions offer a scalable and cost-effective alternative. These tools can provide continuous, personalized therapy that mirrors in-person interventions, thus bridging a substantial gap in care delivery.

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Digital cough management is not intended to replace traditional therapies but to complement them. For patients undergoing behavioral therapy under the care of a GP, apps that digitalize science-based cough suppression techniques may enhance adherence, provide real-time feedback, and improve overall outcomes. The ability to monitor cough frequency objectively and continuously also offers clinicians valuable data to tailor treatment plans more effectively.

Recommendations for Future Studies

To fully realize the potential of digital cough management, several key recommendations are proposed:

1. <u>Conduct larger, controlled studies</u> - Robust, large sample size studies are needed to validate the initial findings. These studies should aim to differentiate the effects of digital interventions from placebo effects and external factors[4].

2. <u>Explore demographic and behavioral factors</u> - Investigate how user demographics, such as age, gender, and comorbidities, influence engagement and outcomes. Understanding these factors can help tailor digital interventions for different user groups.

3. <u>Explore how app-use patterns affect outcomes</u> - Investigate how user behavior in the app, including time devoted to each of the sections, affects cough outcomes.

4. <u>Further optimize Cough Management protocols</u>, by more completely digitizing content, improving engagement and adherence and so on - these processes are currently underway

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[4] Hyfe, in partnership with lead academic institutions, is in the process of conducting rigorous, larger sample size studies on Cough Management.

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