

# Risk Definition and Standard Operating Procedures for: EXERCISE TESTING

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## SECTION 1 – EXECUTIVE SUMMARY

This document outlines the pre-exercise evaluation and exercise testing/training procedures to be implemented by research studies within the Leicester Biomedical Research Centre (BRC). This document has been developed in accordance with best practice and guidance set out by the European Association for Cardiovascular Prevention and Rehabilitation (EACPR) (Borjesson *et al.*, 2011).

This document contains two sections which:

1. define the risks associated with exercise testing
2. outline the pre-exercise evaluation and standard operating procedures that will be used in exercise-based studies undertaken within the BRC

Habitual physical activity and exercise reduces all-cause mortality. Nevertheless, physical exertion can cause risks in unaccustomed populations. It is important to remember that exercise only provokes cardiovascular events in people with pre-existing heart disease, whether diagnosed or occult. Exercise, whether maximal or sub-maximal, does not provoke cardiovascular events in individuals with normal cardiovascular systems.

This document outlines the pre-exercise evaluation procedures to be followed during the recruitment of participants to BRC studies. Specifically, this document identifies:

- the pre-exercise evaluation procedures to be implemented that are determined by the habitual activity levels/training status of the individual, as well as the intensity of exercise desired to be undertaken
- the level of staff qualification needed to perform pre-exercise evaluations/exercise testing
- the necessary emergency equipment needed to deal with any adverse events

The implementation of the following procedures will ensure that the risk to study volunteers is minimised and managed appropriately.

The enclosed screening criteria have been agreed by all Institutions involved in the Leicester BRC (University Hospitals of Leicester NHS Trust, Loughborough University, University of Leicester) and applies to all research activity undertaken through the BRC.



## SECTION 2 – RISK DEFINITION AND MANAGEMENT

### RISKS OF CARDIAC EVENTS DURING EXERCISE STRESS TESTING

The risk of exercise varies with the prevalence of underlying coronary artery disease in the population. Consequently, the risk of exercise stress testing also varies with the populations studied. Exercise stress testing performed in previously healthy, active individuals has a very low rate of cardiovascular events, whereas exercise testing in those that have an underlying, clinically significant disease and who are inactive have a higher risk. The overall risk of exercise stress testing in a mixed population is approximately four cardiac events (i.e. one myocardial infarction and three cardiac arrests) per 10,000 tests. These results include exercise testing supervised by non-physicians.

### PREVENTION OF EXERCISE-RELATED CARDIAC EVENTS

The development and evaluation of strategies to reduce the risk of vigorous exercise is complicated by the low incidence of events. Interventions cannot be proposed and tested because an enormous number of subjects would have to participate in order for this to achieve sufficient statistical power.

To minimise the risk of adverse events, we have developed a comprehensive set of standards and standard operating procedures (SOPs), which were informed by EACPR and ACSM guidelines, outlining the recommended pre-exercise evaluation procedures that should be followed before individuals undertake exercise. This document therefore outlines rigorous pre-exercise evaluation and exercise testing procedures to minimise the likelihood and/or severity of serious adverse events during exercise. All exercise-related research conducted as part of the Leicester BRC will adhere to these SOPs.

Extensive participant pre-participation evaluation must be undertaken before individuals take part in exercise testing or training in any research encompassed within the Leicester BRC. This applies to all participants, regardless of age.

### DISCUSSION OF CRITERIA – ACTIVITY STATUS

#### • DEFINITION OF ACTIVITY STATUS

The EACPR identifies two separate pre-exercise evaluation workflows that establish more stringent pre-exercise evaluation procedures for those who are currently inactive, compared with those who are active. This reflects the greater risk in those who are routinely inactive. The EACPR classifies participants' activity status based on whether they perform more or less than 2 METS hours/week of physical activity. In essence, this definition of activity only categorises individuals as inactive if they habitually undertake a very low amount of physical activity. In addition, the risk of an adverse event is highly dependent on whether or not participants engage in

regular vigorous physical activity; habitual vigorous physical activity (> 6 METs) substantially reduces the risk of sudden cardiac death during exercise. Therefore, a more robust definition of activity status is proposed here. Only individuals habitually performing exercise at a vigorous intensity on three or more days per week for a period of at least 20 minutes will be classified as active. Published data detailing the MET equivalents of diverse activities (Ainsworth *et al.*, 2011) will be used to determine the intensity of activities reported by prospective participants.

In instances where there is ambiguity in the categorisation of an individual, a judgement will be made by the investigator responsible. A copy of the questionnaire used to classify activity status can be found in Appendix 1. Appendices 2-6 contain all of the forms needed for pre-exercise evaluation.

### DISCUSSION OF CRITERIA – EXERCISE INTENSITY

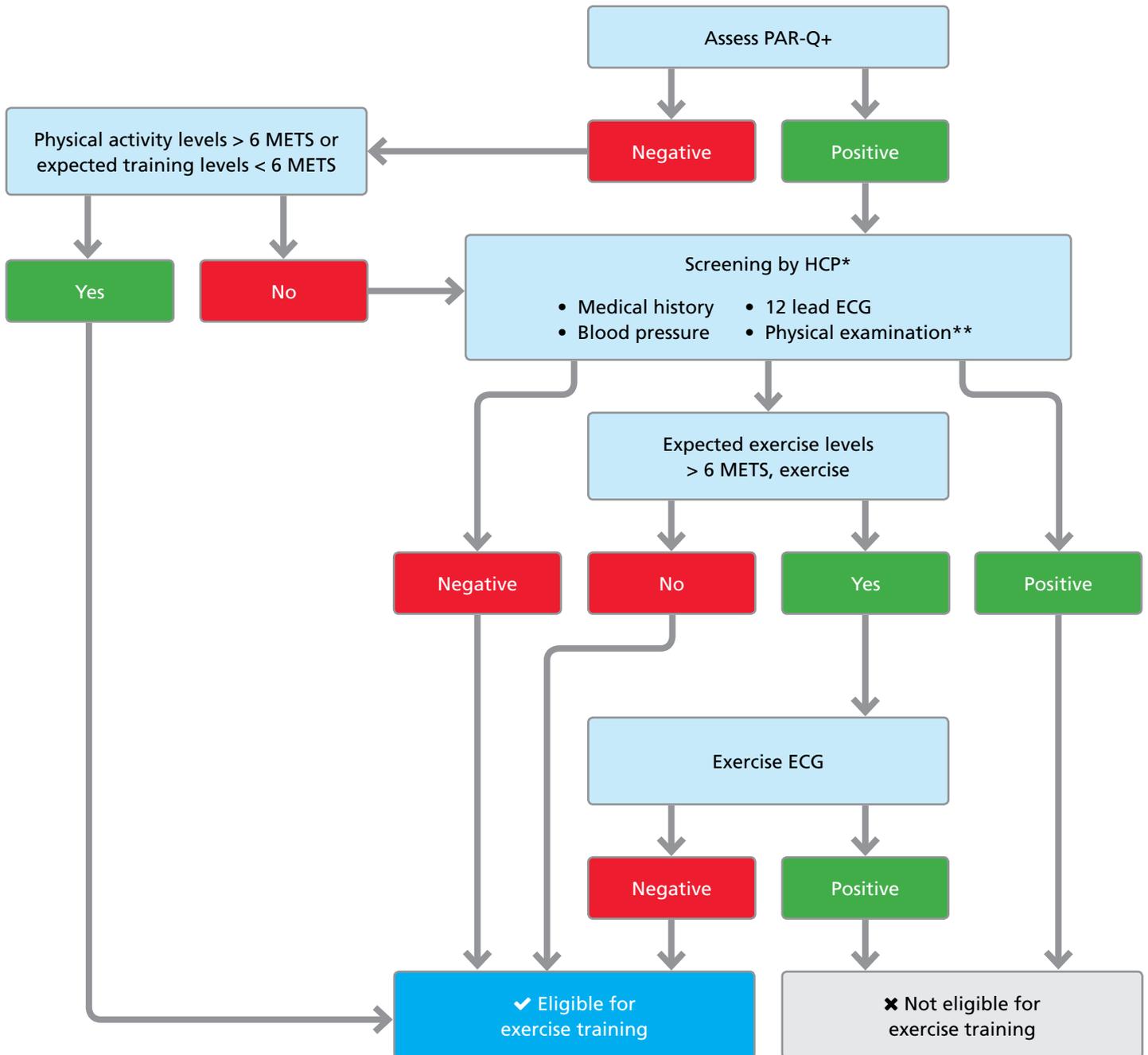
#### • STRATIFICATION FOR THOSE WHO ARE INACTIVE/UNTRAINED (FIGURE 1)

Light-to-moderate-intensity exercise (see Figure 1): Individuals due to engage in light intensity exercise (identified as 3-6 METs) must first complete the Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) (Appendix 2). If responses to this questionnaire are negative (individuals answer 'no' to all seven questions) individuals are eligible to participate in an exercise intervention involving low-intensity exercise without further evaluation. One or more positive responses dictates that further evaluation is necessary, which in the first instance should involve consultation with a physician (which could be either the individual's GP or a BRC physician). At this point a judgment must be made by the physician/GP on whether the issue identified by the PAR-Q+ necessitates further, in-depth evaluation (such as medical history, physical exam or 12 lead resting ECG) before the individual can take part in light intensity exercise. If the issue identified by the PAR-Q+ is deemed to be insufficient to warrant such further evaluation, then the physician/GP can give permission for the individual to participate in light-to-moderate intensity exercise.

Vigorous intensity exercise (see Figure 1): Inactive/untrained individuals being recruited to studies involving high (> 6 METs) intensity exercise must undergo a detailed, stepped evaluation before participation. This evaluation should begin with completion of the PAR-Q+, a medical history, physical exam\* and 12 lead resting ECG. Clinical judgment will be used to ascertain if a participant is suitable for exercise training/testing. If negative, the participant will be eligible for exercise training/testing.

\* Physical examination is optional and dependent on findings from the medical history and 12 lead ECG, and should be performed by an individual qualified to do physical examinations.

FIGURE 1. PRE-PARTICIPATION EVALUATION



\* Clinical judgement will be used as to whether the participant is suitable for exercise, based on medical screening and study activity.

\*\* Physical examination is optional and dependent on findings from Medical History and 12 Lead ECG. To be performed by individual qualified to do physical examinations.

## STRATIFICATION FOR THOSE WHO ARE ACTIVE/TRAINED (FIGURE 1)

Individuals who habitually undertake three or more vigorous (>6 METS) intensity exercise sessions per week for 20 minutes or more are classified as active/trained.

Regular participation in vigorous intensity exercise is associated with a significant reduction in the risk of exercise-related sudden cardiac death. Consequently, active/trained individuals will, first of all, be required to complete the PAR-Q+. In the absence of any positive responses these individuals will be cleared to participate in exercise of any given intensity. One or more positive responses dictates that further evaluation is necessary and participants will enter into the same pre-exercise screening algorithm (see Figure 1).

## PATHWAY FOR DEALING WITH UNDIAGNOSED RISK FACTORS DURING THE PRE-EVALUATION

Any undiagnosed complications that arise from the pre-exercise evaluation, such as hypertension, will be notified to the participant's General Practitioner (with participant approval) in writing by the Principle Investigator. A decision about the participant continuing in the research study will be based in accordance with the wider evaluation.

In instances where individuals fail the pre-exercise evaluation, a report will be sent by the Principle Investigator to the individual's General Practitioner outlining the issues. Participants will be advised not to begin exercise until they have undergone further evaluation by their General Practitioner or other Clinical Specialist.

## NECESSARY STAFF QUALIFICATION FOR PRE-EXERCISE EVALUATIONS

All pre-exercise evaluation procedures will be undertaken by an appropriately-trained healthcare professional, e.g. exercise physiologist (graduate), nurse or physician. A register of suitably-trained healthcare professionals who possess sufficient qualification(s) and expertise to undertake pre-exercise evaluation will be maintained. Verification of adequate training/competency will be made by the BRC Executives. Pre-exercise evaluations can take place at any location within the Institutions undertaking BRC research activity.

A physical examination must be undertaken by a suitably-qualified healthcare professional and involve the following: (Appendix 4)

- auscultation of the lungs and heart
- examination of the abdomen
- inspection of the skin
- evaluation of lower extremities

- palpation of the cardiac apical impulse
- blood pressure assessment
- assessment of neurological function
- orthopaedic evaluation

Resting ECG must be undertaken by an individual who is trained and competent in conducting ECG monitoring. Exercise ECG must be undertaken by an individual who is trained and competent in conducting and interpreting exercise ECGs:

e.g. Clinical Exercise Physiologist with appropriate qualification

e.g. American College of Sports Medicine Clinical Exercise Specialist/Physiologist or European equivalent, Specialist Cardiac Nurse or a General Physician.

During exercise ECGs, two members of staff must be present at all times. Both members of staff should be trained in basic first aid/life support and the use of an automated external defibrillator. During the exercise ECG, the exercise test should be terminated immediately if any symptoms identified in Appendix 5 occur. During the exercise test, expired gases, respiration, blood pressure and cardiac function should be monitored throughout. After testing, participants should be monitored (ECG, heart rate, blood pressure) for at least 10 minutes.

All participant details and notes gathered during the evaluation phases, including ECG traces, must be signed off by a Physician before commencement into the study.

## EQUIPMENT REQUIRED DURING EXERCISE ECGS

The following emergency life support equipment must be available when exercise ECG testing is being performed in a clinical setting. The same equipment should also be available when any exercise training is conducted through the BRC.

- Automated external defibrillator
- Oxygen cylinder
- Crash bag to hold equipment
- Temporary airway supports (nasal/oropharyngeal)
- Laryngeal mask airway
- Large bore venflon cannulas
- IV giving set
- 500 mL saline bags
- Tourniquet
- Salbutamol inhaler
- GTN spray
- Aspirin (300 mg)
- Epipen
- Non-sterile gloves
- Adrenaline 1 mg in cardiac arrest format
- Asthma nebuliser mask and saline nebuliser

## ADVERSE EVENTS DURING EXERCISE ECGS

Specific agreed SOPs detailing the procedures undertaken in the event of a peri-arrest situation or post-arrest management of the research subject must be in place and accompany this document within all Institutions conducting exercise ECGs through the BRC. Such SOPs must be signed off by a Physician and the Institution. This document and the procedures are only valid with these accompanying SOPs.

## MANAGEMENT OF ADVERSE EVENTS

All exercise testing/training will be undertaken in an environment where support infrastructure is in place to manage an adverse reaction to exercise, with specified and agreed SOPs detailing the exact procedures to be undertaken in the case of an adverse event. This may be the same as the SOPs used in the case of adverse events during an exercise ECG. However, it should be reiterated that the major risks associated with exercise relate to having undiagnosed heart disease. Any individual who reaches the stage of formal exercise testing/training as part of BRC studies will have undergone robust pre-evaluation for undiagnosed heart disease, so the risk of an adverse event is low. This is represented by the level of management of an adverse event. Acute injuries, e.g. musculoskeletal problems, will be managed by responsible Study Investigators via local procedures.

## SECTION 3: POST-EVALUATION

### EXERCISE TESTING/TRAINING

Following pre-exercise evaluation, in the absence of any positive responses, individuals can then undertake exercise at the intensity for which they have undertaken evaluation. Under no circumstances should individuals exercise at intensities greater than what they have been evaluated for.

After participants have been cleared to exercise, the subsequent testing/training can be performed by an exercise physiologist (graduate), research nurse, physician, or suitably-trained healthcare professional. An additional member of staff should always be within the adjacent vicinity and accessible within 60 seconds when testing is being undertaken. Both individuals should be trained in basic first aid/life support and use of an automated external defibrillator.

## APPENDIX 1 – PHYSICAL ACTIVITY QUESTIONNAIRE

To be completed by the participant with assistance from the study investigator e.g. exercise specialist, research nurse, physician or suitably-trained healthcare professional.

### PHYSICAL ACTIVITY QUESTIONNAIRE

**NIHR Leicester Biomedical  
Research Centre**

During a typical week, how many times, on average, do you do the following kinds of exercise?

**a. Vigorous exercise ( $\geq 6$  METs) (heart beats rapidly)**

For example: hiking, carrying heavy loads, running, jogging, squash, hockey, football, volleyball, vigorous swimming, vigorous long distance cycling.

Times per week: .....

Duration: .....

**b. Moderate exercise (3-6 METs) (not exhausting)**

For example; fast walking, tennis, easy cycling, badminton, easy swimming, dancing, golf, mowing the lawn

Times per week: .....

Duration: .....

**c. Light exercise ( $\leq 3$  METs) (minimal effort)**

For example; yoga, archery, fishing, bowling, easy walking, light house work

Times per week: .....

Duration: .....

**Participant classified as:**

Active/Trained

Inactive/Untrained

Signed (investigator): .....

Date:

DD MM YYYY

**APPENDIX 2 – PHYSICAL ACTIVITY READINESS QUESTIONNAIRE (ADAPTED FROM ACSM 2010)**

**PHYSICAL ACTIVITY READINESS QUESTIONNAIRE**

**NIHR Leicester Biomedical Research Centre**

Becoming more active is very safe for most people, but if you're in doubt, please complete the questionnaire below. Some people should check with their doctor before they start becoming more physically active. Start by answering the seven questions below. If you are between the ages of 18 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and are not used to being very active, definitely check with your doctor first.

	Yes	No
1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?		
2. Do you feel pain in your chest when you do physical activity?		
3. In the past month, have you had chest pain when you were not doing physical activity?		
4. Do you lose your balance because of dizziness or do you ever lose consciousness?		
5. Do you have a bone or joint problem that could be made worse by a change in your physical activity?		
6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?		
7. Do you know of any other reason why you should not do physical activity?		

- If you answered YES to one or more questions, talk with your doctor before you start becoming more physically active.
- If you answered NO to all questions, you can be reasonably sure that you can start becoming more physically active right now.

**Delay becoming much more active if:**

- You are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- You are or may be pregnant – talk to your doctor before you start becoming more active.

Note: If your health changes so that you then answer YES to any of the above questions, ask for advice from your fitness or health professional.

Signed (investigator): .....	Date: <input type="text" value="DD MM YYYY"/>
Signed (participant): .....	Date: <input type="text" value="DD MM YYYY"/>

## APPENDIX 3 – MEDICAL HISTORY

### MEDICAL HISTORY

NIHR Leicester Biomedical Research Centre

<b>Medical Diagnosis:</b>	
History of cardiovascular disease	Yes <input type="checkbox"/> No <input type="checkbox"/>
Peripheral vascular disease	Yes <input type="checkbox"/> No <input type="checkbox"/>
Hypertension	Yes <input type="checkbox"/> No <input type="checkbox"/>
Diabetes	Yes <input type="checkbox"/> No <input type="checkbox"/>
Pulmonary disease	Yes <input type="checkbox"/> No <input type="checkbox"/>
<b>Previous Physical Examination:</b>	
Have you had anything reported previously from a physical examination? Yes <input type="checkbox"/> No <input type="checkbox"/>	
<b>History of Symptoms:</b>	
Discomfort in the chest, jaw, neck, back or arms (e.g. pressure, tingling, pain, heaviness, burning, tightness, squeezing or numbness) Yes <input type="checkbox"/> No <input type="checkbox"/>	
Light-headedness, dizziness or fainting spells? Yes <input type="checkbox"/> No <input type="checkbox"/>	
<b>Recent Illness:</b>	
Hospitalisation/new medical diagnosis/surgery Yes <input type="checkbox"/> No <input type="checkbox"/>	
Details:	
<b>Orthopaedic Problems:</b>	
Do you suffer from arthritis, joint swelling, or anything which would make exercise difficult? Yes <input type="checkbox"/> No <input type="checkbox"/>	
<b>Medication Use:</b>	
Medication	Yes <input type="checkbox"/> No <input type="checkbox"/> Details:
Allergies	Yes <input type="checkbox"/> No <input type="checkbox"/> Details:
<b>Other Habits:</b>	
Caffeine	Yes <input type="checkbox"/> No <input type="checkbox"/> If yes units per week: .....
Alcohol	Yes <input type="checkbox"/> No <input type="checkbox"/> If yes units per week: .....
Tobacco	Yes <input type="checkbox"/> No <input type="checkbox"/> If yes units per week: .....
<b>Exercise History: (Please circle)</b>	
Frequency (per week)	1      2      3      4      5      6      7      8
Duration per session (min)	10    20    30    40    50    60    70
<b>Work History: (Focus on current physical demands)</b>	
<b>Family History:</b>	
Cardiac	Yes <input type="checkbox"/> No <input type="checkbox"/> Metabolic disease Yes <input type="checkbox"/> No <input type="checkbox"/>
Pulmonary	Yes <input type="checkbox"/> No <input type="checkbox"/> Stroke Yes <input type="checkbox"/> No <input type="checkbox"/>

## APPENDIX 4 – PHYSICAL EXAMINATION

### PHYSICAL EXAMINATION - Part A

NIHR Leicester Biomedical Research Centre

Name:		DOB:
Body Weight (kg):		Waist Circumference (cm):
% Fat Free Mass:	% Fat Mass	Apical Pulse Rate (min):
Resting blood pressure - seated (mmHg): /		Rhythm: OK / Not OK
<b>Auscultation of the lungs</b> <i>with specific attention to uniformity of breath sounds in all areas (absence of rales and wheezes)</i>	OK <input type="checkbox"/>	Not OK <input type="checkbox"/> Comments/sounds:
<b>Palpation of cardiac apical impulse</b> <i>point of maximal impulse</i>	OK <input type="checkbox"/>	Not OK <input type="checkbox"/> Comment:
<b>Auscultation of the heart</b> <i>with specific attention to murmurs, gallops, clicks and rubs</i>	OK <input type="checkbox"/>	Not OK <input type="checkbox"/> Comment:
<b>Evaluation of the abdomen</b> <i>Bowel sounds, masses, visceromegaly and tenderness</i>	OK <input type="checkbox"/>	Not OK <input type="checkbox"/> Comment:
<b>Evaluation of lower extremities</b> <i>Oedema and presence of arterial pulse</i>	OK <input type="checkbox"/>	Not OK <input type="checkbox"/> Comment:
<b>Inspection of the skin</b> <i>focus on lower extremities in people with diabetes</i>	OK <input type="checkbox"/>	Not OK <input type="checkbox"/> Comment:
<b>Neurological function</b> <i>Reflexes</i>	OK <input type="checkbox"/>	Not OK <input type="checkbox"/> Comment:
<b>Any orthopedic or medical condition that would limit exercise.</b>	OK <input type="checkbox"/>	Not OK <input type="checkbox"/> Comment:
<b>Ventricular tachycardia</b>	OK <input type="checkbox"/>	Not OK <input type="checkbox"/> Comment:
<b>ST elevation (+1.0 mm)</b> <i>in leads without diagnostic Q-waves (other than V<sub>1</sub> or a VR)</i>	OK <input type="checkbox"/>	Not OK <input type="checkbox"/> Comment:
<b>ST or QRS changes</b> <i>such as excessive ST suppression &gt;2mm horizontal or down sloping ST-segment depression</i>	OK <input type="checkbox"/>	Not OK <input type="checkbox"/> Comment:
<b>Arrhythmias</b> <i>(other than sustained ventricular tachycardia) including multiple PVCs, triplets of PVCs, supraventricular tachycardia, heart block, or bradyarrhythmias</i>	OK <input type="checkbox"/>	Not OK <input type="checkbox"/> Comment:

Cleared to start exercise test: YES  NO

Completed by: .....

Date:

## APPENDIX 5 – EXERCISE ECG

### EXERCISE ECG

**NIHR Leicester Biomedical  
Research Centre**

Exercise Stress Testing Exercise Protocol:			
Absolute indicators for terminating the Exercise Stress test:			
Drop in blood pressure of >10mm Hg <i>from baseline blood pressure despite an increase in workload, when accompanied by other evidence of ischemia</i>	OK <input type="checkbox"/>	Not OK <input type="checkbox"/>	Comment:
Any form of chest pain or shortness of breath	OK <input type="checkbox"/>	Not OK <input type="checkbox"/>	Comment:
Increasing nervous system symptoms <i>(e.g. ataxia, dizziness or near syncope)</i>	OK <input type="checkbox"/>	Not OK <input type="checkbox"/>	Comment:
Technical difficulties monitoring ECG or blood pressure	OK <input type="checkbox"/>	Not OK <input type="checkbox"/>	Comment:
Ventricular tachycardia	OK <input type="checkbox"/>	Not OK <input type="checkbox"/>	Comment:
ST elevation (+1.0 mm) <i>in leads without diagnostic Q-waves (other than V<sub>1</sub> or aVR)</i>	OK <input type="checkbox"/>	Not OK <input type="checkbox"/>	Comment:
ST or QRS changes <i>such as excessive ST suppression &gt;2mm horizontal or down sloping ST-segment depression</i>	OK <input type="checkbox"/>	Not OK <input type="checkbox"/>	Comments:
Arrhythmias <i>(other than sustained ventricular tachycardia) including multiple PVCs, triplets of PVCs, supraventricular tachycardia, heart block, or bradyarrhythmias</i>	OK <input type="checkbox"/>	Not OK <input type="checkbox"/>	Comment:
Fatigue, shortness of breath, wheezing, leg cramps, or the patient develops discomfort	OK <input type="checkbox"/>	Not OK <input type="checkbox"/>	Comment:
Development of bundle-branch block or intraventricular conduction delay <i>that cannot be distinguished from ventricular tachycardia</i>	OK <input type="checkbox"/>	Not OK <input type="checkbox"/>	Comment:
Hypertensive response <i>Systolic blood pressure of &gt; 250 mm Hg and/or diastolic pressure of &gt;115 mm Hg</i>	OK <input type="checkbox"/>	Not OK <input type="checkbox"/>	Comment:

Adverse reaction to exercise: YES  NO

Cleared to start exercise test: YES  NO

Completed by: .....

Date:

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The National Institute for Health Research (NIHR) Leicester Biomedical Research Centre (BRC) is a partnership between University Hospitals of Leicester NHS Trust, University of Leicester and Loughborough University.

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