MEASURING THE BLOOD PRESSURE

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Adequate blood pressure is essential to maintain the blood supply and function of vital organs. Measurement of blood pressure is therefore a key part of the monitoring of patients during anaesthesia and critical care.

What is normal blood pressure?

'Normal' or 'acceptable' blood pressure varies with age, state of health and clinical situation. At birth, a typical blood pressure is 80/50 mmHg. It rises steadily throughout childhood, so that in a young adult it might be 120/80 mmHg. As we get older, blood pressure continues to rise and a rule of thumb is that normal systolic pressure is age in years + 100. Blood pressure is lower in late pregnancy and during sleep.

From this, you can see that a systolic pressure of 160mmHg for an elderly man or 90 mmHg for a pregnant woman may be quite normal. To judge whether any particular reading is too high or too low, we must compare the reading with the 'normal' for that patient.

Techniques of measurement

Rough estimates without using any equipment at all

It is not possible to derive a numerical value for blood pressure without some equipment, but a crude assessment of the circulation can still be obtained. If you can feel a radial pulse the systolic blood pressure is usually at least 80 mmHg. The character of the pulse, i.e. bounding or thready, gives a further clue. In most cases, shocked patients have cold hands and feet. (The most important exception to this is a patient who is shocked because of severe sepsis). Capillary refill time is another simple test of circulatory adequacy: press firmly on the patient's nail bed with your thumb; release your thumb and see how long it takes for blood to return. A refill time of greater than 2 seconds suggests an inadequate circulation.

Manual non-invasive blood pressure measurement

This requires, at the very least, an inflatable cuff with a pressure gauge (sphygmomanometer). Wind the cuff round the arm (which should be at about heart level) and inflate it to a pressure higher than the expected blood pressure. Then deflate the cuff slowly. With a stethoscope, listen over the brachial artery. When the cuff reaches systolic pressure, a clear tapping sound is heard in time with the heart beat. As the cuff deflates further, the sounds become quieter, but become louder again before disappearing altogether. The point at which the sounds disappear is the diastolic pressure. If you have no stethoscope, the systolic blood pressure can be found by palpating the brachial artery and noting the pressure in the cuff at which it returns.

The sounds heard while measuring blood pressure in this way are called the Korotkoff sounds, and undergo 5 phases:.

I initial 'tapping' sound (cuff pressure = systolic pressure)

II sounds increase in intensity

III sounds at maximum intensity

IV sounds become muffled

V sounds disappear

Most inaccuracies result from the use of the wrong size of cuff. A narrow cuff wrapped round a fat arm will give an abnormally high reading, and vice versa. The World Health Organisation recommends a 14cm cuff for use in adults. Smaller cuffs for infants and children are available. In occasional patients, the reading obtained from one arm can be different from that obtained from the other arm. An appropriate size of cuff can be applied to the calf, and pressure estimated by palpation of the posterior tibial pulse.

Oscillotonometry

The Von Recklinghausen Oscillotonometer is a device which allows both systolic and diastolic blood pressure to be read without a stethoscope. It consists of two overlapping cuffs (one large, one small) a large dial for reading pressure, a bleed valve and a control lever. The large cuff performs the usual function of the sphygmomanometer cuff. The job of the smaller cuff is basically to amplify the pulsations which occur as the larger cuff is deflated, so that instead of listening for the Korotkoff sounds, they are seen as oscillations of the needle on the pressure gauge. The lever simply switches the dial between the two cuffs.

Wrap the cuff round the arm in the usual way, and inflate it. Adjust the bleed valve so that the pressure falls slowly. Pull the control lever towards you. The needle will jump slightly in time with the pulse. As the cuff pressure approaches systolic, the needle suddenly starts to jump

more vigorously. At this point, let go of the lever, and the needle will display systolic pressure. Pull the lever forward again. As the pressure is reduced, the needle jumps more vigorously. If the lever is released at the point of maximum needle oscillations, the dial will read the mean arterial pressure. If it is released at the point when the needle jumps get suddenly smaller, the dial reads diastolic pressure.

Automatic non-invasive blood pressure measurement

Automatic devices which essentially apply the same principle as the oscillotonometer have been produced (e.g. the 'Dinamap' made by Critikon). They require a supply of electricity. A single cuff is applied to the patients arm, and the machine inflates it to a level assumed to be greater than systolic pressure. The cuff is deflated gradually. A sensor then measures the tiny oscillations in the pressure of the cuff caused by the pulse. Systolic is taken to be when the pulsations start, mean pressure is when they are maximal, and diastolic is when they disappear. They can produce fairly accurate readings and free the hands of the anaesthetist for other tasks. There are important sources of inaccuracy, however. Such devices tend to over-read at low blood pressure, and under-read very high blood pressure. The cuff should be an appropriate size. The patient should be still during measurement. The technique relies heavily on a constant pulse volume, so in a patient with an irregular heart beat (especially atrial fibrillation) readings can be inaccurate. Sometimes an automatic blood pressure measuring device inflates and deflates repeatedly "hunting" without displaying the blood pressure successfully. If the pulse is palpated as the cuff is being inflated and deflated the blood pressure may be estimated by palpation and reading the cuff pressure on the display.

Invasive arterial pressure measurement

This technique involves direct measurement of arterial pressure by placing a cannula in an artery (usually radial, femoral, dorsalis pedis or brachial). The cannula must be connected to a sterile, fluid-filled system, which is connected to an electronic monitor. The advantage of this system is that pressure is constantly monitored beat-by-beat, and a waveform (a graph of pressure against time) can be displayed. Patients with invasive arterial monitoring require very close supervision, as there is a danger of severe bleeding if the line becomes disconnected. It is generally reserved for critically ill patients where rapid variations in blood pressure are anticipated.