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**Pulmonary rehabilitation – a preference clinical trial of centre based and mHealth delivered rehabilitation.**

MedTech Core Flagship Project

Principal Investigator: Sarah Candy

Trial Registration Number: **U1111-1264-9454**

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Project Sponsors

The principal financial sponsor of this study is MedTech Core.

The design, conduct, analyses and interpretation of study results will be made independent of the study sponsor.

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**Study centres**

Auckland University of Technology

University of Auckland

Counties Manukau Health

Waitemata District Health Board

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# Overview

**Title:** Pulmonary rehabilitation – a preference clinical trial of centre based and mHealth delivered rehabilitation.

**Investigators and study centres**

This study has been designed in collaboration with investigators at Auckland University of Technology (AUT), University of Auckland (UoA), National Institute for Health Innovation (NIHI), Counties Manukau Health (CMH) in consultation with clinicians, consumers and Maori. The overall design and conduct of this trial is the responsibility of the principle investigator and members of the project management committee. Publication of data from this trial will be the responsibility of members of the project management committee.

**Objectives**: The primary objective of this study is to evaluate participant rate of attendance to pulmonary rehabilitation (PR) programmes delivered with two different delivery modes (centre based and mHealth). Secondary aims are to evaluate; (1) patient preference for mode of delivery, (2) determine if different delivery methods can achieve equivalent results in health outcomes (3) patient experience.

**Study period**: March – November 2021

**Study design and methodology**

The study will be a two arm, parallel, patient preference clinical trial (PCT). Participants will be recruited from three hospital led PR services in Auckland. Referrers to the programmes will be made aware of the different delivery methods available. Potentially eligible participants will be invited to participate and offered the choice of either centre based PR or mHealth delivered PR (mPR). Both interventions will be eight weeks in duration and consist of individually prescribed and progressed exercise therapy in conjunction with education and self-management support. All participants will complete a follow up assessment, and a purposefully selected sample of participants will complete a follow up interview.

**Study population**

The study involves adults living with a chronic respiratory disease who are eligible for traditional PR and are able to provide informed consent.

**Sample size**

Sample size calculations have been undertaken to determine if the mPR programme is able to achieve equivalent attendance to centre based PR. Based on an average attendance rate of 60% allowing for a 30% difference and 5% margin of error and 80% power, a sample size of 50 participants in each group is required, allowing for a 10% drop out. Recruitment will continue until there are 50 participants in the smallest group.

**Intervention:**

Participants will be provided the two options for the mode of delivery of PR, either centre based or mHealth delivered (mPR) rehabilitation.

**Group A: Centre Based PR**

This group is representative of standard care. PR follows provided based on best practise guidelines (Alison, McKeough et al. 2017)

**Group B: mHealth PR**

This group will receive an mHealth delivered PR programme. The intervention is mapped from standard PR programmes and based on best practise guidelines (Alison, McKeough et al. 2017). The mPR programme will be delivered through an mPR-app, SMS, wearable sensors and paper manual.

**Study Outcomes**

The primary outcome will be attendance at PR. For the centre based group attendance at each of the 16 session is recorded. For the mHealth group a proxy of digital attendance will be used. This will be the responses received from participants to two questions per week. Secondary outcome measures will include adherence to the prescribed exercise programme, patient preferences for mode of delivery, outcome measures (6MWT, 1-min STS, EQ5D, CAT) , patient satisfaction and follow up interviews.

# 2. Study Flow Diagrams

Figure 1. Overview of study flow

Referred to Pulmonary Rehabilitation

Participant contacted via telephone. Advised of study and invited to attend. Written information sent (post/email). Initial assessment appointment made

(+/- informed consent completed)

Participant attends PR assessment clinic

(CMH, Northshore, Waitakere)

Informed consent completed. Registration Completed

**Participant chooses intervention group**

**N = 100**

**Participant completes baseline assessment (Blinded assessor)**

Exercise Capacity (6MWT, 1min STS)

Symptom score (CAT)

Health related QoL (EQ5D)

**Group A: Centre based PR**

**Group B: mHealth PR (mPR)**

**Participant attends follow up assessment**

Exercise Capacity (6MWT, 1min STS)

Symptom score (CAT)

Health related QoL (EQ5D)

Participant satisfaction

**Participant attends follow up interview**

(n = 10 purposefully selected group)

Figure 2. Flow diagram for centre based PR group

**Group A: Centre based rehabilitation**

**N > 50**

Attend **centre based PR** for eight

(Exercise and education programme as per site protocol)

* Individually tailored, progressive exercise prescription completed as per circuit record (twice weekly)
* Group self-management education sessions (twice weekly)
* Home based exercise prescription completed thrice weekly (activity diary)

**Baseline**

* **Standard PR reassessment**
  + Review problem list
  + Goal setting
* **Outcome Measures**

Exercise Capacity 6MWT

One minute sit to stand

* + Health related QoL EQ-5D
  + Symptom score CAT
  + Participant satisfaction
  + Intervention preference
  + Attendance
  + Adherence to exercise prescription
* **Standard PR assessment** 
  + Problem identification
  + Goal setting
* **Outcome Measures**

Exercise Capacity 6MWT (x 2 allowing practise test)

One minute sit to stand

* + Health related QoL EQ-5D
  + Symptom score CAT

**Follow up**

**Intervention 8 weeks**

**Figure 3**. Flow diagram for mHealth PR group

**Group B: mHealth PR**

**N > 50**

* **Standard PR assessment** 
  + Problem identification
  + Goal setting
* **Exercise Capacity** 6MWT (x 2 allowing practise test)

One minute sit to stand

* **Health related QoL** EQ5D
* **Symptom score** CAT

**Baseline**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Module Options** | | | | | | | |
| **C**ore | | Maori | | Pacific | | Non-Maori/Pacific | |
| Exercise Level | One | | Two | | Three | | Four |
| Smoking cessation | | | | | | | |
| Secretion Clearance | | | | | | | |
| Motivations | | | | | | | |
| Key support people | | | | | | | |

**Intervention**

**8 weeks**

**mPR-app with individually tailored SMS**

Exercise prescription, self-management education and feedback

Tips and Tools to manage chronic condition

Links to further support

**mPR-sensor**

Step count data

(optional)

**mPR Manual**

Paper material to replace / compliment mPR-app

**Individually tailored SMS alone**

Exercise prescription + self-management

* **Standard PR reassessment** 
  + Review problem list
  + Goal setting
* **Outcome Measures**
  + Exercise Capacity 6MWT

One minute sit to stand

* + Health related QoL EQ-5D
  + Symptom score CAT
  + Participant satisfaction
  + Intervention preference
  + Attendance
  + Adherence to exercise prescription
* **Follow up interview**

**Follow up**

# 3. Background

Chronic respiratory diseases (CRD) including; chronic obstructive pulmonary disease (COPD), asthma, bronchiectasis and interstitial lung disease (ILD), contribute to 7% of global burden of disease, and are thought to be the third leading cause of death worldwide (Maio, Baldacci et al. 2016). In New Zealand, COPD is estimated to affect 14% of adults over 40 years of age(Telfar, Baker et al. 2015). Maori, ethnic minority groups and people from socioeconomically deprived areas are disproportionally affected by COPD, with higher prevalence and increased rates of hospitalisation and mortality (Telfar, Baker et al. 2015).

There is a great symptom burden for people who are living with a CRD. They experience shortness of breath, fatigue and exacerbations, which may lead to reduced exercise capacity, poor health related quality of life (HRQoL), increased dependency, repeated hospitalisation and increased levels of anxiety and depression. Whilst these conditions are not curable, treatment can relieve symptoms and improve their quality of life.

Pulmonary rehabilitation (PR) is an evidence-based, multidisciplinary intervention, which is a key component in the management of people with CRD. PR is a formalised, structured programme which includes; exercise training, education, self-management and behaviour change (Spruit, Singh et al. 2013). It is usually delivered in group sessions which occur twice per week over a six to eight week period (Alison, McKeough et al. 2017) and is normally delivered and supervised by a team of health professionals. A recent systematic review investigating PR has clearly demonstrated it can reduce breathlessness, improve HRQoL and reduce hospital admissions for exacerbations of COPD [(McCarthy, Casey et al. 2015, Puhan, Gimeno‐Santos et al. 2016) ]. Clinical guidelines strongly recommend referral to PR for all patients with COPD, particularly following hospital admissions (Puhan, Gimeno‐Santos et al. 2016), and there is a growing body of evidence to support PR for other CRD.

Despite the compelling evidence regarding the effectiveness PR, the uptake of, and adherence to, PR programmes in NZ is poor, with estimates in 2012 of less than 2% of all patients with COPD participating in PR (McNaughton, Weatherall et al. 2016). Barriers to attendance have been studied and include; travel, transport, illness and lack of perceived benefit. In addition, NZ studies have found ethnic disparity with Maori and Pacific participants being less likely to complete PR (Candy, Jepsen et al. 2020 48) (Levack, Weatherall et al. 2012, Levack, Jones et al. 2016, McNaughton, Weatherall et al. 2016).

To allow people living with CRD accessible and equitable opportunities to participate in PR, different methods of delivery need to be considered. One recent global trend to address many of these barriers is the option of delivering PR with the assistance of technology. Technology may assist PR in different formats including; using home-based teleconference facilities, utilisation of community centres, via web-based interventions or mobile health applications (mHealth).

MHealth is a growing field which has been shown to enhance the management of other chronic health conditions through providing support, monitoring and self-management strategies (Pfaeffli Dale, Dobson et al. 2016, Whittaker, McRobbie et al. 2016, Dobson, Whittaker et al. 2018). There are many opportunities which mHealth can bring to PR including; access to PR almost anywhere and, anytime, on-going support and motivation and potentially individually tailored PR.

Extensive formative work has been undertaken for this project to understand the needs, preferences, and priorities of end users for the development of a mobile PR (mPR) support programme (Dobson, Herbst et al. 2019). The results of this study found a high interest in mPR to overcome barriers to traditional centre based PR programmes, but highlighted concerns regarding digital access and digital literacy and the need for a range of solutions to meet individual needs. The results led to the development of a mPR programme with a core component of SMS supporting the mPR app and the addition of optional mPR sensors. For participants unable to access the mPR-app a paper manual is provided to integrate with the text messaging. By delivering the core components of mPR via SMS this would ensure equitable access for a wider group of participants.

mPR was developed by a multidisciplinary team including public health and mHealth experts, physiotherapists, respiratory physician, psychologists, respiratory nurse specialists, a Maori advisory group , with ongoing input and feedback from end users. The intervention involves a core exercise based rehabilitation programme, which is individualised and progressive. Self-management education is delivered in a variety of formats, including SMS, written and audio content. The mPR-app contains 12 sections with tips and tools for managing your health condition. This has written content, short education video clips and links to further information

Pretesting of the first mPR prototype was undertaken with 26 participants and four family members. The study was completed at Middlemore and Northshore Hospitals in Auckland. Of the 26 who enrolled, completion data and follow up interviews were completed with 20 participants. All 20 of these participants reported they would recommend the programme for other people living with a chronic respiratory condition. Of the 16 participants who opted to receive the app in addition to SMS, this was only accessed by 11 participants, with one user only accessing the app on the day they logged in. Important feedback from the pretesting has led to further development of the mPR intervention. In particular, the development of mPR to a web based app to allow access on a range of devices (computers, ipads, tablets ), development of the exercise component to include alternative exercises in the case the participants cannot complete the prescribed activity, the addition of increased feedback of progress to participants, the integration of the SMS and app +/- sensors. The results have shown it is feasible and acceptable to deliver PR via mHealth.

# 4. Rationale for present study

The efficacy of PR in reducing symptoms and improving quality of life for people with COPD is irrefutable (McCarthy, Casey et al. 2015). However, less that 2% of NZ population living with COPD access PR on an annual basis (Levack, Weatherall et al. 2012). Alternative models of PR are required to increase the uptake and completion of PR in order to achieve important and equitable health outcomes for people living with chronic respiratory disease. The current study aims to investigate whether delivering PR via alternative modes (mPR) can achieve comparable attendance and adherence to PR as a centre based programme. It will also investigate if mPR can achieve comparable results in health outcomes and patient satisfaction.

The study will utilise patient preference methodology. According to Kowalski three criteria to be met for a preference based trial (Kowalski and Mrdjenovich 2013).

* Two programmes are to be compared
* Blinding is difficult or impossible
* At least some people are likely to have preference to which programme they receive

It is likely that some people would rather attend the in-person group and some would rather receive a mobile device based programme. Randomising may impact recruitment as participants maybe concerned about group allocation. There are participants who may not physically be able to attend in-person (due to transport, work or illness) and so if randomised to this arm would be unlikely to attend or complete, affecting the results. The fact that people have preferences mean that if they are randomised to the intervention they did not want, they may be less satisfied and less likely to complete.

We are interested in a pragmatic trial – we envisage that if successful, mPR would be offered to people in this way and as an alternative to existing standard PR programmes. Therefore, information on patient preferences (how many choose which version) is important information for funders and planners prior to making a decision to implement mPR.

# 5. Study Objective

This study aims to assess the patient attendance and adherence with different modes of delivery of PR. In addition, the study will investigate patient preference to delivery mode, and if the mPR programme is able to achieve equivalent clinical outcomes and patient satisfaction as a centre based PR programme.

Specific study objectives include to investigate:

* The attendance and completion rates of mPR and centre based PR
* The adherence to exercise prescription with mPR and centre based PR
* Patient delivery mode preference?
* Whether mPR achieve comparable improvements in exercise capacity as centre based PR
* Whether mPR achieve comparable improvements in health related quality of life as centre based PR
* Patient satisfaction from the different delivery modalities
* Participant feedback on PR delivered via mPR

# 6. Study Design

A multi-centre, two arm patient preference clinical trial (PCT) will be undertaken. Upon consent, participants can opt for either centre based PR or mHealth (mPR) delivered PR. Both interventions will be eight weeks in duration. All participants will attend a centre based initial assessment and follow up. The study will be conducted at three metropolitan hospitals in Auckland. Ethics will be sought from the Health and Disability Ethics committee (HDEC) and locality approval from each study site.

## 6.1 Inclusion criteria:

* Aged 18 years or older
* Have a chronic respiratory disease e.g. COPD
* Eligible for PR (according to the recruitment site’s existing protocols)
* Able to read and understand English
* Able to provide informed consent
* mPR group only must own or have regular access to a mobile phone.

## 6.2 Exclusion criteria

* Not available for the duration of the study
* Completed PR within past one year

## 6.3 Recruitment and baseline data collection

Recruitment will be conducted through three collaborating metropolitan hospitals PR services (CMH, Northshore and Waitakere). Referring healthcare professionals will be advised of the study and the increased options available for PR. This will ensure participants, who may have declined referral in the past due to not being able to attend centre-based options, are given the opportunity to participate. Potentially eligible patients who fulfil the inclusion criteria will be invited to take part by their collaborating healthcare professional. Recruiting clinicians will prioritise recruitment of Māori and Pacific people as well as those who live more rurally. Recruiting healthcare clinicians will keep note of the number of potential participants who decline to participate in the study. Recruitment will be monitored by (SC) on a regular basis to ensure that the recruitment process is effective and that recruitment targets will be met within timelines where possible.

We aim to recruit 50 participants in the smallest group.  If feasible, and funding allows, recruitment will continue until this has been achieved.

**6.4 Blinding**

Due to the nature of the intervention, blinding of participants is not possible. Independent assessors blinded to intervention group will undertake baseline and follow up assessments (6MWT, 1-min STS, CAT, EQ-5D).

## 6.5 Study intervention

All participants in both groups will attend a standard centre based assessment at the site where they are recruited as per best practise guidelines (Alison, McKeough et al. 2017). Both groups will receive an eight-week intervention and then return to the same centre for a follow up assessment.

Group A: Centre based Group

Participants who opt for the centre-based intervention will attend the centre two days per week for eight weeks. The intervention will include one hour of supervised exercise training in a group setting ( 8 – 14 participants) delivered by a physiotherapist and respiratory nurse and/or health care assistant. Exercise prescription includes aerobic, resistance and balance exercises individually prescribed and completed in a circuit programme. Intensity of exercise is prescribed based on the modified BORG scale with all participants encouraged to progress exercise to maintain a breathlessness score of 3 - 4. Participants will be provided with a home based exercise programme, which they are asked to complete three times per week and record in the provided activity diary. The number of sessions attended, the number of completed exercises circuits at the centre based site, and the number of exercises completed in the activity diary will be monitored. In addition, participants will be invited to attend a 30 minute group education session with focus on self-management education. Participants will be offered the opportunity to make up classes that may have been missed by extending the duration of PR up to 12 weeks if required. The centre based PR intervention follows standard clinical practise.

Group B: mHealth Group

Participants who opt for the mHealth intervention will receive a technology delivered PR programme with content mapped from standard PR programmes and based on best practise guidelines (Alison, McKeough et al. 2017). The programme includes a core component of tailored exercise prescription consisting of aerobic, resistance and balance exercises. Information regarding the safe and effective technique of each exercise will be provided in written and video format. Exercise prescription is based on their initial assessment scores (6 minute walk test distance and dyspnoea score MMRC) with participants being stratified to four different exercise levels by the recruiting clinician. Participants are encouraged the work at an intensity equivalent to 3-4 on the modified BORG scale. Information regarding the BORG scale will be provided in the mPR-app and in a paper manual for participants unable to access the mPR-app. The programme is adaptive to patients current health state via; offering alternative exercises if participant are unable to complete the prescribed activity, allowing participants to pause the programme if they are unwell via a question at the end of the week if they are ready to progress their exercise.

Participants can monitor their progress in the mPR-app which displays the number of exercises completed each day. The programme has been designed to monitor adherence with exercise by 2-way messaging. Each week on day 7, a message will be sent asking the participant how many times they have completed their exercises that week. Participants are asked to reply with the number.

Participants will have the option to pause the programme if unwell. The programme can be extended up to 12 weeks.

Where appropriate, participants will be asked if they would like to wear a sensor for the eight-week period. The mPR-sensor used in this component of the study will be a commercially available Fitbit or Withings smartwatch, which monitors step count. Participants who already use a sensor can integrate the data with their own sensor to the mPR-app. Participants will be asked to wear the mPR-sensor as they wish over the eight-week period and will be shown how to use the accompanying app at registration. Daily step count and weekly average step count data will be displayed on the My Progress page of the mPR-app. Step count data from the sensor will be accessed at the end of the study as well as usage data (how the sensor was used and how often).

**Table 1: Description of mPR-app components**

|  |  |
| --- | --- |
| **Page** | **Description** |
| Home | Exercise prescription.  Seven exercises (aerobic, resistance and balance) to complete on five days of the week.  Number of repetitions monitored and completion of exercise displayed.  Menu bar with other options listed |
| Exercise Icons | Written information with how to complete each exercise correctly and the number of repetitions to complete  Video link demonstrating correct technique  Alternative exercise provided if unable to complete |
| Tips and Tools | Twelve tiles providing educational information on key topics of self-management education for people living with a chronic respiratory condition.  Each topic has written material with short video clip and links to further information.  Education topics mapped on education programme delivered in centre based programme |
| My Progress | Graphically displays number of exercises completed each day and results from one minute sit to stand test (assessment, midway and completion)  If a participants opts for the sensor, the number of steps each day and weekly average step count is graphically displayed. |
| I am unwell | Provides participants with option to pause programme for seven days |
| Menu | How to use mPR-app  About mPR information  Contact us form – for technical assistance only. |

To qualify for the mPR-app participants must own or have regular access to a mobile device and have regular access to the internet on the device (mobile data or wifi).

Each participant enrolled in the mPR programme will receive a personally tailored package of text messages over the 8-week period, in addition to mPR-app (see Table 1). The programme consists of different modules to allow content to be tailored to individual clinical characteristics, preferences and demographics. All participants receive a core programme. In addition, if they are a smoker, they receive a smoking module and if they experience retained or excessive respiratory secretions, they receive the secretion clearance module. Table 2 provides more specific details on the content of these modules.

The mPR programme has been tested in a feasibility study (non-published) which found 85% of participants reporting mPR had an impact on how they managed their condition and helped them to change their behaviours.

**Table 2: Description of SMS mPR modules**

|  |  |  |  |
| --- | --- | --- | --- |
| **Module name** | **Platform requirements** | **Description** | **Who can receive this module** |
| **Core** | Scheduled at registration | 1 message per day. Core motivation, support and information messages designed to encourage correct engagement with the programme, PR associated behaviours, and the healthcare system   * Motivational messages * General wellbeing * Links to support services * ACP * General PR information/education * Physical activity: PA related messages designed to provide education, tips, goal setting, motivation and support * Breathing: Information messages about good breathing techniques and management of breathlessness   There are 2 versions of this module:   * Core * Core\_family | Patients |
| **Core\_family** | Scheduled at registration | 1 message per day. Core motivation, support and information messages | Family |
| **Exercise prescription**  (expx) | Manually sent through adhoc messages | Weekly exercise prescription based on exercise capacity including aerobic, strengthening and balance. There are 4 exercise prescription modules:   * expx\_1 * expx\_2 * expx\_3 * expx\_4 | Patients only |
| **Smoking** | Scheduled at registration | For those identified as smokers at baseline, one message every 2 weeks encouraging patients/family to consider quitting smoking and offering a smoking cessation programme. There are 2 versions of this module:   * Smoking * Smoking\_family | Current smokers |
| **Smoking cessation** | Scheduled at any time through the administrator dashboard by an administrator | Those receiving the smoking module will be able to free reply text ‘quit’ if they want support to quit. They will automatically be enrolled in a smoking cessation programme consisting of:   * Countdown to quit day (2 messages per day for a week), quit day (3 messages/day), * Main programme (2 per day for 4 weeks) and * Relapse prevention (3 per week for the reminder of the time they receive mPR) | Current smokers who identify as wanting to quit |
| **Secretion Clearance** | Scheduled at registration | Education and reminder messages for participants with excess or retained secretions. | Patients excess or retained respiratory secretions. |

## 6.6 Withdrawal criteria

Participants can withdraw from either arm of intervention at any time. Their decision to withdraw will not affect their usual care.

Participants can stop mPR programme and any of its components at any time by free texting back STOP to the mPR shortcode, uninstalling the app and/or ceasing wearing the sensor. As their feedback and the reason for wanting to stop the programme is vital to the study, these participants will still be contacted and asked if they would be willing to complete a follow up assessment and interview.

Those from participants from either group who decline to complete the follow up assessment will be withdrawn from the study. Following intention to treat principles, their data will be included in the analysis. Clinicians will be able to stop the programme on behalf of participants if deemed clinically appropriate. If participant in the mHealth group wishes to attend a centre-based programme, they will be given the opportunity to attend on completion of the study.

## 6.7 Baseline assessment

Potential eligible participants will be identified by PR clinicians at one of the recruitment sites. They will be given a Patient Information Sheet (PIS) and Consent Form (CF). The clinician will discuss the programme with the participant and answer any questions they may have. The participant will have the option of contacting a member of the project team to answer any further questions. Participants will be encouraged to discuss their participation with whanau, family and friends. If the potential participant indicates that they would like to take part in the study the clinician will confirm eligibility, obtain informed consent. The recruiting clinician will complete the standard PR assessment and an independent assessor will undertake the outcome measures. Participants will be advised not to discuss their intervention with the independent assessor.

Baseline measures collected on initial visit:

* Form X
  + Contact details: NHI, name, address, phone number and alternative contact number
* Form Y
  + Study ID number
  + Demographic information; Age, gender, ethnicity, postcode,
  + Clinical information: Primary respiratory diagnosis, severity, smoking status, co-morbidities,Exercise capacity (6MWT 1 min STS), symptom score (CAT),
  + Psychological and behaviour change measures: health relate quality of life (EQ5D),
  + Preference for intervention
* Form Z
  + mPR registration – participants who choose the mPR intervention the following information will be completed at registration and entered into the mPR system;

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Module selection** | | | | |
| Core | Maori | Pacific | Non-Maori/Pacific | |
| Exercise level | One | Tow | Three | Four |
| Smoking cessation |  | | | |
| Secretion Clearance |  | | | |
| **Tailoring selections** | | | | |
| Preferred name |  |  |  |  |
| Preferred delivery time | Morning | Afternoon | Evening | No preference |
| Motivations |  |  |  |  |
| Key support people |  |  |  |  |

## 6.8 Outcome measures

All participants from each group (including participants that withdraw) will be asked to complete a follow up assessment appointment at the end of the intervention. The following data will be collected:

Attendance

Attendance at the centre based programme will be assessed based on the number of classes the participant attended (% of 16).

Attendance for the mHealth group (mPR) will be assessed via digital responses to two SMS questions per week. The percentage of return messages (% of 16).

A priori definition of pulmonary rehabilitation completion will be attending (in person or digitally) a minimum of 70% of the sessions (Williams, Lewis et al. 2014).

Self-reported adherence

The adherence to the prescribed exercise prescription will be assessed by the number of times participants completed >50% of the prescribed exercise prescription for that day.

Each participant will be given an exercise prescription to complete five days of the week.

The centre-based group will complete two supervised sessions and three home based sessions. The number of completed exercises will be obtained from the PR centre exercise circuit card and the activity diary provided for home based exercises.

The mHealth group will complete five home based sessions. The number of completed sessions will be obtained from the mPR-app or from activity diaries provided to the group with SMS only.

Exercise Capacity

Exercise capacity will be measured by change in distance walked on 6-min walk test (6WMT) and one minute sit to stand (1-min STS) scores from baseline to follow up. The 6MWT has been found to be a valid and reliable measure of exercise capacity if two tests are conducted to allow for learning effect (Holland, Spruit et al. 2014). The 6MWT has been shown to be responsive to change following PR for people living with a chronic respiratory condition (Holland, Spruit et al. 2014).

The 1-min STS has been shown to be valid and reliable measure of exercise capacity in people with COPD (Crook, Büsching et al. 2017). The test has also been found to be responsive to change following PR with a minimal important clinical difference found to be 3 repetitions (Crook, Büsching et al. 2017).

Symptom Score

Changes in participant’s symptoms will be monitored by the COPD assessment tool (CAT) tool at baseline and follow up. The CAT tool is valid and reliable assessment tool for health status in people with chronic respiratory conditions (Tsiligianni, van der Molen et al. 2012) (Lee, Lee et al. 2012, Suzuki, Kondoh et al. 2019).

Health related quality of life

Participant’s health related quality of life will be assessed with the EQ-5D tool at baseline and follow up.

Intervention preference

Patient preference will be assessed by their choice of intervention at recruitment.

Participant satisfaction

All participants will be asked to complete a satisfaction survey at the end of the intervention (see form X). Participants can complete the survey in paper or electronic format. This will be completed at the time of the follow up assessment. The survey data will be de-identified.

Follow up interview

A purposefully selected sample of participants will be invited to complete a follow up interview. Participants will be invited at the follow up assessment. The follow up interviews will gather further information to aide understanding of the results. The interviews will follow a semi-structured format. Participants will be asked about their experiences and opinions of the mPR programme. Interviews will be completed by the principle investigator (SC). This sample will ensure diversity of participants is included. The follow up interviews will be audio recorded and transcribed verbatim.

Following completion of re-assessment all participants will be offered a koha as appreciation of their time.

In addition to the outcomes described above the recruitment rate (based on consented/refused numbers from referring clinicians) and data completeness will be described.

**6.9 Schedule of intervention and follow up**

The table below summarises the schedule for intervention and follow up

|  |  |  |  |
| --- | --- | --- | --- |
| **Timing**  **Description** | **Baseline** | **During study period** | **8 weeks** |
| **Eligibility criteria** | X |  |  |
| **Consent** | X |  |  |
| **Demographic and clinical information** |  |  |  |
| * **Name** | X |  |  |
| * **Date of birth** | X |  |  |
| * **Ethnicity** | X |  |  |
| * **Gender** | X |  |  |
| * **DHB region** | X |  |  |
| * **Diagnosis** | X |  |  |
| * **Contact number** | X |  |  |
| * **PR Attendance (> 1 yr previous) yes or no** | X |  |  |
| * **6MWT** | X |  | X |
| * **1 minute sit to stand test** | X | X | X |
| * **MMRC** | X |  | X |
| * **FEV1%** | X |  |  |
| * **BMI** | X |  | X |
| * **Smoking status** | X |  | X |
| * **Social situation (living alone)** | X |  |  |
| **Intervention preference** | X |  |  |
| **Quality of life measures** |  |  |  |
| * **EQ-5D** | X |  | X |
| * **CAT** | X |  | X |
| **Intervention tailoring questions** | X |  |  |
| **Attendance (in centre or digital attendance)** |  | X |  |
| **Adherence with exercise prescription** |  | X | X |
| **Participant satisfaction** |  |  | X |

## Key; 6MWT = six minute walk test, MMRC = modified medical research council scale, FEV1% = forced expiratory volume in one second, BMI= body mass index, EQ-5D = EuroQoL 5D, CAT= COPD assessment tool.

## 6.10 Longer term follow up

In the current research funding, no longer term follow up assessments are possible. If additional funding is obtained, further follow up assessments will be undertaken (3, 6 and 9 months post intervention) to evaluate the sustainability of outcomes.

## 6.11 Data analysis

Sample size

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Outcomes | Power | Sample size in each group | Proportion | (MICD) | margin of error | St.dev | Difference | Final size in each group (accounting for 10% dropout rate) |
| Completion rate | 0.8 | 45 | 0.6 |  | 0.05 |  | 0.3 | 50 |
| Completion rate | 0.9 | 62 | 0.6 |  | 0.05 |  | 0.3 | 69 |
| 6MWT | 0.8 | 14 |  | 30 |  | 5 | 25 | 16 |
| 6MWT | 0.9 | 18 |  | 30 |  | 5 | 25 | 20 |
| CAT | 0.8 | 29 |  | 3 |  | 1.5 | 2 | 32 |
| CAT | 0.9 | 40 |  | 3 |  | 1.5 | 2 | 44 |

Two sample proportion test for Non-Inferiority trial was used to produce the sample size which demonstrates that the mPR intervention is not worse (equivalent  or  better) than the centre-based within an acceptable level to be worse known as the margin of error (Wang, Zhang et al. 2003). Sample size was calculated for each of the outcomes based on 80% and 90% and accounting for a drop-out rate of 10%.  Based on an average completion rate of 60%  with 30% difference and 5% margin of error and 80% power, we would need a sample size of 50 in each group. Assuming a minimal important clinical difference of 30 metres of 6MWT and mean difference of 25 with a standard deviation of 5 and 80% power, we would be need 16 in each group.  And based on  CAT, we would need 32 in each group. The sample size needed was based on highest of the three outcomes, so total of 100 is needed (50 in each group).

## 6.12 Ethical approval

Ethical approval will be sought from the Health and Disability Ethics Committee (HDEC). All research will be conducted according to the principles outlined in the Declaration of Helsinki and with ICH-GCP Guidelines (Vijayananthan and Nawawi 2008).

Participation in the study will be entirely voluntary. Informed consent will be obtained from patients before starting the study either over the phone by the recruiting clinician (who will sign and date the Consent Form on behalf of the participant), or on paper in person with the recruiting clinician. All participants will be made aware of how to contact the team should they have any questions about the consent process.

**6.13 Safety and adverse events**

If an adverse event was to occur onsite or is reported, the researcher will record the AE on the adverse events form (see Appendix 7) and a meeting of the project management team will be called to discuss the AE. The outcome of this meeting will be a) minor AE – monitor with subsequent participants b) minor AE – halt data collection until modifications have been made, or c) serious AE – halt data collection and investigate AE, inform HDEC.

## 6.14 Dissemination of results

At the end of the study, all study participants (who requested it and provided their details) will receive a brief summary of the study results, an outline of their significance, and future research plans.

## 6.15 Ownership of data

Individual study data will remain the property of individual participants. AUT has the responsibility for storage, protection and retrieval of study data. Data will be stored securely on a password protected data stick within a locked cabinet, located in a locked office at AUT North for 10 years and after this time will be safely destroyed.

## 6.16 Data management

All data will be stored on a purpose-built online database (RedCap), with password protection and restricted access. No identifying information will be stored on the online database.

## 6.17 Monitoring and Quality Assurance

The study investigators are responsible for monitoring and quality assurance. The investigators will submit to the reviewing ethics committee, annual (or more frequent if requested) reports of the study. The Principal Investigator, or her nominee, will be responsible for reporting any serious adverse events to the Reviewing Ethics Committee as soon as possible, and in accordance with local regulations. Day-to-day monitoring of the study will be managed by the study project manager.

## 6.18 Publication policy

Every effort will be made to publish the data.

**7. Study Timeline**

**Timeline for the study is:**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **June** | **July** | **Aug** | **Sep** | **Oct** | **Nov** |
| Study set up (study materials, ethics) |  |  |  |  |  |  |  |  |  |  |  |
| Participant recruitment |  |  |  |  |  |  |  |  |  |  |  |
| Data collection |  |  |  |  |  |  |  |  |  |  |  |
| Data analysis |  |  |  |  |  |  |  |  |  |  |  |
| Dissemination |  |  |  |  |  |  |  |  |  |  |  |

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