

ACTIVITY BRIEF

Using blood pressure monitors

Medical professionals routinely check for health problems by measuring **vital signs**. If these stray from the normal range of values, they know that something is wrong and that a patient requires attention. Hospital patients are regularly checked for changes in their vital signs to assess their progress. They can also be used by sports scientists to assess levels of fitness. They are:

- pulse rate (normally the same as heart rate)
- body temperature
- blood pressure
- respiratory rate

Breathing volumes are also valuable in the assessment of health and fitness.

A variety of devices is available for taking these measurements. Practitioners must be familiar with their use and able to apply standard procedures to obtain accurate and reliable measurements. They also need to keep up to date, as technological advances lead to the development of new and better methods.



For example, the older methods using a pressure gauge and stethoscope to measure blood pressure are gradually being replaced by a range of modern instruments.

In the last few years, automatic digital devices have become commonplace in doctor's surgeries and hospitals. Patients can be monitored more frequently, as they can be used effectively by nursing assistants and trainee nurses. They can even be used successfully at home. However, the earlier automatic devices were not as reliable as the older methods. Some doctors still prefer to employ the methods which use a stethoscope to listen for arterial sounds. They consider them more reliable and accurate, especially for diagnosis of high blood pressure (hypertension).



The older instruments are also valuable in countries with limited resources. They are cheaper, have lower running costs (e.g. do not need batteries replacing) and have longer working lives.

Blood pressure is affected by a wide range of factors, including “white coat hypertension”. It is believed that about 25% of diagnoses of high blood pressure are due to the effect that having your blood pressure measured can raise your blood pressure! To overcome this problem, an ambulatory blood pressure monitor can be used to take measurements automatically at regular intervals over a 24 hour period.

Your brief

Medical professionals and sports scientists need to be skilled in the measurement of vital signs and related factors. They must be able to use a variety of standard procedures effectively, including those for blood pressure monitors which use a stethoscope or those which obtain readings automatically.

Your task is to follow at least one standard procedure to measure blood pressure. Your teacher will tell you which study sheets to use from:

Study Sheet: Blood pressure measurement

Study Sheet: Using an ambulatory blood pressure monitor

STUDY SHEET

Blood pressure measurement

Sphygmomanometers

Blood pressure monitors vary in type, but most non-invasive methods use an inflatable cuff which is applied to the arm and connected to a pressure meter or mercury filled manometer.

You will find two sets of instructions later.

- **Procedure 1** may be used for automatic digital devices.
- **Procedure 2** may be used for devices requiring the use of a stethoscope.

Preliminaries

- 1 Obtain the devices that you will be using. Read any accompanying instructions.
- 2 Read through the whole procedure. What are the hazards and how will you reduce the risks to acceptable levels?
 - a If a risk assessment is available for this procedure, consider whether it needs to be adapted to suit the particular circumstances of your investigation. Record any modifications you think are necessary.
 - b If there is no risk assessment available, carry one out. Use a table with the headings below or a risk assessment form that your teacher provides:

Initial risk assessment			
Hazard	Risk	Action to reduce risk (with references, e.g. HAZCARDS)	Acceptable?

- c Check your decisions with your teacher before you begin.
- 3 To obtain normal readings for a participant at rest, make sure that they:
 - a have not taken part in exercise, taken any drugs (including medicines, alcohol, tea, coffee) or smoked for at least 30 minutes beforehand
 - b are sitting quietly and comfortably for at least five minutes before the measurements are made.

Procedure 1 for automatic digital devices

This work must be supervised by your teacher/lecturer.

- 1 Check the batteries are working. If the device has a battery check mode, use this. Otherwise check that the display lights up.
- 2 Cuffs will work over thin clothing. If necessary, *loosely* roll up a sleeve out of the way. Use the Velcro fastener to attach the cuff snugly, but not tightly, around the arm. Apply an upper arm cuff above the elbow at about heart level. Apply a wrist cuff just before the wrist joint.
- 3 Support the forearm on a bench or table at about heart level, using books or similar.
- 4 Explain to the participant that the cuff will inflate and squeeze their arm quite firmly for a short while before deflating again.
- 5 Switch on the device and start the blood pressure measurement. Allow the cuff to inflate and deflate. Switch off and remove the cuff if the participant expresses any discomfort for longer than a couple of minutes (normally the cuff will deflate before you have time to remove it). Record the data for systolic and diastolic blood pressures which appear on the readout screen.
- 6 Also record pulse rate if this is given. A raised pulse rate (>80) may be a sign that the participant is under stress and possibly suffering from "white coat hypertension".
- 7 Allow the participant to relax for a few minutes and then take another set of readings. If systolic values are within 5 mm Hg of each other and likewise for diastolic pressures, find the mean values for each. If differences are greater than 5 mm Hg, repeat once more and find the mean of the two closest readings.
- 8 Record the blood pressure using the conventional method: systolic pressure in mm Hg "over" diastolic pressure in mm Hg, e.g. 120 / 80.
- 9 If values appear above normal, reassure the participant that it is not unusual for blood pressure to rise when it is being measured, causing so called "white coat hypertension". Suggest that they ask their doctor for a professional measurement to check. If values exceed 180 / 120 inform your teacher.

Procedure 2 for devices requiring the use of a stethoscope

This work must be supervised by your teacher/lecturer.

- 1 Use data tables to find and make a note of the expected normal systolic blood pressure of a person the same age as the participant. (See *Factsheet: Blood pressure*).
- 2 Make sure that the cuff is connected to the pressure meter or manometer.
- 3 Use the most convenient arm. Rest the forearm on a bench or table using books or similar to raise it slightly to just below heart level. Ask the participant to rotate their palm uppermost and slightly bend their arm at the elbow.
- 4 Use your first and second fingers to locate the pulse of the brachial artery. Do not use your thumb, which has a pulse of its own. You can find the artery just above the bend of the elbow. Slide your fingers towards the inside of the arm until they rest in a slight dip between the biceps and triceps muscles and press firmly. If you can't feel the pulse, just find the slight hollow between the muscles. This is where you will place your stethoscope.
- 5 Cuffs will work over thin clothing. If necessary, *loosely* roll up a sleeve out of the way. Use the Velcro fastener to attach the cuff snugly, but not tightly, around the arm well above the elbow at about heart level.
- 6 Explain to the participant that the cuff will inflate and squeeze their arm quite firmly for a short while before deflating again.
- 7 Ensure that the valve is closed and inflate the cuff using the rubber bulb to obtain a pressure about 20 mm Hg above the expected normal value.
- 8 Use the stethoscope to listen for thumping or whooshing sounds (Korotkoff sounds) in the brachial artery. If your stethoscope has a diaphragm, use this rather than the bell side.
 - (a) If sounds are still present gradually increase the pressure in the cuff until they just stop.
 - (b) When sounds are absent, gradually deflate the cuff by slowly opening the valve. Record the pressure reading when intermittent sounds just return. This is the *systolic* pressure.
 - (c) Continue to slowly deflate the cuff and record the pressure when the sounds just disappear. This is the diastolic pressure.
- 9 Remove the cuff and allow the participant to relax for a further five minutes if they complain of discomfort during the process.
- 10 Allow the participant to relax for a few minutes and then take another set of readings. If systolic values are within 5 mm Hg of each other and likewise for diastolic pressures, find the mean values for each. If differences are greater than 10 mm Hg, repeat once more and find the mean of the two closest readings.
- 11 Record the blood pressure using the conventional method: systolic pressure in mm Hg "over" diastolic pressure in mm Hg, e.g. 120 / 80.
- 12 If values appear above normal, reassure the participant that it is not unusual for blood pressure to rise when it is being measured, causing so-called "white coat hypertension". Suggest that they ask their doctor for a professional measurement to check. If values exceed 180 / 120 inform your teacher.

STUDY SHEET

Using an ambulatory blood pressure monitor (ABPM)

Preliminaries

- 1 Obtain the devices that you will be using. Read any accompanying instructions.
- 2 Read through the whole procedure. What are the hazards and how will you reduce the risks to acceptable levels?
 - a If a risk assessment is available for this procedure, consider whether it needs to be adapted to suit the particular circumstances of your investigation. Record any modifications you think are necessary.
 - b If there is no risk assessment available, carry one out. Use a table with the headings below or a risk assessment form that your teacher provides:

Initial risk assessment			
Hazard	Risk	Action to reduce risk (with references, e.g. HAZCARDS)	Acceptable?

- c Check your decisions with your teacher before you begin.

Procedure for ambulatory blood pressure monitor (ABPM)

- 1 Check the batteries are working. If the device has a battery check mode, use this. Otherwise check the instructions on battery use and life.
- 2 Allow at least five minutes for patient to relax in a quiet room.
- 3 Enter patient's personal details such as age into the monitor.
- 4 Measure blood pressure (BP) in both arms.
- 5 If the BP difference is less than 10 mm Hg use non-dominant arm.
- 6 If the BP difference is equal to or greater than 10 mm Hg use higher pressure arm.
- 7 Select appropriate cuff - see British Hypertension Society guidelines, e.g. http://www.bhsoc.org/bp_monitors/BLOOD_PRESSURE_1784b.pdf
- 8 Select frequency of measurement to 30 minutes day and night (unless otherwise indicated).
- 9 Inactivate LCD display.

10 Give patient written instructions and diary. The written instructions explain:

- how to use the ABPM
- how to take blood pressure readings
- what to include in their diary
- helpline details.

The diary should contain information about:

- level of activity at time of blood pressure measurement
- time of going to bed
- time of rising
- time of taking medication
- record any symptoms.

11 Printout the results and chart them for analysis.

If values exceed 180 / 120 seek medical advice.

FACT SHEET

How blood pressure is measured

Non-invasive techniques

Non-invasive techniques measure changes from outside the body.

The inflatable cuff

The most common methods use an inflatable cuff around the upper arm or wrist to apply enough pressure to stop the blood flow through the brachial or radial arteries.

The cuff is then slowly deflated until maximum arterial pressure is just enough to cause an intermittent blood flow. This is the systolic pressure. It is found by detecting the whooshing or thumping sounds of turbulent blood flow (Korotkoff sounds) using a stethoscope, or by using an automatic pressure sensor.

The cuff is then further deflated to find a lower pressure at which the sounds just disappear. This is the diastolic pressure. It is the minimum pressure in the artery. At this point the cuff just causes no constriction, so that blood flow is smooth with no turbulence. Methods which use a stethoscope are called *auscultatory*, from the Latin for *listening*.

Sources of error

A number of factors affect the accuracy of this method, including the subjective nature of the decisions of when sounds just start and just stop. There is also the problem that, for many people, having blood pressure measured causes it to rise. This phenomenon is known as white-coat hypertension. Using the incorrect cuff size is a major source of error. Undersized cuffs give too high a pressure, whereas oversized cuffs give too low a pressure.

Automated devices

Automatic devices use a variety of methods for detecting pressure changes in arteries. Oscillometric methods use an electronic pressure sensor instead of the expert with a stethoscope. The cuff is inflated and released by an electronically operated pump and valve. Cuff pressure becomes constant when blood flow ceases or is unrestricted. Restricted blood flow oscillates – it varies in accordance with the cardiac cycle. Systolic and diastolic pressures are computed from matching the pattern of oscillations to the pressure changes.



Automated devices are simple to use and avoid the errors associated with identifying the sounds in the arteries. They do not require experts to use them and are suitable for home monitoring.

It is possible to obtain a blood pressure profile, rather than an isolated measurement. Modern ambulatory blood pressure monitors (ABPMs) use computer assisted analysis for automatic monitoring. They are small enough to be worn on a belt. The machine is

connected to cuff that is worn continuously for 24 hours. Readings can be taken every 15 to 30 minutes over this period. Home monitoring is possible, preventing anxiety.

Diagnosis is more accurate, for example by:

- avoiding white-coat hypertension
- deciding diagnosis in borderline hypertension
- identifying elderly patients in need of treatment
- identifying nocturnal hypertension
- aiding diagnosis of hypotension

ABPMs also allow the effectiveness of treatment to be analysed, for example to test the success of a drug at a given dose.

Sources of error

Oscillometric devices may produce inaccurate readings for patients with irregular heartbeats. They also tend to drift and need to be recalibrated regularly. Wrist cuffs tend to give higher readings than upper arm cuffs.

Invasive techniques

Blood pressure can be measured directly, and most accurately, by inserting a needle attached to a tube (cannula) into an artery. The tube contains sterile fluid and is connected to an electronic pressure sensor. Pressure is constantly monitored, beat by beat, and shown on a visual display.

This technique is normally only used in hospital as there is a risk of severe bleeding if the needle is displaced. Constant supervision is necessary. Rapid variations in blood pressure can be detected, so this is useful in surgery and for patients undergoing intensive care for life-threatening conditions such as heart attacks. Usually, systolic, diastolic and mean pressures are displayed. High and low alarm limits can be set to give warning of a dangerous change.

FACT SHEET

Blood pressure terms and values

Why measure blood pressure?

Measurements of blood pressure are one of the “vital signs” used by medical and sports professionals as indicators of fitness and health. If blood pressure strays out of the normal range, it generally means that remedial action is necessary.

Related terms

- **Sphygmomanometer** (sometimes sphygmometer): a device which measures blood pressure, usually by means of an inflatable cuff connected to a column of mercury (with a graduated scale) or to another form of pressure meter.
- **Systolic pressure (SBP)**: the maximum pressure in an artery generated by the heart during ventricular systole (contraction).
- **Diastolic pressure (DBP)**: the lowest pressure in an artery during diastole, when the heart is relaxed.
- **mm Hg**: millimetres of mercury. The units normally used to measure blood pressure, though kiloPascals (kPa) are sometimes used. It derives from the use of mercury manometers to measure blood pressure. The first measurement was made by connecting a mercury column to the artery of a horse.
- **Hypertension**: having blood pressure above the normal range for the age group and gender.
- **Hypotension**: having blood pressure below the normal range for the age group and gender.
- **Brachial artery**: the major blood vessel of the upper arm, it branches from or near to the aorta and runs between the biceps and triceps muscles.
- **Radial artery**: the major artery in the wrist.
- **Korotkoff sounds** (variously spelled, e.g. also Korotov): whooshing or thumping sounds heard in a constricted artery, due to turbulent flow of the blood.

Blood pressure values

In the UK, high blood pressure or hypertension is defined as SBP above 140 or DBP above 90 for anyone. “Normal” blood pressure values have been taken as the averages for particular groups. Factors such as age, gender and race influence blood pressure values. In children values tend to be lower. In old people they are usually higher, largely due to reduced flexibility of the arteries. Pressure also varies with exercise, emotional reactions, sleep, digestion and time of the day.

Examples of normal blood pressure values / mmHg

18 year old male	120/80	20 year old male	125/80	40 year old male	135/85
		20 year old female	123/80	40 year old female	133/85

Teacher notes

This activity links to **AQA A2 Unit 9: Sports science**

Specification content related to this activity:

18.1 About this Unit

In this unit you will learn about:

- *how to take measurements which relate to assessing a person's health and fitness;*

18.2 How you will be assessed

You need to produce a portfolio of evidence which shows the links between exercise, sport, injury and the human body.

Your portfolio of evidence should comprise:

A. a personal health and fitness programme to prepare yourself, or another person, for participation in a particular sport over a four-week period by:

- *carrying out appropriate research into the person and sport and linking this research to the aspect to be improved*
- *identifying in your programme initial and final measurements that you will need to take in order to, at the end of the four-week period, assess the overall effectiveness of the programme providing quantitative experimental data (initial and final measurements) to assess the specified outcomes over the four week period of the programme*
- *evaluating the programme at the end of the four-week period in terms of the specified outcomes including relating these to the initial and final measurements that you have taken.*

18.3 You need to know, understand and be able to demonstrate

Health and fitness

In connection with sporting activities you will learn how to take measurements of ... vital capacity, blood pressure...

- *devise and implement a suitable four-week programme to improve the stated aspect of health and fitness*
- *take relevant measurements at the start and the end of the health and fitness programme*
- *explain the significance of these measurements*
- *interpret these measurements in relation to particular cases.*

These measurements are important in terms of your fitness programme in order for you to:

- *state which aspects of fitness you are aiming to improve*
- *assess your (or another person's) health, fitness and performance at the start of a fitness/training programme*
- *assess your (or another person's) health, fitness and performance at the end of a fitness/training programme*
- *use the data obtained to evaluate the effectiveness of the programme.*

This activity may also be useful for:

- AQA A2 Unit 8 Medical physics
- AQA A2 Unit 14 The healthy body

Aims and teaching strategies

These activities provide the standard procedures for methods which may be employed to measure blood pressure at the beginning and end of a fitness programme. Methods are provided for automatic digital devices, for using a manually inflated cuff and stethoscope and for ambulatory blood pressure monitoring.

Study Sheet: Blood pressure measurement

'Once-off' use of the techniques will need one lesson to carry out measurements, with time for a short follow-up discussion. Students may work in pairs or threes and rotate roles. In a threesome, one may act as a participant, another use the device to take measurements and the third can record measurements and other observations. Longer lessons or follow-up sessions could be used to explore the effects of exercise on the parameters measured.

Students may become concerned if they have BP values above normal. They should be reassured that such readings are not unusual, as having your blood pressure taken can cause it to rise ('white coat hypertension'). If readings consistently exceed 180 / 120 (use another device for confirmation), medical assistance should be sought immediately.

If time allows, students can take a BP measurement in each arm and repeated measurements to find a mean for the arm with the highest pressure. Further measurements for comparison must be made using the same arm and the same instrument.

Study sheet: Using an ambulatory blood pressure monitor

If an ambulatory blood pressure monitor is available, students could work in pairs or small groups to discuss its use and results, but individuals will need to have exclusive use of the instrument for a 24 hour period to obtain a complete set of results.

Students could use the device for shorter periods, to make it possible for more of them to have experience of using it.

Requirements

Each group will need a blood pressure monitor with associated instructions. Aneroid upper arm and digital wrist sphygmomanometers can be obtained for as little as £20.

Health and safety

Students should carry out risk assessments and these should be checked before they start any activity.

If mercury containing manometers are used, students should be aware of the necessary safety precautions and spillage kits should be on hand.

Do not allow students to carry out blood pressure measurements unsupervised. Sometimes students experience dizziness or fainting if the cuff pressure is too high for too long. The bulb operated cuff type in particular can be over inflated and cause pain.

Resources

Two fact sheets are provided:

Fact sheet: Blood pressure terms and values

Glossary of terms, hypertensive and some comparative normal values given

Fact sheet: How blood pressure is measured

Description of auscultatory and oscillometric methods. Manual and automatic methods, including ambulatory blood pressure monitoring, are compared and sources of error suggested.

The British Hypertension Society

Useful information can be found at the website of the BHS. They provide a DVD on blood pressure measurement for £5.99 and supporting materials that include:

Auscultatory tutorials and answer sheet

Latest hypertension management guidelines

BHS Posters on BP measurement with mercury and electronic monitors

BHS Factfile on Blood Pressure Measurement

BPA Guide to measuring blood pressure at home and table to record readings

NHLBI BP levels for children

ABC of Hypertension

Ambulatory BP monitoring

Useful posters:

- Measuring blood pressure using a digital monitor
http://www.bhsoc.org/bp_monitors/BLOOD_PRESSURE_1784a.pdf
- Measuring blood pressure using a mercury blood pressure device
http://www.bhsoc.org/bp_monitors/BLOOD_PRESSURE_1784b.pdf

Resources

Excellent guidelines for blood pressure measurement and an interactive video can be found at <http://www.abdnac.uk/medical/bhs>

The nurse distance learning course is at <http://www.bhsoc.org/pdfs/hit.pdf>

European Society of Hypertension recommendations are at http://www.bhsoc.org/bp_monitors/ESH_BP_rec.pdf

BBC Measuring Blood Pressure <http://www.bbc.co.uk/dna/h2g2/A706763>

NetDoctor

http://www.netdoctor.co.uk/health_advice/examinations/measuringbloodpressure.htm

Detailed site, including proper technique

<http://highbloodpressure.about.com/od/highbloodpressure1>

Blood Pressure Association <http://www.bpassoc.org.uk/>

Invasive arterial blood pressure measurement <http://www.ebme.co.uk/arts/iabp/index.htm>

BMJ article on auscultatory blood pressure measurement
<http://www.bmj.com/cgi/content/full/322/7293/1043>