Measurement of Vital Signs

Study Guide:

With respect to skills:

Level 1 = should have confidence in performing the task and can recognize normal signs;

Level 2 = should have performed the task;

Level 3 = should have observed the task performed in real life or on video.

With respect to knowledge:

Level 1 = should understand the subject matter and can apply it to practice;

Level 2 = should have a sound understanding of the subject matter;

Level 3 = should be aware of the importance of the subject matter.

Level of Achievement	1	2	3
• Clinical charts	•	-	-
• Temperature: oral	•	-	-
• Temperature: rectal	-	-	•
• Temperature: tympanic membrane	-	-	•
• Pulse rate	•	-	-
• Pulse rhythm: sinus arrhythmia	•	-	-
• Pulse rhythm: ectopic beats	-	•	-
• Pulse rhythm: atrial fibrillation	-	•	-
• Respiratory rate & rhythm	•	-	-
• Blood pressure by auscultation of Korotkoff sounds	•	-	-
• Non-invasive BP (NIBP) measurement	-	-	•

N.B. *Year 1 & 2 students are expected to recognize normal findings only*, although abnormal findings are also included for students in their senior years.

Clinical Charts

• Vital signs include: temperature, pulse, respiratory rate, blood pressure, and height & weight.

• In a hospital setting, these signs and their variations during the day and from day to day are recorded on clinical charts. A sample chart is enclosed for your scrutiny.

• As you can see, the magnitudes of some of these variables are recorded numerically and others are displayed graphically. Symbols used for graphic display varies from institution to institution. You should check the practice of your own institution

• When checking vital signs, the magnitude of current readings is obviously important; but the trend, i.e., change in magnitude over time, is equally important.

Temperature

• The digital **electronic thermometer** has replaced the traditional **mercury thermometer**.

• There are different makes of electronic thermometer. The steps required to take a temperature measurement are similar between makes.

Exercise
• Take an oral temperature measurement using the digital electronic thermometer shown:

1. Place a disposable plastic sheath over its probe end and switch it on.
2. Place the probe under the subject's tongue near the base of the frenulum where it is warmest because of the rich plexus of veins.
3. Ask the subject to relax his tongue and close both lips around the thermometer.
4. Leave the thermometer in place until a sound signal indicates completion of the measurement.
5. Read the temperature displayed.
6. Discard the disposable plastic sheath.

• Normal findings

1. Normal oral temperature is 37oC.
2. There is a circadian (day and night or over 24 hours) variation in oral temperature: as low as 36oC around 5:00 AM and as high as 37.5oC around 5:00 PM.

3. Hot or cold oral intakes can affect oral temperature artificially for up to 15 minutes.
4. Rectal temperature is generally 0.5oC higher than oral temperature. (Rectal temperature can be measured by inserting the probe 3 – 4 cm into the anal canal.)

• The **tympanic membrane thermometer** shown is another device that can give a temperature reading within seconds.

• The probe should be covered with a disposable plastic shield each time it is used in a new patient.

• The funnel-shape probe should be pointed in the direction of the ear canal until it fits the canal comfortably.

• Switch on the probe and take the reading when a sound signal indicates completion of the measurement.

• Tympanic membrane temperature is core temperature; it is approximately 0.8oC higher than oral temperature.

• Excessive cerumen (wax) in the ear canal can yield a spuriously low reading.

The Pulse

• Peripheral arteries accessible for examination of its pulse include:

1. radial artery at the wrist,
2. brachial artery at the antecubital fossa,
3. carotid artery in the neck,
4. common femoral artery at the groin,
5. popliteal artery in the popliteal fossa,
6. posterior tibial artery behind the medial malleolus,
7. dorsalis pedis artery at the dorsum of the foot.

• Palpation of the **radial artery** pulse is part of general physical examination. In special occasions, palpating pulses of the other arteries may be indicated and necessary.

• The following features should be sought when palpating the radial artery pulse:

1. Rate,
2. Rhythm,
3. Volume,

4. Character or form.
5. Delay (between the radial and femoral artery pulse).

• In your junior years, concentrate just on **rate** and **normal rhythm**.

Pulse rate, heart rate, and rhythm

• When pulse rate is regular, this rate reflects heart rate. But when pulse rate is irregular, there may be a pulse deficit between heart rate and pulse rate because some of the heartbeats are too weak to be transmitted as pulses to the radial artery. In these situations, auscultation of the heart is required to determine heart rate.

• The radial artery can be located on the ventral aspect of the wrist, deep to the skin and subcutaneous tissue over the inner aspect of the radius, and just proximal to the skin creases.

Exercise

• Palpate and count the radial pulse of your fellow student and note its rhythm:

1. Locate the radial artery with the tips of the index and middle fingers of your dominant hand. Apply gentle pressure until the strength of the pulses is maximal. With the help of a watch with a second hand, count the number of beats over 15 seconds and note if the rhythm is regular.
2. Stop if the rhythm is regular and there are more than 15 beats over the 15-second interval. Multiply the number you obtained by 4 to get the pulse rate, which is equal to the heart rate.
3. Count the number of beats over 30 seconds if the rhythm is regular but there are less than 15 beats over the 15-second interval. Multiply the number you obtained over 30 seconds by 2 to get the pulse and heart rate. Counting the pulse rate over the longer period is recommended for better accuracy if the pulse rate is slower than 60 beats per minute.
4. When the rhythm is irregular, try to determine whether it is only an occasional irregularity superimposed on a regular basic rhythm or whether the rhythm is simply irregular. In the latter scenario, count the pulse rate by palpation over a minute and the heart rate at the apex by auscultation also over a minute and compare the numbers to see if there is a significant pulse deficit.

• Normal findings

1. Normal pulse rate in an adult subject at rest is between 60 and 88 beats per minute (bpm); the rhythm is regular. Well-conditioned athletes may have a resting pulse rate well below 60 bpm.

2. In children and young adults the basic rhythm may be regular but the rate varies with the phase of the respiratory cycle: speeding up slightly during inspiration and slowing mildly during expiration. This is sinus arrhythmia. Arrhythmia mean irregular rhythm. The origin of this arrhythmia is physiological in nature and does not imply any disease state.

• Abnormal findings

1. A faster than normal heart rate is called tachycardia. Tachycardia may be due to a large variety of clinical conditions including, but not exclusively, fever, respiratory or heart disease, anemia, hypovolemia due to any cause, thyrotoxicosis, metabolic acidosis, etc.
2. A slower than normal heart rate is called bradycardia. Bradycardia may be physiological in well-conditioned athletes. It may be due to abnormalities in cardiac impulse generation (e.g., sick sinus syndrome) or conduction (e.g., complete heart block), or due to medication (e.g., beta blockade), etc.
3. When counting the pulse, note whether the rhythm is regular or irregular. If the rhythm is irregular, try to determine whether it is an irregularity superimposed onto a regular basic rhythm or whether it is totally irregular.
4. Sinus arrhythmia is an example in which the basic rhythm is regular but there is an irregularity in rate between the inspiratory and expiratory phase.
5. Another arrhythmia with a regular basic rhythm but occasional irregularity is **ectopic beats** (extra beats or early beats that come either from the atria or the ventricles). However, if the ectopic beats are frequent and erratic, then the underlying basic rhythm may be masked, giving the impression that the rhythm is totally irregular.
6. In **atrial fibrillation**, the rhythm of the atria is totally chaotic. Some of these atrial beats are conducted to the ventricles and some are not. Some of the ventricular beats are strong and can be felt as pulses in the periphery and some are not. In this condition the radial pulse is totally irregular and is described as irregularly irregular. There is always a pulse deficit in this situation and both the apical heart rate and the radial pulse rate should be recorded.

Respiratory rate & rhythm

Exercise

• Count the respiratory rate of your fellow student:

1. Observe the rise and fall of the chest when he breathes in (inspiration) and out (expiration). Do this discretely and unobtrusively so that he does not become self-conscious. A self-conscious person may not breathe naturally.
2. Count the number of cycles of inspiration and expiration over 60 seconds and note the rhythm or any irregularity that you may observe.

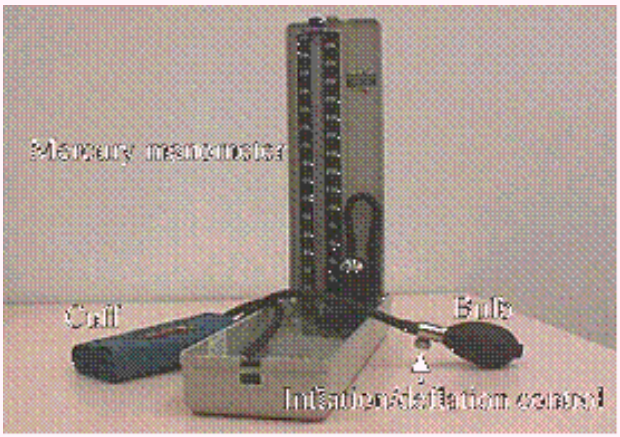
• Normal findings

1. Normal respiratory rate in a healthy adult is between 12 to 20 breaths per minute. (With such a slow rate, it is best to count the number of breaths over a full minute for accuracy.)
2. Respiratory rhythm should be regular.
3. Respiratory depth (as seen in the amplitude or excursion of chest wall movement) should also be the same between breaths.
4. Regular respiratory rate, rhythm, and depth are interrupted occasionally by a large breath called a “sigh” in normal subjects.

• Abnormal findings

1. A respiratory rate faster than normal is called hyperpnoea. It is seen in a wide variety of clinical conditions including, but not exclusively, pyrexia, chest infection, acute asthma, congestive heart failure and pulmonary edema, metabolic acidosis, hysteria, etc.
2. A ready example of slower than normal respiratory rate is seen in opioid overdose.
3. Absence of respiration (respiratory rate equals zero) is called apnea.
4. An example of abnormal respiratory rhythm and pattern is Cheyne-Stokes breathing seen in some comatose (unconscious) patients affected by disease of the central nervous system. In Cheyne-Stokes breathing there is a cyclical change in respiratory depth from increase to decrease interrupted by apnea.

Blood pressure



• The instrument for measuring blood pressure (BP) is called a sphygmomanometer. It consists of a cuff, within which lies an inflatable bladder connected by tubing to a rubber bulb that controls inflation and deflation of the bladder and to an instrument for measuring pressure called a manometer.

• The traditional pressure-measuring device is the mercury manometer and BP is measured in millimeters of mercury (mmHg).

• The mercury manometer is bulky and the lightweight mechanical aneroid manometer is often preferred.

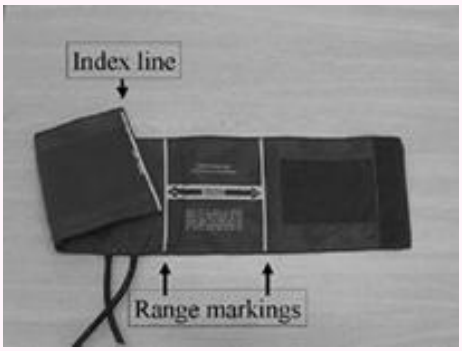
• Accuracy of the aneroid manometer can deteriorate with time. Its accuracy must be checked against that of a mercury manometer (the gold standard) when inaccuracy is suspected.

• BP is usually measured from the upper limb; on occasions measurement from the lower limb may be necessary or more appropriate.

• For accuracy, the width of the bladder within the cuff should match the size of the chosen limb. An inappropriately wide bladder will give an erroneous lower-than-normal BP reading; an inappropriately narrow bladder will give and erroneous higher-than-normal BP.

• Ideally the bladder should have a width of about 40% the circumference of the limb. In practice BP cuffs come in fixed sizes for newborns, infants, children, adult arms, and adult thighs. You have to exercise your judgment in choosing the proper cuff size (e.g., a child's cuff for a very thin adult arm; a leg cuff for a very obese adult arm).

• The length of the bladder within the cuff is also important; it should be about 80% the circumference of the limb. Modern BP cuffs have an index line at one end and 2 range markings in the middle. If the index line falls within the range markings after the cuff is wrapped around the limb, the bladder is of the correct length.



• Some patients find the tightness of the cuff around the arm during BP measurement uncomfortable. You will do well by forewarning your patient of such possibility.

Exercise

• Check the BP of your fellow student manually by auscultation:

1. Rest the arm at heart level, center the bladder over the brachial artery and wrap the cuff around the upper arm. (If the arm is dangling below the heart, the measured BP will be erroneously high; if the arm is elevated above the heart, the measured BP will be erroneously low.)
2. Palpate the radial artery and inflate the bladder until the radial pulse disappears and add another 30 mmHg of pressure.
3. Using the bell of your stethoscope, listen over the brachial artery at the antecubital fossa for the changing character in sounds (Korotkoff sounds) associated with the return of pulse beats as the bladder is allowed to deflate at a rate of 2 to 3 mmHg per second.
4. Note the pressure (to the nearest 5 mmHg) at which 2 consecutive beats are heard; this is the systolic BP.

5. Continue to deflate the cuff until the sound of the pulse beats begins to muffle and then disappears. The pressure (to the nearest 5 mmHg) at the point when sound disappears is the diastolic BP. (Some doctors regard the pressure at which the pulse beat sound becomes muffled as the diastolic BP. But using the point at which the pulse beat sound disappears as an indicator of diastolic BP gives more consistent results, particularly between observers.)
6. Continue deflating the bladder, more rapidly now, to zero and confirm total disappearance of the pulse beat sounds.

• Normally the point where the pulse beat sound disappears is only a few mmHg below the muffling point. But this difference is farther apart in some individuals and the muffled beats do not disappear in some others. If the difference is more than 10 mmHg, both diastolic points should be recorded (e.g., 135/85/70 or 130/85/0).

• Normal findings

1. The range of systolic BP in a normal healthy adult is 100 to 140 mmHg with an average of 120 mmHg; the normal range of diastolic BP is 60 to 90 mmHg with an average of 80 mmHg.
2. Both alcohol and caffeine containing drinks can cause an increase in BP. It is good practice to check if your patient has had these drinks in the hours before you measure his BP.
3. Nervousness can also increase a patient's BP. This is often why a patient's BP is elevated when he first meets his doctor (the so called "white coat syndrome"). Re-check the BP after he has rested will confirm that the first reading is incorrect.

• Abnormal findings

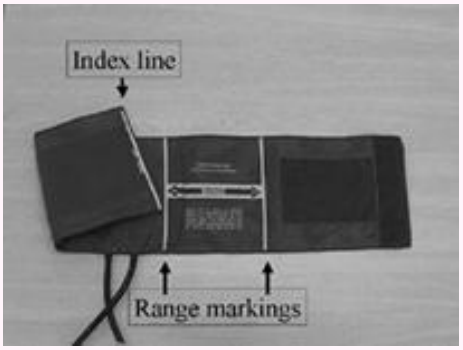
1. Hypertension is defined as a persistent elevation of BP above 140/90 mmHg.
2. A systolic BP of above 140 mmHg alone is systolic hypertension; a diastolic BP of above 90 mmHg alone is diastolic hypertension.
3. In some hypertensive patients, sounds of the pulse beats may disappear at a pressure somewhat below systolic pressure only to reappear again at a lower pressure before final disappearance at the diastolic level. This silent period, called the auscultatory gap, falls usually between 180 and 160 mmHg. If you obtain the systolic BP purely by auscultation, without first inflating the cuff to a pressure above that at which the radial pulse disappears, you may "land" in this gap by chance and miss the higher true systolic pressure. (There is no gap with palpation.) Similarly it is good practice to continue auscultation for pulse beat sounds until the cuff is fully deflated to rule out reappearance of the sounds.

Automated non-invasive blood pressure (NIBP) monitor

• Checks BP automatically; the principle is similar to that of checking BP manually by auscultation.

• Instead of using the stethoscope to check Korotokoff sounds, a built-in sensor checks the changing character of the arterial pulse between the systolic and diastolic pressures.

• There are sophisticated models available for hospital use and affordable models available for home use.



• Accuracy, particularly of home use models, should be checked against that using mercury manometer.

Height & Weight

Measurement of height and weight will be covered in the next PCLM 04/CSLC session.