SAFE MOTHERHOOD

Detecting pre-eclampsia: a practical guide

Using and maintaining blood pressure equipment

MATERNAL HEALTH
AND SAFE MOTHERHOOD PROGRAMME
DIVISION OF FAMILY HEALTH
WORLD HEALTH ORGANIZATION
GENEVA

Practical Guide

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WHO/MCH/MSM/92.2
DISTR.: GENERAL

S A F E M O T H E R H O O D

Detecting pre-eclampsia: a practical guide

Using and maintaining blood pressure equipment

Richard Guidotti
David Jobson

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P r a c t i c a l G u i d e

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Contents

I. INTRODUCTION

The Hypertensive Disorders of Pregnancy (HDP) and in particular pre-eclampsia and eclampsia are a major cause of maternal deaths in the world. Although the incidence varies from region to region, eclampsia accounts for up to forty percent of maternal mortality in some countries. These guidelines, prepared by the Maternal Health and Safe Motherhood programme of the World Health Organization, are intended to help improve health workers' knowledge and clinical skills necessary for the early detection of high blood pressure, proteinuria and oedema which are hallmarks of this condition. They can be adapted by MCH programme managers for the training of staff, upgrading skills and knowledge, or as a guide for assessing training, equipment and supply needs.

The chief aim of this booklet is to provide instructions for health workers which will help identify the early signs and symptoms of pre-eclampsia, and permit early treatment and prevention of severe forms of the disease.

Blood pressure is often wrongly measured and recorded (in both developing and developed countries), though important clinical decisions depend on accurate measurement. Therefore, a large part of these guidelines is devoted to describing how blood pressure should be taken, and how to avoid making mistakes. The importance of the EARLY detection of pre-eclampsia by taking accurate blood pressure measurements, testing for protein in the urine, and detecting meaningful oedema is stressed.

Guidelines on the clinical management and treatment of severe pre-eclampsia/eclampsia, will form a companion document. The importance of having the skills, equipment and supplies to prevent and treat the convulsions (eclamptic fits) of eclampsia cannot be over-emphasized.

A part of the guidelines is devoted to the routine maintenance of the sphygmomanometer and how to detect some common errors in blood pressure recording.

It is hoped that the information contained in these guidelines will be used in order that health workers will be able to:

- take a blood pressure accurately.
- measure proteinuria.
- assess oedema meaningfully.
- detect when blood pressure equipment is faulty and know what to do about it.

II. HOW TO MEASURE BLOOD PRESSURE

A. The Equipment

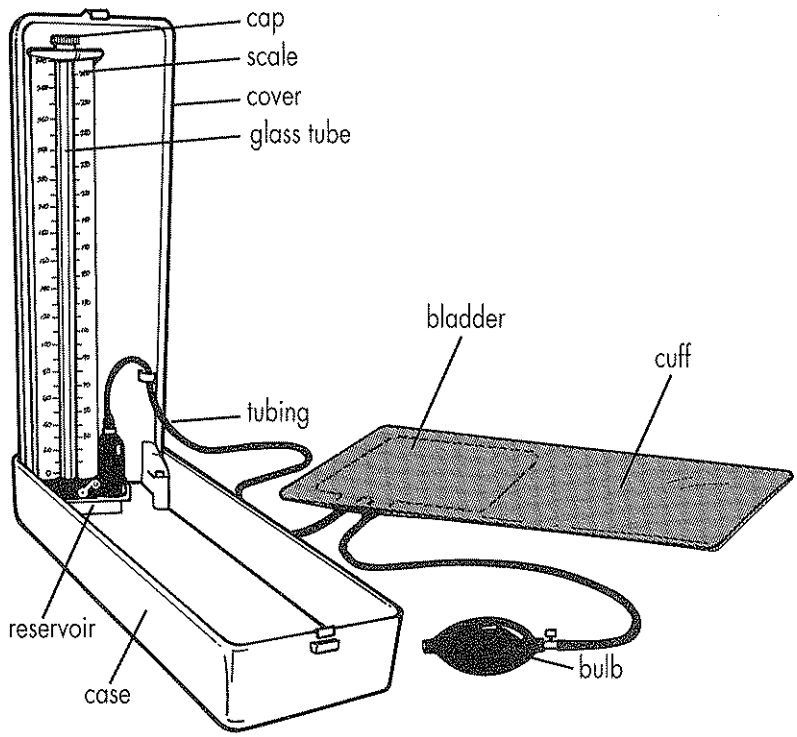
Blood pressure machines are called sphygmomanometers (often shortened to "sphyg").

There are only two types of "sphygs" commonly found – mercury and aneroid.

1. The Mercury Sphygmomanometer

The mercury sphygmomanometer is made up of a transparent (clear) glass tube with markings on the outside. This is firmly attached to a box, sometimes made of wood, sometimes of metal. Some machines have hinges and will close.

The bottom of the glass tube is connected, usually by a small rubber tube, to the bottom of a metal container or "reservoir". This container is closed. The top of the container is attached to a long rubber tube that connects to the rubber balloon or bladder.



The reservoir is full of mercury and this mercury can be seen at the bottom of the glass tube. When not in use, the level of the mercury in the glass tube should be on the zero ("0") of the scale.

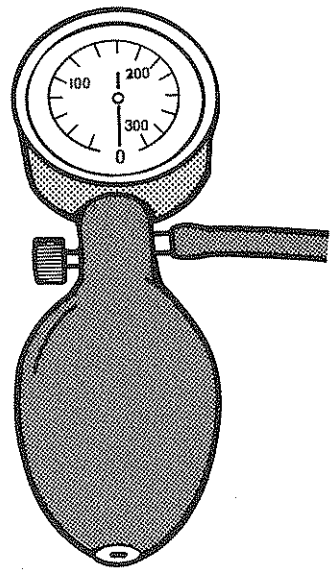
When air is pumped into the top of the closed reservoir it forces mercury out of the tube at the bottom and then up inside the glass tube.

When we measure blood pressure we note the level of the mercury in the tube.

Mercury cannot come out of the top of the glass tube because there is a leather diaphragm held in place that allows air to pass through, but not the mercury.

2. The Aneroid Sphygmomanometer

The aneroid sphygmomanometer works on a spring mechanism which can be damaged by the normal bumps and jolts of a busy clinic.



Choice of sphygmomanometer

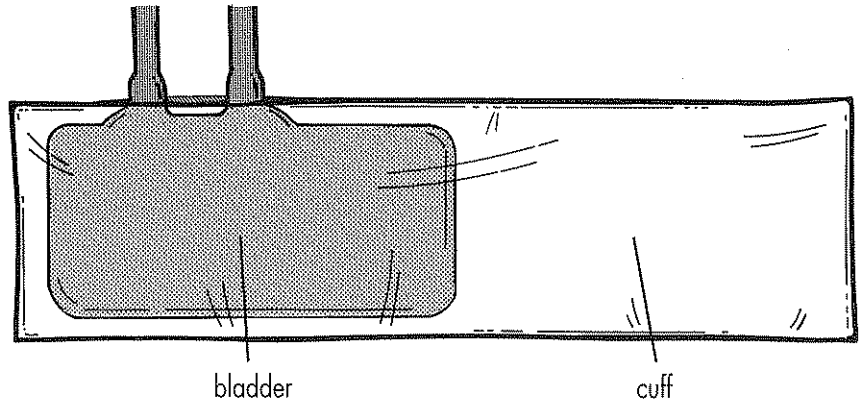
The mercury sphygmomanometer is the preferred instrument for taking blood pressure. Although the small size of the aneroid sphygmomanometer appears to make it desirable, its calibration, requiring special knowledge and tools, is more difficult to do than the calibration of the mercury type.

Mercury sphygs may leak during shipment and as a consequence are not stocked by some supply agencies. When ordering sphygs, consideration should be given to these points. Whichever instrument you choose, it must be kept carefully and its accuracy checked regularly.

3. The Cuff

The cuff is made up of an outer layer, with a pocket at one end. A rubber balloon or bladder fits inside this pocket. Usually two tubes come out of the side (some aneroids have only one).

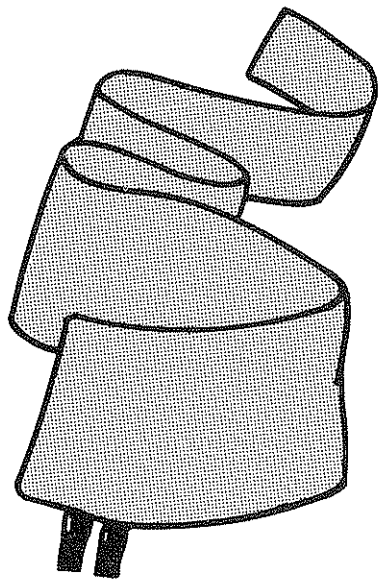
The material of the outer layer must be non-elastic so that it will not stretch. It is longer than the rubber balloon so that it can be wrapped around the upper arm and secured.



Common methods of securing the cuff around the arm are:

i) Cloth:

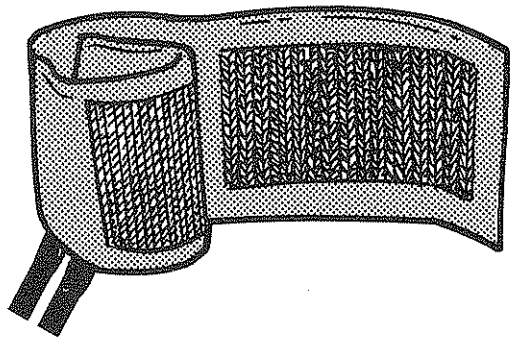
A long piece of material that will go two, three or four times round the arm. This is held in place by tucking the end under the wraps. This is the best type of covering for long term, trouble free use.



Such outer coverings can be locally made, but the material must not be too thick, and must not stretch.

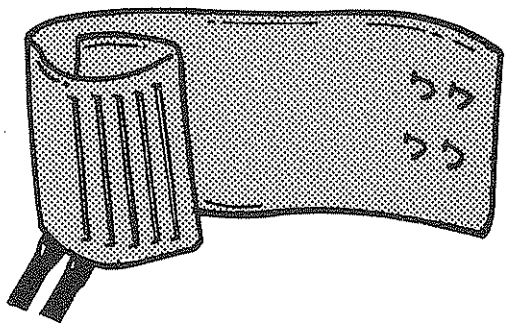
ii) Velcro:

Many small hooks on one end of the cuff lock onto a plastic hairy mat, on the opposite side of the cuff.



Velcro wears out with constant use, and then comes apart when the blood pressure is taken. Scrubbing the hooks with a dry brush may remove fluff, and temporarily improve the locking. Order a new cuff when it no longer grips or holds properly.

iii) Hooks and metal bars:



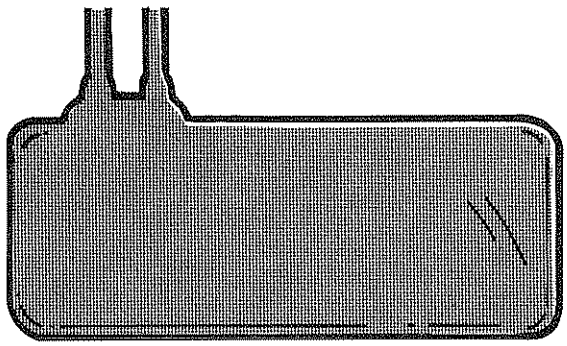
When used often the stitching tends to loosen and the bars may be lost. It may require restitching from time to time.

4. The Rubber Bladder

In some clinics the standard bladder (i.e. 11 cm [4 in] x 23 cm [9 in]) is commonly used. However, it is likely that this gives inaccurate results in women with a mid-arm circumference greater than 29 cm.

THE SIZE OF THE BLADDER IS VERY IMPORTANT

The length of the bladder should be approximately 80% of the mid-arm circumference.



A bladder that is too small will overestimate blood pressure (i.e. falsely high). A bladder that is too large will underestimate blood pressure (i.e. falsely low).

A bladder which is too short (less than 80% of the mid-arm circumference) will overestimate blood pressure (i.e. falsely high).* Data show that for most countries in the developing world, the standard bladder is long enough. It would be too short to measure blood pressure accurately in only about 1 to 5% of women. For those women with larger arms (more than 29 cm), a longer bladder should be used.

The width of the bladder should be about 40% of the mid-arm circumference, however it is felt that correct bladder length is more crucial to accuracy of blood pressure measurement.

MEASURE THE INSIDE RUBBER BLADDER YOURSELF. IS IT THE RIGHT SIZE?

USE THE CORRECT SIZE.

RECOMMENDED SIZE OF BLADDER

Mid-arm Circumference (cm)	Bladder width (cm)	Bladder length (cm)
17-29	11	23
30-42	12.5	35

You should have a general idea what a large arm looks like (measure a few to get the idea; measure when in doubt).

If you only have standard cuffs, with an 11 x 23 cm inside bladder, order larger cuffs. Keep both handy.

*There is no evidence that a bladder which encircles the arm more than 100% of the circumference will give erroneous results.

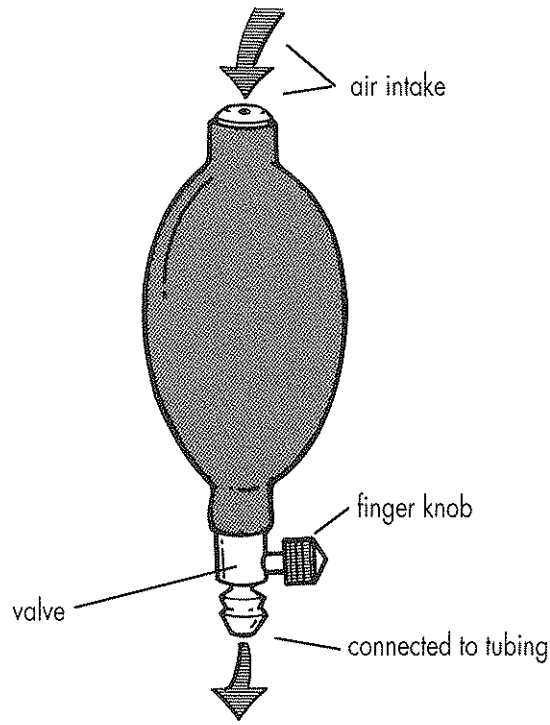
When you have only a small cuff and a patient with large (> 29 cm) arms:

i) Put the centre of the rubber bladder on the inside of the upper arm, over the pulsating brachial artery.

ii) If the bladder bulges when air is pumped in, it is usually because the material is also too small for the arm. Let out the air and wrap a cotton bandage (not a crepe one, which will stretch) around the whole cuff to prevent it bulging.

Many cuffs now have helpful markings printed on them. These usually show where the centre of the rubber bladder is to be found, so that it can be placed over the brachial artery.

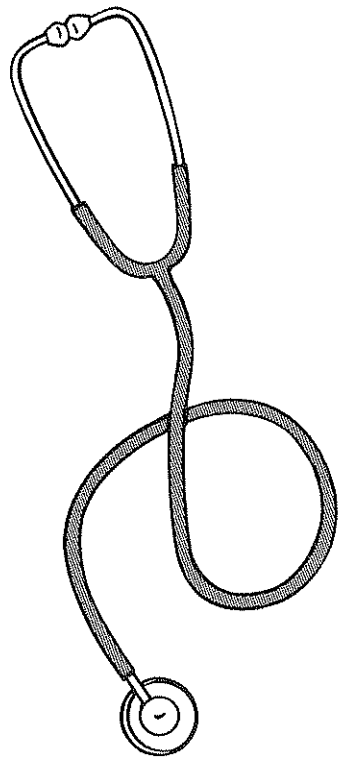
5. Pump and Control Valve



The hand pump is made of rubber and is used to inflate the cuff. The metal control valve and finger knob allow the operator to regulate the amount of air flow.

6. Stethoscope

The stethoscope should be in good condition in order to transmit sounds properly.



Stethoscopes are furnished with either a bell, a diaphragm or both.

Make sure the earpieces are not blocked with dirt and wax.

When placing the earpieces, they should face slightly forward **not** backward.

Some stethoscopes do not have curved earpieces.

i) Dual type:

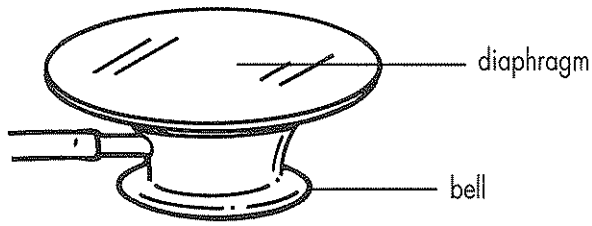
If a stethoscope has both a diaphragm and bell, determine which side is connected by gently tapping them.

Usually a half twist (turn) or some other simple mechanical arrangement will change the connection to the opposite side.

Diaphragm side – Usually the larger side, and covered by a thin sheet of plastic.

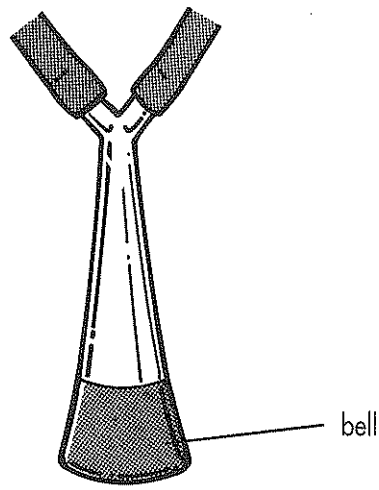
Bell side – The hollow end is in the shape of a small cup and contains a small hole. To hear properly make sure that the metal or plastic rim is in firm contact with the skin.

Because sounds generated over the blood vessels are of relatively low frequency, the bell head of the stethoscope should be used to measure blood pressure.



If the plastic splits or cracks it will not work properly. Order a new one.

ii) Single type:



B. The Patient

1. The Circumstances

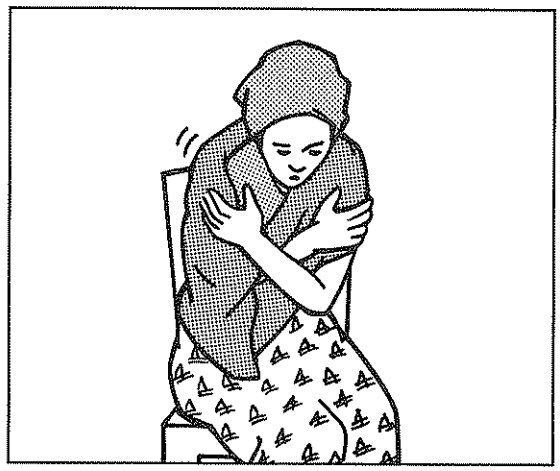
Accurate blood pressure measurement requires attention to detail. Blood pressure can rise in normal patients in the following circumstances.

FEAR

Fear raises blood pressure, so be calm and do not hurry. Happy relaxed patients have lower blood pressures.

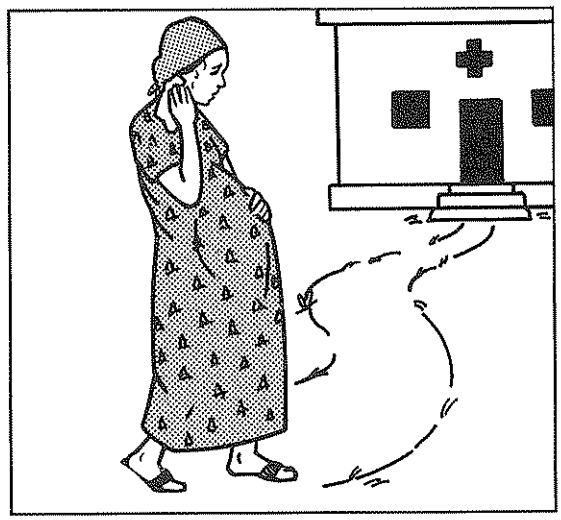
COLD

Whenever possible keep the clinic warm.



FULL URINARY BLADDER

This may make the blood pressure rise.

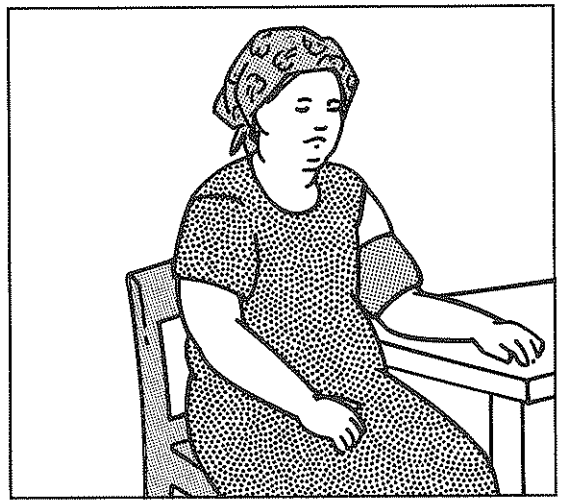


EXERCISE

If patients have just arrived at the clinic, let them rest for 5, preferably 10 minutes before taking their blood pressure. Even walking at the end of pregnancy is strenuous.

Note that people who demonstrate higher blood pressures under stressful conditions like fear, cold, a full bladder, exercise, etc. may be at a higher risk of developing hypertension in pregnancy and should receive closer attention.

An abnormal blood pressure reading must be rechecked after 10-15 minutes. The patient should be relaxed and comfortable.



OBESITY

(Mid-arm circumference greater than 29 cm)

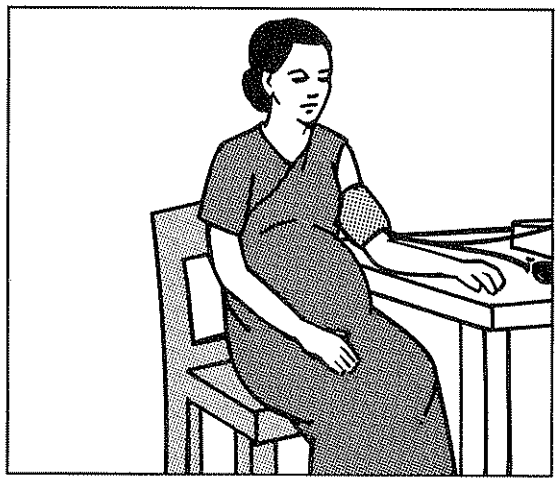
Overweight patients do not usually have higher blood pressure BUT small cuffs cause falsely high readings. Remember that the rubber bladder inside the cuff should go at least 80% of the way round the arm. (If a large cuff is not available, place the middle of the rubber bladder over the inside of the arm.)

REMEMBER :

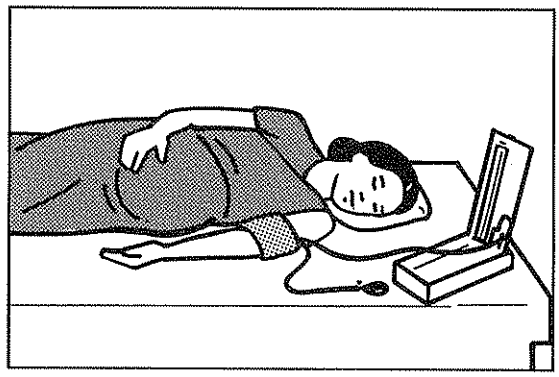
ORDER A PROPER SIZED CUFF FOR THE FUTURE. YOU MUST HAVE THE CORRECT EQUIPMENT TO DO YOUR JOB PROPERLY.

2. Position of the Patient

The sitting position is acceptable for blood pressure measurement.

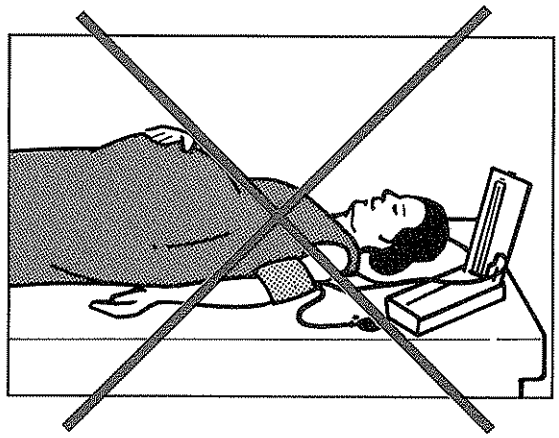


Lying on the left side is good.



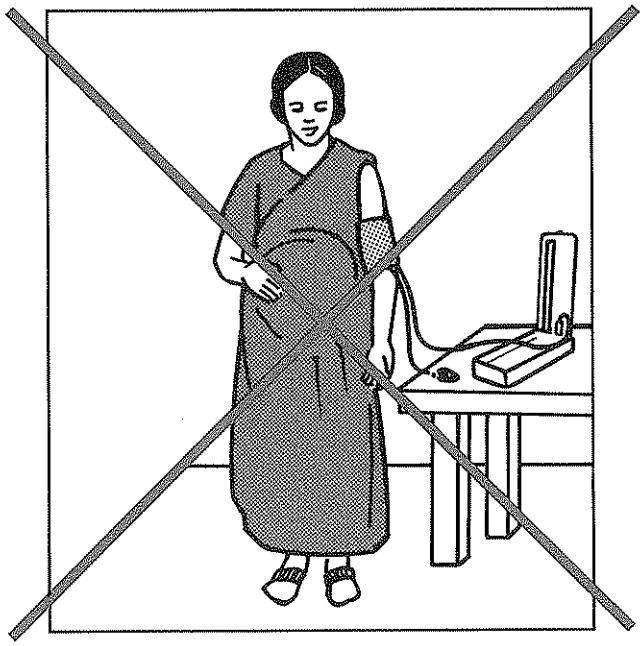
This is the preferred way to take the blood pressure, if possible in your clinic setting. (Note that in this position the baby does not press against the large veins located in the mother's abdomen and a true reading of blood pressure is made.)

Lying on the back is bad.



This position should be avoided for pregnant women. (Note that in this position the baby presses on the large veins inside the mother's abdomen hindering the blood from getting back to the heart. The blood pressure falls rapidly, causing the women to feel dizzy when she tries to get up.)

Do not take blood pressure on a standing patient.

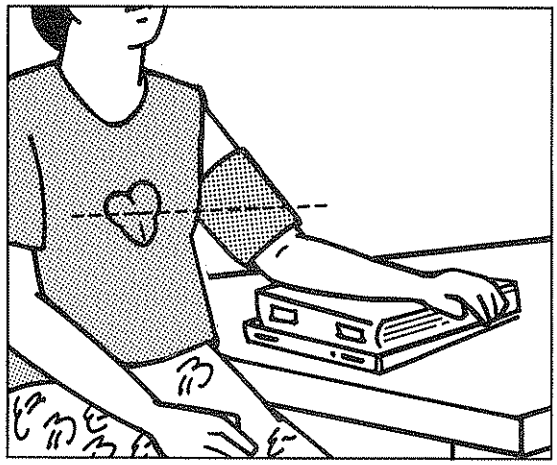


TAKE BLOOD PRESSURE WITH THE WOMAN EITHER SITTING OR LYING ON HER LEFT SIDE.

3. Position of Arm

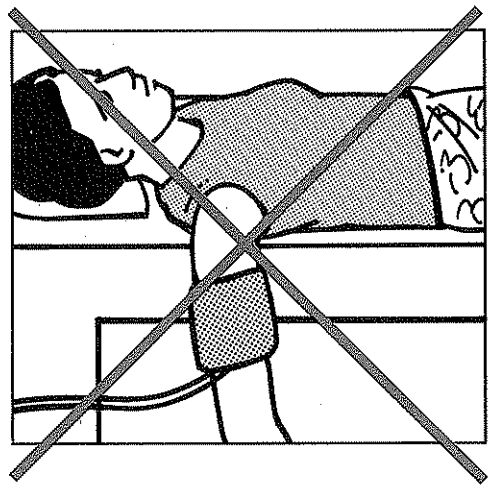
The arm must be supported so that the muscles are relaxed. Tight muscles lead to a falsely high reading.

Ensure that the height of the upper arm allows the cuff to be at the same level as that of the heart.

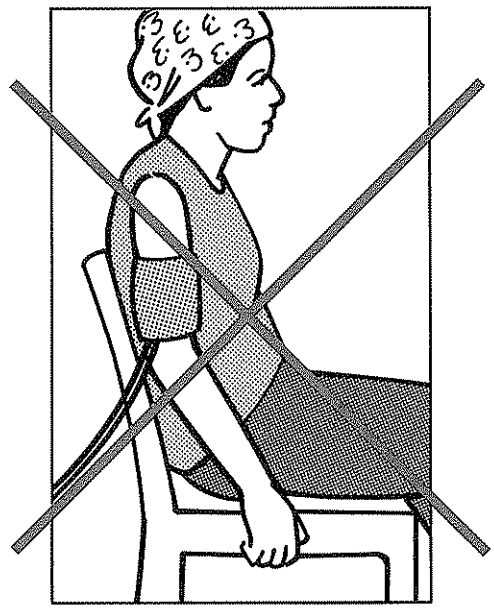


Support arm on a table. Use extra support (e.g. books) if the table is too low.

Avoid letting the arm hang over the side of the bed which can falsely raise the blood pressure reading (up to 10 mm Hg).

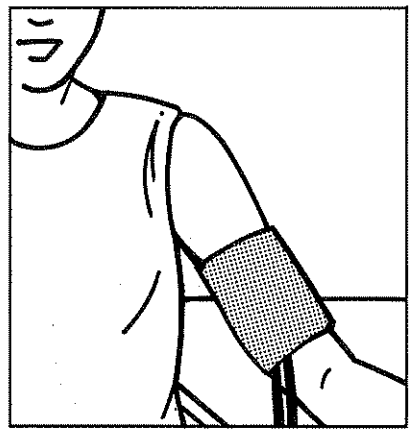


Letting the arm hang unsupported beside the patient (even in a sitting position) can also falsely raise the blood pressure reading (up to 10 mm Hg).



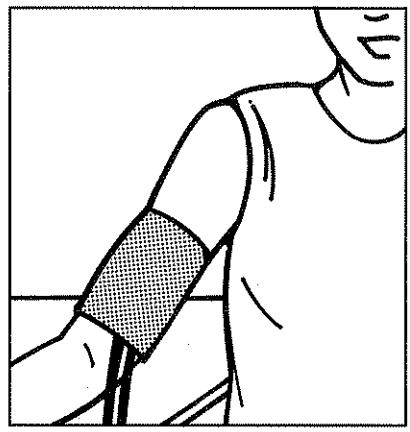
4. Which Arm?

Left



OR

Right



There can be small differences in the pressure between left and right, but **it is not important which arm you use**.

C. Techniques

Step by Step Guide

Remove all tight clothes from around the arm. Tight clothes may partially block the artery and give a falsely low reading.

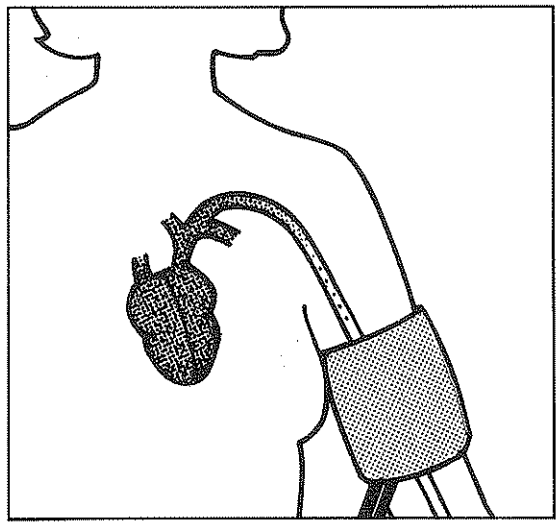
Wrap cuff firmly around upper arm. The cuff must be at least 2-3 cm (1 in) above the elbow.

A loose cuff gives a falsely high reading, and the bladder may bulge out.

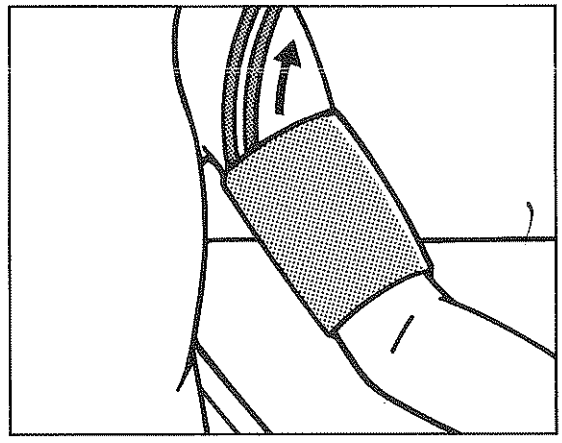
Make sure your patient is relaxed and comfortable.

Reassure the patient. Explain that the cuff will become tight and uncomfortable, but it will last only a minute or so.

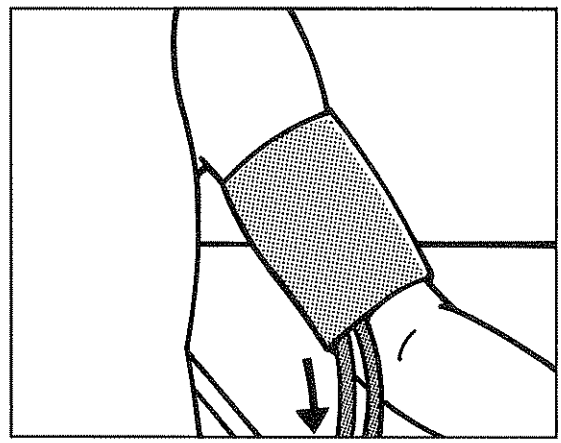
If the rubber bladder does not go 80% of the way around the arm, make sure the centre of the bladder is on the inside of the arm (over the brachial artery).



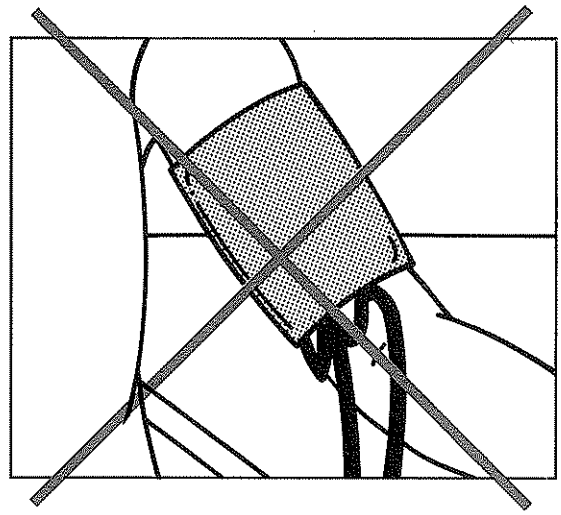
You may have to feel through the outside material to know exactly where the rubber bladder starts and finishes.



It does not matter if the tube comes out at the top or the bottom.

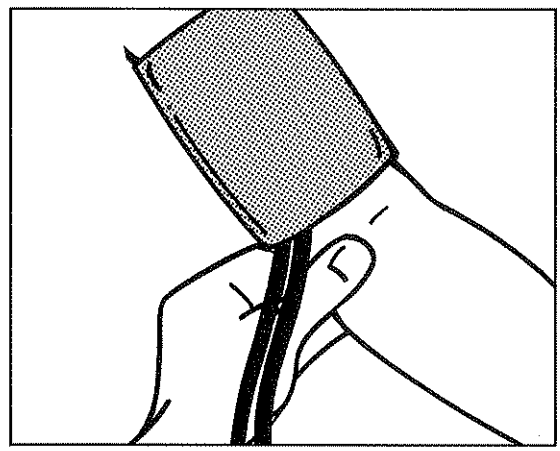


Do not kink or twist the tubes, or allow them to be tucked, or caught under the cuff.

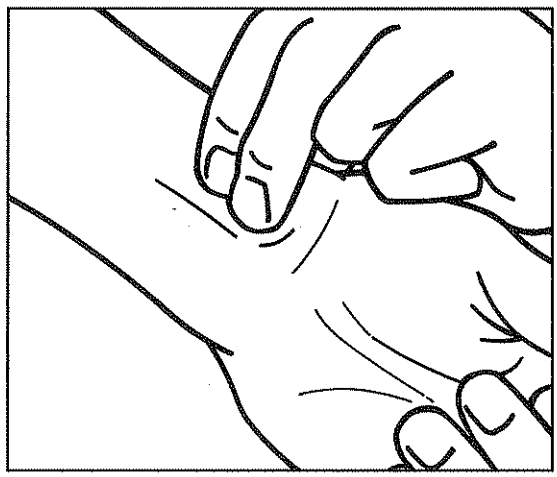


Feel the brachial pulse. It is on the inside half of the arm, in front of the elbow joint. If you feel the brachial pulse you know where to put your stethoscope. With a little experience this step will not be necessary.

Firm pressure is usually needed to feel the brachial pulse.



The radial pulse is felt with the index and middle fingers. It is found over the wrist joint, in a groove, on the thumb side of wrist.

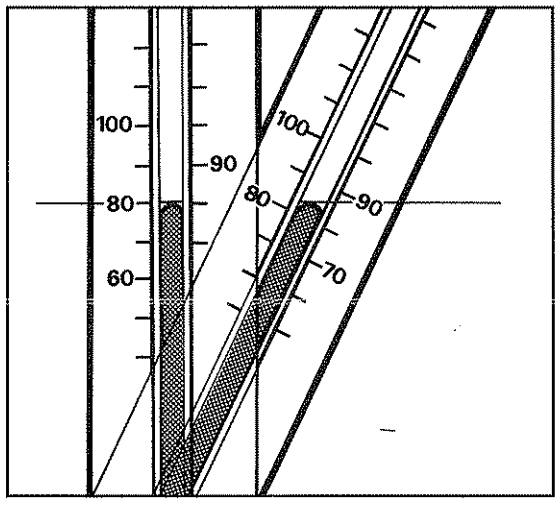


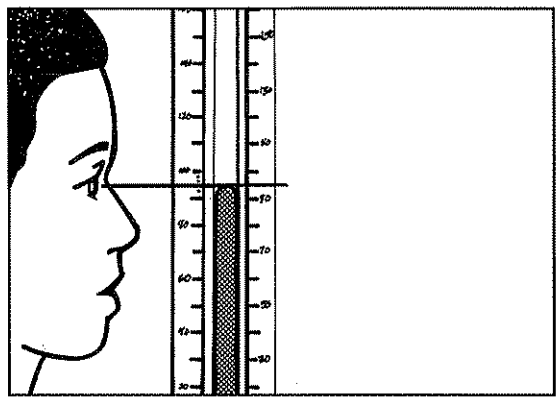
Make sure that the stethoscope fits into your ears firmly and snugly.

You will not hear quiet sounds if the stethoscope is loose in your ears.

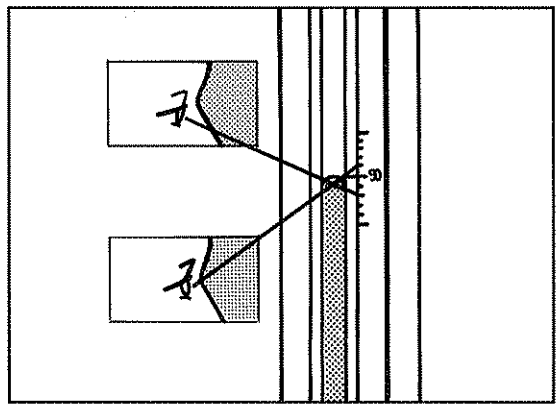
If you are using a mercury blood pressure machine, it must be vertical.

(Note: some standing machines are constructed with a slight tilt for easy reading together with a specially designed scale to compensate for it.)



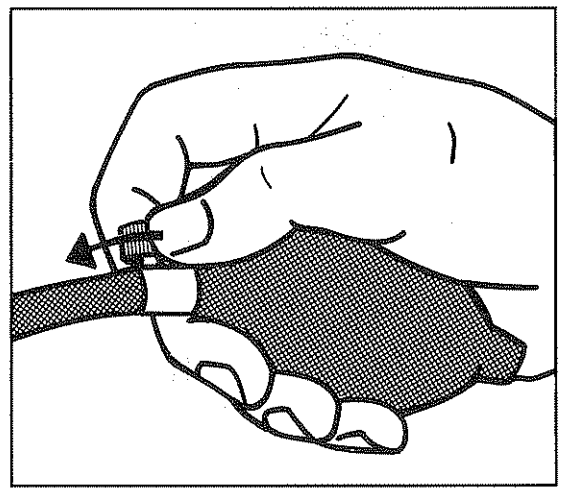


Your eyes must be at approximately the same level as the top of the mercury column or the reading will not be accurate.

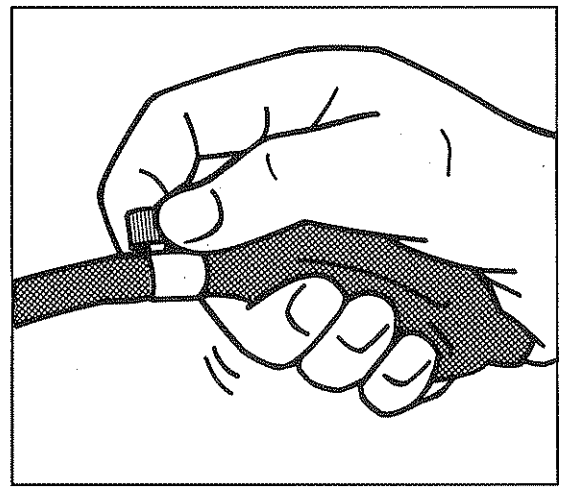


Close the control valve. Feel for either the brachial or the radial pulse.

Pump up the bulb until the pulse is no longer felt.

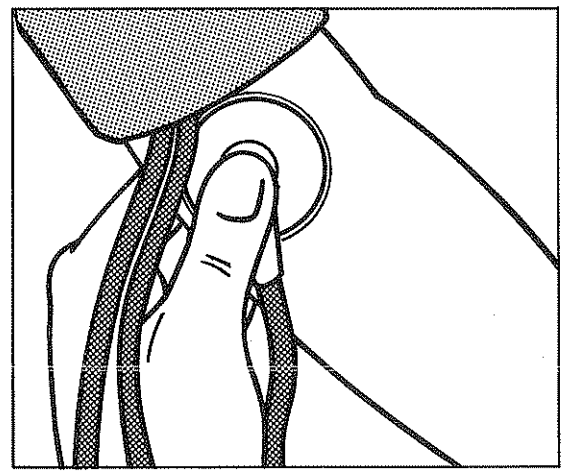


NOW pump up another 30 mm. (Do not go higher. Remember, it may be painful to the patient and pain raises the blood pressure.)

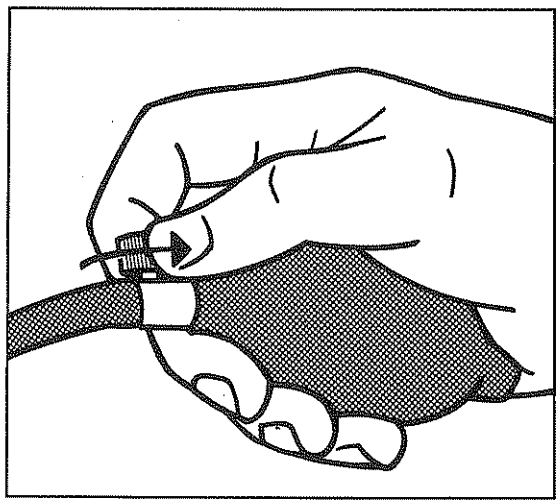


Place the stethoscope over the brachial pulse. You must use the brachial pulse for this, not the radial pulse.

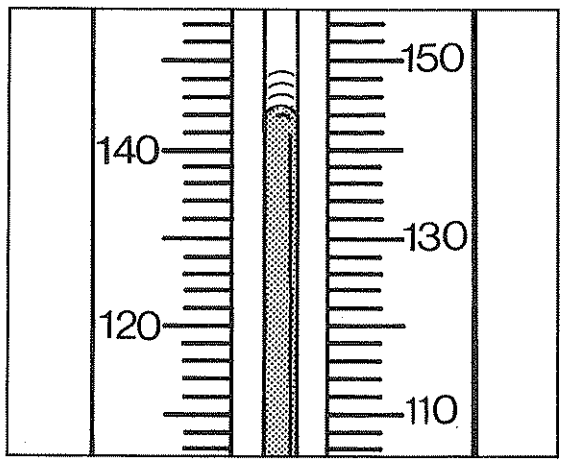
The brachial pulse is on the inside half of the arm, over the elbow joint.



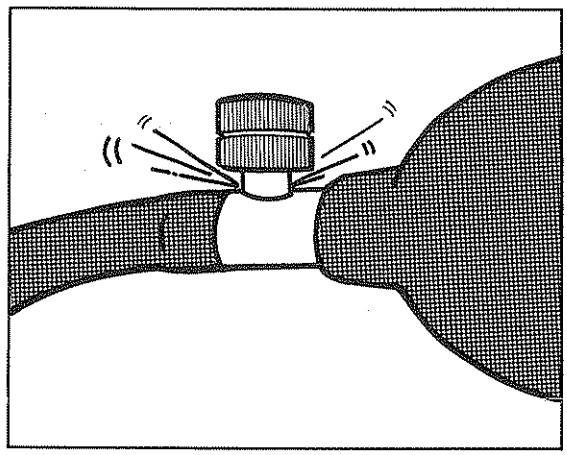
SLOWLY release the control valve until the mercury level falls.



Pulsation, or bouncing of the mercury may be seen.

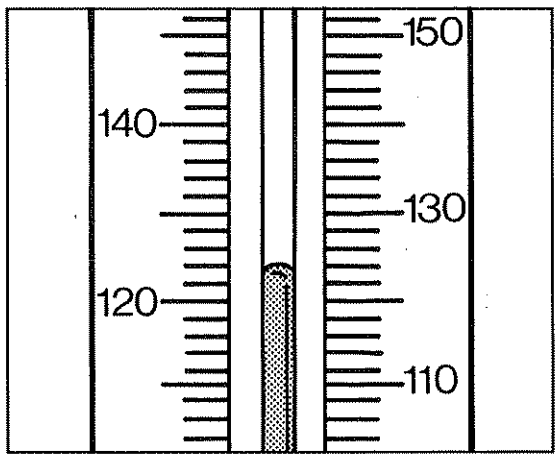


Air can usually be heard hissing as it escapes from the valve. This is normal.



Allow the mercury to fall slowly. To stop it falling too fast it is often necessary to tighten the valve slightly.

DO NOT HURRY.



SYSTOLIC BLOOD PRESSURE

Let the column of mercury fall at around 2 – 3 mm per second or 1 mark per second (note: on most machines 1 mark or division is 2 mm).

Note the exact level of the top of the mercury at which the tapping sound in first heard. This is called Korotkoff's 1st phase. This is the SYSTOLIC BLOOD PRESSURE.

Record it to the *nearest 2 mm.*

Continue to let the column of mercury fall slowly.

DO NOT press too hard with the stethoscope, as it may partly block the artery, so sounds continue to be heard. This gives falsely low readings.

In some patients, the sounds disappear, and are no longer heard for a short time, but then come back again. This is normal. Because this may happen you should always feel for disappearance of the radial pulse, and then raise the pressure another 30 mm Hg **before** using the stethoscope.

DIASTOLIC BLOOD PRESSURE

As the mercury falls, the sounds often suddenly become quieter or "muffled" as the pressure drops. Then the sounds disappear completely. This point of total disappearance of sounds, Korotkoff's 5th phase, is used for the diastolic measurement.

RECORD BOTH SYSTOLIC AND DIASTOLIC VALUES AT ONCE.

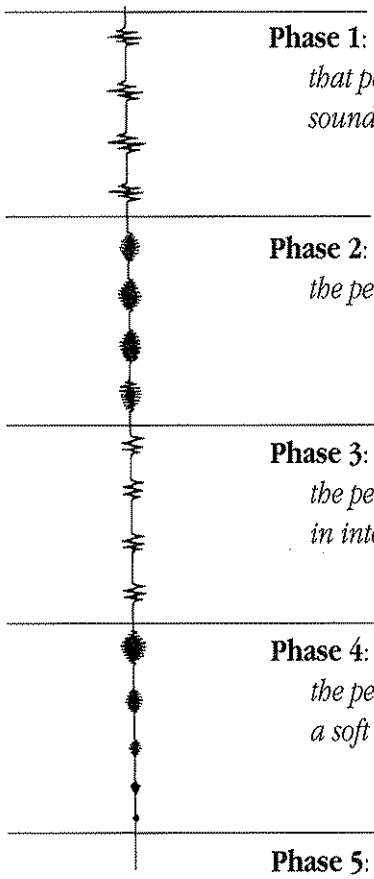
If you are not sure of the exact levels: Do it again.

Wait 15 seconds to allow blood to circulate in the arm. Not waiting can falsely raise the level.

Record the systolic, followed by a slash and the diastolic. For example a blood pressure with a systolic of 124 and a diastolic of 86 is recorded as 124/86.

Korotkoff Sounds

As the pressure falls, the Korotkoff sounds become audible over the artery below the cuff and pass through the following phases:



Phase 1:
that period marked by the first appearance of faint, clear tapping sounds which gradually increase in intensity.

Phase 2:
the period during which a murmur or swishing quality is heard.

Phase 3:
the period during which sounds are crisper and increase in intensity.

Phase 4:
the period marked by a distinct abrupt muffling of sound so that a soft blowing quality is heard.

Phase 5:
the point at which sounds disappear.

D. Training

Measuring the blood pressure is one of the most common procedures in antenatal care clinics. It is important therefore to ensure that health workers:

1. follow the proper procedures of taking blood pressure measurements.
2. have the proper equipment and cuff size.
3. know how to inspect equipment and judge whether it is working properly.
4. know how to maintain and when to reorder supplies.

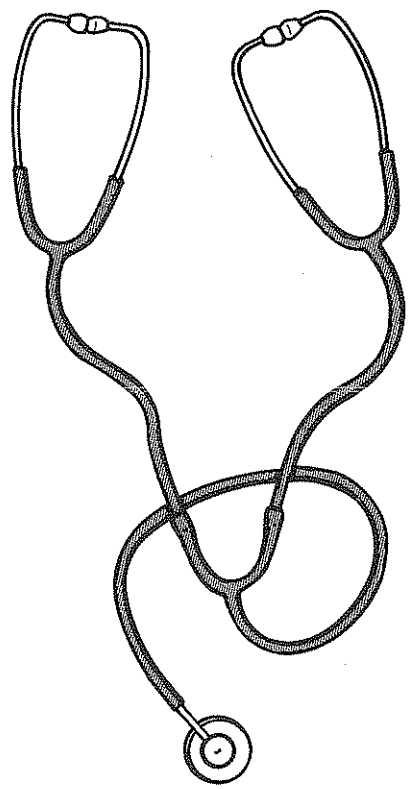
A lack of knowledge and equipment may result in some patients with hypertensive disorders in pregnancy being missed and others being misdiagnosed.

Staff at all levels of health care should be instructed on how to measure blood pressures correctly.

Special training sessions should be held and periodic checking of staff performance should be done during supervisory visits.

The following suggestions may be helpful for trainers:

1. Teach staff how to measure blood pressures away from busy and noisy clinics.
2. Use a double stethoscope for training. Any two stethoscopes can be adapted simply with a Y connector (parts from a broken stethoscope can be used to make the Y-juncture of a double stethoscope).



3. Periodically check your staff in the clinic. Look especially for:

   i) proper sized cuffs for patients with large upper arms

   ii) patient in proper position

   iii) a too rapid fall of the mercury

   iv) anxious and hurried patients

   v) too much pressure applied with the stethoscope

   vi) digit preference and number bias (rounding off) – see section VI.

III. DETECTING PROTEINURIA

A. Proteinuria

Proteinuria is defined as the presence of 300 mg or more of protein per litre in a clean-catch, midstream specimen of urine. A woman developing pre-eclampsia rarely has proteinuria **before** there is a rise in her diastolic blood pressure. When proteinuria is present with a normal blood pressure, kidney disease is often present.

TESTING FOR PROTEINURIA IN PREGNANCY IS IMPORTANT, PARTICULARLY WITH AN ABNORMAL BLOOD PRESSURE

B. A Clean-Catch Urine Sample

Vaginal secretions and discharges are common in pregnancy and if mixed with urine give a positive test for protein. To avoid this, instruct the patient to do the following:

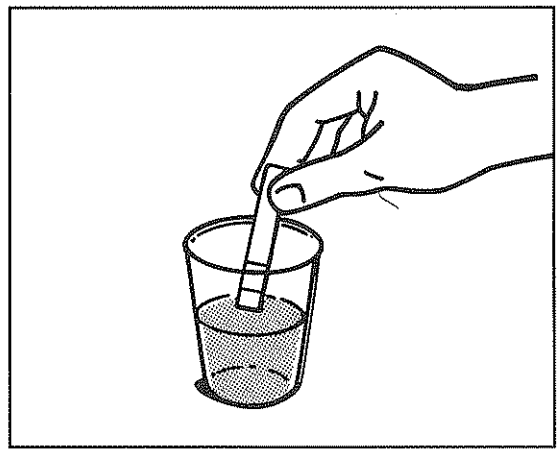
Clean her vulva with water and spread the labia minor with her fingers in order not to contaminate the urine with vaginal secretions.

Next, collect a mid-stream specimen of urine (a full bladder will make this easier) by passing urine normally, and without stopping, catch the middle part with a clean container and making sure to remove it before finishing.

C. Methods of Testing for Protein in Urine

1. Dipstick method

Dipsticks are commercially made and can be expensive. If you cut them in half lengthwise, each test will cost half as much to do. They are simple to use and require little training. Store them in a cool dry place if possible. A colour coded grading system for estimating the amount of proteinuria is usually printed on the label. Colours range from yellow for "negative" through yellow-green and green-blue for "positive" reactions.

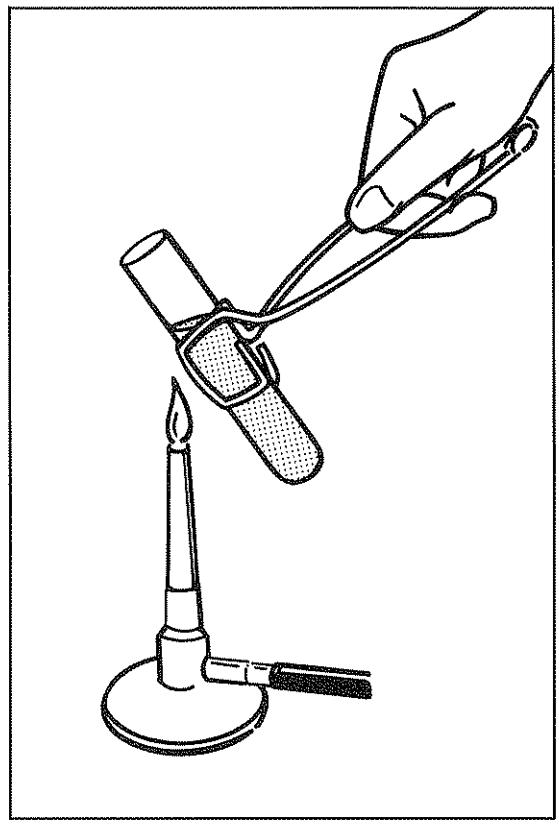


How to use Dipsticks

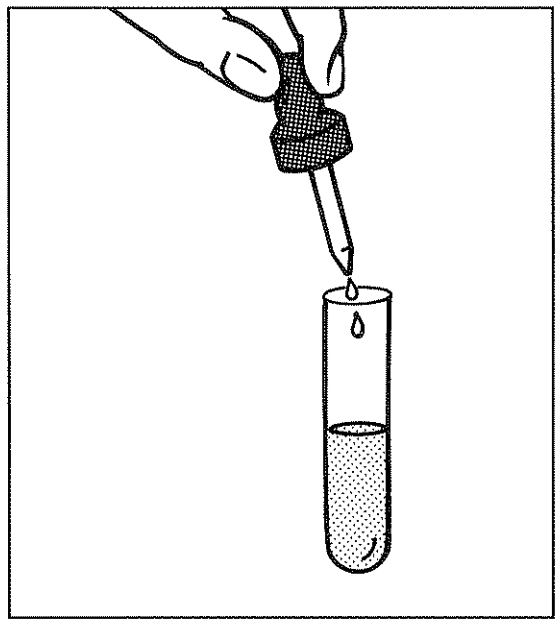
The end of the stick is dipped in urine and shaken off by tapping the stick on the side of the container. The result is then read by comparison with the color chart on the label. Note that a "trace" response found in an early morning specimen (normally more concentrated) is probably within normal limits, whereas one found in a specimen collected later in the day (more dilute) might in fact indicate significant proteinuria.

2. Boiling method

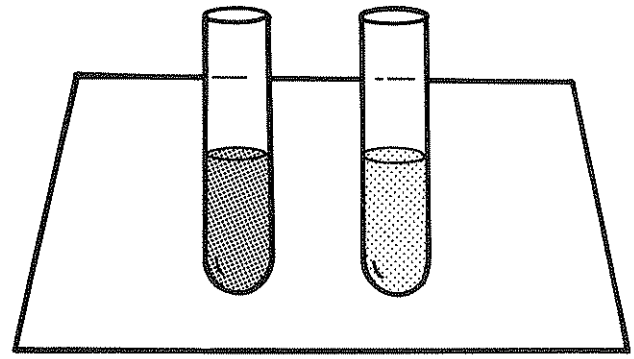
Boil the top half of the urine in a test tube. Compare the boiled top half of the urine with the unboiled bottom half. The boiled part may become cloudy (this is called a "precipitate").



Add 2 or 3 drops of 2-3% acetic acid. Do this even if the urine has not become cloudy. If, after adding the acetic acid, the boiled part of the urine remains cloudy then protein is present in the urine. If the boiled urine was not cloudy to begin with, but becomes cloudy when the acetic acid is added, then this is another indication that protein is present.

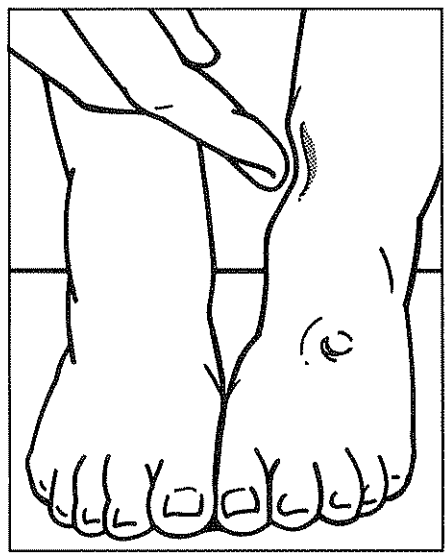


If cloudy urine becomes clear when acetic acid is added then protein is not present.



IV. DETECTING OEDEMA

Oedema is not a reliable sign of hypertensive disorders of pregnancy (except when oedema of the face and/or hands is of sudden onset). Ankle oedema alone does not accurately diagnose pre-eclampsia.

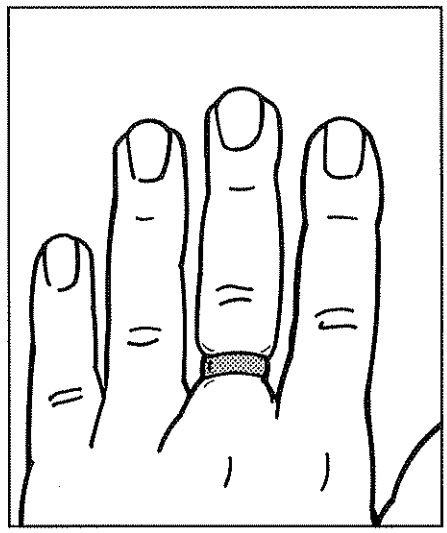


Ankle and foot oedema are common in normal pregnancy.

Traditional birth attendants should be instructed in the danger signs of severe pre-eclampsia:

- sudden swelling of hands and face
- severe headaches
- epigastric pain.

These are ominous signs, especially in late pregnancy, and are indications for immediate referral.



RING BECOMES TIGHT BECAUSE FINGERS ARE SWOLLEN (OEDEMA OF HANDS).

V. DIAGNOSING PRE-ECLAMPSIA

A diagnosis of hypertension in a pregnant woman is made when the blood pressure is 140/90 mm hg or greater on at least two occasions, four or more hours apart.

Proteinuria is an important sign of pre-eclampsia, and is defined as a protein concentration of 300 g/l or more in at least two random urine specimens collected six hours or more apart.

The following table provides a guide.

Table I: Findings associated with mild and severe forms of hypertensive disorders of pregnancy

Finding	Mild	Severe
Convulsions (eclampsia)	Absent	Present
Diastolic Blood Pressure	≥ 90 mm Hg but < 110 mm Hg	110 mm Hg or higher
Proteinuria	Trace or 1+	2+ or greater persistently
Generalized oedema (including face & hands)	Absent	Present
Headache	Absent	Present
Visual Disturbances	Absent	Present
Upper Abdominal Pain	Absent	Present
Oliguria	Absent	Present <400 ml/24 hr
Diminished fetal movement	Absent	Present

SEVERE SIGNS OF PRE-ECLAMPSIA ARE A MEDICAL EMERGENCY. TREATMENT, AND IF NECESSARY REFERRAL, SHOULD BE UNDERTAKEN IMMEDIATELY.

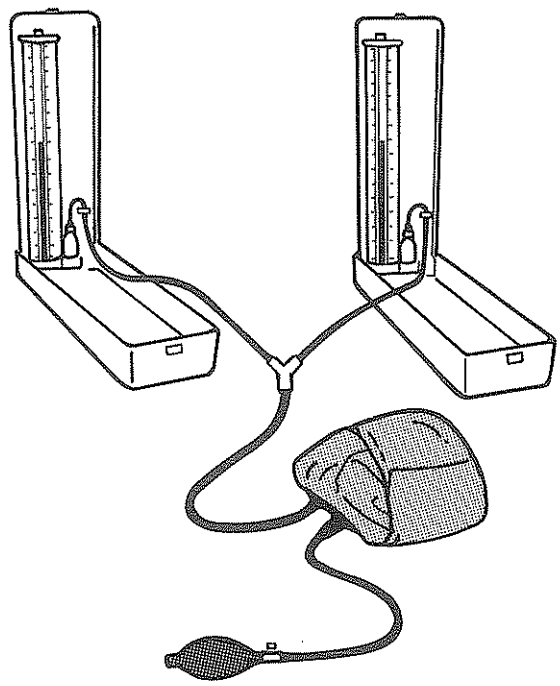
A companion document on the clinical management of these conditions is in preparation.

For clinical management of these conditions, please refer to Managing Complications in Pregnancy and Childbirth (WHO/RHR/00.7 www.who.int/reproductive-health)

VI. ROUTINE MAINTENANCE AND TROUBLE SHOOTING

Mercury sphygmomanometers are reliable, but do need regular checking once a year.

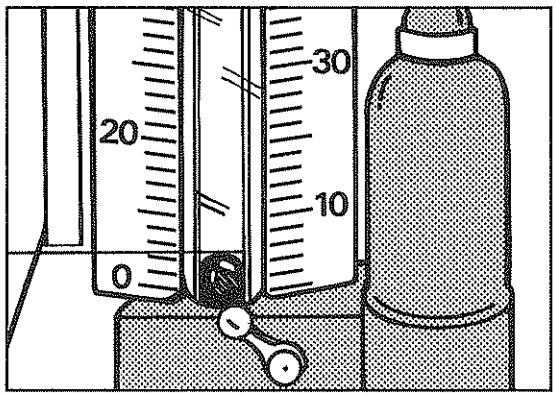
Compare accuracy against another mercury sphygmomanometer. Aneroid sphygs should be checked against a mercury sphyg every three months.



Roll up the cuff, and connect two machines together with a Y connector. (The same connector that was used for joining two stethoscopes will do.) There should be no more than 2 mm difference between the two sphygmomanometers.

Check the following:

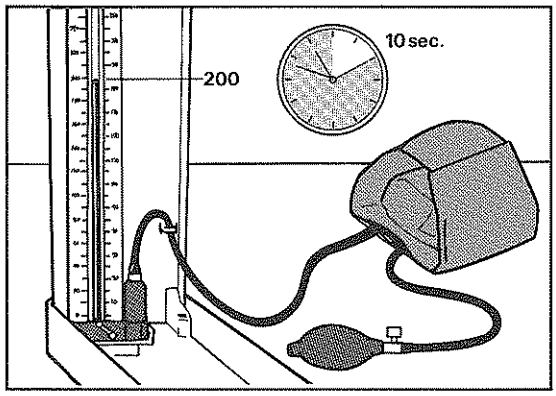
Mercury level. The machine will require attention if the mercury is not at zero when valve and tube are open to air. Mercury needs to be taken out if the level is above the zero mark (as seen in the picture), or added if the level is below the zero mark.



Take care: mercury is expensive, and poisonous if it gets into the body via hands and mouth.

Leaks. Close the valve. Roll up and fasten the cuff on itself. Pump up the bladder until 200 mm shows on the scale.

There should be no fall of the mercury column in 10 seconds.



Leaking machines may cause false blood pressure readings.

LEAKS are commonly a result of:

i) Deterioration of the rubber tubing

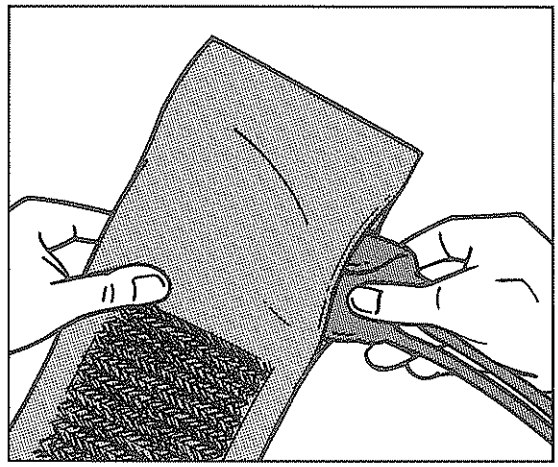
Check the ends where the tubing attaches to the bulb and/or the machine. Rubber tends to deteriorate with age especially in hot, humid climates. A temporary repair can be made by cutting out the cracked end section (2 cm) and re-attaching the good part. Moistening the end of the tubes with water may help re-attach the tubes. (DO NOT use oil as it will damage the rubber.)

This is only a temporary measure; try to order new rubber parts BEFORE they begin to leak.

ii) Punctures in the rubber bladder

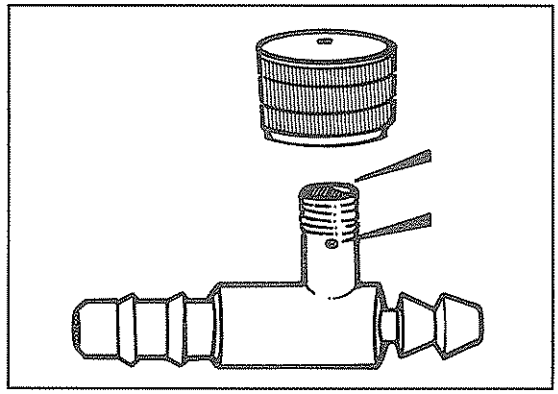
A new bladder should be ordered as quickly as possible, however, a temporary repair can be done with a ordinary tyre repair patch.

Remove the bladder by gently pulling it through the small slit found on the side of the cuff where the tubes go through. A few stitches may need to be cut in order to easily remove the bladder, and should be mended on replacement. This is to avoid bulging on inflation, which will give a false reading.



iii) Dirt in the control valve

Unscrew the valve completely. The last 2-3 twists are usually tight to prevent the cap from accidentally falling off. (It may not come off on some of the newer machines.)



Look for:

a) dirt inside the cap.

b) dirt in groove or in hole, according to design type.

c) deteriorated tubing (see above).

Record the date of maintenance directly on the machine. (Use marking pen or biro on tape.)

A POORLY MAINTAINED BLOOD PRESSURE MACHINE MAY CAUSE YOU TO MISS HYPERTENSION IN PREGNANCY OR TO TREAT SOMEONE UNNECESSARILY!!

Trouble-shooting for some common mechanical faults

1. Mercury drops when valve is closed

See "Leaks" page 38.

2. Very slow fall in mercury when control valve is opened

Causes:

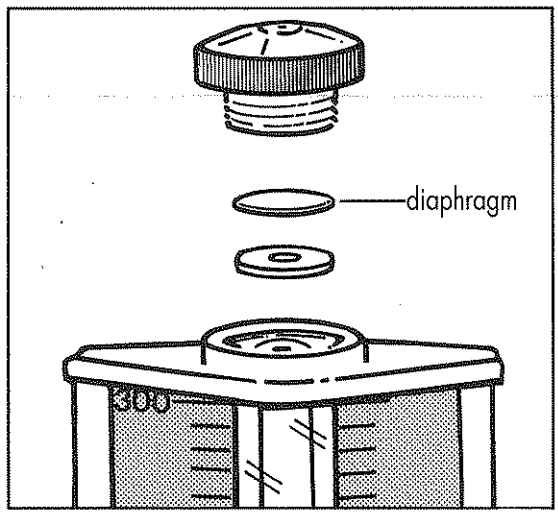
i) blocked control valve (see above)

ii) blockage of the metal cap at the top of the tube. Its function is to let air in or out slowly, but not the mercury.

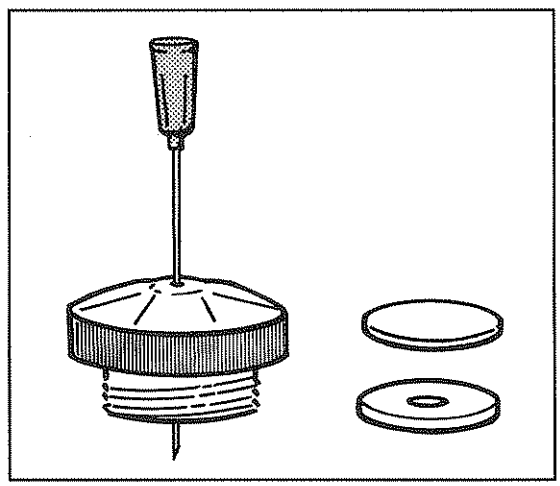
Blockage of this system will cause a very slow fall in the mercury when the valve is opened, and may cause falsely high blood pressure readings.

Make sure to REMOVE the leather diaphragm first, to avoid puncturing it!

The flat circular piece of leather (leather diaphragm) inside the cap may also get dirty and not let air through. Replace it if possible. If no replacement is available, try scrubbing both sides with a dry nail brush.



The pinhole in the metal cap can be cleared of dirt with a straight hyperdermic needle. (Do not re-use used needles.)

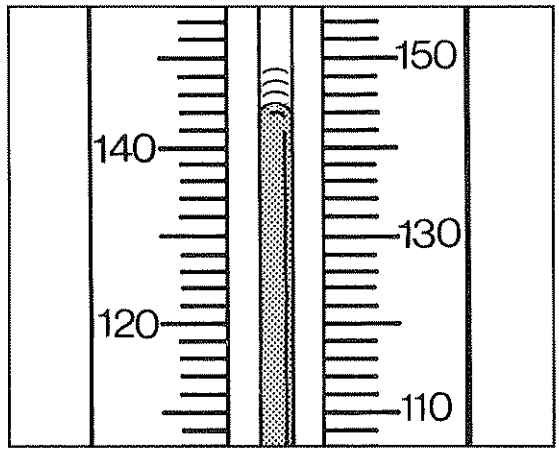


3. Large oscillations or pulsations in mercury

The mercury bounces violently up and down, so it is impossible to take a reading.

This is caused by a hole in the leather diaphragm.

Get a replacement.



4. Difficulty in pumping

Causes:

i) Air will not go into cuff.

Check for kink in tube, or dirty filter (metal gauze). If dirty, clean with dry nail brush.

If the valve is still not working properly, there is probably dirt inside, and you will need a new valve.

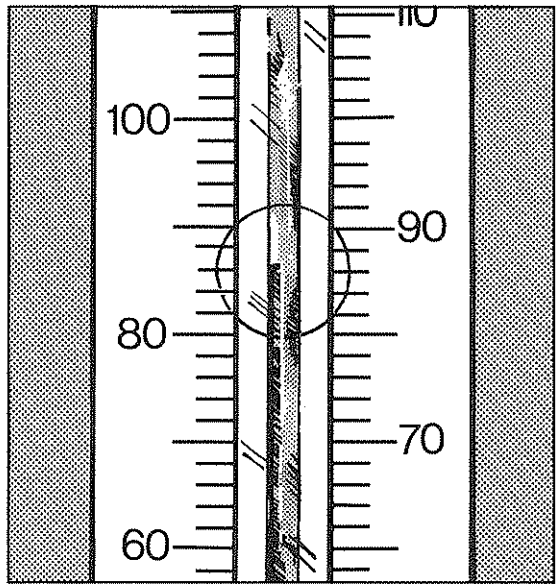
Newer machines have a rubber valve and filter combined. This can be pulled out with artery forceps and washed.

ii) Dirty or damaged valve.

Order a new one.

5. Dirty Tube

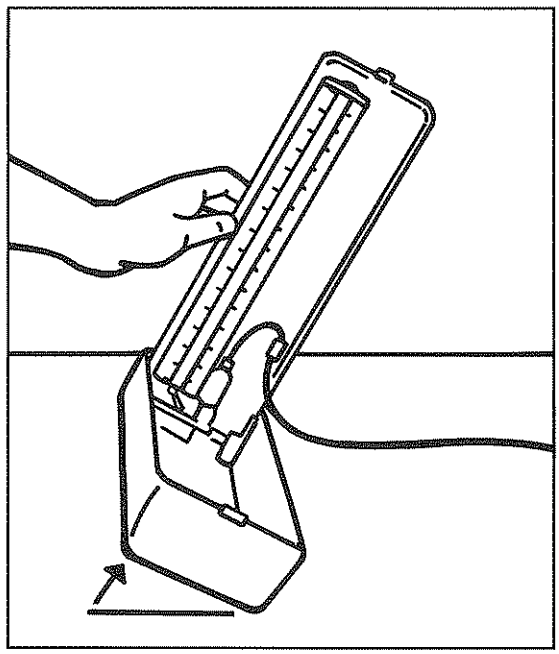
If the inside of the glass tube is dirty, the scale and top of mercury are not easily seen. This is more likely to occur in a hot climate.



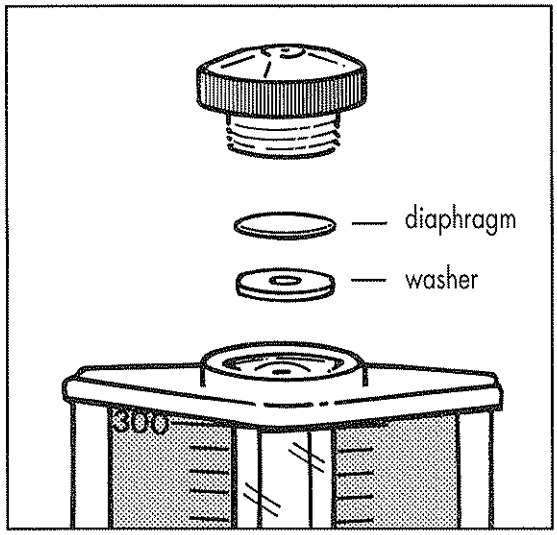
Remove glass tube for cleaning by carefully following these instructions:

i) Tilt the machine so that the mercury reservoir is lower than the glass tube (usually this is in the direction shown, however in some machines it may be opposite), and the mercury can no longer be seen in the tube.

IMPORTANT! Do not stand the machine upright until the glass tube is firmly put back in place – mercury will run out if you do.



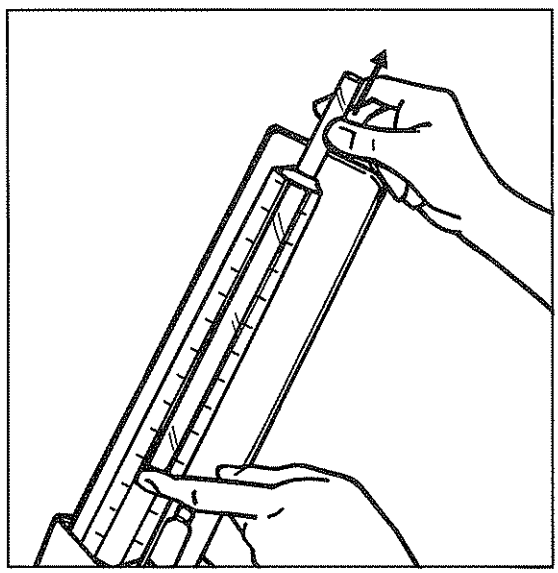
ii) Unscrew the metal cap found at the top of the machine, and lift it off. Under the metal cap, look for the leather disk or diaphragm (it has no holes in it), and the rubber (or cork) washer. These are very important. Put them away in a safe spot.



Remember where you put them.

iii) Push up the glass tube gently from below, then lift it out. Note that there is also a rubber or cork washer at the bottom end of the glass tube. Be careful not to lose it.

iv) Support the machine securely, keeping it tipped to one side so as not to let the mercury out.

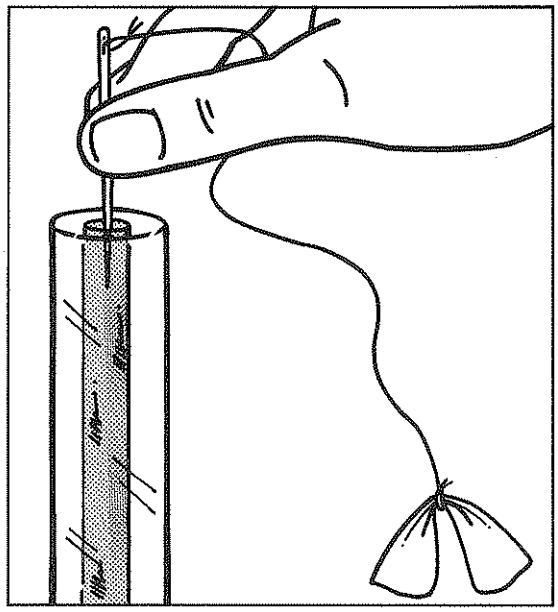


v) The tube can now be cleaned with the long "pipe cleaner" (usually supplied with the machine). A home-made cleaner can be made with cotton or thread. Tie a needle on one end and drop it through the tube. Tie a piece of material, approximately 3 cm by 0.5 cm on the other end and pull it through.

It may be necessary to wet the material in order to clean the glass tube properly. If so, make sure to dry it well before reconnecting to the machine.

vi) Replace the tube BEFORE you stand up the machine. Do not forget the washers.

vii) Tighten metal cap firmly with fingers.

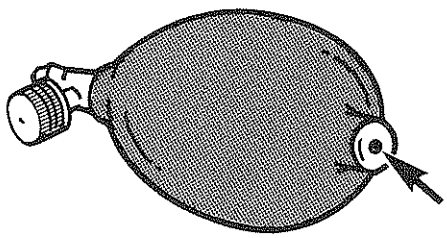


REMEMBER: DO NOT STAND THE MACHINE UPRIGHT UNTIL THE TUBE IS FIRMLY BACK IN PLACE.

6. Faulty bulb

If air squirts out of the end when the bulb is squeezed, or does not fill properly after squeezing, it is probably due to a sticking valve in the bottom of the rubber bulb. Replace the bulb.

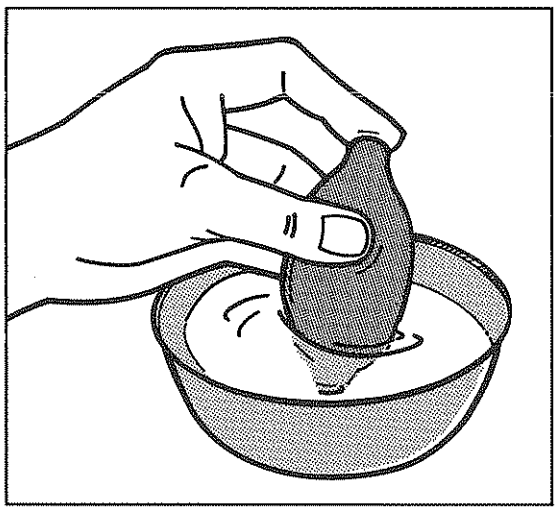
If no new bulb is readily available, you may be able to clean the valve.



Take off the control valve. Place the bottom of the BULB in warm soapy water. Squeeze and release the bulb with the valve under water and a finger blocking the top.

Dry the bulb out well (24 hours) before re-using.

Two drops of kerosene (paraffin) may also help unclog a sticking valve.



VII. EVALUATION OF TWO COMMON ERRORS IN BLOOD PRESSURE RECORDING

In addition to evaluating whether blood pressures are measured correctly and whether the equipment is in good working order, an effort should be made to look for common errors in reading and recording them. These fall under two general types:

A. Terminal Number Preference and Number Bias

1. Terminal number preference

All medical workers, including professors, tend to make this mistake.

Terminal number preference means that we tend to favour certain numbers over others at the end of a two or three digit number. In blood pressure recordings we usually favour a "0" (zero).

If you take a sample of blood pressure measurements recorded to the nearest 2 mm, the numbers 0, 2, 4, 6, and 8 should occur approximately the same number of times.

However in reality this is not the case because we tend to record the number "0" much more often than other numbers.

You can easily confirm this fact for yourself.

Choose a random sample of approximately 50 clinic records containing blood pressure measurements, and write down the last or terminal digit of each blood pressure taken that day. You can use either systolic or diastolic readings or both. The number "0" (zero), will probably be found more often than it should be; statistically it should appear around 20% of the time, or once for every five recordings. Usually it is 50% or sometimes even as high as 100%.

2. Number bias

This error is also common and we all have difficulty in admitting it.

Number bias means that we avoid recording certain numbers, but we do not consciously realize we are doing it.

In blood pressure measurements we tend to avoid recording levels that leave doubt in our minds. For example, health personnel are told to refer

all patients with a diastolic pressure of *more than 90.* If the records are examined, 90 will rarely be found; 84 and 94 will be found often, since at these values a clinical decision is easier.

We all dislike uncertainty. Discuss number bias and terminal number preference with your staff.