BRITISH REGIONAL HEART STUDY

BRHS 30 year follow-up (Q30)

Physical examination protocol

2010 - 2012

British Regional Heart Study:
A follow-up study of cardiovascular risk factors and outcomes in older men

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1.0 STUDY BACKGROUND

1.1 Who is invited to take part?

The British Regional Heart Study originally included 7735 men, recruited at age 40-59 years in 1978-1980 in 24 British towns. We are now inviting the surviving men in each town (approximately 150 on average) to attend for re-examination at 72-92 years of age.

Participants who are still living in their original study town will generally be expected to be remeasured in that town. Participants who have migrated from the original town have been invited for remeasurement, and have been offered a choice between:-

(a) returning to their original town
(b) going to another BRHS town which is closer and more convenient for them
(c) coming to London for examination

1.2 Liaison with Practices

The study will focus on the single Practice in each town which was originally involved in the study, and where most study participants are still registered.

By the time the Study Team visits a particular town, the town Practice will already have been visited and a meeting held with the Practice Staff to confirm the survey arrangements in the town. The survey will take place either within the Practice or (where this is not possible) in a local Health Clinic or other Health Authority premises.

1.3 Invitations to participants (Appendix A)

The participants have received a letter inviting them to take part in the study which is sent out one month in advance of the survey visit. Where the participant is still registered with the main study Practice in the town, the invitation letter is signed by the Practice partners. For participants who are no longer registered in the main study Practices, an invitation letter is sent directly from the Department.

The package received by the study participants will include:-

- the main invitation letter
- an appointment card (with tear-off reply slip)
- a questionnaire
- an information sheet
- a reply paid envelope

The participants are asked to return:-

- the reply slip confirming, changing or declining their appointment
- the questionnaire

In preparation for the survey visit men are asked:-

- to fast overnight or (in the case of appointments at or after 11.20) for about five and a

half hours;
- to wear clothing which is easily adjustable;
- to bring reading glasses and their medications or a prescription list.

1.4 Framework of assessments being made

The participants will proceed from the receptionist to Workstation 1 (Research Nurse 1), then to Workstation 2 (Vascular Technician, ultrasound), then to Workstation 3 (Vascular Technician 2) and then to Workstation 4 (Research Nurse 2), returning to the Receptionist before departure. Each of these workstations will last approximately 20 minutes:-

Reception, each participant will:-
- be logged in and have documentation prepared
- prepare for assessment (dressing gown etc)

At **Workstation 1,** each participant will have measurements of:
- anthropometry
- blood pressure
- lung function
- physical function
- body composition. (Body composition was initially done using the TANITA VISCAN (AB140 M)SOP but was later replaced with the TANITA MA418BC).

At **Workstation 2 (Cardiff University team),** each participant will have:

- carotid ultrasound measurements

At **Workstation 3 (Cardiff University team),** each participant will have:

- carotid-femoral pulse wave velocity and
- ankle-brachial pressure index measurements;
- Bioelectrical impedance measurements using Bodystat 1500 (initially in workstation 4, later moved to workstation 3)

At **Workstation 4**, each participant will:-

- have a resting electrocardiogram
- have bioelectrical impedance measurements using Bodystat 1500 (initially in workstation 4, later moved to workstation 3)
- provide a fasting blood sample
- be asked about consent for record tracing, result recording, blood storage, Actigraph measurement
- be provided with an Actigraph

2.0 RECEPTION

2.1 Email to locally recruited receptionist.

Dear XX,

Thank you so much for agreeing to help run the reception for the British Regional Heart Study 30-Year Follow Up clinic in [TOWN]. We really appreciate your help. You will find instructions in the rest of this pack, which I hope you will find useful. However, please do not hesitate to contact me using the details below should you have any queries/problems.

2.2 Receptionist Equipment checklist

Receptionist instructions

- Car park charge list
- Time sheet
- Petty cash Participant Receipt Forms
- Information of numbers of men in the study
- Blank data sheets
- Data sheet labels for Cardiff and UCL data sheets
- Test Your Memory Sheets and labels
- Log book
- Appointment schedule (? = unconfirmed appointment)
    - Appointment order
    - Study number Order
    - Alpha surname Order
- Folder for ECGs x2 (one for each week)
- Folder for completed datasheets x4 (2 for UCL and 2 for Cardiff) (Appendix B)
- Folder for Jane (to include: completed time sheet, marked up appointment schedule, petty cash form and anything else you are unsure about)

- Examination Gowns + white dirty laundry sacks
- Participant belongings carrier bags and red zip bags for smaller items
- Refreshments
- Souvenir mugs + bubble wrap bags + brown paper bags
- Pens, stapler, cellotape, brown tape, scissors etc-
- Clipboards x 10
- BRHS Headed paper
- A4 blank paper
- Notepads
- Compliments slips
- Assorted envelopes
- BRHS direction signs (if needed)

Paperwork for nurses

- Vacutainer tube labels
- Blood accompanying information slips + labels
- Action Sheets
- High Blood Pressure Cards

2.3 Contact information (telephone numbers) for:

Field team nurses, CV technicians, BRHS Coordinators

2.4 Useful Information

Participant identification

- The Study number is a unique identifier for each participant and is six or seven digits long
- The batch number is a short number indicating the time slot that the study participant has been allocated
- All paperwork is labelled with both the batch and study numbers in the following format: Batch/Study

Removals

- Removals are men who have moved away from the original GP practice
- 'R' in the 'Code' column of the appointment list, denotes a "removal"

Approximate working hours

- 8:45 – 16:00 Lunch break to be taken as and when appropriate

2.5 Receptionist Instructions

Greet participant on arrival

- Enter the batch number/serial number, full name and time of arrival in log book (please use a new page for each day)
- If the participant is a known removal, please write 'R' in the 'Removal?' column of the log book
- Affix the study participant's data sheet labels to the data sheets
- Draw the patient's attention to amend their details on the front of the UCL data sheet if necessary
- If the participant has recently moved from the original practice, please write 'New' in the 'Removal?' column of the log book and ensure that they amend their GP details on the front of the UCL data sheet
- Affix the appropriate label to the **Test Your Memory sheet** (Appendix B) and attach this to the clipboard – the participant can complete this while they are waiting to be seen and/or at the end
- Give the clipboard to the participant and explain that they are to carry this around the workstations with them
- Ask the participant to remove their clothes above the waist and put on a gown (ties at the front) – Please make sure that they return the zip bag to you as these are re-useable
- Offer the participant a second gown if necessary ie. If they are cold
- Give them a carrier bag to put their clothes in
- Ask the participant to empty their pocket and give them a small red zip bag to put these smaller items in (wallet, keys etc-) - Recommend using bags as this prevents loss of belongings
- If the clinic is running late, please apologise to the participants and only ask them to change into the gown around five minutes before they will be seen
- If a confirmed appointment does not attend, mark **'DNA'** on the appointment list in **red pen**
- Please return the marked up appointment schedule in the folder for study coordinator(J. Cryer)

End of assessment, the participant returns to reception

- Take the clipboard from him
- Ask him to get dressed
- Take back the gown and place in the purple, dirty laundry basket
- Enter the time he finished the examination in the log book
- Reimburse the participant for any travel/expense if necessary (see below) and record the amount in the 'comments' column of the log book
- If the participant has parked in the carpark, ask to see his parking ticket and reimburse the appropriate amount (using the parking charges list) from the petty cash – enter amount in the log book and on the Participant Receipt Form
- Offer the participant refreshments (fruit juice, cakes, bananas etc)
- Give the participant a BRHS mug

Reimbursements

We aim to reimburse all reasonable expenses from the petty cash, particularly the following:

- Travel costs for removals
- Parking charges

Please complete petty cash receipts for each payment and staple them to any corresponding receipts if possible. Keep petty cash receipts in the zippy bag provided and put in the folder for Jane at the end of the two weeks.

2.6 Other receptionist duties

Filing

- Please file the completed data sheets in **batch number order** in the appropriate data sheet folder
- Please clip ECG tracings together each day in **attendance order**, with listings of ECGs on top (the research nurse will provide this for you) – place these in the appropriate ECG folder

Gowns

- Please fold enough clean gowns for the following day (around 20) and place them each in their own plastic zip-bag
- Bagged, clean gowns should be kept in the blue basket next to the reception desk
- At the end of each day, empty the purple dirty laundry basket into the white plastic linen bags.

Mugs

- Please prepare enough mugs each day for the participants
- Mugs should be placed in a bubble wrap bag and then into a brown paper bag

3.0 WORKSTATION 1 (RESEARCH NURSE 1) PROCEDURES

On arrival in the morning Research Nurse 1 will be responsible for switching on all equipment on the workstation and for calibrating equipment (stadiometer, spirometer) (q.v.)

Procedures with each participant will be as follows:-

- greet participant, checking identity on arrival. Take clipboard with Questionnaire and data sheet.
- participants should be asked to remove shoes and to remove any heavy or bulky item from pockets and place in a receptacle (bowl). Shoes can be restored after initial measurements.

3.1 Calibration and checking of instruments (research nurse 1)

Morning session - The following calibration steps should be undertaken:-

3.1.1 Stadiometer

Please check recorded height of standard 1 metre rule once instrument set up and record result. (This ensures that recorder has not become displaced)

3.1.2 Tanita body composition / Bioimpedance scales

Check paper supply

3.1.3 Scales

The zero setting on the scales should be checked by pressing the reset button with the scales empty. This should be 00.0. The result should be recorded. If there is a problem:-

- check that correct adapter voltage (9.0 volts) is being used
- if persists, please discuss with base at earliest convenience

3.1.4 Skinfold caliper

Check that the gauge is zeroed

3.1.5 Spirometer

- Please ensure that the spirometer(Vitalograph) is turned on early and left to warm up before testing.
- Check paper supply
- Enter 'set up' mode and do to 1 'accuracy + calibration'. When the machine invites you to blow air through the flowhead to equilibrate temperatures, please blow 3 litres through slowly. Then 'continue'.
- Set ambient (room temperature) consulting the electronic thermometer.
- Pump 5 litres of air slowly (each litre must take more than 1 second) through the flowhead to calibrate and then 'exit'.
- Read in 5.00 as reference volume and enter.
- Update calibration if error is 1% or greater.
- 'Retest' by putting a further 5 litres of air through the flowhead, If error is 1% or greater update calibration again and retest one more time.
- If calibration will not settle, raise threshold for correction to 3%.
- When you have finished, move to main menu and to FVC test, and when the machine says 'perform blow', blow 1 litre through calibration syringe and record the result.

Afternoon session.

Recalibrate Vitalograph as before(above). No calibrations needed for other instruments.

3.2 Measurements

These will be taken in order as follows. First two measures with shoes on, remainder with shoes off:-

3.2.1 Chair stand test (5 stands) (chair rises)

Explain that will want the participant to stand up from a chair 5 times to see how long it takes. Seek their agreement – if they do not wish to undertake test indicate reason (refusal =1, disability = 2)

Set Up

Use a standard chair without arms and with a seat height of approximately 17 inches for all assessments, regardless of the height of the participant. If possible, place the back of the chair against a wall to prevent movement during the test.

Please ensure that the participant is wearing sensible flat shoes.

Procedure

- Instruct and demonstrate the following protocol before asking the participant to perform the test:
- Sit as far back as possible in the chair seat. Keep feet firmly planted on the floor approximately hip width apart and the back of lower legs away from the chair.
- Keep knees bent at a 90-degree angle and **arms crossed over the chest.**
  (An individual of average or taller height will be able to sit with their upper back against the back of the chair. Individuals of shorter than average height will not be able to touch the chair back while maintaining proper position and are not required to touch the chair back during testing).
- Demonstrate the procedure once, returning completely to the correct starting position.
- As a trial go, ask the participant to stand from a sitting position with their arms folded, to a straight-legged fully standing position.
- The participant should stand to a fully erect position ie their knees should not be bent and their back should be upright. This can be assessed on an individual basis ie they should stand as upright as they would normally.
- After successful completion of the practice go, explain to the participant that on your word "go" you would like them to stand up and sit back down as practiced, five times. Explain that you would like them to do this as quickly as possible and that you will be timing them.
- At the command "Ready, Set, Go" the tester begins timing by starting the stopwatch. Count each chair stand out loud when the participant is in the standing position. Provide continuous verbal encouragement during the test.
- Stop the "stop watch" when the participant is seated back in the chair on the final go, with arms remaining folded and back supported by the chair.
- If participant are unable to stand up one time without assistance than they can use their hands to assist them in rising and returning to the seated position while following all other procedures as described above. Make sure to note that hands were used when recording the assessment data.
- If the test is not completed within 30 seconds, record how many completed lifts have been made at that point.

3.2.2 Three metre walking test

General preparation
A 3-metre walkway or 'corridor' is constructed along a wall in a smooth-floored area. Narrow 15-centimetre vertical strips are fixed on the wall at floor level and 3 metres apart within the corridor. We prefer this to sticking a line on the floor which, in our experience, can distract patients. Chairs should be positioned at each end, but at least 0.5 m from the markers to allow for acceleration and deceleration effects. These chairs are of a height to suit the person and facilitate easy standing up.

Explain that will want the participant to walk a short distance along a corridor at their normal walking pace. Seek their agreement – if they do not wish to undertake test indicate reason (refusal =1, disability = 2).

If the participant cannot walk without your assistance they cannot perform the test. Please indicate this in the boxes provided on the data entry sheet.

Participants sit on a chair wearing their usual comfortable footwear or something suitable which has been provided. Thick-soled trainers are avoided so far as possible.

Avoid doing test while other people are passing close by.

Initial Instructions
I will ask you to stand up and will then say "Go". Then you should walk down to the chair facing you [indicate] at a comfortable pace without rushing. Do not stop until you have reached the other chair. Are you clear about what you are going to do?'

Starting Position
If necessary participants are helped to stand up. They may be reminded to walk at a comfortable pace, without rushing and without stopping, until they reach the opposite chair.

Instructions
Once the person is upright and steady the command 'Go' is given calmly, not in a way to imply the need for speed.

Warnings and Encouragement
During the walk no oral encouragement should be given although occasionally the command 'Keep going' is given if participants seem about to stop or be distracted. Afterwards their efforts are rewarded with 'Well done'.

Feedback about the actual time taken is not given.

Timing
Stop-watches, which time to at least 0.01 seconds, should be checked for accuracy regularly. Ordinary wrist watches with second hands are not suitable. The tester, carrying the stopwatch, walks quietly at the side of participants as they pass the first marker, then continues slightly behind them until close to the final marker when he moves forward opposite it. The tester avoids conveying any sense of pressure on the participant to hurry. Timing begins when the tip of the first foot crosses the first vertical strip, and stops when the heel of the last foot crosses the second vertical strip.

If the test is not finished after 30 seconds, mark the data sheet accordingly.

3.2.3 Height

Restrictions
None unless participant is unable to stand to have his/her height measured

Site - flat surface
Preparation – participant not wearing shoes
Equipment – Harpendon stadiometer

The participant is asked to stand on the stadiometer facing forwards, and as tall as he can. The Research Nurse should check for the following points:-

- FEET: ankles should be together and resting on the bar at the back,
- ARMS: should be resting by sides, not behind or in front,
- BACK: should be as straight as possible
- HEAD: participant should look straight ahead (i.e. lower edge of orbit is in line with external auditory meatus [earhole]) – this is the Frankfort plane, should be horizontal.
- The index fingers of both hands should then be placed below the mastoid process on each side. During inspiration the increase in height should be maintained and during expiration a gentle stretch should be applied.
- Then bring down headplate gently, record height to last completed millimetre.

Particular care is needed to ensure that the participant does not stand on tiptoe.

Record any problems which the participant has which may lead to underestimation of height in the `problem with height' box

Any problem = yes = 1

Nurse check – Make sure can set up and take down the stadiometer

3.2.4 Weight and Body composition measurements

NOTE: ***TANITA VISCAN (AB140 M)*** *was initially used(in the first few towns) for the measurement of body composition after which, as the instrument was not reliable, it was replaced with the upright* ***Tanita MA418BC instrument*** *which was used in the examination in the remaining towns.*

IMPORTANT NOTE: Body composition measurements using a body composition analyser will only be done for those participants who have no pacemaker or defibrillator.

- Ask participant if he has a pacemaker, which also includes a defibrillator.
- If he **HAS** a pacemaker or defibrillator, he should **NOT** have measurements with the Tanita body composition analyser, but should be weighed with the **simple Tanita scales**.
- If he does **NOT** have a pacemaker or defibrillator, he should have measurements with the Tanita body composition analyser and should **NOT** be weighed with the simple Tanita scales.

IF Participant has pacemaker/defibrillator

Site	flat surface
Preparation	Participant wearing light clothing and not wearing shoes, all heavy items removed from pockets
Equipment	Tanita scales ONLY(**NOT the Tanita body composition analyser**)

Use of Tanita scales (pacemaker cases):-
Participant should stand straight if possible - leaning to one side (or forwards) can affect the weight recorded. If the weight registered is between two 0.1 kg marks, take the lower one.

IF Participant does not have pacemaker/defibrillator

Use body composition analyser: TANITA SEGMENTAL BODY COMPOSITION ANALYSER BC-418
(for non-pacemaker/defibrillator cases only)

- Enter required information by theTanita BC-418 analyser on the following:-
    - clothing weight (1 kg)
    - age (whole years) from data sheet label
    - gender
    - height (cm)
    - fitness designated as normal.

- Participant stands on scales for weighing and then grasps handles for body composition measurements when instructed to do so.
- Nurse records participant's weight on the data collection sheet
- Printout of all the body composition measurements (weight, %Fat, Fat Mass, Fat Free Mass, Total Body Water, Visceral Fat Rating, Impedance for: Whole Body, Right Leg, Left Leg, Right Arm, Left Arm. Segmental analysis for left and right leg, left and right arm and trunk which includes measures of: %Fat, Fat Mass, Fat Free Mass and Predicted Muscle Mass) is automatically produced and stapled to the datasheet (minimum 2 staples).

TANITA VISCAN (AB140 M) SOP

(INSTRUMENT **ONLY USED IN FIRST FEW TOWNS**. It was replaced with the TANITA MA418BC body composition)

WARNING

- Do not use on participant with pacemakers or other mechanical implants
- Do not shine the laser beam directly into eyes
- Do not expose items sensitive to magnetic forces to the equipment

1. Charge the main unit using the AC adapter
    a. This takes approximately two hours
    b. The green light flashes during charging and remains on once fully charged
    c. The unit will not work while plugged in
2. Insert batteries into the impedance meter if not already done so
    a. The green light should be off when stored and on when away from the main unit
3. The participant should be lying face up on the couch with their hands placed on their chest
4. Expose the abdominal area by 5cm above and below the navel
5. Position the main unit over the abdominal area
    a. The unit sensors should not come into contact with the abdomen
6. Switch the unit on
    a. The unit will automatically switch off if inactive for approximately 2 minutes
7. Select gender in order to initiate the laser

WAIST MEASUREMENT

Instrument will ask whether waist circumference is more than 130 cm or not. If > 130 cm, no waist measurement will be performed.

8. Align the main unit so that the laser is in line with the participant's navel
9. Ask the participant to breathe normally before pressing the 'Start' key
    a. The waist measurement will appear on the screen shortly

FAT MEASUREMENT

NB/ The unit will automatically progress to fat measurement mode. Do not move the unit.

10. Wet the exposed abdominal area with moistened cotton wool or a cloth, on the left and right sides – LEAVE THE NAVEL AREA UNMOISTENED (SEE VISCAN DIAGRAM)
11. Place the impedance meter across the navel of the participant in either direction with the electrodes in contact with the skin
12. Check that the green power LED is illuminated
13. Check that the impedance meter has registered a connection with the participant's body by sounding once with a 'beep'.
14. Align the positioning line on the impedance meter with the laser on the main unit
15. Press the 'Start' key on the main unit
16. The impedance meter sounds twice with a 'beep' when the measurements are complete
17. Clean the impedance meter with an antibacterial wipe and hang back on the main unit hook
18. Check the green power LED is off
19. Turn the main unit off

3.2.5 Waist circumference

Restrictions No restriction, unless participant is unable to stand to have his weight measured.
Site Flat surface
Preparation Participant wearing light clothing with shirt removed or tucked away - standing
Equipment Circumference tape measure

- Waist and hip measurements should be made with the participant standing with feet one foot apart on a marked template.

- The waist should be identified as the mid point between the iliac crest below and the lower edge of the ribs above, i.e. measured on the right side in the mid-axillary line. Mark the mid-point with a water-soluble marker.

- Pass the tape around the waist (for large participants, ask them to help passing the tape around) and reinsert at front, positioning level at the waist.

- Ask participant to breathe out gently and record measurement at the end of expiration to the last completed millimetre.

If you are not satisfied about the accuracy of your measurement, record a 1 in the appropriate coding box `problem'.

Move on to do the first hip circumference, and then repeat the measurement

3.2.6 Hip circumference

Restrictions No restriction, unless participant is unable to stand to have his weight measured.
Site Flat surface
Preparation Participant wearing light clothing with shirt removed or tucked away - standing
Equipment Circumference tape measure

- This is measured by placing the tape measure around the hips at the point of maximum circumference.

- The tape should be horizontal and the gluteal muscles not contracted. Record to the last completed millimetre. If you are not satisfied about the accuracy of your measurement, record a 1 in the appropriate coding box.

- There is no need to ask the participant to breathe out (or in) for this measurement.

- Repeat the measurement

If you are not satisfied about the accuracy of your measurement, record a 1 in the appropriate coding box `problem'.

3.2.7 Upper arm circumference (right side)

Restrictions: No restriction, unless participant is unable to stand.
Site Flat surface
Preparation Participant wearing light clothing with shirt removed or tucked away - standing
Equipment Circumference tape measure

- Ask the participant to bend the Right arm to 90^{o}.
- Identify the acromial process and the lower tip of the olecranon.
- Using the tape measure, identify the midpoint of the upper arm, between the acromial process and the lower tip of the olecranon and mark with a felt tip pen.
- With the arm hanging down loosely at the side the arm circumference should be measured at this point with the tape measure to the last completed millimetre.

If you are not satisfied about the accuracy of your measurement, record a 1 in the appropriate coding box `problem'.

3.2.8 Triceps and Subscapular Skinfold thicknesses (right side)

Restrictions No restriction, unless participant is unable to stand
Site Flat surface
Preparation Participant wearing light clothing with shirt removed or tucked away - standing
Equipment Skinfold caliper (Holtain)

- Check that calliper reading set to zero before starting measurements.
- Explain that you want to measure the thickness of the skin tissue behind the arm and shoulder.
- Measure the **triceps skinfold** at the midpoint of the upper arm as marked above.
- Grasp the skin and subcutaneous tissue without muscle immediately above the mark.
- Apply the skinfold caliper, below the fingers holding the skinfold (continue to hold the skinfold throughout the measurements.
- Skinfold calliper dial should be horizontal for the triceps skinfold measurement.
- Place the callipers around the skinfold – count 1,2,3,4,5 and record the reading
- Measure the **subscapular skinfold** immediately below the tip of the scapula.
- Scapula tip can be made more prominent by pushing arm forward, or by bringing up behind the back into a (gentle!) half-Nelson position
- Mark the site at the scapular tip for the reading
- Grasp the skinfold firmly (not too firmly!) and apply callipers immediately below fingers. Count 1,2,3,4,5 and record the reading
- Skinfold calliper dial will tend to be oblique for the subscapular skinfold measurement
- Record first measurements in each of the two sites and then repeat procedure.

3.2.9 Blood pressure (right arm)

Restrictions No restriction
Site Flat surface
Preparation Participant seated wearing light clothing
Equipment Omron blood pressure recorder, multiple cuffs

The participant should sit down at the measurement table and rest their right arm on the table. This will ensure that the participant is sitting with their upper arm at chest level.

Apply the appropriate size of cuff on the basis of the information on arm circumference (already measured).

Arm circumference < 22 cm	small cuff
Arm circumference 22 to 32 cm	medium cuff
Arm circumference > 32 cm	large cuff

It should be placed around the upper arm with the bladder centre over the artery. Explain that the cuff will inflate and squeeze the arm during measurement.

Use of the instrument

- During initial setting up, the Omron should have been set to take two measurements at one minute intervals.
- This is done by setting the function mode. Do this by pressing on/off button for more than 3 secs while `start' button is also pressed in. To move between function modes F1, F2 and F3, use the start button.

  F1 setting = 2 (number of measurements)
  F2 setting = 0 (delay to first measurement)
  F3 setting = 30 sec (measurement interval)
- Machine should then be set to `auto' and `average' ready for the first measurement.
- To begin the process of blood pressure measurements, press `start' and start the timer to go off in two minutes. The machine will immediately inflate the cuff and begin the first reading. During the measurement the participant:-
  - should not be encouraged to talk
  - should be encouraged to keep the right arm still.

The result of the first reading will appear on the screen and should be written down while waiting for the second reading to be completed. The second measurement will be made after a one minute interval on the automatic cycle. While waiting for the second measurement, entries on cuff, instrument, room temperature and ethnic origin can be recorded.

Once the second reading has been made, the `deflate 1st 2nd 3rd ' button should be pressed successively to read off the second reading and reconfirm the first reading (do NOT record the average).

When the 2 minute alarm goes off, the participant should be asked to stand up and the `start' button pressed again to record two further standing blood pressure readings in exactly the same way as the sitting measurements already described.

(NOTE – it is crucial to write down the results of the sitting readings before the start button is pressed, because these readings will be deleted from the instrument).

While these readings are being made, note whether the participant reports faintness on standing or appears breathless and whether a problem with making four consecutive BP measurements.

3.2.10 Items recorded with blood pressure

- **Cuff** – mark down cuff size used as 1 (small) 2 (medium) and 3 (large).
- **Instrument** – will generally be 1, but a spare machine will be identified.
- **Problem** unable to get 4 consecutive BP readings as in protocol, if this is the case problem = 1
- **Faintness** – participant reports being faint on standing up for BP measurement Y = 1
- **Breathless**– participant appears breathless on standing up for BP measurement Y = 1
- **Room temperature** – from digital thermometer

- **Ethnicity** – almost all participants will be
  - White European = 1.

  Other codes should be based on the appearance of the individual are:-
  - Black African-Caribbean = 2
  - South Asian (Indian, Pakistani, Bangladeshi) = 3
  - Chinese, Japanese, other Eastern = 4
  - Other or unclear = 5

3.2.11 Spirometry

Equipment: Vitalograph Compact II instrument

Preliminary explanation to participant. "We would like to measure the size of your lungs by asking you to blow into this machine.

Contraindications: There are no absolute contraindications to spirometry but common sense should be exercised. Defer spirometry until about six weeks in patients who have had:-

- pneumothorax
- eye, ear chest or abdominal surgery
- myocardial infarction or stroke

Then proceed with instructions

"What I want you to do is to take a very big breath in and to blow out as hard and as long as you can, until your lungs are empty. Watch me."

(Demonstration by nurse using mouthpiece)

Participant then practices once: ensure that:-

- full breath in
- lips tightly around mouthpiece
- long hard blow right to the end

Before measurements made check about use of inhaler use within last 24 hours, and record the time of last inhaler use

Before starting the test enter the participant's 3 digit batch number and press the 'enter' key in order to proceed.

On the main menu press 'FVC test'. The machine will then say 'perform test', indicating that it is ready for the first blow.

We want to record three definitive blows. Encourage the participant with the first blow `big breath in….and out….blow, blow, blow…right to the end'

After each blow, press 'end test' to expedite results and then 'retest' to go on to the next test.

The machine takes a short period to calculate results, after which FVC, FEVI and PEF figures will then be displayed on the screen. Once the results of each of the first two blows are displayed press 'retest' and the machine will display 'perform test' to indicate readiness for the next reading.

Once the result of the third reading is recorded, check the `best test variation' which is recorded on the screen. If best test variation is more than 5% after 3 readings, please take an additional reading by pressing 'retest' again.

If you are not satisfied that participant has done an adequate blow on at least one reading, please enter 1 in the `problem' box.

Once the 3 (4) readings are complete, press 'end test' to return to the main menu. Press 'print' and then 'selected' to print out the results. The printed output should be stapled onto the front of the data sheet in the space provided. Then press the 'new patient' category and agree to delete old patient's results. This will leave the machine waiting for the next participant's serial number to be entered in due course.

Changing printer paper

Open the printer slot.

Feed the paper in from R side from the lower side of the roll with the printer release switch pushed or held over to L side. The paper may slide through, or can use `paper feed' on lower L panel of main menu to drive paper through – this will only function when the printer release switch is pushed to the L side.

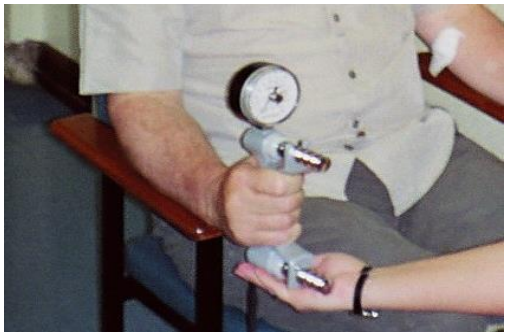
In the event of Vitalograph printer failure

Please record the number of readings and the best test variation directly from the screen before leaving the test screen. Then on main menu press option 5, display results, and write down the other parameters on the data sheet.

3.2.12 Grip strength

1. Sit the participant comfortably in a standard chair with legs, back support and fixed arms. Use the same chair for every measurement.
2. Ask them to rest their forearms on the arms of the chair with their wrist just over the end of the arm of the chair – wrist in a neutral position, thumb facing upwards.
3. Demonstrate how to use the Jamar handgrip dynamometer to show that gripping very tightly registers the best score.
4. Start with the right hand.
5. Position the hand so that the thumb is round one side of the handle and the four fingers are around the other side (see picture). The instrument should feel comfortable in the hand. Alter the position of the handle if necessary. One can usually observe if the participant is uncomfortable.
6. The observer should rest the base of the dynamometer on the palm of their hand as the subject holds the dynamometer. The aim of this is to support the weight of the dynamometer, but care should be taken not to restrict its movement.
7. Encourage the participant to squeeze as long and as tightly as possible or until the needle stops rising. Once the needle stops rising the participant can be instructed to stop squeezing.
8. Read grip strength in kilograms from the outside dial and record the result to the nearest 1kg on the data entry form.
9. Repeat measurement in the left hand.
10. Do two further measurements for each hand alternating sides to give three readings in total for each side.
11. The best of the six grip strength measurements is used in statistical analyses so encourage the participants to get as high a score as possible.
12. Ask `which is your dominant hand? (for writing) and record right, left or ambidextrous (people who can genuinely write with both hands).
13. In `dominant' boxes, put 1 in L box or R box to indicate dominance; 1 in both boxes for ambidextrous.

Equipment: Model J00105 JAMAR Hydraulic Hand Dynamometer
Supplier: http://www.lafayetteinstrumenteurope.com/



3.2.13 Completion

- Participant should remain in dressing gown and proceed to workstation 2
- Ensure that any possessions are restored or stored for collection later.
- Records should be taken through to the next workstation.

3.2.14 At end of day

Switch off all instruments; none of workstation 1 instruments require overnight charging.

3.3 Markedly abnormal results

3.3.1 Abnormal Blood pressure results

During study measurements
The only abnormalities which are likely to be identified during the study measurements are a high blood pressure reading or an abnormal electrocardiogram.

Action for high blood pressure readings
Comparability: The OMRON 907 blood pressure measurements should be very consistent with those made by the mercury sphygmomanometer.

Based on the current recommendations of the British Hypertension Society [1], the following should be taken as indicators

Diastolic pressure readings

Average 110 mm Hg or more: markedly raised
Average 100-109 mm Hg: moderately raised

Systolic blood pressure readings

Average 180 mm Hg or more: markedly raised
Average 160-179 mm Hg: moderately raised

If either systolic or diastolic pressure is **markedly raised**, should tell the participant:-

> `Your blood pressure is **high** today. Has your blood pressure been high before, or have you received treatment for high blood pressure?'
>
> (If no), `Blood pressure can vary from day to day, so that one high reading does not necessarily mean that you have high blood pressure.'
>
> (All) `You would be well advised to arrange to see your doctor **within a week** to have a further check on your blood pressure. I will give you a card with a note of your blood readings today to give to your doctor'

If either systolic or diastolic pressure is **moderately raised**, should tell the patient:-

> `Your blood pressure is **on the high side** today. Has your blood pressure been high before, or have you received treatment for high blood pressure?'
>
> (If no), `Blood pressure can vary from day to day, so that one high reading does not necessarily mean that you have high blood pressure.'
>
> (All) `You would be well advised to arrange to see your doctor **within two to three weeks** to have a further check on your blood pressure. I will give you a card with a note of your blood readings today to give to your doctor'

Dear Doctor_____,

British Regional Heart Study

Your patient_____ attended our survey examination. His sitting blood pressure readings were:-

SBP*_____DBP_____

SBP*_____DBP_____

We recommended that he should attend your surgery for a further blood pressure measurement within a week/within two-three weeks.

Thank you for your attention.

British Regional Heart Study

* These measurements were made with a Dinamap instrument, which overestimates systolic blood pressure by about 8 mmHg compared with a mercury sphygmomanometer.

3.3.2 Other abnormalities

Weight and blood pressure readings, together with ECG and blood test results will be routinely fed back to GPs (subject to participant consent).

Heart rates should be considered with the results of the ECG (see workstation 4). Specific ECG abnormalities (some of which are particularly associated with very slow and very rapid heart rates) will be fed back to GP.

3.4 Simplication of Workstation 1

If a participant cannot be measured completely, key priorities in Workststation 1 are:-

- Height
- Weight and body composition
- Waist circumference
- Hip circumference
- Blood pressure - seated readings only x 2
- Spirometry

4.0 WORKSTATION 4 (RESEARCH NURSE 2) PROCEDURES

4.1 On arrival

- Set up relevant equipment
- Prepare blood syringes and collection tubes for the morning and (if possible) afternoon session, following the appointment list for the day

4.2 Procedures for each participant

Research Nurse 2 will greet the participant, checking his identity on arrival and taking the data sheet and Questionnaire.

4.3 Dental examination

- A brief oral health assessment will comprise a tooth count and examination of 6 'index' teeth.
- Contraindications – none
- Participants should be seated comfortably on the couch reclining at about 45 degrees – do not place a pillow under the head.

4.3.1 Briefing participant

Very briefly explain the dental examination:

- I would like to do a simple dental assessment.
- I will do a tooth count and look at the gums of only a few teeth and will not disturb any existing dental work or fillings.
- If you would like to close your mouth at any time, please indicate by raising your left hand.

4.3.2 Check for dentures, implants and difficulty opening mouth

Dentures: if partial dentures or complete set in only 1 arch, ask participant to remove denture and place in disposable tray. If complete dentures in upper and lower arch, do not examine and enter tooth count on data sheet.

Implants: this is a whole tooth replacement not just a crown. Ask participant to point to implant if he has one. **Do not probe gums around implants** – choose another tooth in the sextant. This age group is unlikely to have implants.

Difficulty in opening mouth wide: "do you have any problems opening your mouth wide?". If difficulty in opening or clicking of jaw, ask participant to open only as much as he can. If history of dislocation of jaw on opening mouth wide, then do not perform examination.

4.3.3 Examination light

Adjust and position the light while asking the participant to open his mouth.
Headlight is to be worn and adjusted by the examiner.

4.3.4 Dictaphone

The Dictaphone should be placed on the desk and switched on.
When ready for examination, press 'play' on Dictaphone. All measurements will be spoken out loud to record data on the Dictaphone.

4.3.5 Gloves and examination kit

- Put on gloves when ready for examination.
- Open the sterile instrument kit which has a mouth mirror and a CPITN probe.
- Mouth mirror is to be held in left hand and probe in the right hand. Mouth mirror is used both for retraction of cheek/lips and for viewing posterior (back) teeth.
- Correct grasp of probe "modified pen grasp" – note the corner contact points of middle finger and thumb; handle rests against bony area of knuckle.

4.3.6 Dental measurements

Start with saying the batch number to record on the Dictaphone – "batch number …".

Teeth must be examined in the following order:
Always begin from upper right last (distal most) tooth to upper left last tooth; lower left last (distal most) tooth to lower right.

4.3.7 Tooth count

Use the mouth mirror (left hand) to gently retract the cheek for better visibility of the posterior teeth and use the probe to count the teeth (right hand).

Count teeth in the **upper arch** starting from the right and call out "Upper arch …teeth".

Lower arch: start counting from the last tooth (distal most) in the lower left arch.
Count teeth in the lower arch and call out "Lower arch …teeth".

Root stumps (without crown) are not to be included in tooth count; broken tooth can be included even if crown is broken.

4.3.8 Loss of attachment (LoA) and Pocket depth measures

- Upper and lower arches are divided into three sextants:
- Right sextant - premolars and molars (posterior teeth);
- Front sextant - from canine to canine (anterior teeth)
- Left sextant - premolars and molars

One tooth in each sextant of upper and lower arches will be assessed in the following order:

- Tooth 1: Upper right – 1st molar
- Tooth 2: Upper front – right central incisor
- Tooth 3: Upper left – 1st molar
- Tooth 4: Lower left – 1st molar
- Tooth 5: Lower front – right central incisor
- Tooth 6: Lower right – 1st molar

If the 1st molar is missing, move mesial for a premolar; if no premolars, look for 2nd molar.
If right central incisor is missing, move distal to find the next tooth in the sextant.

Two sites to be measured on the buccal side of each tooth (facing the cheek) – mesial and distal – for loss of attachment.
One site (mesial) to be measured for pocket depth.

Start with tooth 1: insert the probe gently in the mesial site to measure the depth of the space between the tooth and gum tissue.

Loss of attachment (LoA) is measured from neck of tooth (junction of crown and root) to base of pocket (as far as the probe goes). Neck of tooth can be identified as either a line along the crown of the tooth, or by darker shade of root surface.

Insert the probe in the distal site of tooth 1 and measure loss of attachment.

4.3.9 Pocket depth

Insert probe on mesial site again and measure pocket depth from gingival crest (top of gum) to base of pocket (as far as the probe goes).

Recording measures: Call out scores for the 3 measures for each tooth as follows -
"Tooth 1 mesial …, distal …., pocket …; Tooth 2 mesial …, distal …., pocket …".

Similarly, measure LoA and pocket depth in other teeth. If in doubt, record the lower score.

Score to measure loss of attachment and pocket depth:

0 = First probe band - Up to 3.5 mm
1 = First dark band - 4-5.5 mm
2 = Between two dark bands - 6-8.5 mm
3 = Second dark band - 9+ mm
8 = Unscorable
9 = Missing tooth in sextant

(Score 8 should only be used if the pocket cannot be probed either because of discomfort or because there is a physical barrier e.g. a large shelf of calculus or filling).

When probing lower central incisor or another front tooth, retract lower lip gently with left hand if needed – tense muscles of lower lip maybe difficult to retract with mouth mirror.

Adequate lighting is crucial for reliable measurements – adjust light and headlight as needed during examination.

4.3.10 Bleeding on probing

Bleeding of gums in response to probing should be recorded next. There maybe a delay of 20-30 seconds for bleeding to occur after probing. This will be minor bleeding which will stop.

Score:
0 – no visible bleeding
1 – evidence of bleeding
9 – missing tooth in sextant

Upper arch:
After measuring loss of attachment and pocket depth in the upper arch, go back to tooth 1 to check for bleeding at the 2 sites (mesial and distal). Retract the cheek to observe posterior teeth.

Call out bleeding scores as:
"Measure 2; tooth 1 mesial…; distal…;Tooth 2 mesial…; distal …Tooth 2 mesial …; distal …"

The participant may close his mouth for a couple of seconds before probing teeth in lower arch.

Lower arch:
After recording LoA and pocket depth in lower arch, look for bleeding in tooth 4 to tooth 6.
Call out bleeding scores as:
"Measure 2; tooth 4 mesial…; distal…;Tooth 5 mesial…; distal …Tooth 6 mesial …; distal …"

Press the 'stop' button on the Dictaphone to stop recording.

4.3.11 After examination
Ask the participant to put on dentures if removed.

4.3.12 Disposal of gloves, probe, mirror:
Gloves should be removed inside out and disposed with clinical wastes. Mouth mirror and probe are to be disposed in sharps bin.

4.3.13 Transcribe data from Dictaphone to data entry sheet:
At the end of workstation play back the recording to transcribe data recorded to the data entry sheet.

Probe grasp:
The probe is to point toward the apex of the tooth, parallel to the long axis of the tooth. If tooth is tilted the probe should be aligned according to the position of the tooth.

The probe is to be held with a light grasp not to exceed 20 grams – it should be possible to remove the probe from the examiner's hand without resistance.

Do not exert force greater than 20 grams. Probing should not cause pain or blanching of the gum tissue, if it does, too much pressure is being exerted. As an indication of the force required when probing, place the probe below your fingernail, this should not be painful if the appropriate pressure is used.

Other points for briefing participant if needed:

- I will use a mirror and a blunt instrument/probe, no sharp instrument; it will not be painful.
- This examination is for only study purposes to specifically examine your gum tissue. I will be calling out numbers that have meaning only for this study.

Possible concerns that might be raised by participants and appropriate responses:

- Treatment: Assure him that the exam will not include treatment, X-rays, a drill, or anaesthesia. Only a mirror and a blunt-ended hand instrument will be used to examine the gums of few teeth.
- Qualifications of the examiner/advice on dental health: The examiner is a registered nurse and would not be in a position to comment on the dental health of the participant.
- Existing dental work: The exam will not interfere with any existing dental work such as fillings, crowns or bridges.
- Pre-existing medical conditions: If participants raise the issue of not probing because of pre-existing medical conditions the following statement may be helpful "In the past there was a policy not to examine the gums of some patients with some heart problems or joint replacements. However, the National Institute for Clinical Excellence (NICE) has recently reviewed the evidence in this area and concluded that there is no significant risk from the examination of teeth and gums. Our policy is in line with this, but if you prefer not to have the gum examination please let me know." Ask for permission to do a tooth count in this case.

- Comment on dental health/ need for treatment: "We are not qualified to comment on your dental health. The exam is not the designed to collect information on which treatment can be planned; the examination is not the same as visiting a high street dentist, which is the best way of ensuring a thorough dental check-up. We cannot check the teeth as thoroughly as a dentist in a surgery." This is not only a way of deflecting potentially difficult questions, it is also absolutely true.

- Reporting serious pathology: If the examiner notices a lesion which he /she considers may be serious and potentially life threatening (such as a suspected malignancy) – examiners are very unlikely to encounter such potentially serious pathology, the incidence of these lesions is very low, the examination is not a screening exercise and does not involve examination of the oral soft tissues (except for gums of some teeth). However, it is possible that such a lesion may be noticed and, as the implications are serious, a protocol to deal with this eventuality is in place.
  In the extremely unlikely event that such a lesion is noted, the examiner can make sure that the participant's GP is informed, whilst ensuring not to cause the participant unnecessary worry.

  The following wording is suggested –

  > "In this survey it is our policy to inform your doctor of any ulcers or inflamed areas we see. As there is an area like this in your mouth I would like to inform your doctor, who should contact you to arrange a check-up. If you do not hear from them in the near future, please arrange your own appointment."
  >
  > It is most unlikely that any such lesions will be found and it is also unlikely that, even those which are reported, will turn out to be serious. It is the responsibility of the examiner not to alarm the participant unduly.
  >
  > If the participant asks what the examiner thinks the lesion is, the examiner should answer honestly that they do not know, before re-iterating standard survey policy as above.

4.4 Electrocardiogram (Appendix D)

- Explain to participant that would like to carry out an electrocardiogram `electrical heart tracing' which will not be painful.
- Protocol for this part of examination is provided separately in the booklet.
- At the end of the ECG, please check for presence of pitting oedema at the left and right ankles.
- Check again whether participant has pacemaker, taking account of the new information from the ECG as well as the previous enquiry about pacemakers.

4.5 Action on abnormal electrocardiograms

Always consider the state of the participant first in interpretation. If the participant is well and symptom-free, threshold for rapid action on the ECG will be higher.

The following ECG abnormalities should be referred to Glasgow for checking and (if confirmed or if no Glasgow response available) referred to the General Practitioner:-

- `acute myocardial infarction', unless stated to be resolving or old
  If the ECG specifies `acute myocardial infarction' ask the participant about recent chest pain, breathlessness or other symptoms of ill-health and about any previous history of heart trouble. Irrespective of answers to these questions, should refer participant directly to G.P.
- ventricular tachycardia
- AV dissociation
- Bradycardia < 40/minute
- Atrial fibrillation or flutter with rapid ventricular response (>=120)
- Supraventricular tachycardia (>=120)
- Sinus tachycardia would not provide a routine basis for referral in an apparently well participant.

If the ECG specifies digoxin toxicity and the participant is taking digoxin or any other cardiac glycoside, he should be referred to the G.P. directly.

4.6 Blood sampling

(Detailed blood collection and handling procedures are described in **Appendix C**)

The blood sample will be taken at the end of the examination, after the electrocardiogram is completed. The blood sample should be taken with the participant lying down.

> We would like to ask you to give us a blood sample for the measurement of factors related to the heart and circulation – would that be OK?

Check whether the participant has had previous problems with blood sampling.
Alcohol swabs will be provided for skin cleaning where needed - allow to dry after use.

A tourniquet may be used throughout. Wear the rubber gloves provided for taking the sample. A 21 gauge butterfly needle (or Sarstedt needle) should generally be used; a supply of 23 gauge needles will also be supplied for more exceptional use.

A maximum of three attempts may be made in the different arms if the participant consents. No further attempt to obtain blood should be made.

There are nine collection tubes which will be prepared in advance. They should be taken in the order specified on the separate protocol, with citrate tubes (x2) taken first followed by serum tubes (x3), followed by EDTA tubes (x3) followed by fluoride-oxalate (x1).

After venepuncture, raise participant's arm and encourage participant to press firmly on cotton wool pad to avoid bruising. Plasters are provided. Please check for elastoplast allergy - if present, use cotton wool and tape.

After venepuncture the tubes should be gently agitated and placed in a rack. Please label the tubes with the appropriate serial number labels, sticking an extra label copy in the space provided on the data sheet. Please record:-

- the full success/partial success/failure of sampling
- the reason for failure if appropriate
- the time of venepuncture
- the time when the participant last ate
- if partial success, which of the `primary' collection tubes have blood in them

Bloods should be sorted by individual participant. The serum tubes will be taken apart for centrifugation at least 30 minutes after collection (see below) and then restored to the main sample base collection.

4.7 Biompedance using Bodystat 1500 (Task moved to Workstation 3)

- Participant lies flat, though with head supported. Arms and legs must be uncrossed, forearms pronated
- Place electrodes on right side of body following instructions – placing of proximal electrodes especially critical.
- Record bioimpedance coefficient only.

Setting up the Bodystat 1500 to record bioimpedance coefficient only.

The results can be omitted by resetting the instrument. Access the Installation mode by holding down

the 'Up' arrow key and then switching the device on. This will then take you though all the sections of the test and results that you can change the parameters for. Once you are happy with the alterations you have made, continue to enter through until it asks you if the installation is complete. Change this to `yes' and you will have changed to output of the machines. Should you require any further information then please do not hesitate to contact Prof P Whincup.

4.8 Actigraph distribution

Explain to the participant that we would be very grateful if he would consider wearing a small activity monitor, the size of a matchbox, for a one week period after the survey. (show the instrument). If he is happy to do so please hand out the envelope, having checked it against participant documentation:-

If the participant is unexpected, the Actigraph will not be pre-labelled. It will then be necessary –to stick a participant label on the Actigraph
- to note the serial number of the Actigraph on the data sheet

4.9 Consent form

Go through the consent form (Appendix B) with the participant. Give the form for them to read, complete and sign.

4.10 Task to be completed at the end of day

- Blood samples
  The 3 serum tubes should stand for a minimum of 30 minutes and then centrifuged for 10 minutes at 4200 rpm. These will either be shipped overnight or refrigerated and then despatched the following day.

- Transmit ECGs to Glasgow
  1. Connect telephone cable to a fax line (preferably) or telephone connection
  2. Ensure power cable is plugged in
  3. Switch on Atria 6100
  4. Press Home button
  5. Press SEND/RECEIVE button
  6. Select the RECORDS TO BE SENT'
  7. Check all records to be sent are highlighted 'SEND' or 'HOLD' for those not need to be sent
  8. Press 'Enter' to HOLD or SEND
  9. Press 'BACK'
  10. Send 'all new records' or 'selected ECGs'
  11. Press ENTER
  12. Remember to print out 'sent confirmation sheet after sending is completed
  13.
- Put Viscan and ECG machine on to charge for the following day

4.11 Simplication of Workstation 4

If a participant cannot be measured completely, key priorities in Workstation 1 are:-

- Blood test
- ECG
- Actigraph

If only one observer is unavailable, the other observer should prioritise the following:

- Height
- Weight and bioimpedance
- Waist circumference
- Hip circumference
- Blood pressure seated readings only x 2
- Spirometry
- Blood test
- ECG
- Actigraph

5.0 Feedback of results to BRHS participants

When the participant agrees, results will be fed back to the participant's G.P. including:-

Height
Weight
Body mass index with cut-offs as a comment, viz:-

20 or less = underweight
>20-25 = acceptable
>25-30 = overweight
>30 = obese

Systolic BP (mean of 2 readings)
Diastolic BP (mean of 2 readings)

Blood results

From biochemistry

Include: Total, LDL, HDL cholesterol and triglycerides, Blood glucose, urea, k, na , creatinine, urate , Total protein, albumin , Total Bilirubin, Alkaline Phosphatase , Aspartame Transaminase(AST), Alanine Aminotransferase (ALT), Gamma-Glutamyl transferase (gamma-GT, GGT). (exclude mg ca corr ca po4)

From haematology

Include: White blood cell count(WBC), Haemoglobin(hb), platelets, Red blood cell count (RBC), Haematocrit, Mean Cell volume (MCV), Mean Cell Haemoglobin Concentration(MCHC), Mean Cell Haemoglobin(MCH) only.

Abnormal values as defined by the laboratory will be indicated with a star next to the abnormal parameter. A copy of the ECG with report will be attached to this output. Abnormal values requiring more urgent attention are summarized on the next page.

6.0 Markedly abnormal results

6.1 During study measurements

The only abnormalities which are likely to be identified during the study measurements are a high blood pressure reading or an abnormal electrocardiogram.

6.1.1 Action for high blood pressure readings

Comparability issue

Diastolic pressure readings

Average 120mm Hg or more:	severely raised
Average 100-119mm Hg:	moderately raised

Systolic blood pressure readings

Average 210mm Hg or more:	severely raised
Average 180-209mm Hg:	moderately raised

If either systolic or diastolic pressure is **severely** raised, should tell the patient:-

`Your blood pressure is **high** today. Has your blood pressure been high before, or have you received treatment for high blood pressure?'

(If no), `Blood pressure can vary from day to day, so that one high reading does not necessarily mean that you have high blood pressure.'

(All) `You would be well advised to arrange to see your doctor **within a week** to have a further check on your blood pressure. I will give you a card with a note of your blood readings today to give to your doctor'

If either systolic or diastolic pressure is **moderately** raised, should tell the patient:-

`Your blood pressure is **on the high side** today. Has your blood pressure been high before, or have you received treatment for high blood pressure?'

(If no), `Blood pressure can vary from day to day, so that one high reading does not necessarily mean that you have high blood pressure.'

(All) `You would be well advised to arrange to see your doctor **during the next two or three weeks** to have a further check on your blood pressure. I will give you a card with a note of your blood readings today to give to your doctor'

Direct notification of GP - to be discussed **

6.2 Abnormalities on biochemical/haematological tests

Results which should be phoned through to the General Practitioner directly would include:-

- blood glucose above 15 mmol/L (provide urea and electrolytes also)
- blood urea above 20 mmol/L
- serum potassium below 2.5 mmol/L or above 6.0 mmol/L
- serum sodium below 120 mmol/L
- Haemoglobin below 8.0 g/dl; acute leukemia

7.0 Protocol violations/departures from plan

These will need to be dealt with as they arise. Details should be recorded in the study log book.

If a member of staff is ill:-

- please phone base so that a replacement can be found as soon as possible and any other arrangements made
- if one nurse is out of action without replacement please refer to section 4.10.1 of this document.

END OF PROCEDURES FOR WORKSTATION 1 AND 4

8.0 Test your memory (TYM)

8.1 TYM Testing instructions

The participant can complete this while they are waiting to be seen and/or at the end of their examination

Please sit the patient down somewhere quiet and comfortable with a good pen. Please help them ***if necessary*** with everything but the answers! There is no time limit but encourage them to keep going and not become stuck on one question. They should not go back to questions twice or turn back the TYM test once they have turned it over. Please make sure that they cannot check the date or time eg with a watch.

Please give them test and the introduction (Appendix B).

- Please do not allow relatives to sit too close and help.
- If the patient is unable to do the TYM test because of physical problems eg unable to write due to a stroke, then please write the answers for them. Please tick the box at the bottom of page 2
- If the person has memory or other similar problems and it is clearly a struggle then please write the answers for them.
- Please watch the person and check the answers and if they have misunderstood a question or omitted a section then please point this out to them. So missing out box 2 remind them or filling in box 5 with 4 non animal words such as star, sugar then gently correct them. You will need to deduct a point at the end for such reminders.

At the end please record how much help the person needed:

- No help: the person completed the test in the right order with no help
- Trivial help: the person needed a single reminder
- Minor help: the person needed two or more reminders
- Moderate help: the person could only do the test if you led them though the Tym test
- Major help: you need to do nearly everything for the person to attempt the Tym test

8.2 TYM scoring protocol (Appendix B)

8.3 TYM score interpretation (Appendix B)

8.4 Reference:

Self administered cognitive screening test (TYM)for detection of Alzheimer's disease: cross sectional study. Brown J, Pengas G, Dawson K, Brown LA, Clatworthy P.BMJ. 2009 Jun 9;338

BRITISH REGIONAL HEART STUDY
Vascular Assessment protocol

2010-2012 (Q30) rescreen - 30 year BRHS follow-up

Vascular Assessment

carried out by

Wales Heart Research Institute(WHRI)
Cardiff University

WORKSTATIONS 2 and 3

VASCULAR ASSESSMENT PROTOCOL

Written by Dr Libby Ellins
Date: May 2010

CONTENTS

List of abbreviations

ABI – Ankle Brachial Index

ABPI –Ankle Brachial Pressure Index

BP – Blood Pressure

BRHS – British Regional Heart Study

CCA – Common Carotid Artery

ECA – External Carotid Artery

ICA – Internal Carotid Artery

IMT – Intima-Media Thickness

m/s – Metres per Second

PPG - Photoplethysmography

PWA – Pulse Wave Anlysis

PWV – Pulse Wave Velocity

Protocol for non-invasive vascular measures for the British Regional Heart Study

Introduction:

The British Regional Heart Study (BRHS) is a prospective study in middle-aged men drawn from general practices in 24 British towns, recruited in 1978-1980. It was set up to determine the factors responsible for the considerable variation in coronary heart disease, hypertension and stroke in Great Britain. It also seeks to determine the causes of these conditions in order to provide a rational basis for recommendations towards their prevention.

For this revisit the surviving study participants in this established cohort (approximately 4000 men aged 70-89 years) will undergo a final screening. The field study team will use imaging techniques to measure disease and ageing of the heart and arteries and measure a wide range of established and novel factors which may affect CVD risk at this age. The study aims to increase understanding of how health behaviours and the ageing process affect CVD in later life, and how CVD risk and cardiovascular ageing can be reduced in the elderly.

The study will involve a field team of two nurses and two ultrasound technicians staying in the 24 participating BRHS towns (based in England, Scotland and Wales) for two week periods between early 2010 and late 2011. Participants will then come to the study General Practice for re-examination; home visits will be made to a limited number of study participants who are not able to travel.

Vascular Measures

Carotid intima-media thickness (IMT) is a measure of early structural changes in the vessel wall and is related to cardiovascular risk. IMT will be measured from the far wall of the common carotid artery (CCA) with computer assisted acquisition, processing and storage. IMT will be determined as the interface between the lumen-intima and media-adventitia and will be measured 1-2 cm proximal to the carotid bifurcation. Optimal images are recorded in DICOM format as a cine loop and downloaded for later offline analysis.

Plaque presence

Presence or absence of plaque in the carotid artery has been shown to be an indicator of cardiac risk.

Arterial distensibility is a measure of vascular elastic properties of the artery and will be measured in the common carotid artery, using high-resolution ultrasound on a segment of vessel 1-2 cm proximal to the bifurcation. This can be acquired at the same time as the IMT. Stiffer arterial walls re less prone to expand during systole and related blood pressure variability, and this can be quantified by means of measuring changes in vessel diameter during the cardiac cycle. Brachial artery blood pressure will be measured using an oscillometric blood pressure device following a 10 minute supine rest, immediately after the image acquisition.

Pulse wave velocity (PWV) is a measure of arterial stiffness, measured over an extended section of the arterial circulation. Increased PWV reflects increased arterial stiffness. Carotid-femoral PWV which predominantly reflects aortic stiffness is considered the optimal measure of arterial stiffness and is now widely used as a valid non-invasive measure of arterial disease. Carotid –femoral PWV will be measured at rest using both the Vicorder and sphygmocor systems.

Using the Vicorder, proximal and distal blood pressure cuffs are wrapped around the neck and thigh. The distance between the sternal notch and the middle of the thigh cuff is measured and recorded. The cuffs are then inflated to 65mmHg and the corresponding oscillometric signal for each cuff is analysed digitally to provide the PWV.

The sphygmocor system uses applanation tonometry. A pressure tonometer is used to record transcutaneously the pressure pulse waveform in the underlying artery. An R-timing reference is provided by simultaneous recording of an ECG signal. Consecutive pressure pulse recordings are performed at two superficial artery sites (carotid – femoral segment).

The mean time difference between R-wave and pressure wave is calculated on a beat-to-beat basis from each set of pressure-pulse and ECG waveform data using integral software. PWV

is calculated using the mean time difference and arterial path length between the two recording points.

Pulse wave analysis (PWA) measures the augmentation index (a representative surrogate of wave reflection) and generates a central blood pressure. It is measured using the sphygmocor system. A pressure tonometer is used to record transcutaneously the pulse pressure waveform in the underlying radial artery. A transfer function is then used on the signal to generate information regarding central and augmentation pressures.

Ankle-brachial pressure index (ABPI) is the ratio of the systolic pressure at the ankle to that in the arm. This is measured using the Vicorder system to record systolic pressures in both the right brachial artery and the right and left posterior tibial arteries using oscillometric sensors.

Arrival at site:

Assess room being used for measurements. Decide on best positions for the two workstations taking into account lighting levels, privacy for the subjects using screens, sufficient room for movement around couch, flow of subjects between the two workstations.

General Comments

When the participant arrives at the workstation, Collect BRHS form from them, and confirm their ID by asking name and date of birth.The participants need to be rested prior to commencing the measurements, to allow baseline cardiovascular variables to stabalise. In addition, ensure that all procedures are described to the participant, and explain that they will be repeated.

All data should be backed up to the USB drives at the end of each day, and then to the Analysis computer at the end of each week.

Equipment /consumables:

Carotid IMT and distensibility.

- Zonare ultrasound machine and linear array probe
- Key board, printer and extra monitor
- Omron blood pressure monitor and cuffs
- Couch for participant to lie on
- Trolley with wheels to hold machine
- Adjustable stool
- Pillow
- Consumables: tissues, tissue for couch, ultrasound gel, pens

PWV/ PWA/ABPI

- Laptop
- Vicorder
- Sphygmocor
- Cuffs
- Trolley with wheels to hold equipment
- Couch
- Adjustable stool
- Thermometer for room and skin temperature
- Tape measure
- Consumables: tissue for couch, pens

PROTOCOL FOR WORKSTATION 2

Scanning procedure for Carotid IMT and distensibility.

Slide the scan engine onto the 1st shelf of the cart, until it locks into place. Attach the ultrasound probe to the side of the scan engine and place in the holder. Place the plug in the socket and switch on.

Ask the participant to lie down with their head near the top end of the couch.

Ensure the ultrasound machine is within easy reach when scanning the participant's neck and the screen is at a comfortable angle without the operator straining their neck. Adjust height of the stool to ensure a comfortable position at the head end of the couch.

When the participant is settled on the couch, place a blood pressure cuff securely onto the participant's right arm. Then request they hold a thermometer probe for a few minutes. When a relatively constant temperature is given, record the skin and room temperatures on the data sheet.

Whilst waiting for a steady temperature, input the participant details:

Press New Patient
Using the keyboard enter:

- ID
- Gender
- Date of Birth
- Operator

The exam type is always vascular and the preset Vascular Research (these should not be altered).

Selecting Exit will cause the scanning screen to return. Initials and ID of participant should be in the top left corner of the screen. Label image as RCCA (right common carotid artery)

The participant will be scanned supine, with lateral, chin-up head tilt to 45^{o}. Ensure there is easy access to the participant's neck and that this is a comfortable position for the participant. Apply gel to the probe.

Starting on the right side, place the probe at the bottom of the neck in the transverse position. The notch on the probe should be pointing towards the right. Aligning the transverse image of carotid artery in the middle of the screen, slide probe up the neck until the carotid widening into bulb is visible and the common carotid bifurcates into the internal carotid artery (ICA) and external carotid artery (ECA). Two distinct vessels should be seen. Sweep up as far as possible. Repeat this upward sweep having first pressed store to record as a cine loop.

Slide back down the neck to the beginning of the bulb; turn the probe 90^{o} to image a longitudinal plane. The notch on the probe should be pointing up towards the head. Check the angle of the probe; it should be about ear to ear. Align image with beginning of the bulb at the left side of the screen, the artery should be horizontal across screen, and intima should be visible on both anterior and posterior CCA walls.

Select Zoom, position the box to the desired spot, and push select twice, (image should zoom). Adjust the image, then press store to record cine loop (see figure 2 (the perfect image). Maintain the image for the entire 10s recording, a minimum of 5 consecutive beats is required. Remove the probe, and wipe it clean and along with the participant's neck.

Take 2 blood pressure recordings on right arm, 30 seconds apart, recording the readings on the datasheet.

Repeat these measurements on the left side, then press end Exam to exit and save the data.

Image optimization:

Push Optimize or try increasing/decreasing the Gain (by turning the grey dial). This can help the picture quality and display the intima more clearly

If the artery is sitting very low on the screen, adjust the depth so that it sits closer to the middle of the screen.

If the artery is sitting very high on the screen try to lift the probe so still in contact with the gel but not so close to the skin, this can help the artery to drop towards the middle of the screen which allows a better image.
If one wall is very 'fuzzy', use the 'time gain controls' to improve the image.

If the presence of plaque is found
Record still images of the thickest point of plaque in both cross-sectional and longitudinal orientations ensure images are correctly labelled with artery location.
Record a cross-sectional scan of carotid going down to the root of the vessel and back up as far as possible beyond the bifurcation with flow.
Image the area of plaque longitudinally with flow –adjust flow box to correct angle, and record a cineloop.

If possible measure the amount of plaque in the area and record as a still image correctly labelled.

Note location of plaques on the data sheet.

Data management

Exporting data
First turn the machine off, place the USB stick into back port, and turn the machine on again. Press Archive and select the exams for export. When the USB stick is recognised, select the Drive, and press Export. Wait for data to be transferred, click OK
Press Archive to return to the main screen.

Back up of data
To be done at Cardiff after each period of field work.
Attach then ultrasound machine to the cart. Switch on both the cart and the ultrasound machine (using the on button on the cart). Press Archive, then highlight the data to be backed-up, and click Export. Select the device to be copied to i.e. Cart hard drive, and click Export. Press Archive again to close this window and return to the main screen.

Copy data from USB stick onto computers at Cardiff files labelled BRHS and town name.

PROTOCOL FOR WORKSTATION 3

Procedure for measuring PWA using Sphygmocor

Open Sphygmocor programme on laptop by double clicking on icon on desktop. Ensure that BHRS is the default database, if this is not the case, click System, Database Manager, Select BRHS. Then click Select and OK.

Select 'Create New', then insert participant details:

- patient ID
- Initials
- Date Of Birth
- Sex

Then select 'Update'.

Click PWA and Study. Take 2 blood pressure measurements with the Omron, write them on the data sheet and enter the average into the PWA screen. Check default Radial is ticked, and insert Operator initials

Click Capture Data. Record 15 seconds of good quality waveforms and press space bar/the foot pedal to capture the data.

Clicking on the Detailed screen, all numbers under Quality Control should be GREEN Operator Index should be 85 or above. If these criteria are not met the measurement should be repeated.

To repeat the measurement press F3, and then enter. Two measurements should be taken at the Radial artery, and the difference between the AIx of the two data sets should be ≤5%.

NOTE: Ensure the tonometer is always replaced and secured after each measure, as it is fragile

Procedure for measuring PWA using Vicorder

Place the SC10 cuff securely around the upper right arm with the tube positioned in line with the brachial artery. Attach this to the red pressure hose.

Click on PWA in Quick Launch. The acquire screen will appear overlaid by PWV study screen, ensure that the data will be saved in a file BRHS.pwa (this will need to be altered before and after taking the Osc BP)

Click on OSC BP. Inform the participant that the cuff will inflate and press Space to inflate the cuff for a BP reading. When completed press return to save blood pressure which is automatically entered into the study screen.

Remember to ensure that the PWA data will be saved to BRHS.pwa, then click OK. Also ensure that the data is being backed up to the CSV file, on the right side of the input box.

On the acquire screen press the Space to inflate the cuff. When there has been a run of good quality waveforms press space to freeze, then return to save the results. Repeat for a second reading – if there is a difference of >0.5 between the two Augmentation Index results take a third reading.

Procedure for measuring PWV using Sphygmocor

Equipment/consumables:

- Sphygmocor with tonometer and laptop with integral software.
- Omron BP monitor with adult cuff.
- Consumables: water based felt tip pen, 3 x ECG electrodes per participant

Scanning procedure for pulse wave velocity

In the patient details screen, ensure the correct participant is highlighted, click the 'PWV' icon and then 'Study'.

Ensure that at Site A the Carotid box is ticked, and at Site B the Femoral box is ticked. Feel the pulses at the carotid and femoral, mark with a pen, and measure the distance to them from the suprasternal notch. Note: Ensure that the measurement does not follow the contours of the body. Enter the sternal notch to femoral artery measurement (mm) in the Distal box, and the sternal notch to carotid artery in the Proximal box.

Systolic and Diastolic blood pressures should remain the same.

Note: Ensure that the PWV algorithm is 3-Intersecting Tangents

Insert initials in Operator. Connect the ECG leads from the Sphygmocor to the electrodes on the chest.

Click Capture Data, and the screen will appear with the ECG in yellow.

Sit at the head of the couch, asks the participant to extend their neck backwards as far as possible, this tightens the sternocleidomastoid muscle to give you a firm structure to exert pressure against. Feel for the right carotid pulse and place the tonometer directly over the strongest pulse point on the neck. Exert gentle, steady pressure to obtain a reading. When there is 15 seconds of steady readings with uniform shape, height and rhythm; press the space bar /foot pedal to capture the data. Pay particular attention to the upstroke of each wave as the readings are taken from the intersecting tangent at the base of the upstroke.

Both the operator and the subject must be perfectly still for this recording. The operator should ensure they are in a comfortable position with their arm rested on the couch and with a straight back (couch/bed and chair at the correct height).

A message will appear, asking if a measurement will be taken at Site B, click 'Yes' to accept, and move to take a measurement at the femoral artery.

Repeat for Femoral pulse:
Feel for the femoral pulse and place the tonometer over the point where it is strongest. Repeat as for the carotid measurement.

Once both measurements have been taken, the report screen will appear with the Carotid reading at top and the Femoral reading below. In the panel at the bottom marked SD (m/s) both numbers must be GREEN, if one or both are RED repeat the measures. Under Pulse Wave Velocity (m/s) a value with a standard deviation will be given, a PWV with a SD above 10% of the PWV is not acceptable.

These measurements should be repeated, to gain to PWV values with a difference of <0.5 m/s.

The Sphygmocor software can be shut down by pressing the X in the top right hand corner, all data will be saved to the hard drive automatically.

Procedure for measuring PWV using Vicorder

Procedure for Carotid to Femoral PWV:

Click on the PWV icon in the Quick launch Tab of the main Vicorder screen. Click edit patient data and enter the patient details:

- Surname
- first name
- ID number

Ensure that the data is saved in the BRHS.pwv, which can be altered in the top left box.

Position the participant at a 30° angle, so that their head and shoulders are higher than the rest of their body. Attach the femoral cuff to the top of the participant's right leg, with the tube facing upwards towards the centre of the body. Connect the blue cable to this tube. Next attach carotid sensor around the participant's neck, making sure that the bladder of the cuff is anatomically positioned over the carotid artery, and attach the red cable to this tube.

Measure the distance from the suprasternal notch to the middle of the leg cuff, in a straight line (not following the stomach contour). Record this measurement in the Length box in the PWV study information, and on the data sheet. Following this, measure the distance from the suprasternal notch to the bottom of the neck sensor (angled towards the participant's ear). Record this measurement in the comments box in the PWV study information, and the data sheet.

Inform the participant that the cuff is going to inflate, and then click the space bar to start the cuff inflation. To change the scale of the waveforms so that they fit on the screen, use the up and down buttons on the Vicorder, or change gain icon on the screen (F5). When three waveforms of a similar shape and size are obtained click Space to stop the recording.

Click Enter/Return button to save the data. It will then be possible to repeat the measurement.

Repeat this procedure two more times, as two PWV measurements within a range of 0.5 m/s are required.

Saving Data:

Plug in USB stick.
Open:

- My computer
- Programme files
- Skidmore medical folder
- Data folder
- Highlight required data
- Right click on mouse – copy
- Open removable disk file
- Open PWV folder
- Right click on mouse – paste

Safely remove USB stick and turn off laptop.

Procedure for measuring ABPI using Vicorder

PPG

Place SC10 cuffs over the Brachial artery on both arms, and above the ankle on both legs. The red pressure hose should be used at the Brachial cuff and the blue at the ankle. With the PPG sensors inserted into the clips, attach the red sensor to the middle finger and the blue sensor to the big toe. Note that extraneous light should be excluded.

Click on the ABI icon, when the screen opens ensure that it is in the multi-channel, bilateral mode. If this is not the case, press Multi-Chan/F4.

When clear waveforms are observed, inform the participant that the cuff will be inflated and press Space. The cuff will then automatically bleed pressure, the PPG signal reappears when the cuff reaches systolic pressure. At any point after the reappearance of the signal the display may be frozen by pressing Space.

Press Enter to save the Data. This should be repeated twice for each side, the repeated measurements (each side) should be <5mmHg apart

Doppler

The pressure cuffs should remain in place from the PPG measurement. The red pressure hose should be attached at site of measurement. Click on the Pressures icon. When the screen opens, PPG will be the default measurement, to change this to Doppler click press Mode/F12 twice.

Apply ultrasound gel to the end of the Doppler probe, and place the probe over the right Brachial artery distal to the cuff. The probe should be positioned such that the direction of blood flow is towards the probe, with the probe at a 45° angle. Both the operator and the participant should remain still during the measurement.

Once an adequate signal is obtained, inform the participant that the cuff will inflate, then press Space to inflate. The cuff will then automatically bleed pressure, the Doppler signal reappears when the cuff reaches systolic pressure. At any point after the reappearance of the Doppler signal the display may be frozen by pressing Space. To save data press Enter.

This measurement should then be repeated at the Posterior Tibialis and the Dorsalis Pedis, on the right and left sides.

Return to the main screen by pressing Close/Esc

HOME VISITS

Home visits were made to a limited number of study participants who are not able to travel to the examination site. A reduced number of measurements were made during the home visits which included:

- Fasting Blood Sample
- Electrocardiogram
- Ankle oedema examination
- Tooth count
- Blood pressure (sitting)x2
- Room temperature recording
- Ethnicity
- Grip strength
- Height
- Weight
- Waist circumference
- Hip circumference
- Actigraph (offer participant to participate in the Actigraph study)
- Consent form (obtain participant signed consent)

VASCULAR STATION

- Bioimpedance - using the Bodystat instrument
- Room temperature
- Skin temperature
- Carotid ultrasound scan
- Vicorder PWV
- Vicorder ABPI

The same protocol for each of the measurements was followed as that used at the examination site.

Q30 Physical examination protocol appendices (30 year BRHS follow-up)

2010 - 2012 rescreen

APPENDICES TO THE Q30 PHYSICAL EXAMINATION PROTOCOL

Appendix A: Q30 BRHS invitation letters

1. Invitation letter to participants
2. Appointment card for participants
3. BRHS newsletter for participants

Appendix B: Q30 BRHS data collection forms, consent form and TYM

1. Data collection form used in the physical examination (workstations 1 - 4)
2. Consent form
3. Test your memory questionnaire(TYM),
4. TYM scoring protocol
5. TYM Score interpretation

Appendix C: Q30 BRHS blood collection and sample handling protocol

A: Introduction

B: Study pathway

1. At the examination site: tubes and specimen draw sequence
2. At the laboratory - pre-analysis
3. At the laboratory - analysis
4. At the laboratory - post-analysis
5. Laboratory agreements

Appendices

Appendix i Vacutainer accompanying documentation
Appendix ii Blood aliquoting schedule
Appendix iii Laboratory costs

Appendix D: Q30 BRHS ECG protocol

1. BRHS ECG requirements
2. ECG Core Lab ECG Handling Protocol
3. BRHS ECG faxing guidelines
4. Creating and managing data query password protected documents
5. The Minnesota Code Classification System for Electrocardiographic Findings

1. Invitation letter to participants

APPENDIX A

UCL MEDICAL SCHOOL
DEPARTMENT OF PRIMARY CARE & POPULATION HEALTH
Royal Free Campus
Rowland Hill Street
London NW3 2PF
Tel: 020 7830 2335
Email: jane.cryer@ucl.ac.uk/ l.lennon@ucl.ac.uk

DATE

Dear Mr «Surname»,

British Regional Heart Study 30-Year Follow Up

It is now thirty years since you kindly agreed to take part in the British Regional Heart Study and to be examined by a team of research nurses. The information you provided has been of great value in helping to understand and explain some of the causes and risk factors for cardiovascular disease in Britain today, and in contributing towards its prevention in the future.

We are writing to you now to invite you to a further Heart Study check up, arranged by the same research team from London with the support of the British Heart Foundation. This will take place at **[VENUE]** from [DATE1] until [DATE2].

The examination will include a height, weight, and waist measurement, blood pressure, lung capacity and a
fasting blood sample. It will also include a detailed assessment of your heart including an ECG (electrocardiogram), a series of simple tests measuring the size of your arteries and the speed at which blood travels round the circulation and a brief dental health assessment. At the end of the assessment the team will ask whether you would consider wearing a small physical activity monitor for a few days, to provide information about the amount of activity you do. **The examination should take about two hours** and refreshments will be provided at the end. All reasonable transport costs will be reimbursed.

We hope that you will be willing to return for this check up, whether or not you have had any form of heart trouble. We believe it will provide valuable new information about the health of British men and could also be in your own interest. However, should you choose not to take part in the study, it will have no effect on your usual medical care.

Enclosed with this letter is a questionnaire and an appointment invitation offering a date and time for you to attend. Please tick the box either:

1. Accepting the appointment offered
2. Choosing another date and time on the calendar provided.
3. Indicating that you would like to take part but are unable to do so (please provide your telephone number and we will call you to discuss)
4. Declining to take part

Please return the reply slip and the completed questionnaire in the enclosed pre-paid envelope even if you are unable to accept the appointment. No stamp is needed. Further information relating to the study can also be obtained directly from the research team on **020 7830 2335**. We will call you back if you leave your phone number.

Thank you again for your help!

Professor Peter Whincup
Study Director

Dr. ???
Senior Partner

2. Appointment card for participants

Name: [INSERT NAME]

Address:

[Insert address]

Study Number: [Insert study number]

Your appointment is at:

[INSERT VENUE ADDRESS]

Date: [Insert appt. date]

Time: [Insert appt time]

PLEASE BRING THIS PART WITH YOU

Please bring with you:

- Your reading glasses
- Your slippers, if possible

Preparation for the survey:

- If you can manage, please have nothing to eat or drink (except at least two glasses of water) from:

****[Insert fasting start time]****

- Take any medicines as usual with water
- **If you are a diabetic patient taking either insulin or tablets for diabetes, please eat and drink as normal**
- Please wear simple, easily removed clothing as we ask you to undress to the waist and put on a gown
- We will provide refreshments after your check up

If required, please call us on **020 7830 2335** for further information.

PLEASE TEAR OFF AND RETURN THIS PART WITH YOUR QUESTIONNAIRE USING THE PRE-PAID ENVELOPE

Study Number: [Insert study number] Name: [Insert name]

Please tick the box or boxes that apply:

☐ **Yes**, I would like to attend a Heart Study check up at the appointment time and date shown above

☐ **Yes**, I would like to attend a Heart Study check up, but on another occasion **(please indicate by ticking one or more preferences on the calendar)** ➡

☐ **Yes,** I would like to attend, but I am unable to do so **(please give us your telephone number below and we will phone you to discuss)**

☐ **No**, I do not wish to take part in the Heart Study 30-Year Follow Up

CALENDAR	8:45-12:30	13:00-15:45
Mon DD MM	XXXXXXXX	XXXXXXXX
Tues DD MM	☐	☐
Wed DD MM	☐	☐
Thurs DD MM	☐	☐
Fri DD MM	☐	☐
Sat	XXXXXXXX	XXXXXXXX
Sun	XXXXXXXX	XXXXXXXX
Mon DD MM	☐	☐
Tues DD MM	☐	☐
Wed DD MM	☐	☐
Thurs DD MM	☐	☐
Fri DD MM	☐	☐

Please amend your address if necessary:

[Insert address]

Signed: _____

Date: _____

Tel. no.: _____

UCL MEDICAL SCHOOL
RESEARCH DEPARTMENT OF PRIMARY CARE & POPULATION HEALTH
BRITISH REGIONAL HEART STUDY

BRITISH REGIONAL HEART STUDY

(BRHS) KEY FINDINGS OVER 30 YEARS

How common is coronary heart disease?

At the beginning of the study (in 1978-1980), evidence of coronary heart disease (CHD) was present in an unexpectedly high proportion of middle aged men in the BRHS (about a quarter), most of whom had not been diagnosed. However, although risk rises with age, the condition is becoming less common overall – death rates from coronary heart disease in the UK have fallen by about a half since the study began.

Is blood cholesterol level important in coronary heart disease?

There is a strong relationship between blood cholesterol level and coronary heart disease. Having a high blood cholesterol level increases risk by three or four times. The BRHS showed that average blood cholesterol levels were very high in middle-aged men, so that even these average levels were associated with high risk. During the course of the study (between 1978 and 2000), cholesterol levels did fall, probably because participants in the study reduced the overall amount of saturated fat in their diets.

What part does cigarette smoking play in coronary heart disease?

Cigarette smoking is an important risk factor for coronary heart disease. Being a heavy cigarette smoker increases heart disease risk by a factor of at least three. After giving up cigarette smoking, heart disease risk is considerably reduced over the following 5-10 years.

Reports from the BRHS suggest that the effects of passive smoking (inhaling smoke from other people's cigarettes) on heart disease are greater than originally thought. Heavy passive smoking exposure increases the risk of heart disease by as much as a half. At the start of the study, heavy passive smoking exposure was very common, but (with a fall in cigarette smoking as a whole) it is now much less so.

APPENDIX A

Overweight – how important for coronary heart disease and diabetes?
Being overweight is a risk factor for heart disease, but it is much more strongly related to risk of diabetes – the heaviest men in the BRHS have had a risk of diabetes about ten times higher than the lightest. It is likely that being overweight over a longer period has a particularly strong effect on diabetes risk.

Is exercise beneficial in coronary heart disease?
In the BRHS, regular physical activity appears to protect against heart disease, and even light and moderate forms of activity are beneficial. Taking up physical activity in later life appears to be good for health, even among people who were not previously active.

Is infection an important cause of coronary heart disease?
Although some people have suggested that chronic infections can be a cause of coronary heart disease, evidence from the BRHS does not support this possibility. Although some experts think that inflammation is a risk factor for heart disease risk, it is not clear that the link is causal, or that it helps to predict heart disease.

What is happening to heart disease and diabetes over time and why?
Coronary heart disease is becoming less common in the UK, partly because cigarette smoking is less common than it used to be, partly because of changes in diet and partly because of improved treatment (perhaps especially the widening use of cholesterol lowering drugs). In contrast, diabetes is becoming more common, probably because more people are overweight and less active than they used to be.

How to stay healthy?
Not smoking, keeping physically active, and avoiding gaining weight are powerful ways of remaining healthy in the longer term. The risks of developing coronary heart disease, diabetes and disability are much lower in men who have been able to do this.

Thank you to all the men who have taken part in the British Regional Heart Study - your contributions to the study have helped to make all this possible!

UCL Research Department of Primary Care & Population Health, British Regional Heart Study,
UCL, Royal Free Campus, London NW3 2PF
Tel:+44 (0)20 7794 0500 Ext 34755 Direct Dial: +44 (0)20 7830 2335

APPENDIX B
Data collection form Workstation 1

DATASHEET : UCL LONDON
British Regional Heart Study 2010-2012

Batch / Study # Name **Please amend your details if necessary:**

DOB: Age:

Tel:

GP:

STATION 1 Observer ☐☐ Initials, Time ☐☐ ☐☐ (24 hr)

Sit/Stand 5 times No reas ☐ ref=1 dis=2 ☐☐ ☐☐ secs N at 30sec? ☐ Hands ☐ P/T

Walk 3 metres No reas ☐ ref=1 dis=2 ☐☐ ☐☐ secs Incompl at 30 sec ☐ P/T

Height (cm) ☐☐☐ ☐ Problem? ☐ P/T

Weight

Pacemaker? No →TANITA BODY COMPOSITION ☐☐☐ ☐ (kg) Problem? ☐ P/T

Yes →SCALES ☐☐☐ ☐ (kg)

1. Waist circ 1 (cm) ☐☐☐ ☐ 3. Waist circ 2 ☐☐☐ ☐ Problem? ☐ P/T

2. Hip circ 1 (cm) ☐☐☐ ☐ 4. Hip circ 2 ☐☐☐ ☐ Problem? ☐ P/T

Arm circ R (cm) ☐☐ ☐ Problem? ☐ P/T

1. Triceps R1 (mm) ☐☐ ☐ 3. TricepsR2 ☐☐ ☐ Problem? ☐ P/T

2. SubscapR1 (mm) ☐☐ ☐ 4. SubscapR2 ☐☐ ☐ Problem? ☐ P/T

Cuff size Armcirc < 22 cm = **1 (small)** 22-32 cm = **2 (medium)** >32 cm = **3 (large)**

Blood pressure R	SITTING 1			SITTING 2			STANDING 1			STANDING 2		
Systolic (mmHg)												
Diastolic (mmHg)												
Heart rate (per min)												

Cuff ☐ Instr ☐ Problem? ☐ P/T Faintness ☐ Y =1 Breathless? ☐ Y = 1

Room temp (°C) ☐☐ ☐ Ethnicity WE =1 BAC = 2 SA = 3 Ch/J/O = 4 Other = 5 ☐

Spirometry Instr ☐ Inhal 24hr ☐ Y = 1 Time24hr ☐☐ ☐☐

BTV % ☐☐ ☐ C I ☐ Y=1 Problem? ☐ P/T

Grip Instr ☐

Grip strength (R) ☐☐ ☐☐ ☐☐ Dom ☐ P/T Problem? ☐ P/T

Grip strength (L) ☐☐ ☐☐ ☐☐ Dom ☐ P/T Problem? ☐ P/T

P = Participant T= Technical

APPENDIX B
Data collection form Workstation 1

STAPLED DATA RECORDS

SPIROMETRY DATA

Ref number

N blows BTV %

FVC

FEV1

FEV0.5

PEF

FEF25-75%

FEF75-85%

FEF25%

FEF50%

FEF75%

BIOIMPEDANCE DATA (TANITA)

TANITA BODY COMPOSITION ANALYSER

Date DD MM YYYY Time (24hr)

Body type Standard=1/Athletic=2

Gender Female=1/Male=2

Age

Height cm

Weight kg

BMI kg/m2

BMR kJ

Kcal

Fat % %

Fat mass kg

FFM kg

TBW kg

Visceral fat rating

IMPEDANCE

Whole Body

Right leg

Left leg

Right arm

Left arm

Segmental Analysis

Right leg

Fat % %

Fat mass kg

FFM kg

Predicted Muscle Mass kg

Left leg

Fat % %

Fat mass kg

FFM kg

Predicted Muscle Mass kg

Right arm

Fat % %

Fat mass kg

FFM kg

Predicted Muscle Mass kg

Left arm

Fat % %

Fat mass kg

FFM kg

Predicted Muscle Mass kg

Trunk

Fat % %

Fat mass kg

FFM kg

Predicted Muscle Mass kg

DATASHEET: CARDIFF UNIVERSITY
British Regional Heart Study 2010-2012

Batch / Study #	Date
DOB:	

BIOIMPEDANCE

Pacemaker? ☐ No = 2 Both Bio impedance measurements

YES = 1→ NO BIOIMPEDANCE MEASUREMENTS GO DIRECT TO BLOOD TEST

NO Pacemaker: BOTH BIOIMPEDANCE MEASUREMENTS

1. Bodystat Instrument ☐ Reading ☐☐☐☐

STATION 2: Observer ID.☐☐ ROOM TEMP☐☐.☐ °C SKIN TEMP☐☐.☐ °C

RIGHT SIDE **Comments**

RCCA ☐ .....

RDist ☐ .....

PLAQUE ☐ **Y=1**

RCCA ☐ RCCB ☐ RICA ☐ RECA ☐

Cuff size (Armcirc < 22 cm = 1 (small), 22-32 cm = 2 (medium), >32 cm = 3 (large)

RBP1 Sys ☐☐☐ Dia ☐☐☐ HR ☐☐☐

RBP2 Sys ☐☐☐ Dia ☐☐☐ HR ☐☐☐

Left side **Comments**

LCCA ☐ .....

LDist ☐ .....

PLAQUE ☐ **Y=1**

LCCA ☐ LCB ☐ LICA ☐ LECA ☐

LBP1 Sys ☐☐☐ Dia ☐☐☐ HR ☐☐☐

LBP2 Sys ☐☐☐ Dia ☐☐☐ HR ☐☐☐

Observer ID ☐☐ **Comments**

APBI (PPG)

1.Sys BP R brachial ☐☐☐	Sys BP R toe ☐☐☐	RABPI ☐.☐☐
2.Sys BP R brachial ☐☐☐	Sys BP R toe ☐☐☐	RABPI ☐.☐☐
3.Sys BP R brachial ☐☐☐	Sys BP R toe ☐☐☐	RABPI ☐.☐☐
1.Sys BP L brachial ☐☐☐	Sys BP L toe ☐☐☐	LABPI ☐.☐☐
2.Sys BP L brachial ☐☐☐	Sys BP L toe ☐☐☐	LABPI ☐.☐☐
3.Sys BP L brachial ☐☐☐	Sys BP L toe ☐☐☐	LABPI ☐.☐☐

STATION 3 Observer ID

Comments

PWA (Sphyg)

R BP Sys Dia HR

R BP Sys Dia HR

Reading 1 Augmentation (mmHg) AIx (%)

Reading 2 Augmentation (mmHg) AIx (%)

PWA (Vicorder)

R BP Sys Dia HR

Reading 1 Augmentation (mmHg) AIx (%)

Reading 2 Augmentation (mmHg) AIx (%)

Comments

R BP1 Sys Dia HR

R BP2 Sys Dia HR

PWV (Sphyg) **Accepted**

1 CAR-FEM Dis Prox (mm) . ± . m/s ☐

2 CAR-FEM Dis Prox (mm) . ± . m/s ☐

3 CAR-FEM Dis Prox (mm) . ± . m/s ☐

4 CAR-FEM Dis Prox (mm) . ± . m/s ☐

PWV (Vicorder)

1 CAR-FEM Dis . Prox . (cm) . m/s

2 CAR-FEM Dis . Prox . (cm) . m/s

APPENDIX B

Data collection form Workstation 4

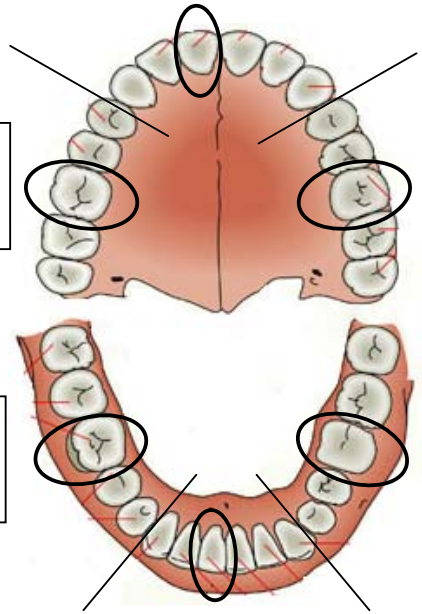
STATION 4 Observer ID ☐☐ ☐ Refusal=1 ☐ Prob =1 ORAL HEALTH

I. TOTAL NUMBER OF NATURAL TEETH: **Upper** ☐☐ **Lower** ☐☐ Batch No: ☐☐☐

II. PERIODONTAL POCKET

2. Mesial = ☐☐
Distal = ☐

1. Mesial = ☐☐
Distal = ☐



3. Mesial = ☐☐
Distal = ☐

6. . Mesial = ☐☐
Distal = ☐

4. . Mesial = ☐☐
Distal = ☐

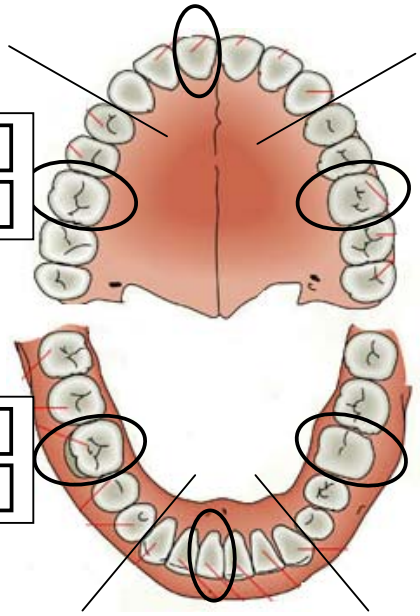
5. . Mesial = ☐☐
Distal = ☐

Score -
0 = Up to 3.5 mm (first probe band)
1 = 4 to 5.5 mm (first dark band)
2 = 6 to 8.5 mm (between two dark bands)
3 = 9 to 11.5 mm (second dark band)
8 = Unscorable
9 = Missing

III. GINGIVAL BLEDING

2. . Mesial = ☐
Distal = ☐

1. . Mesial = ☐
Distal = ☐



3. . Mesial = ☐
Distal = ☐

6. . Mesial = ☐
Distal = ☐

4. . Mesial = ☐
Distal = ☐

5. . Mesial = ☐
Distal = ☐

Score -
Yes = 1
No = 0
Missing = 9

BLOODS

Blood test Success? ☐ Full = 2 Part = 1 None = 0 Problem? ☐ Refusal = 1 Technical = 2

Time (blood test) ☐☐☐☐ (24 hour) Fasting instructions followed? ☐ Yes= 1 No=2 Diabetes =3

Time last eaten? ☐☐☐☐ (24 hour) Day last eaten ☐ Today = 1, Yesterday = 2

ID AFFIX BLOOD LABEL HERE

Incomplete sample – mark completed tubes with 1

☐	☐	☐	☐	☐	☐	☐	☐	☐
A	B	C	DE	FJ	K	LN	PS	T

ECG

Electrocardiogram ☐ Yes= 1 No=2

Ankle oedema: Left ☐ Right ☐ Yes= 1 No=2

PHYSICAL ACTIVITY SURVEY

Would you be prepared to wear this small monitor (which will measure how much activity you do) around your waist for the next week or so and then post it back to us?

Actigraph? ☐ Yes= 1 No =2 Tel Number: _____ (if not already recorded on the front of the datasheet)

If activity survey has not been **prepacked**, please use a spare and record the Monitor Serial number below. Ensure the participant ID is recorded on the questionnaire, diary & monitor.
If no telephone number is provided, the participant will be unable to take part in the Activity Survey.

ID: AFFIX BLOOD LABEL HERE

M	A	T	2	C	0												

CONSENT

We will arrange to have your blood sample checked for cholesterol and other factors which are important for heart disease risk. The results of the blood tests and other measurements will be sent back to your doctor in the next four to five weeks. If any of the results give cause for concern, you will be asked to make an appointment with your doctor.

1. Do you agree to us passing the test results to your doctor?

☐$_1$ Agreed ☐$_2$ Not Agreed

Part of your blood sample will be frozen and kept for special scientific studies of factors affecting heart disease risk, which may help us to understand how to prevent heart disease in the future. Among the factors we may need to study will be the way in which genetic factors affect heart disease risk.

2. Would you allow us to use your sample in this way?

☐$_1$ Agreed ☐$_2$ Not Agreed

Following the future health of all the men taking part remains a very important part of the study. However, because of new data protection laws, we are only able to continue to do this if you give us **specific written permission**.

In order to update your health record effectively, we need to obtain routine information from your family doctor and, where appropriate, from hospitals and several National Health Service agencies listed below*. We are particularly concerned to know about illnesses of the heart and circulation, diabetes, cancer and other disabling conditions. Even if you do not have any of these conditions, the review of your medical records is of very great importance to us. The information we obtain is kept securely and is only seen by members of our small research team.

3. Do you agree to us following your future health through your health records?

☐$_1$ Agreed ☐$_2$ Not Agreed

I agree to allow the Research Team to continue to study my health in accordance with the criteria above. I understand that any details recorded will be treated in complete confidence.

Signed: _____

Print name: _____

Date: _____

*The agencies related to the National Health Service are:-

-the NHS Information Centre
-the General Register Office
-the National Cancer Intelligence Centre
-the Primary Care Patient Registration Service

TEST YOUR MEMORY

The TYM Test

PLEASE WRITE YOUR FULL NAME……..

TODAY IS ……..DAY

TODAY'S DATE IS THE : …..… OF ……(MONTH) 20……

HOW OLD ARE YOU? ……..YEARS

ON WHAT DATE WERE YOU BORN? ……../ ……(MONTH) 19……

10

PLEASE COPY THE FOLLOWING SENTENCE:

GOOD CITIZENS ALWAYS WEAR STOUT SHOES

……...

PLEASE READ THE SENTENCE AGAIN AND TRY TO REMEMBER IT

2

WHO IS THE PRIME MINISTER ? …… ……..……..

IN WHAT YEAR DID THE 1ST WORLD WAR START?.....

3

SUMS

20 – 4 = ……..
16 + 17 = ……..
8 x 6 = ……..
4 + 15 - 17 = ……..

4

PLEASE LIST FOUR CREATURES BEGINNING WITH "S"
e.g. Shark
1 S……
2 S……
3 S……
4 S……

4

WHY IS A CARROT LIKE A POTATO?.....

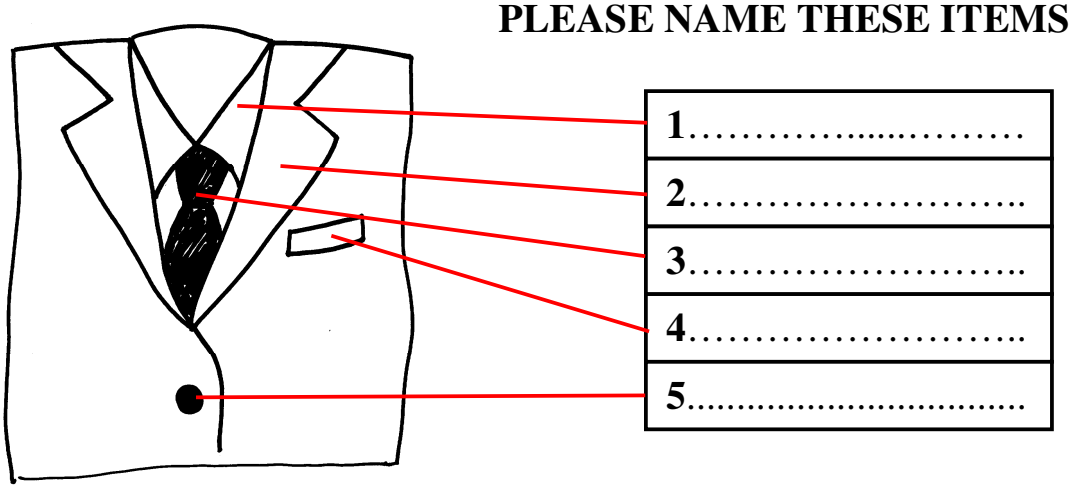
WHY IS A LION LIKE A WOLF? .....

4

REMEMBER: GOOD CITIZENS ALWAYS WEAR STOUT SHOES

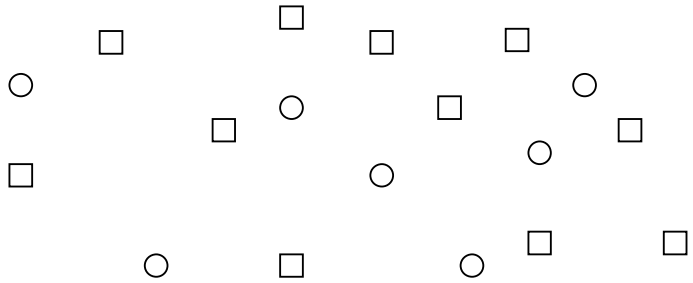
Please Turn Over

PLEASE NAME THESE ITEMS



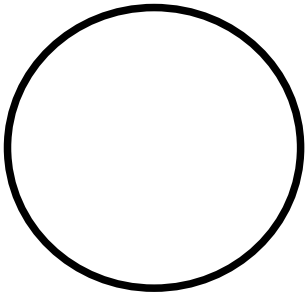
5

PLEASE JOIN THE CIRCLES TOGETHER TO FORM A LETTER (IGNORE THE SQUARES)



3

PLEASE DRAW IN A CLOCK FACE, PUT IN THE NUMBERS 1 – 12 AND PLACE THE HANDS AT 9.20



4

WITHOUT TURNING BACK THE PAGE, PLEASE WRITE DOWN THE SENTENCE YOU COPIED EARLIER :

……

6

……

FOR THE TYM TESTER:
HELP GIVEN: NONE/TRIVIAL/MINOR/MODERATE/MAJOR

TICK BOX IF ANSWERS WRITTEN FOR PATIENT ☐

5

/50

TYM TESTING

Please sit the patient down somewhere quiet and comfortable with a good pen. Please help them ***if necessary*** with everything but the answers! There is no time limit but encourage them to keep going and not become stuck on one question. They should not go back to questions twice or turn back the TYM test once they have turned it over. Please make sure that they cannot check the date or time eg with a watch.

Please give them test and the introduction.

Please do not allow relatives to sit too close and help.

If the patient is unable to do the Tym test because of physical problems eg unable to write due to a stroke, then please write the answers for them. Please tick the box at the bottom of page 2

If the person has memory or other similar problems and it is clearly a struggle then please write the answers for them.

Please watch the person and check the answers and if they have misunderstood a question or omitted a section then please point this out to them. So missing out box 2 remind them or filling in box 5 with 4 non animal words such as star, sugar then gently correct them. You will need to deduct a point at the end for such reminders.

At the end please record how much help the person needed:

No help: the person completed the test in the right order with no help

Trivial help: the person needed a single reminder

Minor help: the person needed two or more reminders

Moderate help: the person could only do the test if you led them though the Tym test

Major help: you need to do nearly everything for the person to attempt the Tym test

TYM SCORING

Spelling/ abbreviations/punctuation are unimportant if the words make sense (with the exception of box 2). Minimum score on a question is 0

Box 1 2 points for full name, 1 for initials/other minor error
1 point for each space correctly filled in the remainder of the box. If the date is wrong by a day it still scores a point.

Box 2 2 points all correct, 1 point - mistake in 1 word, 0 - mistakes in 2.

Box 3 1 point for first name 1 for surname. 1914 scores 1 point, total 3

Box 4 1 point for each correct sum

Box 5 Any creature is fine bug, fish, bird or mammal. Breeds of dog/cat eg spaniel are fine. Mythical creatures (eg sea monster) and shark not allowed.

Box 6 2 marks for precise word such as “vegetable” or “animal/mammal/hunter/meat eater/pack animal”. Reasonable but less precise answer such as food, four legs or fierce scores 1 point. 2 such statements score 2 eg “grows in ground”, “fierce and four legs” = 2

Jacket naming Answers are collar/lapel/tie/pocket/button, 1 each. Shirt is acceptable for answer 1 and jacker/blazer acceptable once for 2 or 4.

Letter W if traced with no mistakes 3 points, another letter formed 2 points, if all circles are joined 1 point

Clockface all numbers 1, correct number position 1, correct hands 1 each

Sentence Score 1 point for each word remembered up to maximum 6

Please add the score for the amount of help the patient needed:

The definitions of trivial etc are in the Tym testing sheet

None	Score + 5
Trivial	Score + 4
Minor	Score + 3
Moderate	Score + 2
Major	Score + 1

A more detailed scoring sheet is available at www.tymtest.com

INTERPRETING THE TYM

WHAT IS A NORMAL TYM SCORE?

From age 18 years to age 70 years the normal score is 47/50
From age 70 years to age 80 years the normal score is 46/50
Over the age of 80 years the normal score is 45/50

HOW WELL DO PATIENTS WITH MILD ALZHEIMER'S DISEASE (AD) OR MILD COGNITIVE IMPAIRMENT (MCI) DO THE TYM?

The average score for patients with mild AD 33/50

The average score for patients with moderate AD on the TYM is 25/50

Patients with mild cognitive impairment (MCI) – organic memory problems which may or may not progress to Alzheimer's disease may score much better. An average score for the best MCIs is 45/50 with particular problems with recall of the learnt sentence

HOW DO I INTERPRET A SCORE BETWEEN 37 AND 47?

The TYM test is part of the assessment of a patient with memory problems and the TYM score alone cannot be used as a substitute for a clinical opinion but 93% of patients with AD score 42 or less.

CAN YOU USE THE TYM AS A SCREENING TEST?

Yes with some caution. A person in whom you have a low suspicion of organic memory problems who scores well on the TYM is highly unlikely to have AD.

CAN I USE THE TYM AS A DIAGNOSTIC TEST?

No a low TYM score is a sign that a patient needs further assessment but is not a diagnostic test for AD

BMJ

RESEARCH

Self administered cognitive screening test (TYM) for detection of Alzheimer's disease: cross sectional study

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ABSTRACT

Objective To evaluate a cognitive test, the TYM ("test your memory"), in the detection of Alzheimer's disease.

Design Cross sectional study.

Setting Outpatient departments in three hospitals, including a memory clinic.

Participants 540 control participants aged 18-95 and 139 patients attending a memory clinic with dementia/amnestic mild cognitive impairment.

Intervention Cognitive test designed to use minimal operator time and to be suitable for non-specialist use.

Main outcome measures Performance of normal controls on the TYM. Performance of patients with Alzheimer's disease on the TYM compared with age matched controls. Validation of the TYM with two standard tests (the mini-mental state examination (MMSE) and the Addenbrooke's cognitive examination-revised (ACE-R)). Sensitivity and specificity of the TYM in the detection of Alzheimer's disease.

Results Control participants completed the TYM with an average score of 47/50. Patients with Alzheimer's disease scored an average of 33/50. The TYM score shows excellent correlation with the two standard tests. A score of ≤42/50 had a sensitivity of 93% and specificity of 86% in the diagnosis of Alzheimer's disease. The TYM was more sensitive in detection of Alzheimer's disease than the mini-mental examination, detecting 93% of patients compared with 52% for the mini-mental state exxamination. The negative and positive predictive values of the TYM with the cut off of ≤42 were 99% and 42% with a prevalence of Alzheimer's disease of 10%. Thirty one patients with non-Alzheimer dementias scored an average of 39/50.

Conclusions The TYM can be completed quickly and accurately by normal controls. It is a powerful and valid screening test for the detection of Alzheimer's disease.

INTRODUCTION

Dementia and other cognitive problems are common. An estimated 24 million individuals in the world have dementia and the number affected will double every 20 years.[1] Milder forms of cognitive dysfunction, including mild cognitive impairment, affect many more people.[2] Alzheimer's disease is the commonest form of dementia. Cognitive problems are a feature of many neurological and medical diseases including stroke, Parkinson's disease, head injury, and epilepsy.

Assessment of a patient's cognition is a crucial part of many medical consultations. Cognitive tests aid the diagnosis of dementia and are important in the medical and social management of patients and in the assessment of capacity. Once there are effective treatments for Alzheimer's disease there will be an even greater need for a quick sensitive test that is suitable for use in primary care and by non-specialists.

Many cognitive tests are available but none meets the three critical requirements for widespread use by a non-specialist—that is, take minimal operator time to administer, test a reasonable range of cognitive functions, and are sensitive to mild Alzheimer's disease. We designed the TYM ("test your memory") to fulfil these requirements. The paradox of thorough testing in minimal time was achieved by allowing patients to fill in the test themselves.

The TYM was administered to 540 normal controls aged 18-95, 108 patients with Alzheimer's disease/amnestic mild cognitive impairment, and 31 patients with non-Alzheimer's degenerative dementias. The test was validated by comparing scores with those obtained with the mini-mental state examination[3] and Addenbrooke's cognitive examination-revised.[4] The Addenbrooke's revised test was developed from the original examination[5] and is similar in both content and scoring.[4] We determined the specificity and sensitivity of the TYM in the detection of Alzheimer's disease by comparing the scores of 94 patients with Alzheimer's disease with the scores of 282 age matched controls. Three scorers of differing backgrounds marked 100 tests to assess inter-rater reliability.

METHODS

The TYM test

The TYM is a series of 10 tasks on a double sided sheet of card with spaces for the patient to fill in (see appendix 1 on bmj.com). The patient's ability to complete the test is an 11th task. The tasks are orientation (10 points), ability to copy a sentence (2 points), semantic knowledge (3 points), calculation (4 points), verbal fluency (4 points), similarities (4 points), naming (5 points), visuospatial abilities (2 tasks, total 7 points),

and recall of a copied sentence (6 points). The ability to do the test is also scored (5 points), giving a possible total of 50 points. The scores for the subsets are printed on the card and the total score calculated by adding the subset scores. To ensure consistent scoring a single sheet of scoring instructions is available.

Participants

Selection of patients with Alzheimer's disease

Patients were seen and diagnosed by a consultant neurologist with an interest in dementia in a dedicated memory clinic at Addenbrooke's Hospital. Patients attended the memory clinic between March and December 2007 and underwent neurological assessment, the Addenbrooke's cognitive examination-revised (which includes the mini-mental state examination), structural imaging, and blood tests. Many also had a psychiatric and neuropsychological assessment. The diagnosis of Alzheimer's disease was made with the NINCDS-ARDRA (National Institute of Neurological and Communicative Disorders and Stroke-Alzheimer's Disease and Related Disorders Association) criteria for probable Alzheimer's[6] without reference to the TYM result. The diagnosis of amnestic mild cognitive impairment was made according to published criteria.[7] We excluded patients whose cognitive problems were thought to be substantially caused by depression.

A total of 108 patients (59 men, 49 women) received a clinical diagnosis of Alzheimer's disease or amnestic mild cognitive impairment. Alzheimer's disease was diagnosed in 85 and amnestic mild cognitive impairment in 23. Amnestic mild cognitive impairment has clinical and pathological similarities to Alzheimer's disease[8 9] and patients with amnestic mild cognitive impairment who score poorly on the Addenbrooke's cognitive examination are likely to progress to Alzheimer's disease.[10] These patients were regarded as having early Alzheimer's disease. Nine patients with a diagnosis of amnestic mild cognitive impairment who scored below the cut off for dementia on the Addenbrooke's cognitive examination-revised ($\leq$83[4]) were included in the Alzheimer's cohort. Patients with a diagnosis of amnestic mild cognitive impairment who score well on the Addenbrooke's cognitive examination are unlikely to progress to Alzheimer's disease over the next two years[10]; such patients might never progress to Alzheimer's disease and might return to normal.[11] The 14 patients with a diagnosis of amnestic mild cognitive impairment who scored >83 on the ACE-R were analysed separately.

Table 1 | Average scores on memory test (TYM), Addenbrooke's cognitive examination-revised (ACE-R), and mini-mental state examination (MMSE) and variability of these scores for patients with Alzheimer's disease (n=94)

	Mean (SD) raw score
TYM (total)	33.2 (8.2)
ACE-R	66.9 (12.0)
MMSE	22.5 (3.8)

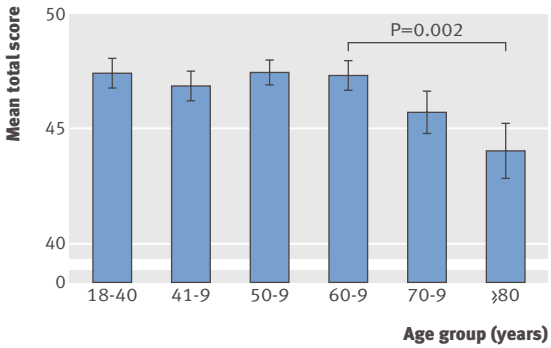

Fig 1 | Mean total TYM scores (out of maximum possible score of 50) in control participants grouped according to age (decade). Errors bars are 2SE. Post-hoc testing showed significant impairment in performance for participants aged ›80 compared with all younger age groups except age 71-80 (mean difference in score between age groups 61-70 and ›80 was 2.7, P=0.002)

Selection of controls

Controls were recruited from relatives accompanying patients to the memory clinic. Additional controls were recruited from relatives of patients attending neurology and medical outpatients departments at two other hospitals. We also included some dermatology outpatients. We excluded people with a history of neurological disease, memory problems, or brain injury. All participants gave informed consent.

We tested 540 controls aged 18-95. Over half (54%) were women. We calculated normal values for each decade from the age of 30 with standard errors. Three age matched controls were selected for each patient with Alzheimer's disease. To assess any differences in controls between different hospitals, we compared 100 controls from Addenbrooke's with 100 age matched controls from the other hospitals. To assess any sex differences, we compared 100 male controls with 100 age matched female controls.

Testing and validation

The 94 patients in the Alzheimer's cohort were given the TYM as well as the Addenbrooke's cognitive examination-revised (that includes the mini-mental state examination). The TYM was administered when the patient first arrived in the clinic.

We compared the scores of patients and age matched controls on subsets and total scores using *t* tests with Bonferroni correction for multiple comparisons (equal variances not assumed). We compared the TYM scores of patients with the Addenbrooke's and mini-mental scores using Pearson's correlation coefficients. The internal consistency of the TYM was assessed with Cronbach's α.

Sensitivity and specificity of TYM in mild Alzheimer's disease

We used data from the 94 patients with Alzheimer's disease to plot a receiver operating characteristic curve. We randomly selected three age matched controls (n=282) from the 540 controls for each patient with mild Alzheimer's disease. We calculated positive

and negative predictive values for different TYM scores for different prevalences of Alzheimer's disease.

Sensitivity of TYM *v* mini-mental state examination

A direct comparison between the TYM and the mini-mental state examination in identifying the 94 patients with Alzheimer's disease was performed by calculating the percentage of patients with Alzheimer's disease who were detected using the cut off of ≤42 for the TYM and ≤23 for the mini-mental state examination (the accepted cut off for dementia[12]).

Performance of TYM *v* other tests in other forms of dementia and mild cognitive impairment

In the same period, 31 patients (17 men, 14 women; average age 63.3) with other degenerative dementias seen in the Addenbrooke's memory clinic as new patients were given the TYM and Addenbrooke's cognitive examination-revised. Of these patients, 16 had dementia with Lewy bodies, 13 had frontotemporal dementia, and two had progressive supranuclear palsy. The diagnoses were made according to accepted criteria.[13-15] Pearson coefficients were used to calculate the correlation between the TYM scores and the other examinations.

TYM in mild cognitive impairment

Fourteen patients in the mild cognitive impairment cohort (average age 67.9) were given the TYM as well as the Addenbrooke's examination. We compared these scores with the TYM scores attained by the controls used for the Alzheimer's cohort.

Inter-rater variability

Three individuals scored the same 100 TYM sheets (38 patients, 62 controls) using the scoring sheet. One was a consultant experienced in the diagnosis of degenerative dementia (JB), one was a neurology specialist registrar working in the memory clinic (GP), and one a registered general nurse (LAB) with no specialised experience of patients with dementia who received 10 minutes of tuition. The tests were scored independently.

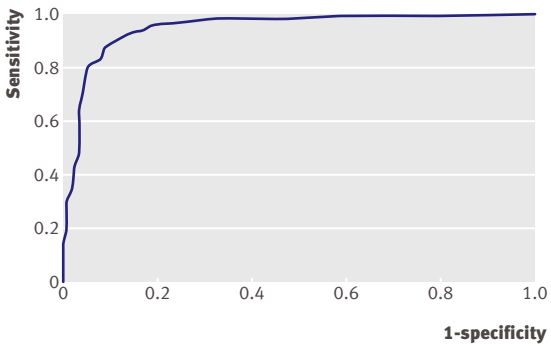

Fig 2 | Receiver operating characteristic curve for TYM scores differentiating between healthy controls (n=282) and patients with Alzheimer's disease (n=94)

Table 2 | Comparison of performance (mean (SD) scores) on TYM (total and subscores) between patients with Alzheimer's disease (n=94) and age matched controls (n=282)

Subscore (maximum)	Controls	Patients	Difference	P value*
Orientation (10)	9.9 (0.5)	8.3 (2.0)	1.6	<0.001
Copying (2)	1.8 (0.6)	1.7 (0.7)	0.1	0.09
Semantic knowledge (3)	2.6 (0.6)	1.4 (1.0)	1.3	<0.001
Calculation (4)	3.7 (0.6)	3.1 (1.2)	0.7	<0.001
Fluency (4)	3.5 (1.0)	2.2 (1.5)	1.4	<0.001
Similarities (4)	3.4 (1.0)	3.0 (1.3)	0.5	0.002
Naming (5)	4.9 (0.4)	4.4 (1.1)	0.5	<0.001
Visuospatial 1 (3)	2.7 (0.7)	1.8 (1.2)	1.0	<0.001
Visuospatial 2 (4)	3.7 (0.7)	2.9 (1.5)	0.8	<0.001
Anterograde (6)	5.2 (1.5)	0.9 (1.8)	4.2	<0.001
Executive (help) (5)	5.0 (0.2)	3.7 (1.2)	1.3	<0.001
Total (50)	46.6 (4.0)	33.2 (8.2)	13.4	<0.001

*Two tailed significance (uncorrected). Significance values shown are for independent samples *t* tests and are uncorrected; after Bonferroni correction for multiple comparisons level for significance is P=0.004.

RESULTS

Reliability and normative data

The TYM was filled in quickly and efficiently by controls and patients with minimal supervision from a receptionist or nurse. The average time for a control to complete the test was five minutes.

The value of Cronbach's α for all participants and subsets was 0.80. Figure 1 shows the results for control participants grouped by age. The average TYM score was about 47 for ages 18-70. Above the age of 70, there was a small decline in performance, which became significant above the age of 80. One way analysis of variance confirmed a significant effect of age group on total TYM score ($F_{5,534}$=6.4, P<0.001) and showed a significant effect of age on the subscores: for copy ($F_{5,534}$=5.4, P<0.001), semantic knowledge ($F_{5,534}$=3.7, P=0.003), calculation ($F_{5,534}$=3.1, P=0.008), fluency ($F_{5,534}$=5.2, P<0.001), similarities ($F_{5,534}$=3.7, P=0.002), anterograde memory ($F_{5,534}$=3.5, P<0.004), and help required ($F_{5,534}$=8.0, P<0.001). All subscores except semantic knowledge showed a mild decrease with increasing age; semantic knowledge showed a small improvement.

We compared the performance of 100 controls from relatives in the memory clinic at Addenbrooke's with the performance of 100 age matched controls from the other hospitals. The mean age for both groups was 65 years (t_{200}=0.04, P=0.97). Mean TYM scores were similar in the two groups (46.8 *v* 47.4, t_{200}=1.3, P=0.19).

We examined the effect of sex on TYM scores by comparing the average scores for 100 men and 100 women in a cohort of age matched controls. Mean age for both groups was 61 years (t_{200}=0.1, P=0.92). The mean score for both groups was 47.4 (t_{200}=0.05, P=0.96).

Alzheimer's disease and test validation

Ninety four patients with Alzheimer's with an average age of 69.0 (SD 8.5) were tested with the TYM, the Addenbrooke's cognitive examination-revised, and the mini-mental state examination. Table 1 shows the average scores.

Table 3 | Results of receiver operating characteristic analysis for detection of Alzheimer's disease with TYM in 94 patients with Alzheimer's and 282 age matched controls

					Prevalence									
					1%		5%		10%		20%		30%	
Score	False +ve rate	Specificity (%)	False −ve rate	Sensitivity (%)	PPV	NPV	PPV	NPV	PPV	NPV	PPV	NPV	PPV	NPV
≤38	4	96	25	75	16	100	50	99	68	97	82	94	89	90
≤39	5	95	19	81	14	100	46	99	64	98	80	95	87	92
≤40	8	92	17	83	9	100	35	99	54	98	72	96	82	93
≤41	9	91	13	87	9	100	34	99	52	98	71	97	81	94
≤42	14	86	7	93	6	100	26	100	42	99	62	98	74	97
≤43	17	83	6	94	5	100	23	100	38	99	58	98	70	97
≤44	19	81	5	96	5	100	21	100	36	99	56	99	68	98
≤45	25	75	3	97	4	100	17	100	30	100	49	99	62	98

PPV=positive predictive value; NPV=negative predictive value.

We found strong and significant correlations between all scores in patients with Alzheimer's (TYM *v* Addenbrooke's R^2=0.66, P<0.001; TYM *v* mini-mental R^2=0.51, P=0.001; Addenbrooke's *v* mini-mental R^2=0.70, P<0.001). The Addenbrooke's examination contains the mini-mental state examination; the TYM has much less in common with the mini-mental or Addenbrooke's examinations.

Older patients with Alzheimer's (aged over 70) scored slightly better on the TYM than the younger patients with Alzheimer's, though the differences did not approach significance (average score 33.8 *v* 32.8, t_{78}=0.57, P=0.57).

Comparison of TYM scores

Table 2 shows comparisons between the total TYM score and subscores for patients and controls. The mean age was the same in both groups (69.0). As expected, patients with Alzheimer's were particularly impaired on anterograde memory scores relative to controls. Patients also scored poorly on semantic knowledge, fluency, visuospatial tasks, and executive function. After Bonferroni correction for multiple comparisons all subtests except sentence copying showed a significant decrease in patients with Alzheimer's compared with controls.

Sensitivity and specificity of TYM

The area under the ROC curve for differentiating between mild AD and controls was 0.95 (fig 2). If a single cut off is required then a TYM score of ≤42 predicts mild Alzheimer's in this population, with a sensitivity of 93% and specificity of 86%. Reducing the cut off to ≤39 increases the specificity to 95%, while raising the cut off to ≤44 increases the sensitivity to 96%.

Table 3 shows the negative and positive predictive value for various TYM scores at different prevalences of Alzheimer's. Negative predictive values are high: 100% for a score of ≤42 with a prevalence of Alzheimer's up to 5%. Positive predictive values are lower: a score of ≤42 has a predictive value of 26% with a prevalence of Alzheimer's of 5%.

Comparison of sensitivity

We compared the power of the TYM and the mini-mental state examination to detect the 94 patients with Alzheimer's. With a cut off of ≤42 the TYM detected 93%. With the established cut off of ≤23 the mini-mental state examination detected 52%.[12]

TYM in non-Alzheimer's dementias

For the 31 patients with non-Alzheimer's dementia the mean TYM score was 38.9/50 (SD 8.6), the mean Addenbrooke's score was 77/100 (SD 16.0), and the mean mini-mental score was 25.3/30 (SD 4.1). The average mini-mental score is above the cut off for dementia, while the TYM and Addenbrooke's average scores are well below it, suggesting superior sensitivity of the TYM and the Addenbrooke's test in the diagnosis of non-Alzheimer's dementias.

The numbers with these individual diseases are too small to be meaningful, but there is a good correlation between the TYM scores of these 31 patients and the other scores (TYM *v* Addenbrooke's, Pearson's R^2=0.77; TYM *v* mini-mental, Pearson's R^2=0.74; both P<0.001).

TYM in patients with mild cognitive impairment

The patients with mild cognitive impairment scored highly on all cognitive tests, averaging 27.8/30 on the mini-mental state examination, 86.9 on the Addenbrooke's examination, and 45/50 on the TYM. Their scores on 10 of the subtests of TYM were similar to controls, but they tended to score worse than controls on anterograde memory (3.4/6 *v* 5.2/6, $t_{13.5}$=2.7, P=0.02 uncorrected).

Inter-rater variability

The TYM scores calculated by the three raters were highly correlated (table 4).

DISCUSSION

In this cross sectional study, the new "test your memory" test (TYM) was quick to use and detected 93% of cases of Alzheimer's disease. Control participants completed the TYM quickly and accurately. From

the age of 18 to 70 the average score was stable at 47/50, with a small decline after this age. Scores on all subsets of the TYM deteriorated with age, with the exception of semantic knowledge (these questions were designed for older patients).

Many of the controls were relatives of patients attending the memory clinic and came from the same population base. There was a slight male bias in the patients and slight female bias in the controls, but there was no significant difference in TYM scores between male and female controls. We recruited more controls from two other hospitals in East Anglia because the age range and number of the memory clinic controls was limited. The controls from the Cambridge memory clinic might have been expected to score slightly higher, but actually scored slightly lower. This effect was not large enough to be significant or to affect the results. Control participants were screened for a history of memory problems and neurological disease but not for other problems such as depression or vascular disease; such influences would be expected to reduce the TYM scores of controls and reduce differences in cognitive function between patients and control participants.

The TYM score of controls remained remarkably constant in widely different age ranges in both sexes and all geographical backgrounds. This is likely to be a ceiling effect. The TYM test was designed to be easy for normal controls to allow quick and accurate completion. Most controls of all ages scored almost full marks (for example, 68% of controls aged 60-69 scored 48-50). This ceiling effect suggests that education and social class would have only mild effects on the TYM score, but we did not formally assess this. The reason for the low scoring controls was often apparent from the score sheet—lack of interest, reading problems, or a sense of humour. Some low scoring controls aged over 70 show a typical pattern for mild Alzheimer's and might be in the early stages (they were still included in the control group).

Use in patients with Alzheimer's disease

Patients with Alzheimer's disease performed much poorer than controls on the TYM. They scored an average of 33/50; 13.4 points below the control group. Subtest analysis of scores in patients with Alzheimer's showed that all parts of the test, except copying a sentence, are performed less well by patients than controls. There is the expected pattern in patients with Alzheimer's performing poorly on tests of anterograde memory, semantic knowledge, fluency, and visuospatial tasks. They perform better (although still significantly worse than controls) on naming, orientation, similarities, and calculation subtests. Patients performed worse than controls in the copying subtest, but the difference was not significant; this test was probably too easy to identity patients with mild Alzheimer's.

We separately analysed patients with mild memory problems. These patients had a clinical diagnosis of amnestic mild cognitive impairment and scored well on the Addenbrooke's examination (>83). Amnestic mild cognitive impairment can be a prodrome of Alzheimer's, but some affected patients have mild problems that do not progress.[11] The Addenbrooke's test is a good indicator of which patients with amnestic mild cognitive impairment (or questionable dementia) will develop progressive dementia in the two years after testing: patients who score ≤80 are likely to progress, patients who score >80 are unlikely to progress.[10] In this study as we used the higher cut off of ≤83, the accepted cut off for dementia for the Addenbrooke's test,[5] some non-progressive patients might have been included in the Alzheimer's cohort. The patients with mild cognitive impairment scored an average of 45/50 on the TYM, with a trend towards problems in anterograde memory; they scored well in other subtests of the test.

Patients seen in the memory clinic in Cambridge could be different from those seen in other clinics. Cambridge attracts some younger patients with Alzheimer's from a wide area. The memory clinic serves a dual purpose in Cambridge, and many of the older patients in the study were local and referred directly from primary care. We separately examined the performance of the 42 patients with Alzheimer's aged 70 or over (average age 76.8). There was little difference in these patients compared with the younger patients either in overall TYM score (33.9 *v* 32.6) or in the subtest pattern. This suggests that it is a useful test to detect older patients with Alzheimer's.

The sensitivity and specificity of the TYM for detecting Alzheimer's in this cohort is high. A score of ≤42 detects 93% of cases of mild Alzheimer's with a specificity of 86%; a score of ≤44 detects 96% of patients with mild Alzheimer's. The prevalence of dementia and mild cognitive problems (often with reduced insight) in the population sets a limit on the specificity of a test.

The testers and raters were usually aware of whether individuals were patients or controls at the time of testing or rating. As individuals fill in the test sheet themselves, the tester has minimal influence on the score. All scores were checked by a single rater (JB) using the scoring sheet. The use of a strict scoring scheme minimises the influence of the rater. Scores calculated by the single rater correlated closely with the scores of the other two raters in the inter-rater analysis.

TYM *v* mini-mental state examination

The mini-mental state examination has been the standard short cognitive test for 30 years. It has proved valuable in the assessment of patients with established

Table 4 | Inter-rater agreement for memory test with three different raters, rating 100 randomly chosen participants (38 patients and 62 controls)

Rater	Mean (SD) raw score (/50)	Pearson's r (r_2) correlation		
		Consultant	Trainee	Nurse
Consultant	43.8 (6.4)	—	0.99 (0.98)	0.99 (0.98)
Trainee	43.8 (6.5)	0.99 (0.98)	—	0.99 (0.98)
Nurse	43.8 (6.5)	0.99 (0.98)	0.99 (0.98)	—

WHAT IS ALREADY KNOWN

There is no available short cognitive test that is quick to use, examines various skills, and is sensitive to Alzheimer's disease

There is confusion over how to score and interpret current short cognitive tests

WHAT THIS PAPER ADDS

The new "test your memory" (TYM) test is quick to use, examines 10 cognitive skills, and detects 93% of cases of Alzheimer's disease

There are normative data and a scoring sheet to allow consistent scoring and interpretation

dementia. It has many strengths but fails three of the requirements for a brief screening test for the non-specialist: minimal operator time, testing a wide range of cognitive domains, and sensitivity to mild Alzheimer's.

The mini-mental state examination takes an average of eight minutes to administer. Many clinicians find time to complete this but with an average consultation time in general practice in Europe of 10.7 minutes[16] this is too long. Around 58% of physicians in hospital practice thought the length of time taken to administer the mini-mental examination was too long.[17]

The mini-mental state examination tests several different cognitive domains but has a bias towards dominant parietal and temporal lobe function. It is a useful test of orientation, but the language and memory tests are too easy[18 19] and there is only a single point for visuospatial tasks. These drawbacks lead to the major problem with the test—that it is insensitive in the diagnosis of mild Alzheimer's.[5 18-20] In community and hospital studies the sensitivity of the mini-mental state examination in detecting Alzheimer's using the established cut off of ≤23 is low, varying from 49% to 69%.[5 19-21] In our study it detected 52% of patients with Alzheimer's. This low detection rate probably reflects the high number of patients with mild Alzheimer's.

The TYM fulfils the three requirements. If a patient completes the test while in the waiting area supervised by the receptionist, it can be scored and analysed by the doctor in two minutes. If there is time during the consultation to observe the patients filling in the test, this can also be a useful aid to diagnosis.

The 11 TYM tasks examine more cognitive domains than the mini-mental state examination, with less bias towards dominant hemisphere language functions. The language and memory tests are more difficult. The inclusion of two visuospatial tasks, contributing 7/50 points, is important in distinguishing Alzheimer's disease from pure amnestic syndromes. The test has a high sensitivity for detecting Alzheimer's. In our study it detected 93% of cases of Alzheimer's compared with 52% detected by the mini-mental state examination.

There are some additional problems with the mini-mental state examination. The score is influenced by how the tester asks the questions and also location—spatially disorientated patients might score 4 more points at home than in the clinic on the question of current location. The TYM is less influenced by the tester as it is filled in by the patient and will not vary with location.

The small range of scores in the mini-mental state examination limit its suitability for monitoring, but it is widely used for this purpose. It is the main test chosen by the National Institute for Health and Clinical Excellence (NICE) for deciding which patients in the United Kingdom should have cholinesterase inhibitors and for monitoring their response to treatment.[22] The TYM has a much wider scoring range than the mini-mental state examination, with over 13 points between the average control and the average patient with mild Alzheimer's. In the group of 94 patients with Alzheimer's in this study the range of mini-mental scores was 14-30 while the range of TYM scores was 9-50 (2.5 times greater).

TYM *v* Addenbrooke's cognitive examination

The original and revised Addenbrooke's examinations are sensitive and specific in the diagnosis of degenerative dementia.[4 5] The major drawback of the revised examination is that it fails to fulfil the time requirement for a test for non-specialists, taking 20 minutes to administer and score. It tests a similar number of cognitive domains to the TYM and is sensitive to mild Alzheimer's.

There was a strong correlation between the memory score and the Addenbrooke's score in both Alzheimer's and non-Alzheimer's dementias. The TYM score averages 50% of Addenbrooke's score, enabling the two tests to be easily compared. Both tests provide a permanent record of the patient's performance, which can be assessed later.

TYM *v* abbreviated mental test and other brief tests

Several brief cognitive tests have been published for screening for memory problems.[23 24] Many of these are simple—such as clock drawing tests. These can be useful in distinguishing patients with established Alzheimer's from normal controls but are too limited for routine screening for mild Alzheimer's.[25]

The abbreviated mental test[26 27] is the established brief test. It fulfils the time requirement, taking only two minutes to administer. It does not test many cognitive domains and has a strong bias (40% of the score) towards orientation, which is useful to detect delirium.[28] It is less sensitive and specific than the mini-mental state examination in detecting mild Alzheimer's.[29] There are additional problems with the abbreviated mental test, which is not given and scored consistently by regular users.[30]

Other strengths and weaknesses of TYM

The TYM has several other advantages over current bedside cognitive tests. There is a brief but rigorous scoring system. Inter-rater agreement for scoring is excellent. Ten minutes' training and the scoring sheet allowed a nurse, without experience of memory clinics, to score the TYM sheets as accurately as a specialist.

The standardisation of the scoring should avoid the confusion that arises with scoring and interpreting the mini-mental state examination and the abbreviated mental test.

Cognitive testing usually depends on the tester and patient speaking the same language. The simplicity of the TYM should allow it to be administered and scored in a different language with help from a relative. It is currently being translated into four different languages. A minor adjustment to the semantic knowledge question (president for prime minister) is needed for American, Irish, and Australian use. Versions are being developed for UK patients who do not speak English as their first language; in these versions there are variations in the semantic knowledge and drawings to suit the background of the individual.

Normal values, sensitivity, and specificity are on the scoring sheet. As the test is filled in by the patient with little help and marked with the help of a scoring sheet, the tester and rater have little influence on the score.

The high negative predictive value of scores ≥42 shows that in unselected groups a good score makes Alzheimer's disease unlikely and the TYM is a good screening test for memory problems. A score above 42 (that is, ≥43) correctly excludes the diagnosis of Alzheimer's disease on 97% of occasions, even when the prevalence is as high as 30%. In unselected groups the positive predictive value of a score of ≥42 is relatively low, showing that the test alone cannot be used to diagnose Alzheimer's disease. In selected groups where the prevalence of Alzheimer's will be higher—for example, older patients with memory complaints—the positive predictive value of a score ≥42 is much higher.

The TYM was used successfully in patients outside this study with more severe dementia, visual problems, or other physical disability. The tester needs to fill in the form with these patients and some tasks might be too difficult, so the scores of these patients are not comparable with scores of the patients or controls in this study. The test is also useful for patients with hearing impairment who have difficulty with verbal cognitive tests.

The TYM seems more sensitive than the mini-mental state examination in screening for non-Alzheimer's dementias. In the small group of such patients in our study the average mini-mental score was 25, close to the average for the population. The TYM score in the same group was 39, eight points below the average control score.

A disadvantage of the memory test is the need for the specially printed sheets, though the Addenbrooke's cognitive examination-revised has a similar requirement. A website is being developed to help to solve this problem.

This work would not have been possible without the nurses and receptionists at Queen Elizabeth Hospital, King's Lynn, North Cambridgeshire Hospital, Wisbech, and Addenbrooke's Hospital, Cambridge, who administered the tests. We thank colleagues in the memory clinic, Cambridge, for permission to include their patients and for helpful discussions. A website is being prepared (www.tymtest.com) that will allow downloading of tests, scoring sheets, and instructions.

Contributors: JB devised and helped to design the TYM, he helped to perform and coordinated the clinical research, and wrote the first draft of the paper. GP helped in the clinical testing and in the writing of the paper and was an inter-rater tester. KD performed much of the clinical testing and scoring. PC performed the statistical analysis and prepared the figures and tables. LAB helped design the test and was an inter-rater tester. JB is guarantor.

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APPENDIX C

BRITISH REGIONAL HEART STUDY

Q30 Blood collection and sample handling protocol

2010-2012 (30 year follow-up)

BRHS: A follow-up study of cardiovascular risk factors and outcomes in older men

Document date: 22.04.2010
Updated: 25.02.2022

CONTENTS

BRHS RE-SCREENING STUDY

A: INTRODUCTION

The study will start on 29th June 2010, with a two-day pre-pilot of around 14 individuals.

This will be followed by the pilot from 5th until 9th July, where we aim to see 40 men.

The main study will take place from 19th July 2010 through to May 2012 and cover around 3,000 individuals.

The schedule will be :

2010	Month	Re-screen	2011	Month	Re-screen	2012	Month	Re-screen
	January			January	Gloucester		January	Wigan
	February			February	Burnley N.U.L		February	Scunthorpe Hartlepool
	March			March	Exeter		March	Dewsbury
	April			April			April	
	May	Training Pilot		May	Falkirk Guildford		May	Maidstone Repeat study
	June	Field Team start		June	Ipswich		June	End of team contracts
	July	Pilot Harrogate		July	Ayr Dunfermline		July	
	August			August			August	
	September	Shrewsbury Lowestoft		September	Darlington		September	
	October	Mansfield		October	Carlisle		October	
	November	Southport		November	Grimsby		November	
	December	Merthyr Tydfil		December	Bedford		December	

Serum gel samples will be spun by the field survey team before shipping.

Blood samples will be delivered to the laboratory by Royal Mail (around 15 samples per day) from Tuesday to Thursday with accompanying paperwork. Samples taken on Friday will either be sent by courier to arrive at the lab on Saturday morning, or will be brought back by the field team. . The lab is open 24 hrs, and can receive samples at any time.

Samples would be analysed on receipt for agreed clinical biochemistry and haematology tests with preparation of sub-aliquots and storage of the additional and residual samples at -70^{O}C. Weekend samples may be stored in Clinical Biochemistry at 4^{O}C until Monday for analysis.

B: STUDY PATHWAY

The study will follow the pathway indicated below:

1. AT THE EXAMINATION SITE:

- The following blood tubes will be taken from each subject.

Tubes	Quantity	Size	BD Vacutainer Reference	NHS	Purpose
*Citrate	2	2.7ml	363095	KFK119	Aliquot (to give up to 2, 1.4ml aliquots)
Serum gel	2	5ml	367954	KFK114	Basic automated clinical biochemistry$ QC for Mike Thomas
Serum gel	2	5ml	367954	KFK114	Aliquot (to give up to 2, 1ml aliquots from both tubes)
Serum gel	1	8.5ml	367958	KFK127	Aliquot 4, 1ml aliquots
*EDTA K2EDTA	1	4ml	367839	KFK286	Full blood count
*EDTA K2EDTA	2	6ml	367873	KFK286	Aliquot (to give up to 6, 1ml aliquots)
Fluoride oxalate	1	2ml	367934	KFK250	Glucose/ Glycated Hb

$ Components of the basic automated clinical biochemistry

Original request was to include:

Urea, Urate, Creatinine, Sodium Potassium, Magnesium, Calcium, Corrected Calcium, Phosphate, Total Protein, Albumin, Total Bilirubin, Alk.Phos., AST, ALT, Gamma-GT, Total Cholesterol, LDL-Cholesterol, HDL-Cholesterol, Triglycerides

Current request is to include only:

Total Cholesterol, LDL-Cholesterol, HDL-Cholesterol, Triglycerides

*Residues to be kept -70C

Specimen draw sequence

- All samples must be collected in the correct sequence and gently mixed by inversion according to BD (and ISO) recommendations.
- In particular note that citrate tubes must be fully filled – any under filled citrate tubes should be discarded and a replacement tube taken.

Order of draw	Tube type	Colour	Invert gently through 180^{O}	Clot time
1	Sodium citrate	Blue	3 to 4 times	n/a
2	Serum gel	Gold	5 to 6 times	min 30 mins - max 4 hrs
3	Potassium EDTA	Purple	8 to 10 times	n/a
4	Fluoride Oxalate	Grey	8 to 10 times	n/a

- Serum gel tubes must be allowed to clot for a minimum of 30 minutes before being centrifuged on site to preserve the sample during transit.
- Serum gel tubes only should be centrifuged at 4200rpm for 10 minutes at 25^{O}C room temperature.

- Each tube will be labelled with the following details
    - Study Number (a unique identifier in the format nnnnnnn/nnn

The accompanying documentation will contain:

- Batch/Serial number
- Initials. Surname
- DOB
- Specimen date

Sex(all assumed to be Male)

- Pre-printed labels will be used for blood tubes .
- Blood tubes will be sent in Bio-bottles and conform to the requirements for transport of biological samples.
- Transport will be via Royal Mail with a guaranteed following day delivery.
- The full delivery address should state:

  BRHS Re-screen 2010-2012
  Department of Clinical Biochemistry
  Royal Free Hospital, Pond Street, London NW3 2QG

- An independent listing of samples sent will be forwarded with each Bio-bottle by the on-site team.
- In the event that the site team needs to contact the laboratory the appropriate numbers are:
    - Dr Michael Thomas
    - Mr Rory Browne
    - Ms Keyna Mendonca

  Email is the preferred mode of contact
- The accompanying documentation should be as per Appendix A (see revised suggestion). This will facilitate ease of recording of samples in the laboratory and act as the master index for study samples.
- The site team must keep a duplicate copy of all documentation sent.

2. AT THE LABORATORY - PRE-ANALYSIS

- Samples will be received Tuesday through Friday having been sent via Royal Mail in Bio-bottles to arrive the following day in the laboratory.

- Samples taken on Friday will be delivered by courier directly to Clinical Biochemistry on a Saturday morning.

- These samples will be stored at 4^{O}C for analysis and aliquoting on the next normal working day (usually Monday)

- OR the field team will bring samples back with them and take to the lab on Friday evening. Alternatively, these samples will be stored by BRHS at 4^{o}C and taken to the lab on Monday morning.

- It has been agreed that there is no requirement for Vitamin C collection and analysis

- It has been noted that the instability of insulin means that it will not be possible to determine this parameter.

- The designated MLA (or nominated deputy) will unpack, check and verify the contents of all delivered samples against the documentation provided.

- Samples will be sorted in the order of the documentation and verified as being present or not

- Where there is a mismatch between the documentation and samples received this will be clearly noted on the documentation.

- A copy of the documentation will be made to accompany the FBC samples which will need to be sent on to the Haematology department.

- The samples for FBC and the appropriate separate documentation, which will have been checked and verified for completeness by the designated MLA, will be forwarded to Haematology.

- A copy of the checked and verified documentation will also be retained in the master file in Clinical biochemistry.

  Any discrepancies between the documentation and samples received will be reported as soon as possible (preferably on the day of sample receipt to either:
  Jane Cryer (@ucl.ac.uk) ext. , Lucy Lennon (@ucl.ac.uk) ext. or Peter Whincup

- Samples (one of two Serum gel samples and the Fluoride oxalate sample) which are for analysis in clinical biochemistry (automated profile, glucose and Glycated Hb) will be bar-coded.
- Duplicate bar-codes for the two samples will be applied to the documentation.

- Registration of the two bar-coded samples for analysis will follow normal laboratory procedures.
- A customised profile will be provided according to the agreed automated parameters to be measured.

- Samples for aliquoting will neither be bar-coded nor registered on the WinPath system. The hard copy documentation will provide all the information on these samples
- All samples not for immediate analysis will be spun and the serum/plasma harvested and used to create aliquots for storage.

Aliquots will be prepared as described in the Post-analysis section.

3. AT THE LABORATORY – ANALYSIS

- The bar-coded Serum gel sample will be presented to the Modular system for the agreed automated profile at the analyser sample input buffer.

- This is important as the sample has already been centrifuged off-site and must not be re-centrifuged.

- The bar-coded Fluoride oxalate sample will be presented to the Modular system for glucose analysis at the pre-analytical sample input buffer.
- This is because centrifugation of this sample is required.

- Following analysis both samples will be recovered by the designated MLA from the sample output buffer.
- All recovered Fluoride oxalate samples should be taken to the Protein Section for Glycated Hb analysis and wherever possible should be run overnight.
- Following Glycated Hb analysis the Section will store the Fluoride oxalate sample according to local protocols.
- Any excess serum remaining from the recovered Serum gel sample will be stored as an aliquot (see Post-analysis section below).

- Any unexpected critical results will be brought to the attention of the Validating BMS and/or Duty Officer and will be phoned according to established laboratory protocols.
- The contact number and name for this is:
-

Named Person Contact Number:

Jane Cryer,

Lucy Lennon,

and in their absence to Peter Whincup

4 . AT THE LABORATORY – POST-ANALYSIS

- The designated MLA will check for availability of all results the following day

- Any missing results will be chased immediately by the designated MLA to avoid the risk of samples being discarded before analysis has been completed.

- Sample aliquots will be prepared off-line, on the day samples are received in the laboratory and following centrifugation of the samples by the designated MLA.
- The primary automated Serum gel tube will be recovered following analysis on the modular system.
- The second Serum gel tube will have been pre-spun and must not be re-spun.

- Other tubes sent for immediate analysis (Fluoride oxalate for Glucose and Glycated Hb and EDTA for FBC) will only be stored according to local protocols and will be lost to further study.

- Screw cap aliquot tubes, labels and storage containers will be supplied by BRHS together with an agreed coding system uniquely identifying the subject and type of aliquot (serum, EDTA plasma, citrated plasma)
- All other consumables used in sample preparation and aliquoting e.g. disposable pipettes, will be provided by the department of Clinical Biochemistry- Lab will buy and invoice BRHS.

- A system of colour coded caps has been suggested for the three types of aliquots for example:
  - SERUM GEL Orange
  - EDTA PLASMA Violet
  - CITRATED PLASMA Blue

BRHS WILL PROVIDE COLOURED TOPS

- Peter Whincup will propose an appropriate detailed hierarchy of sub-aliquots labelling. Appendix 3 Blood Aliquoting Schedule

- Because of the imminent procurement of new analytical equipment in Clinical Biochemistry a single separate aliquot will also be retained for re-testing of automated clinical biochemistry parameters should there be a change in methodology/ and/or supplier during the period of the study.
- This will be taken as a 1mL aliquot from the remaining serum of the Serum gel sample which has been previously subjected to automated analysis.
- It will be labelled with the WinPath accession number only
- separate storage sequence will be created for this sub-aliquot using the WinPath bar-code identity as the unique identifier.
- The sample aliquot will be stored in sequence and by site location at -70^{O}C.
- Sample aliquots from all other tubes will be created according to the table below:
- After centrifugation the plasma from tubes of the same sample type will be pooled and gently mixed before creating sub-aliquots.

Tubes	Primary Tubes	Expected Pooled Volume (mL)	Cap colour	Possible Maximum Sub-Aliquots Made					
				1	2	3	4	5	6
Citrate	2	4mL Citrated plasma	Blue	-[	-[	-[	-[		
Serum gel	A	Sample recovered 1mL serum	Orange	-[					
	B	3mL serum	Orange	-[	-[	-[			
EDTA	1	Sample lost to Haematology							
EDTA	2	6mL EDTA plasma	Violet	-[	-[	-[	-[	-[	-[
Fluoride oxalate	1	Sample lost to Protein Section – Clinical Biochemistry							

- Each aliquot tube will be uniquely identified with the Study Number and 3-digit batch number only.
- The type of sample contained within is identified by the Cap colour
- All additional information sample information is available from the printed documentation.
- Aliquots will be stored at -70^{O}C boxed and racked, categorised by site, subject and sample type.

  - Sample aliquots on dry-ice will be dispatched to St George's Hospital by courier every three months.
  - It will be **essential** to check each and every delivery date in advance to make sure Professor Whincup has been able to make preparations to receive the samples.
  - The contact number for Professor Whincup to confirm deliver arrangements is
  - The delivery address will be:

  FAO Prof Peter Whincup
  Division of Community Health Sciences,
  Room 6.08, 6th floor, Hunter Wing,
  St George's, University of London, Cranmer Terrace, London SW17 0RE

- Clinical biochemistry laboratory reports will be printed in standard format with a predetermined return address. This return address will be:
  For the attention of: Jane Cryer
  BRHS Re-screen
  Research Department of Primary Care and Population Health
  UCL Medical School,Royal Free Campus,Rowland Hill Street,London NW3 2PF

- All printed reports will flag abnormal results.
- All printed reports will be scanned by Mike Thomas (or nominated deputy) before being posted.
- An Excel extract of results will be produced on a site bysite basis retrospectively. Copies will be sent to Andy Thomson/Olia Papacosta

- **Haematology laboratory reports** will be agreed with colleagues but will likely follow the same protocol as those for Clinical biochemistry.
- IT aspects will need to be negotiated with Haematology colleagues and no guarantees can be made until those discussions have taken place.

5. AGREEMENT

- This agreed procedural statement is taken as sufficient to agree the principles and basis of this study, what will be provided and the method of remuneration.
- Invoices will be issued retrospectively every three months using the same principles and procedures as for any other work referred from other NHS bodies.
- The costs are detailed in Appendix B
- Separate invoices will be submitted for Clinical biochemistry and Haematology.

This agreement duly signed and dated by:

Professor Peter Whincup
For BRHS, St Georges Hospital, Tooting, London

Dr Michael Thomas
For Clinical Biochemistry, Royal Free Hospital, Hampstead, London

Dr Chris McNamara
For Haematology, Royal Free Hospital, Hampstead, London

Appendix I : Vacutainer accompanying documentation

APPENDIX C

SITE: HOME VISIT					BIOCHEMISTRY LAB USE ONLY			
Patient Idee	**Date**	**Tube Type**	**Tubes Taken** (circle number drawn)	**Tubes Rec'd** (circle number rec'd)	**Bar Code**	**Aliquots** (circle number made)	**Test**
«Batch»/«Serno» «Initials». «Surname» «DOB»	«Appt_Date»	A Citrate 2.7ml	0 1	0 1	affix bar code	0 1	
		B Citrate 2.7ml	0 1	0 1	affix bar code	0 1	Basic Clinical Biochem.
		C Serum 5.0ml	0 1	0 1	affix bar code	0 1	
		DE Serum 5.0ml	0 1	0 1	affix bar code	0 1 2	
		FJ Serum 8.5ml	0 1	0 1	affix bar code	0 1 2 3 4	
		K EDTA 4.0ml	0 1	0 1	affix bar code	N/A	FBC
		LN EDTA 6.0ml	0 1	0 1	affix bar code	0 1 2 3	
		PS EDTA 6.0ml	0 1	0 1	affix bar code	0 1 2 3	
		T Flu.Ox. 2.0ml	0 1	0 1	affix bar code	NA	Glucose/ Glycated H b

CUT

HAEMATOLOGY	SITE:	
	Patient Id	**Date**
	«Batch»/«Serno» «Initials». «Surname» «DOB»	«Appt_Date»

Appendix II. BRHS Re-Examination 2010-2012 Blood Aliquoting Schedule

APPENDIX C

IN THE FIELD				IN THE LABORATORY							
VACUTAINER TUBES	SIZE	TUBE LABEL	BD VACUTAINER REFERENCE	CENTRIFUGE?	ALIQUOTING			TUBE LABELS	CAP COLOUR	RESIDUE	TEST
					N	Vol.	Type				
Citrate	2.7 ml	A	363095	Yes	1	All ~1.4ml	Plasma	A	Green	Retain	N/A
Citrate	2.7 ml	B	363095	Yes	1	All ~1.4ml	Plasma	B	Green	Retain	N/A
				CHANGE PIPTETTE							
Serum gel	5.0 ml	C	367954	No - Prespun in field	1	AUTOANA L 1ml	Serum (QC for Mike Thomas)	C	Yellow	Discard	Basic Clinical Biochem.
Serum gel	5.0 ml	DE	367954	No - Prespun in field	2	1ml Rest ~1.3ml	Serum	D E	Yellow	Discard	N/A
Serum gel	8.5 ml	FJ	367958	No – Prespun in field	4	1ml 1ml 1ml Rest ~ 1.0 ml	Serum	F G H J (no I)	Yellow	Discard	N/A
EDTA	4 ml	K	367839	No	0	0	0	Not applicable	Not applicable	N/A	F.B.C.
EDTA	6 ml	LN	367873	Yes	3	1ml 1ml Rest ~ 1.0 ml	Plasma	L M N (no O)	Red	Retain	N/A
EDTA	6 ml	PS	367873	Yes	3	1ml 1ml Rest ~ 1.0 ml	Plasma	P R S	Red	Retain	N/A
Fluoride oxalate	2 ml	T	367934	No	0	0	0	Not applicable	Not applicable	N/A	Glucose/ Glycated Hb
TOTAL VACUTAINERS PER SUBJECT 9				TOTAL ALIQUOTS PER SUBJECT 15							

Aliquot storage

-Each tube type A to S stored in separate series of 100 space storage boxes

-Each tube type to be packed from front of box in rows from left to right.

-Allow one row empty between each town

-Each box to be labelled with letter, town (x of y), town (x of y) and study details eg.

BRHS RESCREEN 2011-2012 **A** **Harrogate 1 of 2**	**BRHS RESCREEN 2011-2012** **A** **Harrogate 2 of 2** **Shrewsbury 1 of 2**	**BRHS RESCREEN 2011-2012** **A** **Shrewsbury 2 of 2** **Lowestoft 1 of 2**

Etc-.

-Separate boxes for pilot studies

Appendix III

	Quotation
Biochemistry	2009
Original Profile was to include: Urea, Urate, Creatinine, Sodium Potassium, Magnesium, Calcium, Corrected Calcium, Phosphate, Total Protein, Albumin, Total Bilirubin, Alk.Phos., AST, ALT, Gamma-GT, Total Cholesterol, LDL-Cholesterol, HDL-Cholesterol, Triglycerides only per sample	£30.00
	2010
Revised Profile to include: Total Cholesterol, LDL-Cholesterol, HDL-Cholesterol, Triglycerides only per sample	£12.00
Glucose per sample	£2.00
Glycated Hb per sample	£6.00
SUB-TOTAL	£20.00
Optional Additional Tests Urea, Urate, Creatinine, Sodium Potassium, Magnesium, Calcium, Corrected Calcium, Phosphate, Total Protein, Albumin, Total Bilirubin, Alk.Phos., AST, ALT, Gamma-GT added per sample	£15.00

SUB-TOTAL WITH OPTIONALS	£35.00
Aliquot Labour per sample	£5.00

GRAND TOTAL - CLINICAL BIOCHEMISTRY PER SUBJECT WITHOUT OPTIONALS	£25.00
GRAND TOTAL - CLINICAL BIOCHEMISTRY PER SUBJECT WITH OPTIONALS	£40.00

Haematology	Quotation
	2010
	£NN.NN

All costs are for laboratory services only and exclude blood containers, Bio-bottles, Shipping, Screw-top sub-aliquot tubes and racks, Aliquot tube labels and other non-standard laboratory consumables.	
Quotation given March 2010	

APPENDIX D

BRITISH REGIONAL HEART STUDY ECG REQUIREMENTS

Atria 6100 ECG Machine Data Entry

British Regional Heart Study ID = **HsXXXXXX** (study prefix **H** in upper case and **s** in lower case) followed by 6/7 digit ID number)

First Name – initial only e.g. J (upper case)

Last Name – full surname e.g. SMITH (upper case)

Date of Birth – enter in format DD MM YYYY e.g. 21 12 1972

Age (this is calculated automatically once date of birth has been entered)

Sex (M or F)

Medication (relevant e.g. betablockers)

Clinical Class (relevant e.g. hypertensive)

ECG printout

Diagnostic text is visible on British Regional Heart Study hard copy ECGs. If you have any concerns about an ECG, check the ECG Faxing Guidelines (Addendum A), fax the ECG to the Clinical Trials Manager, Louise Inglis (tel/fax 0141 552 7089) who will arrange for it to be urgently reviewed. Addendum A of the protocol provides guidelines on when it is appropriate to fax an ECG to Glasgow. Please provide any additional relevant information on the fax cover sheet. The Clinical Trials Manager will respond either by email or telephone to confirm if any action is required. Any Abnormal ECGs which require referral to a GP will be scanned or faxed by the ECG Core Lab once the automated ECG has been received, processed and confirmed by Professor Macfarlane or in his absence, another Consultant Cardiologist. The scanned or faxed copy will be sent to UCL to be managed by BRHS.

Transmitting* ECGs */ Management of Data Queries

ECGs must be transmitted daily to the ECG core lab. BEFORE transmitting ECGs, print a copy of the Patient Directory Printout and check for any obvious data query e.g. missing study prefix or missing or incorrect digit in the ID. CORRECT errors before transmission to the ECG core lab. NOTE: errors in name or ID number can only be corrected prior to transmission. If a data query is recognised after transmission, inform the Clinical Trials Manager by email (louise.inglis@clinmed.gla.ac.uk). To provide an audit trail, data queries are managed by email and each query is given a separate identity number, e.g. DQ1001 - see Addendum B of the ECG protocol for full details. Data queries should be resolved as promptly as possible.

ECG Serial Comparison

ECGs will be automatically serially compared where a previous ECG is available on the ECG system. As appropriate, Professor Macfarlane will note a serial comparison comment on the Minnesota code sheet e.g. 'NSC' will indicate no significant change between the current and previous ECG. If the Minnesota codes are edited, a photocopy of the Minnesota code sheet with Professor Macfarlane's comment will be attached to the 'Confirmed' ECG and code sheet and sent with the normal batches of ECGs.

Troubleshooting ECG Recording

C.A.R.E. Website: http://www.gla.ac.uk/care provides ECG recording demonstration and troubleshooting tips or use Computerised Reporting of ECGs (C.A.R.E.) Manual. Alternatively, contact staff at the ECG core lab.

Technical Difficulties

If unable to transmit ECGs on day of recording, try the following day but if still unable to transmit ECGs, BRHS staff must contact the ECG core lab Clinical Trials Manager / IT Systems Manager that day and report the fault either by email or telephone to get the problem resolved quickly.

ECG Core Lab Main Contact

Louise Inglis, Clinical Trials Manager / Quality Manager
tel/fax/answering machine: 0141 552 7089, GRI Hospital Page 211 4000, Pager 3923
email: louise.inglis@clinmed.gla.ac.uk

APPENDIX D

ECG Core Lab Technical support

Shahid Latif, IT Systems Manager
tel: 0141 211 4860 email: s.latif@clinmed.gla.ac.uk

APPENDIX D

BRITISH REGIONAL HEART STUDY
ECG Core Lab ECG Handling Protocol

1. Introduction

The ECG Core Lab in Glasgow will manage, review and Minnesota Code 12 lead/25 mm/s ECGs for all participants enrolled into the British Regional Heart Study (BRHS). BRHS staff are responsible for sending the ECG Core Lab, by telephone transmission, good quality ECG recordings with correct participant ID and demographic data.. Each ECG received at the ECG core lab will be reviewed and assessed by Professor Peter Macfarlane (ECG Core Lab Director) or in his absence, when an immediate report is required, a Consultant Cardiologist, and the 'Confirmed' copies sent to the main study centre at University College London (UCL) Medical School on a monthly basis. Professor Macfarlane will also review the Minnesota Codes assigned to each ECG by the Glasgow computer system and edit them if required. A second copy of all ECGs with tracking list sheet will be sent to BRHS which will be sent to GPs by BRHS. Professor Macfarlane will provide a serial comparison comment on the Minnesota code sheet where there is an automated copy of the previous and current ECG.

2. Transmission of ECGs

Good quality 12 lead / 25 mm/s ECGs should be recorded and transmitted over the telephone network to the ECG core lab at the enrolling study centre on a daily basis.

2.1 Receipt of Faxed ECGs

The Clinical Trials Manager should be informed by email or telephone, in advance, when a faxed ECG is being sent for urgent review and/or if it is a 'not saved' ECG which requires review and manual Minnesota coding. BRHS centres should ensure that all faxed ECGs have the correct study ID, name, sex, age and ECG recording date/time visible on the ECG or put this information on an associated fax cover sheet. Please provide any additional useful information on the fax cover sheet, e.g. in the case of a participant's ECG showing Atrial Fibrillation – note: 'no previous history of heart rhythm abnormality' or 'patient not on any treatment' and similarly for myocardial infarction.

2.2 Faxed Urgent ECGs

The ECG core Lab Director or in his absence, a Consultant Cardiologist, will review any 'urgent' ECGs faxed to the Clinical Trials Manager. The type of ECG which should be faxed is dependent on the study participant's symptoms and/or the ECG text and summary content printed on the ECG. Guidelines on the type of ECG which should be faxed are noted in document ECG Faxing Guidelines / Addendum A. A copy of this document is provided by the ECG Core Lab. The report on a faxed ECG will be indicated to the study centre either by email or telephone on the same day that it is received (but normally within 2 hours of receipt). The ECG will be initialled by the reviewer and either 'No action required' or the type of 'Referral' written on the ECG report, as appropriate.

3. Referral ECGs

If an ECG (either automated or faxed copy) is reviewed and 'Referral to GP' or 'Referral to Cardiologist' is recommended, BRHS will be informed either by email or by telephone as soon as possible. A copy of the 'Confirmed' automated ECG indicating the Referral recommendation, e.g. 'Refer to GP', 'Refer to Cardiologist' etc., will be inserted into the text on the ECG. The Confirmed ECG will be faxed / scanned to the BRHS team if the Referral is considered to be required in the relatively near future.

4. Managing ECG Data Queries

The Clinical Trials Manager at the ECG Core Lab will enter data queries regarding an ECG with any missing or incorrect data on an Access database. Each query managed by the ECG core lab will be allocated a query number, e.g. DQ1209. BRHS team will be contacted by email regarding a query and the query number will be included in the email subject. Minimal study participant information should be

included in emails, e.g. ID number only, date and time of recording of ECG. When full study participant demographic 'sensitive' information is required, either by the ECG core lab, study centre or UCL, for Data Protection purposes all parties should protect the 'sensitive' information, e.g. name, sex, and date of birth. This type of information should be inserted into a 'password protected' Word document and attached to the query email. The 'password' will have been agreed and arranged with UCL. Information on how to manage password protected documents is detailed below in Addendum B. BRHS should respond and resolve data queries in a timely manner (preferably within 1-2 days of receipt). As required, the Clinical Trials Manager may also contact a study centre directly by telephone, fax or email to clarify a data query.

5. Sending Paper Copy ECGs to University College London (UCL) Medical School

The automated paper copy ECGs are sent in batches to Lucy Lennon / Jane Cryer at UCL on a monthly basis by the Clinical Trials Manager at the ECG Core Lab. At the beginning of a month, the previous month's batches of ECGs are checked for signature, serial comment (where appropriate), confirmation that data queries are resolved and that any edits have been appropriately carried out. The serial comparison comment will be noted on the Minnesota code sheet. If the Minnesota codes are edited, a photocopy of the Minnesota code sheet with Professor Macfarlane's comment will be attached to the 'Confirmed' ECG and code sheet and sent with the normal batches of ECGs. A daily tracking list of all ECGs received during that month is sent with the batches of ECGs. Any 'not saved' ECGs which have been faxed are sent with the automated batches of ECGs. A second copy of each ECG with a copy of the daily tracking list will be included to be used for sending to GPs. Prior to posting, an email is sent to UCL indicating the date and number of ECGs received each day for the appropriate month. An email confirming receipt of the monthly batch of ECGs is requested from BRHS.

6. Monthly Digital ECG Data

The IT Systems Manager at the ECG Core Lab is responsible for sending the digital ECG list and results files to Lucy Lennon / Jane Cryer at UCL. The list file and result file for ECGs received in the previous month are sent to BRHS on a monthly basis. The list file contains patient demographics and the results file contains the Minnesota codes for the ECGs received in the previous month. The IT Systems Manager creates the results and list file once the Clinical Trials Manager has confirmed that all the ECGs for the previous month have been reviewed, data queries have been resolved and editing has been carried out. The data files are created and then encrypted using WinZip and sent electronically to BRHS by the IT Systems Manager. An email confirming receipt of the monthly digital ECG data is requested from the BRHS staff.

7. ECG Core Lab Contact Details

First point of contact:
Louise Inglis, Clinical Trials Manager
Tel: 0141 552 7089, Email: louise.inglis@clinmed.gla.ac.uk

Fax number for receipt of faxed ECGs:
Tel: 0141 552 7089

Contact for ECG technical problems / Digital ECG Data:
Shahid Latif, IT Systems Manager
Tel: 0141 211 4860 Email: shahid.latif@clinmed.gla.ac.uk

ECG Core Lab Director
Professor Peter W Macfarlane
Tel: 0141 211 4724, Email: peter.w.macfarlane@clinmed.gla.ac.uk

8. Storage of Data

All electronic and paper documentation relating to the British Regional Heart Study will be appropriately retained and filed. Paper documentation will be filed in a designated filing cabinet and stored in a secure alarmed location. The electronic and paper documentation will be made available for audit, as required.

University of Glasgow

APPENDIX D

BRHS ECG FAXING GUIDELINES

ADDENDUM A

ECGs which have the following statements only, even in combination, <u>do not</u> require to be faxed urgently to Glasgow:
Rhythm
Possible ectopic atrial rhythm
Supraventricular extrasystoles
Borderline first degree AV block
First degree AV block where PR < 240 ms [PR interval is printed on the report]
Atrial Abnormality
Possible left atrial abnormality
MI
Possible old inferior myocardial infarction
Possible inferior infarct – age undetermined
Other QRS
Possible right ventricular hypertrophy
Poor R wave progression – etc.
ST Elevation
Consider pericarditis
Extensive ST elevation suggests pericarditis
Possible early repolarisation
T Wave
……. T wave changes are non specific
ECGs with the following statements should be faxed urgently to Glasgow
- Acute myocardial infarction
- Ventricular tachycardia
- AV dissociation
- Bradycardia < 40/minute
- Atrial Fibrillation with rapid ventricular response (>=120)

a) We do not wish to stop the sending of faxes. We are only suggesting how to minimise the number of faxes sent.

b) The guidelines list specifically states that, if these are the **ONLY** statements on an ECG, then there is no need to send it to us.

c) If a participant is complaining of chest pain, he/she should be advised to consult with his/her GP **IRRESPECTIVE** of the ECG interpretation.

d) With respect to an emergency, the nurses should send the ECG to Glasgow for urgent review. The ECG will be reviewed immediately and the result relayed to the respective centre by telephone and/or fax.

ADDENDUM B

CREATING AND MANAGING DATA QUERY PASSWORD PROTECTED DOCUMENTS:

When managing a Data Query in a study which involves documenting participant demographics, i.e. 'sensitive' data, the request for participant information must be noted in a password protected Word document as an attachment to an email and sent to the study centre or to the Clinical Trials Manager at the ECG core lab in Glasgow. The agreed password remains the same for the ECG core lab and UCL when sending or replying to a data query raised by either group.

Creating a protected Word document to send to the ECG core lab:

Create a Word document Data Query Folder to contain all data query documents
Create a new Word document for each query and enter the details of the query with full patient demographics as required
Save the document to the Data Query Folder using a study specific ID if possible, e.g. Hs123456
Select Tools tab
Select Options tab (bottom of the list)
Select the Security tab

- There is a section where it asks for the Password to be entered, which would allow the recipient to view the document – Enter agreed password
- There is a second section where it asks for the Password to be entered again, which will allow the 'sharing option', i.e. the recipient can also open and edit the document – Enter agreed password
- You will be asked to Enter the password again twice to CONFIRM the password
- Word document is now password protected and if all the required information has been entered in the Word document – Close document

Create Email and a short message re the data query but do not enter any participant demographic details. If possible, enter a relevant word or the data query ID number, e.g. Hs123456 into the email subject heading which will help to relate the data query to the protected Word document
Attach the protected Word document to the email and Send as normal to the Clinical Trials Manager

The Clinical Trials Manager can open the Word document only by entering the agreed password twice.

Handling a data query sent from the ECG Core Lab:

A data query sent from the ECG core lab in Glasgow will have been attached to an email and the subject heading will contain the data query ID number, e.g. DQ1800

Open the attached Word document
Enter the agreed password twice to view the Word document and to be able to edit and enter the answer to the query
Save the query to your Word document Data Query Folder
Open the query (again the password will be required)
Enter the requested information
Save the file
Password protect it as noted above
Send by email as an attachment as noted above

SETUP REPORT Page 1/2
17.06.2010 15:13:35

Setup:System
User 1-2 Select: 1
Date Format: DD.MM.YYYY
Date: 17.06.2010
Time: 15:13:35
Language: English
Height Units: IN.
Weight Units: LB.
Inst. Name: BRH Study
Paper Type: Assurance
Paper Size: A4 (8.27 x 11.69)
Administrative Password: OFF
Directory Password: OFF
AC Mains Frequency: 50 Hz
Battery Saver Mode: ON
Battery Saver Timeout(secs): 900
Waveform Grid: ON
Keypad Revision: Revision 2
Adjust Backlight:

Setup:Patient
Last Name: ON
First Name: ON
Date of Birth: ON
Age: ON
Age Format: ON
Gender: ON
Race: OFF
Medication 1: ON
Medication 2: ON
Class 1: ON
Class 2: ON
Height: OFF
Weight: OFF
Systolic BP: OFF
Diastolic BP: OFF
Department: OFF
Room: OFF
Technician: OFF
Physician: OFF
User Field: OFF
V3 Placement: OFF
Comment: ON

Setup:Waveform Preferences
Speed: 25 mm/s
Gain: 10 mm/mV
Artifact Filter: 40 Hz
Baseline Filter: STABLE Baseline
Line Filter: ON
Pacer Enhancement: ON
Lead Group: Custom 1

Setup:ECG:Report Format
12 Lead Format: STANDARD 4 CHANNEL
Rhythm Lead Ch.1: LEAD II
Print Rhythm Page: OFF
Print Median Complex Page: OFF
Number Of Copies: 0

Setup:ECG:Sequence
Wait for Good Data: ON
Auto Print: ON
Auto Save: Prompt
Auto Send: OFF

Setup:ECG:Interpretation Preferences
Analysis Statements: BRIEF
Print Interpretation on Original: ON
Print Interpretation on Copies: OFF
Bradycardia Limit: 60
Tachycardia Limit: 100
QTc Formula: Hodges

Setup:Custom 1
Custom 1: STANDARD LIMB 6-CHANNEL

Setup:Custom 2
Custom 2: STANDARD 12-CHANNEL

Setup:Printhead Resistance
Printhead Resistance: 1175

Setup:Directory
View Directory: View By Id

Setup:Auto Rhythm
Auto Rhythm Pages: 1

APPENDIX D

APPENDIX D

Setup:Send Receive:Network Connection
Network Type: Disabled

Setup:Send Receive:EMR Connection
Connection: Modem
EMR Description: GRI Connection
EMR Phone #: 901415528009
Phone Type: TOUCH TONE
Institution Number: 21
Device Id: 5191

Setup:Send Receive:Fax
Fax: Disabled

Setup:Send Receive:Email
Email: Disabled

Setup:Printer
Plain Paper Printing: OFF

Features Menu
Analysis Feature: ON
Measurements Feature: ON
Storage 150 Feature : OFF
Storage 300 Feature : OFF
Bluetooth Feature: OFF
802.11 Feature: ON
Communications Feature: ON

Option Key #1(G9YL-EEQML-G22P):
. Analysis:
. Measurements:
. 802.11:
. Communications:

The Minnesota Code Classification System† for Electrocardiographic Findings

Q and QS Patterns

(Do not code in the presence of WPW code 6-4-1.) To qualify as a Q- or QS-wave, the deflection should be at least 0.1 mV (1 mm in amplitude).

Anterolateral site (leads I, aVL, V_6)

1-1-1 Q/R amplitude ratio ≥ 1/3, plus Q duration ≥ 0.03 sec in lead I or V_6.

1-1-2 Q duration ≥ 0.04 sec in lead I or V_6.

1-1-3 Q duration ≥ 0.04 sec, plus R amplitude ≥ 3 mm in lead aVL.

1-2-1 Q/R amplitude ratio ≥ 1/3, plus Q duration ≥ 0.02 sec and < 0.03 sec in lead I or V_6.

1-2-2 Q duration ≥ 0.03 sec and < 0.04 sec in lead I or V_6.

1-2-3 QS pattern in lead I. Do not code in the presence of 7-1-1.

1-2-8 Initial R amplitude decreasing to 2 mm or less in every beat (and absence of codes 3-2, 7-1-1, 7-2-1, or 7-3 between V_5 and V_6. (All beats in lead V_5 must have an initial R > 2 mm.)

1-3-1 Q/R amplitude ratio ≥ 1/5 and < 1/3, plus Q duration ≥ 0.02 sec and < 0.03 sec in lead I or V_6.

1-3-3 Q duration ≥ 0.03 sec and < 0.04 sec, plus R amplitude ≥ 3 mm in lead aVL.

Posterior (inferior) site (leads II, III, aVF)

1-1-1 Q/R amplitude ratio ≥ 1/3, plus Q duration ≥ 0.03 sec in lead II.

1-1-2 Q duration ≥ 0.04 sec in lead II.

1-1-4 Q duration ≥ 0.05 sec in lead III, plus a Q-wave amplitude ≥ 1.0 mm in the majority of beats in lead aVF.

1-1-5 Q duration ≥ 0.05 sec in lead aVF.

1-2-1 Q/R amplitude ratio ≥ 1/3, plus Q duration ≥ 0.02 sec and < 0.03 sec in lead II.

1-2-2 Q duration ≥ 0.03 sec and < 0.04 sec in lead II.

1-2-3 QS pattern in lead II. Do not code in the presence of 7-1-1.

1-2-4 Q duration ≥ 0.04 sec and < 0.05 sec in lead III, plus a Q-wave ≥ 1.0 mm amplitude in the majority of beats in aVF.

1-2-5 Q duration ≥ 0.04 sec and < 0.05 sec in lead aVF.

1-2-6 Q amplitude ≥ 5.0 mm in leads III or aVF.

1-3-1 Q/R amplitude ratio ≥ 1/5 and < 1/3, plus Q duration ≥ 0.02 sec and < 0.03 sec in lead II.

1-3-4 Q duration ≥ 0.03 sec and < 0.04 sec in lead III, plus a Q-wave ≥ 1.0 mm amplitude in the majority of beats in lead aVF.

1-3-5 Q duration ≥ 0.03 sec and < 0.04 sec in lead aVF.

1-3-6 QS pattern in each of leads III and aVF. (Do not code in the presence of 7-1-1.)

Anterior site (leads V_1, V_2, V_3, V_4, V_5)

1-1-1 Q/R amplitude ratio ≥ 1/3 plus Q duration ≥ 0.03 sec in any of leads V_2, V_3, V_4, V_5.

1-1-2 Q duration ≥ 0.04 sec in any of leads V_1, V_2, V_3, V_4, V_5.

1-1-6 QS pattern when initial R-wave is present in adjacent lead to the right on the chest, in any of leads V_2, V_3, V_4,V_5, V_6.

1-1-7 QS pattern in all of leads V_1-V_4 or V_1-V_5.

1-2-1 Q/R amplitude ratio ≥ 1/3, plus Q duration ≥ 0.02 sec and < 0.03 sec, in any of leads V_2, V_3, V_4, V_5.

1-2-2 Q duration ≥ 0.03 sec and < 0.04 sec in any of leads V_2, V_3, V_4, V_5.

1-2-7 QS pattern in all of leads V_1, V_2, and V_3. (Do not code in the presence of 7-1-1).

1-2-8 Initial R amplitude decreasing to 2.0 mm or less in every beat (and absence of codes 3-2, 7-1-1, 7-2-1, or 7-3) between any of leads V_2 and V_3, V_3 and V_4, or V_4 and V_5. (All beats in the lead immediately to the right on the chest must have an initial R > 2 mm.)

1-3-1 Q/R amplitude ratio ≥ 1/5 and < 1/3 plus Q duration ≥ 0.02 and < 0.03 sec in any of leads V_2, V_3, V_4, V_5.

1-3-2 QS pattern in lead V_1 and V_2. (Do not code in the presence of 3-1 or 7-1-1.)

QRS Axis Deviation

(Do not code in presence of low-voltage QRS, code 9-1, WPW 6-4-1, ventricular conduction defects, or 7-1-1, 7-2-1, and 7-4.)

2-1 Left. QRS axis from -30^0 through -90^0 in leads I, II, III. (The algebraic sum of major positive and major negative QRS waves must be zero or positive in I, negative in III, and zero or negative in II.)

2-2 Right. QRS axis from $+120^0$ through -150^0 in leads I, II, III. (The algebraic sum of major positive and major negative QRS waves must be negative in I, and zero or positive in III, and in I must be one-half or more of that in III.)

2-3 Right (optional code when 2-2 is not present). QRS axis from $+90^0$ through $+119^0$ in leads I, II, III. (The algebraic sum of major positive and major negative QRS waves must be zero or negative in I and positive in II and III.)

2-4 Extreme axis deviation (usually S1, S2, S3 pattern). QRS axis from -90^0 through -149^0 in leads I, II, and III (The algebraic sum of major positive and major negative QRS waves must be negative in each of leads I, II, and III.)

2-5 Indeterminate axis QRS axis approximately 90^0 from the frontal plane. (The algebraic sum of major positive and major negative QRS waves is zero in each of leads I, II and III, or the information from these three leads is incongruous.)

High Amplitude R Waves

3-1 Left: R amplitude > 26 mm in either V_5 or V_6, or R amplitude > 20.0 mm in any of leads I, II, III, aVF, or R amplitude > 12.0 mm in lead aVL. (All criteria measured only on second to last complete normal beat.)

3-2 Right: R amplitude ≥ 5.0 mm and R amplitude ≥ S amplitude in the majority of beats in lead V_1, when S amplitude is > R amplitude somewhere to the left on the chest of V_1 (codes 7-3 and 3-2, if criteria for both are present).

3-3 Left (optional code when 3-1 is not present): R amplitude > 15.0 mm but ≤ 20.0 mm in lead I, or R amplitude in V_5 or V_6, plus S amplitude in V_1 > 35.0 mm. (Measured only on second to last complete normal beat.)

3-4 Criteria for 3-1 and 3-2 both present.

ST Junction (J) and Segment Depression

(Do not code in the presence of codes 6-4-1, 7-1-1, 7-2-1 or 7-4. When 4-1, 4-2, or 4-3 is coded, then a 5-code must also be assigned except in lead V_1.)

Anterolateral site (leads I, aVL, V_6)

4-1-1 STJ depression ≥ 2.0 mm and ST segment horizontal or downward sloping in any of leads I, aVL, or V_6.

4-1-2 STJ depression ≥ 1.0 mm but < 2.0 mm, and ST segment horizontal or downward sloping in any of leads I, aVL, or V_6.

4-2 STJ depression ≥ 0.5 mm and < 1.0 mm and ST segment horizontal or downward sloping in any of leads I, aVL, or V_6.

4-3 No STJ depression as much as 0.5 mm but ST segment downward sloping and segment or T-wave nadir ≥ 0.5 mm below P-R baseline, in any of leads I, aVL, or V_6.

4-4 STJ depression ≥ 1.0 mm and ST segment upward sloping or U-shaped, in any of leads I, aVL, or V_6.

Posterior (inferior) site (leads II, III, aVF)

4-1-1 STJ depression ≥ 2.0 mm and ST segment horizontal or downward sloping in lead II or aVF.

4-1-2 STJ depression ≥ 1.0 mm but < 2.0 mm and ST segment horizontal or downward sloping in lead II or aVF.

4-2 STJ depression ≥ 0.5 mm and < 1.0 mm and ST segment horizontal or downward sloping in lead II or aVF.

4-3 No STJ depression as much as 0.5 mm, but ST segment downward sloping and segment or T-wave nadir ≥ 0.5 mm below P-R baseline in lead II.

4-4 STJ depression ≥ 1.0 mm and ST segment upward sloping, or U-shaped, in lead II.

ST Junction (J) and Segment Depression (continued)

Anterior site (leads V_1, V_2, V_3, V_4, V_5)

4-1-1 STJ depression ≥ 2.0 and ST segment horizontal or downward sloping in any of leads V_1, V_2, V_3, V_4, V_5.

4-1-2 STJ depression ≥ 1.0 mm but < 2.0 mm and ST segment horizontal or downward sloping in any of leads V_1, V_2, V_3, V_4, V_5

4-2 STJ depression ≥ 0.5 mm and < 1.0 mm and ST segment horizontal or downward sloping in any of leads V_1, V_2, V_3, V_4, V_5.

4-2 No STJ depression as much as 0.5 mm, but ST segment downward sloping and segment or T-wave nadir ≥ 0.5 mm below P-R baseline in any of leads V_2, V_3, V_4, V_5.

4-4 STJ depression ≥ 1.0 mm and ST segment upward sloping or U-shaped in any of leads V_1, V_2, V_3, V_4, V_5.

T-Wave Items

(Do not code in the presence of code 6-4-1, 7-1-1, 7-2-1 or 7-4.)

Anterolateral site (leads I, aVL, V_6)

5-1 T amplitude negative 5.0 mm or more in either of leads I, V_6, or in lead aVL when R amplitude is ≥ 5.0 mm.

5-2 T amplitude negative or diphasic (positive-negative or negative-positive type) with negative phase at least 1.0 mm but not as deep as 5.0 mm in lead I or V_6, or in lead aVL when R amplitude is ≥ 5.0 mm.

5-3 T amplitude zero (flat), or negative, or diphasic (negative-positive type only) with less than 1.0 mm negative phase in lead I or V_6, or in lead aVL when R amplitude is ≥ 5.0 mm.

5-4 T amplitude positive and T/R amplitude ratio < 1/20 in any of leads I, aVL, V_6; R wave amplitude must be ≥ 10.0 mm.

Posterior (inferior) site (leads II, III, aVF)

5-1 T amplitude negative 5.0 mm or more in lead II, or in lead aVF when QRS is mainly upright.

5-2 T amplitude negative or diphasic with negative phase (negative-positive or positive-negative type) at least 1.0 mm but not as deep as 5.0 mm in lead II, or in lead aVF when QRS is mainly upright.

5-3 T amplitude zero (flat), or negative, or diphasic (negative-positive type only) with less than 1.0 mm negative phase in lead II; not coded in lead aVF.

5-4 T amplitude positive and T/R amplitude ratio < 1/20 in lead II; R wave amplitude must be ≥ 10.0 mm.

Anterior site (leads V_2, V_3, V_4, V_5)

5-1 T amplitude negative 5.0 mm or more in any of leads V_2, V_3, V_4, V_5.

5-2 T amplitude negative (flat), or diphasic (negative-positive or positive-negative type) with negative phase at least 1.0 mm but not as deep as 5.0 mm, in any of leads V_2, V_3, V_4, V_5.

5-3 T amplitude zero (flat), or negative, or diphasic (negative-positive type only) with less than 1.0 mm negative phase, in any of leads V_3, V_4, V_5.

5-4 T amplitude positive and T/R amplitude ratio < 1/20 in any of leads V_3, V_4, V_5; R wave amplitude must be ≥ 10.0 mm.

A-V Conduction Defect

6-1 Complete (third degree) A-V block (permanent or intermittent) in any lead. Atrial and ventricular complexes independent, and atrial rate faster than ventricular rate, with ventricular rate < 60.

6-2-1 Mobitz Type II (occurrence of P-wave on time with dropped QRS and T).

6-2-2 Partial (second degree) A-V block in any lead (2:1 or 3:1 block).

6-2-3 Wenckebach's Phenomenon (P-R interval increasing from beat to beat until QRS and T dropped).

6-3 P-R (P-Q) interval ≥ 0.22 sec in the majority of beats in any of leads I, II, III, aVL, aVF.

6-4-1 Wolff-Parkinson-White Pattern (WPW), persistent. Sinus P-wave. P-R interval < 0.12 sec, plus QRS duration ≥ 0.12 sec, plus R peak duration ≥ 0.06 sec, coexisting in the same beat and present in the majority of beats in any of leads I, II, aVL, V_4, V_5, V_6. (6-4-1 suppresses 1-2-3, 1-2-7, 1-2-8, 1-3-2, 1-3-6, all 3, 4, 5, 9-2, 9-4, 9-5 codes.)

6-4-2 WPW Pattern, intermittent. WPW pattern in ≤ 50% of beats in appropriate leads.

6-5 Short P-R interval. P-R interval < 0.12 sec in all beats of any two of leads I, II, III, aVL, aVF.

6-6 Intermittent aberrant atrioventricular conduction. P-R > 0.12 sec (except in presence of 6-5 or heart rate greater than 100); wide QRS complex > 0.12 sec; normal P-wave when most beats are sinus rhythm. (Do not code in the presence of 6-4-2.)

6-8 Artificial pacemaker.

Ventricular Conduction Defect

7-1-1 Complete left bundle branch block (LBBB). (Do not code in presence of 6-1, 6-4-1, 6-8, 8-2-1 or 8-2-2.) QRS duration ≥ 0.12 sec in a majority of beats in any of leads I, II, III, aVL, aVF, *plus* R peak duration ≥ 0.06 sec in a majority of beats (of the same QRS pattern) in any of leads I, II, aVL, V_5, V_6. (7-1-1 suppresses 1-2-3, 1-2-7, 1-2-8, 1-3-2, 1-3-6, all 2, 3, 4, 5, 9-2, 9-4, 9-5 codes. If any other codable Q-wave coexists with the LBBB pattern, code the Q and diminish the 7-1-1 code to a 7-4 code.)

7-1-2 Intermittent left bundle branch block. Same as 7-1-1 but with presence of normally conducted QRS complexes of different shape than the LBBB pattern.

7-2-1 Complete right bundle branch block (RBBB). (Do not code in the presence of 6-1, 6-4-1, 6-8, 8-2-1 or 8-2-2.) QRS duration ≥ 0.12 sec in a majority of beats in any of leads I, II, III, aVL, aVF, *plus*: R' > R in V_1 or V_2; or QRS mainly upright, with R peak duration ≥ 0.06 sec in V_1 or V_2; or S duration >R duration in all beats in lead I or II. (7-1 suppresses 1-2-3, 1-2-7, 1-2-8, 1-3-2, 1-3-6, all 2, 3, 4, 5, 9-2, 9-4, 9-5 codes.

7-2-2 Intermittent right bundle branch block. Same as 7-2-1 but with presence of normally conducted QRS complexes of different shape than the RBBB pattern.

7-3 Incomplete right bundle branch block. QRS duration < 0.12 sec in each of leads I, II, III, aVL, aVF, and R' > R in either of leads V_1, V_2 .(Code as 3-2 in addition if those criteria are met. 7-3 suppresses code 1-2-8.)

7-4 Intraventricular block. QRS duration ≥ 0.12 sec in a majority of beats in any of leads I, II, III, aVL, aVF. (7-4 suppresses all 2, 3, 4, 5, 9-2, 9-4, 9-5 codes.)

7-5 R-R' pattern in either of leads V_1, V_2 with R' amplitude ≥ R.

7-6 Incomplete left bundle branch block. (Do not code in the presence of any codable Q- or QS-wave.) QRS duration ≥ 0.10 sec and < 0.12 in the majority of beats of each of leads I, aVL, and V_5 or V_6.

7-7 Left anterior hemiblock (LAH). QRS duration < 0.12 sec in the majority of beats in leads I, II, III, aVL, aVF, plus Q-wave amplitude ≥ 0.25 mm and < 0.03 sec duration in lead I, plus left axis deviation of -45^0 or more negative. (In presence of 7-2, code 7-8 if axis is < -45^0 and the Q-wave in lead I meets the above criteria.)

7-8 Combination of 7-7 and 7-2.

Arrhythmias

8-1-1 Presence of frequent atrial or junctional premature beats (10% or more of recorded complexes).
8-1-2 Presence of frequent ventricular premature beats (10% or more of record complexes).
8-1-3 Presence of both atrial and/or junctional premature beats and ventricular premature beats (so that individual frequencies are < 10% but *combined* premature beats are ≥ 10% of complexes).
8-1-4 Wandering atrial pacemaker.
8-1-5 Presence of 8-1-2 and 8-1-4.
8-2-1 Ventricular fibrillation or ventricular asystole.
8-2-2 Persistent ventricular (idioventricular) rhythm.
8-2-3 Intermittent ventricular tachycardia. Three or more consecutive ventricular premature beats occurring at a rate ≥100. This includes more persistent ventricular tachycardia.
8-2-4 Ventricular parasystole (should not be coded in presence of 8-3-1).
8-3-1 Atrial fibrillation (persistent).
8-3-2 Atrial flutter (persistent).
8-3-3 Intermittent atrial fibrillation (code if 3 or more clear-cut, consecutive sinus beats are present in any lead).
8-3-4 Intermittent atrial flutter (code of 3 or more clear-cut, consecutive sinus beats are present in any lead).
8-4-1 Supraventricular rhythm persistent. QRS duration < 0.12 sec; and absent P-waves or presence of abnormal P-waves (inverted or flat in aVF); and regular rhythm.
8-4-2 Supraventricular tachycardia intermittent. Three consecutive atrial or junctional premature beats occurring at a rate ≥ 100.
8-5-1 Sinoatrial arrest. Unexpected absence of P, QRS and T, plus a R-R interval at a fixed multiple of he normal interval, ± 10%.
8-5-2 Sinoatrial block. Unexpected absence of P, QRS and T, preceded by progressive shortening of P-P intervals. (R-R interval at a fixed multiple of the normal interval, ± 10%.
8-6-1 A-V dissociation with ventricular pacemaker (without capture). Requires: P-P and R-R occur at variable rates with ventricular rate as fast as or faster than the atrial rate, plus variable P-R intervals, plus no capture beats.
8-6-2 A-V dissociation with ventricular pacemaker (with capture).
8-6-3 A-V dissociation with atrial pacemaker (without capture).
8-6-4 A-V dissociation with atrial pacemaker (with capture).
8-7 Sinus tachycardia (over 100/min).
8-8 Sinus bradycardia (under 50/min).
8-9 Other arrhythmias. Heart rate may be recorded as a continuous variable.

ST Segment Elevation

Anterolateral site (leads I, aVL, V_6)

9-2 ST segment elevation ≥ 1.0 mm in any of leads I, aVL, V_6.

Posterior (inferior) site (leads II, III, aVF)

9-2 ST segment elevation ≥ 1.0 mm in any of leads II, III, aVF.

Anterior site (leads V_1, V_2, V_3, V_4, V_5)

9-2 ST segment elevation ≥ 1.0 mm in lead V5 or ST segment elevation ≥ 2.0 mm in any of leads V_1, V_2, V_3, V_4.

Miscellaneous Items

9-1 Low QRS amplitude. QRS peak-to-peak amplitude < 5 mm in all beats in each of leads I, II, III, or < 10 mm in all beats in each of leads V_1, V_2, V_3, V_4, V_5, V_6. (Check calibration before coding.)

9-3 P-wave amplitude ≥ 2.5 mm in any of leads II, III, aVF, in a majority of beats.

9-4-1 QRS transition zone at V_3 or to the right of V_3 on the chest. (Do not code in the presence of 6-4-1, 7-1-1, 7-2-1 or 7-4.)

9-4-2 QRS transition zone at V_4 or to the left of V_4 on the chest. (Do not code in the presence of 6-4-1, 7-1-1, 7-2-1 or 7-4.)

9-5 T-wave amplitude > 12 mm in any of leads I, II, III, aVL, aVF, V_1, V_2, V_3, V_4, V_5, V_6. (Do not code in the presence of 6-4-1, 7-1-1, 7-2-1 or 7-4.)

9-8-1 Technical problems which interfere with coding.

9-8-2 Technical problems which do not interfere with coding.

Incompatible Codes

The codes in the left column suppress codes in the right column.

Code	Suppress this code(s)
All Q-, QS-codes	7-6
Q > 0.03 in lead I	7-7
3-1	1-3-2
3-2	1-2-8, 7-3
6-1	All other codes except 8-2
6-4-1	All other codes
6-8	All other codes
7-1-1	1-2-3, 1-2-7, 1-2-8, 1-3-2, 1-3-6, all 2-, 3-, 4-, and 5- codes, 7-7, 9-2, 9-4, 9-5
7-2-1	1-2-8, all 2-, 3-, 4-, and 5-codes, 9-2, 9-4, 9-5
7-3	1-2-8
7-4	All 2-, 3-, 4-, and 5-codes, 9-2, 9-4, 9-5
8-1-2	8-2-4
8-1-4	8-1-1, 9-3
8-2-1	All other codes
8-2-2	All other codes
8-2-3	8-1-2
8-3-1	8-1-1, 8-1-2
8-3-2	6-2-2, 8-1-1, 8-1-2
8-3-3	8-1-1, 8-1-2
8-3-4	6-2-2
8-4-1	6-5
8-4-1 + heart rate ≥ 140	All other codes except 7-4 or 6-2
Heart rate > 100	6-5
8-4-2	8-1-1
9-1 All 2-codes	

Categories of Minnesota ECG Abnormalities

Diagnostic ECG:
(any ECG may be used for this classification)

D1. An ECG record with any Diagnostic Q-code (Minn. code 1-1-1 through 1-2-5 plus 1-2-7).

D2. An ECG record with ST-segment elevation code 9-2 PLUS (T-wave inversion code 5-1 or 5-2 in the absence of 7-2-1 or 7-4).

Equivocal ECG:
(any ECG may be used for this classification)

E1. An ECG record with an Equivocal Q-code [(Minn. code 1-2-8 in the absence of a 7-1-1 or 7-3 or (any 1-3-code)].

E2. An ECG record with ST-segment depression (code 4-1-x or 4-2 or 4-3 in the absence of 7-2-1 or 7-4), or 1-3-x.

E3. An ECG record with T-wave inversion (code 5-1 or 5-2 or 5-3 in the absence of 7-2-1 or 7-4).

E4. An ECG record with ST-segment elevation code 9-2.

Other ECG:

01. Reference ECG coded 7-1-1.

02. Any ECG coded 7-1-1.

03. Normal ECG(s), defined as 1 in "clear" field of all ECGs.

04. Other findings including 1-2-6.

Uncodable ECG:

U1. Technical errors coded 9-8-1 by Minnesota Code.

Absent ECG:

A1. No ECG available for coding.

† Prineas R, Crow R, Blackburn H. The Minnesota Code Manual of Electrocardiographic Findings. John Wright-PSG, Inc. Littleton, MA, June 1982.