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The Use of Exercise-Based Cardiac Rehabilitation for Patients with Atrial Fibrillation Receiving Catheter Ablation: Protocol For A Feasibility Randomised Controlled Trial (RCT) with Embedded Process Evaluation

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Exercise-based cardiac rehabilitation for patients with atrial fibrillation receiving catheter ablation: protocol for a feasibility randomised controlled trial (RCT) with embedded process evaluation

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ABSTRACT

Introduction Atrial fibrillation (AF) affects approximately 2.5% of the UK population, with a risk of 1 in 3–5 individuals after the age of 45 years. The global prevalence has risen sharply in the past two decades, from 33.3 million to 59 million individuals living with AF, and is associated with stroke, heart failure and mortality. Catheter ablation is commonly used for symptomatic patients to restore normal rhythm. A recent Cochrane review of randomised clinical trials (RCTs) has demonstrated that exercise training may induce positive effects on AF burden, AF severity, exercise capacity, and quality of life. The aim was therefore to investigate the feasibility of delivering exercise-based cardiac rehabilitation for patients with AF receiving catheter ablation within usual care in the UK.

Methods and analysis A two-armed feasibility RCT with embedded process evaluation will be undertaken as a phased programme of work. Patients on a waiting list for catheter ablation will be offered a referral to cardiac rehabilitation. The intervention consists of supervised exercise sessions run by a clinical exercise physiologist and psychoeducation sessions. The trial (n=60) will involve one National Health Service (NHS) research site enrolling patients to assess intervention and study design processes. Primary outcomes are recruitment rate, adherence to exercise-based cardiac rehabilitation and loss to follow-up. Semistructured interviews and focus groups with patients and clinicians will be used to gather data on the acceptability of the intervention and study procedures. Secondary outcome measures will be taken at baseline (pre-intervention), post-intervention and at 6-month follow-up and will consist of AF burden, AF recurrence, quality of life, exercise capacity measured by peak oxygen consumption and echocardiographic parameters.

Ethics and dissemination The trial was approved in the UK by the Northwest-Preston Research Ethics Committee (24/NW/0061; IRAS project ID: 330155). Results will be published in peer-reviewed journals and presented at national and international scientific meetings, and summaries will be communicated to participants.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This is the first randomised clinical trial to test the feasibility and acceptability of an established cardiac rehabilitation programme in the National Health Service for individuals with atrial fibrillation receiving catheter ablation, with unblinded participants and rehabilitation providers.
⇒ Concurrent economic evaluation with a health service perspective.
⇒ Embedded process evaluation to determine the mechanisms and processes that explain the implementation and impacts of the rehabilitation programme on patients with atrial fibrillation.
⇒ This is a feasibility study and therefore will not report on the definitive effectiveness of cardiac rehabilitation for patients with atrial fibrillation undergoing catheter ablation.
⇒ This trial will be conducted in a single geographical area, which may affect its generalisability.

Trial registration number Clinicaltrials.gov identifier: NCT06401148.

INTRODUCTION

Atrial fibrillation (AF) is the most common cardiac dysrhythmia, with an estimated global prevalence of 46.3 million. AF occurs due to disorganised electrical activity in the atrial chambers of the heart and can present with symptoms such as heart palpitations, breathlessness and fatigue. While AF is not a direct cause of death, it is associated with substantial morbidity and mortality from stroke, heart failure, ans impaired quality of life (QoL). It can be classified into three primary clinical subtypes, indicative of its duration and severity: paroxysmal AF, persistent AF and permanent AF.[1 2] Interventions to reduce

AF burden, prevent disease progression and reduce symptoms typically include pharmacological treatments such as antiarrhythmic drug therapy and catheter ablation.[1 3] This latter, more invasive therapy, uses heat or freeze cauterisation methods to destroy the abnormal heart tissue causing the erratic electrical activity, thus restoring sinus rhythm. Its main function is to prolong the duration of sinus rhythm, as well as reduce the number of acute AF episodes.[4] It has an established value in AF care, evidenced by its superiority over antiarrhythmic drug therapy for long-term outcomes such as stroke, hospitalisation, higher exercise capacity and higher QoL.[4 5]

Evidence from both randomised clinical trials (RCTs) and observational studies indicates that exercise-based interventions, including exercise-based cardiac rehabilitation (ExCR), can improve cardiorespiratory fitness, positively contribute to heart rate regulation, reduce symptom burden, decrease depression and anxiety and increase the QoL for patients with AF.[6 7] There is emerging evidence that lifestyle modifications, including exercise and physical activity, have the potential to improve outcomes following catheter ablation for patients with AF.[8] There is limited but promising evidence for the role of ExCR in patients with AF receiving catheter ablation leading to favourable outcomes, including improvements in physical capacity and reduced anxiety.[9] Due to limited available data, ExCR is not part of usual care for people with AF.[1]

A recent Cochrane review of ExCR for people with AF included 20 trials (n=2039 patients)[10] demonstrated improved AF-specific outcomes and QoL for patients with AF in general, but only six trials included patients receiving catheter ablation, none of which were based in the UK. Collectively, the catheter ablation and ExCR trials were underpowered to investigate long-term clinical outcomes for patients with AF, and the feasibility of adding ExCR to usual care for patients referred for catheter ablation is unknown.

In light of these preliminary findings, investigation into ExCR for patients with AF awaiting catheter ablation is needed to determine if it is acceptable and feasible within UK infrastructure; this will then inform a future definitive trial.

Study aims

The purpose of the study is to determine the feasibility and acceptability of delivering an existing ExCR programme versus usual care to aid the treatment of patients with AF receiving catheter ablation through a feasibility RCT. The feasibility RCT with embedded process evaluation will be conducted to inform the design and conduct of a future larger-scale effectiveness trial for which separate funding would be sought.

The overall aims of this essential preliminary work are:

1. To test the feasibility and acceptability of an existing ExCR programme when delivered to symptomatic patients with AF being referred for catheter ablation.
2. Assess the feasibility and acceptability of the proposed trial methods and outcome measurements.

Study objectives

1. To explore the facilitators and challenges of delivering an existing ExCR programme that focuses on exercise training, physical activity and self-management of AF-related cardiovascular risk factors to people with AF receiving catheter ablation.
2. To determine the feasibility and acceptability of the cardiac rehabilitation programme for patients with AF receiving catheter ablation.
3. Investigate the mechanisms and processes that explain the implementation and preliminary effectiveness of the rehabilitation programme (intervention group) and usual care (control group).
4. Investigate preliminary effectiveness through assessing improvements in (1) symptom severity and burden, (2) AF recurrence, (3) QoL, (4) exercise capacity and (5) cardiac structure and function, and whether this is maintained following the ExCR programme for patients with AF.
5. To provide data for sample size calculation for a RCT.

METHODS AND ANALYSES

Trial design

This is a two-arm feasibility RCT comprising intervention testing, feasibility work and process evaluation. Participants will be randomised to either ExCR (intervention group) or standard care (control group). Outcome assessments will be completed three times: (1) preintervention, (2) after ExCR and (3) at 6-month follow-up (figure 1). Investigations into whether an economic evaluation will be feasible are based on the completion of the five-level EuroQol-five dimensions (EQ-5D).

Aligned with the Medical Research Council (MRC) guidance, this feasibility study will include a qualitative process evaluation in order to ensure that both the intervention and trial procedures are optimised, thus increasing the likelihood that a full-scale trial will generate the desired outcomes, and it can be successfully incorporated into routine care.[11] The trial is described in accordance with the current Standard Protocol Items: Recommendations for Interventional Trials guidelines.[12] Results will be reported following the CONsolidated Standard Of Reporting Trials guidelines for non-pharmacological interventions.[13]

Study setting

The study will be conducted at a single National Health Service (NHS) centre in North-West England: Liverpool Heart and Chest Hospital, where clinical exercise physiologists deliver an existing cardiac rehabilitation service.

Participants

Consecutive patients on the waiting list for catheter ablation at Liverpool Heart and Chest will be screened for inclusion and approached for trial participation. We will

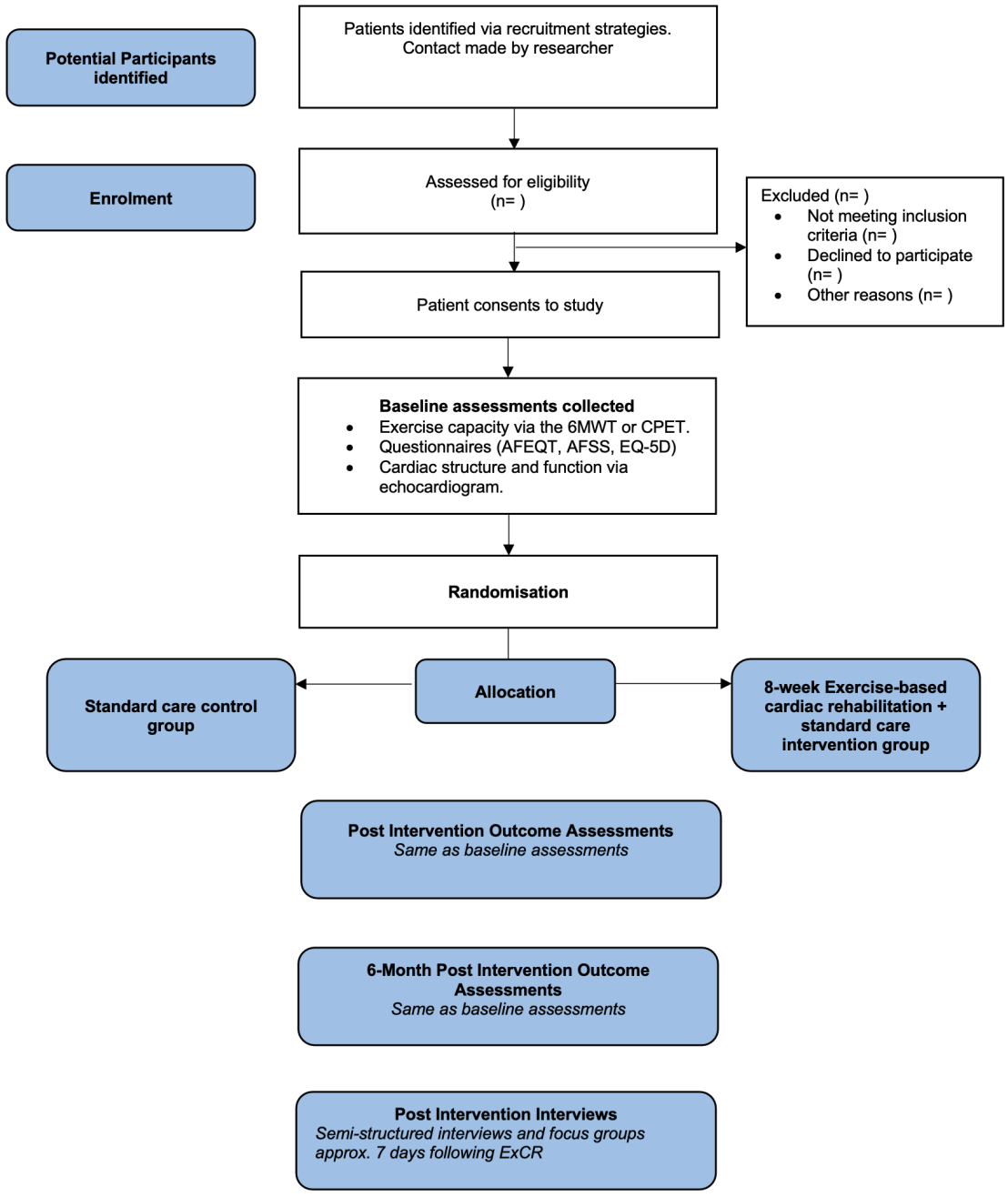

Figure 1 Study flow diagram and participant pathway. AFEQT, Atrial Fibrillation Effect on Quality-of-Life; AFSS, Atrial Fibrillation Symptom Severity; ExCR, exercise-based cardiac rehabilitation; EQ-5D, five-level EuroQol-five dimensions; 6MWT, 6-min walk test; CPET, cardiopulmonary exercise testing; ICECAP-A, ICEpop CAPability measure for Adults.

recruit from catheter ablation waiting lists; however, the ExCR programme may be initiated pre-procedure or post-procedure, depending on patient preference. For example, although patients will consent prior to their catheter ablation procedure, they may choose to initiate the rehabilitation programme post-procedure. The feasibility of ExCR delivery pre versus post-ablation will be investigated. Patients aged >18 years, able to provide verbal and written informed consent, will be eligible for participation. Patients who are unable to understand trial instructions, have reduced ability to follow the planned programme due to other physical illnesses, or who do not wish to participate, as well as patients already enrolled in clinical trials that prohibit participation in additional trials, will be excluded.

Detailed inclusion criteria

1. The participant is willing and able to give informed consent for participation in the study.
2. Aged ≥18 years.
3. Diagnosed with AF and on a waiting list or referred for medical treatment for symptomatic AF (eg, catheter ablation).
4. Is eligible and willing to take part in an ExCR programme.

Detailed exclusion criteria

1. Blood pressure >180/100.
2. Unstable angina.
3. Severe valvular heart disease as diagnosed by echocardiography.
4. Heart failure New York Heart Association class 4.
5. <6 months post-transplant.
6. Resting/uncontrolled tachycardia.
7. Stroke in the last 6 weeks.
8. Cardiac sarcoidosis.
9. Injury or disability preventing exercise.
10. Inability to understand trial procedures, for example, difficulties with speaking and understanding the English language.

Recruitment, consent, randomisation and data collection

Recruitment and consent

Recruitment is planned for between August 2024 and March 2025.

Patients with AF

The following recruitment methods will be employed for patients with AF. The primary care team will advertise the study in face-to-face consultations and via a poster sent to all patients on the waiting list. Verbal consent will be taken for the researcher to contact patients who are interested. Patients who decline to participate after having read the study information will be asked if they would be willing to share their reasons for declining to participate. Participants who agree to take part will be asked to provide informed written consent. A member of the cardiac multidisciplinary team will contact patients with AF and invite them to attend a cardiac rehabilitation clinical/risk stratification assessment to determine whether the patient will be able to safely exercise and plan physical activity goals tailored to individual patient needs. Patients who are deemed safe to exercise will be invited to attend cardiac rehabilitation classes. Patients who decline to attend a clinical/risk stratification assessment will be asked if they would be willing to share their reasons for declining to participate.

Clinical exercise physiologists

All clinical exercise physiologists involved in screening, recruitment and delivery of the intervention will be approached by a researcher and invited to attend a semi-structured, face-to-face interview about their experiences of the trial procedures and the intervention.

Data collection

A screening and recruitment log will be completed by a researcher to document all patients considered for the study and subsequently included or excluded at each stage of the recruitment process and the reasons given. This will include information such as when the patient was given information about the study, referred to cardiac rehabilitation, attended for clinical/risk assessment and received an offer to attend rehabilitation classes. On completion of rehabilitation, semistructured face-to-face interviews will be conducted with a subsample of patients and clinical exercise physiologists involved in delivering the intervention in order to gather responses about the acceptability of the intervention and trial procedures. A recruitment flow chart will be produced to identify patient numbers throughout the recruitment process. Outcome measures will be taken at baseline, upon immediate completion of the intervention and at a 6-month follow-up. Outcome measures (table 1) will be collected at baseline, on completion of the intervention and at 6-month follow-up.

Randomisation and blinding

Participants will be randomised to the intervention or control group after they have consented to participate in the study and after baseline measures have been collected. Participants will be randomised to the intervention (cardiac rehabilitation) or control (standard care) on a 1:1 basis using a computer-generated random allocation sequence. To ensure allocation concealment, researchers will request randomisation on completion of all baseline assessments. Due to the nature of the intervention, blinding of the participants or healthcare practitioners delivering the interventions is not possible.

Outcome measures

Primary outcome

Throughout the study, information will be collected on (1) the total number of patients screened, eligible and approached, (2) the percentage of patients who (a) decline ExCR (including reasons for declining), (b) agree to ExCR and (c) consent to being part of the study; (3) the percentage of patients who take up ExCR and reasons for dropping out of ExCR before the end of the intervention (if provided) and (4) the percentage of participants who complete outcome assessments and reasons for dropping out (if provided). Age, sex, ethnicity, reason for enrolment into ExCR, the centre referred to, education and employment status will also be collected via an initial screening telephone/video call.

Secondary outcomes

The proposed outcomes in a future definitive trial will likely include AF recurrence, AF severity/burden, QoL, and exercise capacity, comparing the intervention with usual care. Data on these will be collected in the proposed feasibility trial. All outcomes will be assessed in all participants at baseline, post-intervention and at 6-month follow-up and the respective data for these will be collected in the proposed feasibility trial.

AF recurrence

AF recurrence will be measured using the AliveCor KardiaMobile, which is a hand-held, one-lead ECG device.[14] The device provides three potential outcomes once the reading is complete: 'possible AF', 'normal' and 'unclassified'. Participants will be asked to measure their heart rate three times a day for a 7-day period, regardless of symptoms and, additionally, if they develop any

Table 1 Primary, secondary objectives and outcome measures

Objectives	Outcome measures	Timepoint(s) of evaluation of this outcome measure (if applicable)
Primary objectives		
Our overall objective is to test the feasibility of an evidence-based intervention prior to evaluation in a future RCT.	Information will be collected on the following. The number of patients screened, eligible and approached. Acceptability of the recruitment and randomisation process. Acceptability of the measurement instruments. The percentage of patients that: 1. Decline ExCR (including reasons for declining if possible). 2. Agree to ExCR and consent to being part of the study. 3. The percentage of patients that take up standard ExCR and reasons for drop out. 4. Attendance of education workshops. 5. The percentage of participants that complete outcome assessments. 6. Reasons for drop out (if willing to provide).	(1–4) Ongoing throughout the intervention.
1. Determine the acceptability of the rehabilitation programme for people with symptomatic AF. 1. Determine the feasibility of trial methods for a future definitive trial.	Information will be collected on the following. The number of patients screened, eligible and approached. Acceptability of the recruitment and randomisation process. Acceptability of the measurement instruments. The percentage of patients that: 1. Decline ExCR (including reasons for declining if possible). 2. Agree to ExCR. 3. Consent to being part of the study. 4. The percentage of patients that take up standard ExCR and reasons for drop out. 5. Attendance of education workshops. 6. The percentage of participants that complete outcome assessments. 7. Reasons for drop out (if willing to provide).	Ongoing throughout the intervention.
Investigate the mechanisms and processes that explain implementation and preliminary effectiveness of the rehabilitation programme (intervention group) and usual care (control group).	Clinical exercise physiologists and patients' qualitative data (semistructured interviews and focus groups) investigating: the acceptability of the intervention components and barriers and facilitators to the intervention.	Postintervention.

Continued

Table 1 Continued

Objectives	Outcome measures	Timepoint(s) of evaluation of this outcome measure (if applicable)
Estimate precision of potential outcome measures required for sample size estimations for the pilot RCT.	Five health outcome measures will be assessed: 1. AF symptom severity via the University of Toronto Atrial Fibrillation Symptom Severity questionnaire. 2. AF recurrence via AliveCor KardiaMobile. 3. Health-related quality of life via the AF effect on quality of life scale and the five-level EuroQol-five Dimensions questionnaire. 4. Exercise capacity via the cardiopulmonary exercise test or 6-min walk test. 5. Cardiac structure and function via transthoracic echocardiography (echo).	(1, 3, 4 and 5) Baseline, postintervention and at 6-month follow-up. Self-measured by participants throughout the intervention.

AF, atrial fibrillation; ExCR, exercise-based cardiac rehabilitation; RCT, randomised controlled trial.

symptoms. They will be asked to do this at three separate time points: at baseline (preintervention), immediately postintervention and at 6-month follow-up. Feasibility of the time frame of device use will be assessed along with the percentage of 'uncertain' ECG recordings. If AF recurrence is identified, the participant will be referred to secondary care for a 12-lead ECG or 14-day patch as necessary.

Transthoracic echocardiography (echo)

A cardiac (heart) ultrasound will be performed by a clinically accredited echocardiographer (J Maxwell BSE 32820). Cardiac structure and function will be assessed non-invasively with the participant lying on their left side. Standard two-dimensional and three-dimensional Doppler, tissue-Doppler and M-mode scans will be performed using a commercially available ultrasound system (Vivid iQ, GE Medical, Horton, Norway) with a 1.5–4 MHz phased array transducer applied to the participant's chests. All participants will be offered a chaperone for the scan and provided with a gown. Images will be stored and analysed offline on password-protected monitors.

Exercise capacity

Exercise capacity (peak oxygen consumption (VO_2peak)) will be measured using cardiopulmonary exercise testing (CPET). The test is performed according to current guidelines for ergo spirometry testing and by an ergometer bicycle, simultaneously monitoring heart rhythm, blood pressure, ECG and measuring gas exchange during workload and in the following recovery period.[15 16] The average test duration is 10–15 min, including the pretest and post-test phases without workload. Before each session, calibration is performed to address changes in room temperature, humidity and air oxygen content. A standardised ramp protocol is used with an initial workload of 25/50 watts, increasing gradually by 25 W load increasing for every 2 min until peak exhaustion is reached or the participant can no longer continue. Peak exhaustion will be evaluated by several variables (eg, respiratory exchange ratio ≥T 1.10, heart rate and subjective exhaustion of the patient). During the test period, clinical manifestations, ECG abnormalities (ST depression, ST elevation, Q wave and T wave changes, supraventricular or ventricular arrhythmias), blood pressure response and several physiological variables are observed and documented. VO_2peak will be defined as the peak VO_2 reached during the test. The test will be performed by two members of the research team. For safety reasons, preset criteria for initiation and/or termination of the test have been defined.

If the CPET is not possible, that is, the participant is unable to complete it for whatever reason, the maximum walking distance (in metres) within 6 minutes[17] will be used to assess exercise capacity, using standardised instructions, while subjective exhaustion with regard to fatigue and dyspnoea using the Borg Scale will be administered.[18]

Questionnaires

Quality of life

All patients will complete two QoL-related questionnaires and their perception of treatment. The internationally validated Atrial Fibrillation Effect on Quality-of-Life (AFEQT; http://www.afeqt.org) questionnaire.[19] The AFEQT questionnaire is a 20-item questionnaire that quantifies four domains of AF-related QoL, including symptoms, daily activities, treatment concern and treatment satisfaction, by using seven-point Likert response scales. An overall summary score can be calculated from the

first three domains, which range from 0 to 100 (100, best possible health status (no impairment); 0, worst health status).

The EQ-5D is a parsimonious measure of health-related QoL consisting of five dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression.[20] The EQ-5D will also be used to inform economic evaluation.[21]

AF severity and burden

AF burden will be measured using the University of Toronto Atrial Fibrillation Severity Scale (AFSS), which is a 19-item self-administered questionnaire developed to obtain both objective and subjective ratings of AF-related symptoms, AF disease burden, including frequency, duration and severity of episodes, as well as healthcare utilisation and AF disease burden, including frequency, duration and severity of episodes.[22] The AF symptom burden score is derived from the AFSS summary score that averages the frequency, duration and patient-perceived severity of AF episodes. A higher score indicates a greater AF burden.[23]

Quantitative analysis

The proportion of eligible patients who consent to participate will be presented, along with the proportions in each intervention group completing each follow-up assessment and the reasons for withdrawal. Descriptive characteristics and outcome data will be summarised overall and by intervention group, as mean (SD) for normally distributed continuous variables, median (IQR) for non-normally distributed continuous variables and number (percentage) for categorical variables. Quantitative data (recruitment logs) will be analysed using descriptive statistics. Uptake will be measured as the percentage of eligible participants agreeing to participate, retention will be measured as the percentage of participants remaining until the close of the study and compliance will be measured by the percentage of compliance to the ExCR programme up until the close of the study. All statistical analysis of quantitative data will be conducted in IBM SPSS Statistics for Windows (V.28.0) and R.[24]

Semistructured interviews and focus groups

Process evaluation

A concurrent mixed-methods process evaluation using the MRC framework for complex interventions[25 26] will be used to identify and explain the mechanisms and processes that enabled/acted as barriers to the implementation of the ExCR programme. We will determine how the intervention was delivered and identify 'active ingredients'[27 28] by examining referral and recruitment rates, compliance with the ExCR and loss to follow-up. This will aid in identifying the mechanisms and processes that enable or challenge the delivery of the ExCR for patients with AF. Postintervention all clinical exercise physiologists will be interviewed, and a focus group will be conducted with a small subsample of patients. A topic guide for both will be used with questions relating to the acceptability of the rehabilitation programme and barriers/facilitators of uptake and completion. All interviews will be audio-recorded and transcribed verbatim.

Patient focus groups

For participants who consented, focus groups will be conducted immediately postservice. Participants will complete focus groups with a member of the Liverpool John Moores University (LJMU) team, guided by a topic guide. Postservice-guided discussions will aim to learn about experiences (barriers, facilitators, receptivity to the clinical exercise physiologists, perceived appropriateness and suggestions for improvement) of the ExCR programme. Guided discussions at follow-up (6 months) will aim to learn about the engagement of physical activity both during the cardiac rehabilitation sessions and self-directed exercises at home, as well as the continuity of exercise and physical activity after the service concluded. This will aid in identifying any causal mechanisms of the ExCR programme related to self-directed activity. Focus groups will be conducted via in-person/phone/video call per patient preference.

Clinical exercise physiologists interviews

Clinical exercise physiologists will be invited to attend interviews after the evaluation period. Clinical exercise physiologists will be given a participant information sheet and have the opportunity to ask questions before providing written informed consent. Interviews will be led by a member of the research team and guided by a topic guide. Guided discussion will aim to learn about experiences of delivering the service, including barriers and enablers to intervention delivery, adaptations made to the service framework and ways to improve the service. Interviews will be in-person or via telephone or video call depending on preference.

Qualitative analysis

Interviews will be audio-recorded and transcribed verbatim, deductively coded and analysed using the theoretical domains framework, enabling challenges and facilitators within the intervention to be identified.[29] Transcriptions will be thematically analysed[30] and coded using NVivo V.12 software. Data will be thematically analysed using reflexive thematic analysis recommendations such as data familiarisation, generating initial themes, coding and finalising patterns of shared meanings underpinned by a central concept and writting them up using data extracts interspersed with researcher interpretations. Although the data themes will be created deductively, the patterns of shared meaning will be inductively generated from the data themselves, allowing interpretation and researcher contextual awareness to be discussed. Member checking will be the final step in the analysis, ensuring that interviewed participants have the opportunity to confirm the researcher's interpretation and add comments that will be incorporated into the final analysis. Our aim is to develop a comprehensive understanding

of the intervention's acceptability, implementation and mechanisms of impact.

Economic evaluation

We will explore the feasibility of an economic evaluation alongside the trial to assess the cost-utility of cardiac rehabilitation compared with treatment as usual. The economic evaluation will compare the costs to quality-adjusted life years (QALYs) and take a societal perspective, as recommended nationally. QALYs will be estimated using the self-reported EQ-5D instrument, which is a standardised instrument assessing five dimensions of self-reported health status (mobility, self-care, usual activities, pain/discomfort and anxiety/depression).[20] The EQ-5D is a useful tool for facilitating the calculation of QALYs that are in turn used to inform economic evaluations of healthcare interventions or policies on health.[31] During the interventions, researcher time per participant will also be recorded in both groups.

Intervention

Cardiac rehabilitation intervention group

The intervention is a comprehensive cardiac rehabilitation programme delivered to patients with AF receiving catheter ablation. The structured exercise service will consist of one supervised exercise session per week for 8 weeks at the chosen centre. In addition, patients will be encouraged to undertake 1–2 home-based exercise sessions per week. Patients will also be invited to a weekly education session and encouraged to increase physical activity levels outside of the exercise sessions. Exercise sessions are circuit-based, cardiovascular and strength exercises of light to moderate intensity (monitored via the Borg rating of perceived effort scale). Classes start with a 15-min warm-up session, followed by the main exercise session lasting 20–30 min. Exercises are designed to improve cardiovascular fitness and include strength training using weights as well as walking, squats, shoulder raises, bicep curls and tricep extensions. Patients will be advised to exercise at a moderate intensity. The classes conclude with a 10-min cooldown. Participants will set individual physical activity goals with advice and support from the clinical exercise physiologist. To optimise intervention fidelity, professionals delivering the intervention will be expected to follow their site-specific rehabilitation programme.

Usual care control group

Participants randomised to usual care will not receive any intervention but continue with usual medical treatment for their AF as determined by their healthcare team.

Study withdrawal

Each participant has the right to withdraw from the study at any time with no obligation to provide a reason. In addition, participants may be withdrawn from the study by the research team at any time if the research team considers it necessary for any reason, including:

- Ineligibility (either arising during the study or retrospectively having been overlooked at screening).
- Significant protocol deviation.
- Significant non-compliance with treatment regimen or study requirements.
- Withdrawal of consent.
- Loss to follow-up.

Withdrawal from the study will not result in the exclusion of the participant's data from analysis, including audio recordings that have already been transcribed, as all of this data will be pseudonymised. Withdrawn participants will not be replaced. Participants will be asked the reasoning behind withdrawal either via email or phone call. The reason will be recorded in the study file. Participants are free to give no reason.

Serious adverse event reporting and monitoring

All adverse events will be reported and assignment of the severity/grading (mild, moderate, severe, life-threatening and death) will be made by the investigator responsible for the care of the participant. The assignment of causality will be made by an independent clinician in the UK. All non-serious adverse events, whether expected or not, will be recorded and updated at each visit. All new SAEs will be reported from the point of consent until follow-up. Investigators will report SAEs to the sponsor within 24 hours of the local site becoming aware of the event. All adverse events will be followed until satisfactory resolution.

Data management

Data will be collected and stored in accordance with the Data Protection Act 1998/General Data Protection Regulation 2018 in the UK. All data will be entered electronically. Outcomes and questionnaire data collected by participants will be reported using online survey software (Microsoft Forms; www.forms.office.com). The administrative database (ie, participant information) and trial data will be managed by the research teams. Random checks will be performed on the entered data against online records. All errors will be logged and corrected. All data will be stored on password-protected and encrypted computers. Participant files will be maintained in storage for a period of 15 years after completion of the trial, with access granted to the local research team only. Our intended policy is that the research team should have exclusive use of the data for a period of 12 months or until the data are published. Data will be shared with named collaborators during this time. Following this period, data will be made publicly available through the LJMU Data Repository and published under a permissive reuse license.

Sample size calculation

A power calculation is not appropriate as the study does not aim to provide a definitive estimate of the treatment effect. Rather, the aim is to provide robust estimates of the likely rates of recruitment and retention and to yield

estimates of the variability of the primary and secondary outcomes to inform power calculations for a future full-scale trial. Our aim is to recruit 60 participants, and this is based on recommendations for pilot/feasibility studies and an audit reporting pilot and feasibility trials registered in the UK clinical research network.[32 33]

Trial oversight

The quality of the study will be assured through the series of management groups. The trial will be overseen by a trial steering committee (TSC) and operated on a day-to-day basis by a trial delivery group (TDG). The TSC will comprise experienced academic experts (the research team), clinicians and patients but does not require and, therefore, will not have an independent chair. The TSC will meet quarterly to discuss progress. The role of the TSC is to provide overall supervision of the trial. In particular, the TSC will concentrate on the progress of the trial, adherence to the protocol, participant safety and consideration of new information. The TSC must be in agreement with the final protocol and, throughout the trial, will take responsibility for major decisions, such as the need to change the protocol for any reason, monitoring and supervising the progress of the trial, reviewing relevant information from other sources and informing and advising the TDG on all aspects of the trial. The TDG will comprise the same research team and will hold monthly meetings to discuss progress. The responsibilities of the TDG will include:

1. Report to the TSC.
2. Maintain the trial master file.
3. Confirm all approvals are in place before the start of the trial at a site.
4. Provide study materials.
5. Data management centre.
6. Give collaborators regular information about the progress of the study.
7. Respond to any questions (eg, from collaborators) about the trial.
8. Ensure data security and quality and observe data protection laws.
9. Safety reporting.
10. Ensure the trial is conducted in accordance with Good Clinical Practice.
11. Statistical analysis.
12. Publication of trial results.

Patient and public involvement

National Institute for Health and Care Research North West Coast-funded patient and public involvement work with patients with AF has been completed. A patient involvement workshop (n=24) exploring their views of incorporating AF rehabilitation into usual care was conducted. All had positive responses regarding the potential to incorporate AF rehabilitation into usual care. Developing an intervention that supports patients with AF to become more physically active in the long term is therefore wanted by patients, is of great potential NHS benefit, and thus fills an important clinical and scientific 'gap'. Workshops with healthcare practitioners (including clinical exercise physiologists and electrophysiologist consultants) were also conducted to determine any facilitators and barriers to pathway referral and rehabilitation delivery to patients with AF. Moving forward, two patient representatives have been invited to the TSC. They will advise on study information materials to recruit participants to the study. At the end of the project, our patient representatives will contribute to the reporting of the study by reading and reviewing the 'lay' sections of the report. They will also be involved in the dissemination of research findings through reviewing literature outlining the results before they are circulated.

Ethics and dissemination

The trial has received a favourable ethical opinion from the Preston NHS Research Ethics Committee (22/NW/0061) in the UK. On study completion, the CI owns the data. On completion of the study, the data will be analysed, and results will be disseminated via publication in clinical and physiological journals, presented at national and international conferences and in the form of feedback sheets or perhaps local articles. Participants will not be identifiable from the results of the study. Pseudonymised data from this study will be made available for sharing with other investigators after the publication of the study's key papers. Data will be shared through the LJMU Data Repository (http://opendata.ljmu.ac.uk/). This is a secure institutional data repository, which is searchable on the www, and it is managed by Library Services. A DOI will be generated for datasets as they are deposited to the repository. Data will be stored in this repository for a minimum of 10 years or for 10 years from the last date of access.

It is our intention to present our research findings to all our research participants in a written lay summary and hold an open feedback session where the results will be presented in a lay-friendly manner. We plan to present the scientific findings as oral communications and abstracts at regional, national and international scientific meetings related to AF and preventative cardiology. We also intend to publish our findings in peer-reviewed journals.

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