

Development of smart mobile phone application to monitor progress and wellness for Chronic Obstructive Pulmonary Disease patients

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ABSTRACT

A bespoke application (app), 'KeepWell', tuned to chronic obstructive pulmonary disease (COPD) self-management has been developed. The app facilitates goal setting, progress monitoring and personal reporting; features were informed by n=4 clinicians. Eight other clinicians tested usability by undertaking a list of interaction tasks and completing a usability questionnaire. Qualitative comments or problems experienced during the completion of each task were noted. Overall the participants reported high levels of usability. Features that scored consistently well were setting goals, self-reporting and viewing progress. Suggested changes were: setting and editing reminders and ensuring the manual information was consistent with the operation of the KeepWell app.

1. INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is characterised by airflow obstruction that is not fully reversible. Current treatment guidelines suggest a tailored and multidisciplinary approach including medical management of medications and potentially surgery, in addition to management of lifestyle behaviours such as smoking, exercising and diet (NICE, 2010). Referral to a Pulmonary Rehabilitation programme is recommended as a fundamental treatment for COPD. In Northern Ireland this is supplemented by a self-management education program developed to help people with COPD and their family to take charge and cope with their disease on a day-to-day basis in collaboration with their healthcare team. Living Well with COPD (LWWCOPD) provides the education programme (Borbeau et al. 2009; Earley et al, 2011).

There is an expectation that through Pulmonary Rehabilitation programmes, individuals will learn the skills, knowledge and confidence to self-manage their condition and maintain appropriate health behaviors after the programme has ended. Nevertheless, long-term outcomes of those who have attended Pulmonary Rehabilitation suggest that this may not be the case; there is a growing awareness that people with COPD may require greater assistance and support to successfully self-manage rather than as an optional extra. This has been aided by the LWWCOPD programme where patients can continue to follow the advice they have been provided with after their programme of Pulmonary Rehabilitation (Earley et al, 2011). For this reason we wish to extend the accessibility of these materials to supplement the current management of COPD after Pulmonary Rehabilitation by developing an Android mobile phone app called 'KeepWell' that incorporates the content of the LWWCOPD programme and helps the patient to develop self-management skills and self-health behaviours in order to improve disease control. The app is designed to harness the functionality of a smart phone and wearable device (Withings Pulse Ox: <http://www.withings.com/uk/en/products>) to enhance rehabilitation by enabling people with COPD to set goals, measure and monitor their physical activity levels and set reminders.

Therefore the aim of this work is to continue the development of the app on an iterative basis in collaboration with clinicians and people with COPD. This paper describes some of our collaborative work with clinical experts.

2. REVIEW OF LITERATURE AND APP STORES

2.1 Previous work in this area

Support for self-management programmes could be provided via a range of formats, for example, via internet, telephone, mentoring or coaching, and face-to-face individual or small-group-based activities (Borbeau et al, 2009). Some technology solutions have been developed to support the management of COPD and there are an increasing number of mobile phone apps available on app stores (such as Resp Assist, GOLD COPD strategy, COPDexchange) aimed to assist clinicians to manage their patients. We were not able to identify a previous study that has embedded an app into an existing Pulmonary Rehabilitation programme to support the patient to self-manage their COPD. With regards to support for the COPD patient, we have only identified computer-aided assistance for patients (e.g. Farmer et al, 2014; Johnston et al, 2014). These incorporated several aspects for self-management and support including treatment advice, physical activity monitoring, event detection and alerting. One planned study has included educational material in the form of text and video resources but has yet to report any results (Farmer et al, 2014).

3. DEVELOPING AND TESTING THE USABILITY OF THE APP

3.1 Preliminary meeting

An incremental prototype methodology was used in the formal technology development of KeepWell, and has been described elsewhere (Patterson et al, 2014). In order to ensure that the system was fit for purpose several structured meetings were conducted with four expert clinicians (n=2 from UK and n=2 from Canada) in order to get their views on the equipment, its usability from a clinical perspective, and make some decisions on how best to integrate the equipment into current COPD practice. At this stage a decision was made that KeepWell would have value as an adjunct to Pulmonary Rehabilitation, and assist people with COPD to self-manage their condition between visits with the health professional. It is envisaged that clinicians will provide the app and wearable device (for monitoring physical activity) during a face to face consultation during which the clinician and person with COPD would collaboratively set physical activity goals on the app. The focus of KeepWell is to assist the person with COPD to monitor their physical activity levels, measured via the wearable device and displayed on the app, be able to set step goals, and monitor their progress. In addition they would also be able to self-report their Borg Breathlessness scale on a daily basis, measured during their physical activity, and share this with the clinician. The Borg Breathlessness scale (called Borg scale from now) is a scale that asks the person with COPD to rate the difficulty of their breathing from number 0 where breathing is causing no difficulty at all through to number 10 where breathing difficulty is maximal. Clinicians advised that people with COPD should be active at a Borg scale of 3-4 (slight to slight to moderate difficulty breathing), so having a record of this will assist the clinician to support the person with COPD to set appropriate physical activity goals.

3.2 Usability of the KeepWell app

Further clinical opinion was obtained by asking clinicians to complete a series of tasks on KeepWell (see Table 1). Throughout the tasks, clinicians were permitted to consult with a printed manual, which explained the operation of the app, as needed.

3.2.1 Methods. The participants in the usability study were eight clinicians, six worked in the area of COPD management across Northern Ireland; and two were clinicians working in a research environment.

3.2.2 Procedure. Ethical approval was not required as the study was conducted under the auspices of Personal and Public Involvement, that is the involvement of expert clinician as specialist advisers in the design of the KeepWell app. Clinicians provided valuable knowledge and expertise based on their experience of patient and COPD management in the development of the KeepWell platform. No information was collected that could identify the clinicians involved, as the sole purpose was to evaluate usability of the KeepWell app. Clinicians were contacted by one of the research team to arrange a time and date for an individual meeting. The meetings took place across Northern Ireland at the clinician's place of work or at Ulster University. Before the participants began, the procedure was explained fully and they had a chance to ask questions. Once each clinician had completed the tasks (Table 1) and consulted with a printed manual explaining the operation of the KeepWell app they were asked to complete a usability questionnaire. Any qualitative comments or any problems during the completion of each task were noted.

Table 1. Tasks completed during the clinical evaluation. PR=pulmonary rehabilitation.

| Task | Purpose |
|---|--|
| Clinician to complete the following steps <ul style="list-style-type: none"> • Put activity tracker together and position on wrist. • Launch app on mobile phone device. • Set a step goal. • Self-report a workout or Borg. • View progress within app including daily/weekly. • Create a reminder using date and time. • Change/edit reminder date and time. | To demonstrate how to wear and use the wearable device. To demonstrate overall function of app and highlight specific features. To obtain clinician opinion on usefulness of features. |
| Clinician to view educational materials | Check format of the included materials. |
| Clinician to review suitability of self-report workouts included in KeepWell. | Check suitability of workouts included. |
| Clinician to complete questionnaire. | Quantitative and qualitative feedback |

3.2.3 Results. All the participants owned a smart phone, although the majority (63%) of these used the iOS platform. Overall, the participants rated the KeepWell app features highly (see Table 2) with lower ratings identified for the ease of the user interface. This might also explain in part the length of time that some of the respondents suggested they may need to learn how to use the KeepWell app which ranged from minutes (63%) to days/weeks (25%). Features that scored consistently well were setting goals, self-reporting work-outs or a Borg scale, and viewing progress. Suggested changes were setting and editing reminders and ensuring the information in the manual was consistent with the operation of the KeepWell app. All of the clinicians who worked in the area of COPD management (6/8) thought that the educational materials were suitable for use in people with COPD. Suggested changes were a search facility for education topics.

Table 2. Likert Scale ratings of KeepWell app characteristics *1=Poor and 5=Excellent, **1=Difficult and 5=Easy, ***= Not useful and 5= Very useful.

| General Questions (n=8) | | | | |
|--|------|------|--------|------|
| | Mean | SD | Median | IQR |
| Please rate the look and feel of the app* | 4 | 0.93 | 4 | 2 |
| Please rate the responsiveness of the app* | 4.38 | 0.74 | 4.5 | 1 |
| Please rate the ease of the user interface* | 3.75 | 0.89 | 3.5 | 1.25 |
| Please rate the ease of menu navigation* | 4.13 | 0.83 | 4 | 1.25 |
| Please rate how easy the app would be to learn to use** | 4.25 | 0.71 | 4 | 1 |
| Please rate how comprehensive the instruction manual is** | 4 | 0.58 | 4 | 0 |
| Please rate how useful you feel this app is for helping to increase your physical activity level*** | 4.25 | 0.71 | 4 | 1 |
| Please rate how useful you feel this app is for improving your knowledge about managing your COPD*** | 4.38 | 0.52 | 4 | 1 |

4. CONCLUSIONS

We have continued the development of the KeepWell app in collaboration with clinicians, in order to support people with COPD to better self-manage their condition. Clinicians rated the KeepWell app as usable, and considered that it could be an adjunct to Pulmonary Rehabilitation programmes, which are standard care in the UK. Some changes were suggested to improve usability, and these have been incorporated as part of an incremental prototype development methodology. Future developments of the app could include automatic generation of step goals based on previous physical activity performance and Borg scale scores, the porting of the app to iOS, and a search facility for the educational materials

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5. REFERENCES

- Bourbeau J and van der Palen J, (2009), Promoting effective self-management programmes to improve COPD. *Eur Respir J*, **33**, pp. 461–463.
- Earley D, O’Neill B, Bourbeau J, MacMahon J and Bradley JM, (2011), The adaptation and evaluation of the Living Well with COPD programme for pulmonary rehabilitation. *British Thoracic Society Winter Meeting Thorax*, **66**, S4, A127.s.
- Farmer A, Toms C, Hardinge M, Williams V, Rutter H and Tarassenko L, (2014), Self-management support using an internet-linked tablet computer (the EDGE platform)-based intervention in chronic obstructive pulmonary disease: protocol for the EDGE-COPD randomised controlled trial, *BMJ Open*, **4**, 1, e004437. doi:10.1136/bmjopen-2013-004437.
- Johnston NW, Lambert K, Hussack P, Gerhardsson de Verdier M, Higenbottam T, Lewis J, Newbold P, Jenkins M, Norman GR, Coyle PV and McIvor RA, (2013), Detection of COPD exacerbations and compliance with patient reported daily symptom diaries using a BlackBerry-based information system, *Chest*, **144**, 2, pp. 507-514.
- National Institute for Health and Care Excellence (NICE), 2010. *Chronic Obstructive Pulmonary Disease. Management of Chronic Obstructive Pulmonary Disease in Adults in Primary and Secondary Care* [online]. London: NICE. NICE guidelines CG101.
- Patterson T, Cleland I, Nugent CD, Black ND, McCullagh P, Zheng H, Donnelly MP, McDonough SM (2014). Towards a Generic Platform for the Self-Management of Chronic Conditions. Conference Paper. DOI:10.1109/BIBM.2014.6999288 Conference: Bioinformatics and Biomedicine (BIBM), IEEE International Conference on, At Belfast, Northern Ireland.