Vital sign

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Vital Sign

- **TEMPERATURE**
- **RESPIRATOY RATE**
- **PULS RATE**
- **BLOOD PRESURE**

- **Oral thermometry** generally is preferred in children who are old enough to cooperate. Oral temperature is typically 0.6ºC (1.0ºF) lower than rectal temperature because of mouth breathing, which is particularly important in patients with tachypnea. Oral temperatures also may be affected by recent ingestion of hot or cold liquids
- **Axillary temperature** is consistently lower than rectal temperature, but the absolute difference varies too widely for a standard conversion
- **Infrared tympanic membrane (TM) thermometers** measure the amount of heat produced by the tympanic membrane.
- Temperature readings are close to core temperature

- Systematic reviews have concluded that TM thermometry shows insufficient agreement with established methods of core temperature measurement to be used in situations where detection of fever has clinical implications (eg, laboratory evaluation of the febrile neonate or young infant)
- **Infrared contact and noncontact forehead thermometers** measure the amount of heat produced by the temporal arteries.
- The accuracy of such measurements may be affected by sweating or vascular changes
- As with tympanic temperature measurement, studies comparing temporal artery and rectal temperatures have contradictory results, and temporal artery temperatures should not be used to make clinical decisions . Readings may be greater or lower than rectal temperature.

TEMPERATURE MEASUREMENT

- **Site and method of measurement —** The most common sites of temperature measurement in clinical practice are the rectum, mouth, and axilla;
- The Bright Futures Guidelines for Health Supervision suggest rectal thermometry for children younger than four years of age
- In contrast, the National Institute for Health and Care Excellence recommends electronic axillary thermometry for children younger than four weeks, and axillary (electronic or chemical dot) or infra-red tympanic membrane thermometry for children four weeks to five years of age because these methods are quicker, easier to use, and better accepted by children and their caregiver
- Rectal thermometry is contraindicated in patients with neutropenia.

Converting between Fahrenheit and Celsius

- ●To convert a temperature measured in Fahrenheit to Celsius:
- •(Temperature in °F – 32) x (5/9) = Temperature in °C
- ●To convert a temperature measured in Celsius to Fahrenheit:
- •[(9/5) x Temperature in °C] + 32 = Temperature in °F

NORMAL BODY TEMPERATURE

- Normal body temperature varies with age, time of the day, level of activity, and phase of the menstrual cycle, among other factors
- The mean normal temperature is generally considered to be 37ºC (98.6ºF)
- In a more recent study of young adults, the upper limit of normal body temperature (measured orally) was 37.2ºC (98.9ºF) in the morning and 37.7ºC (99.9ºF) overall .
- Infants and young children generally have higher temperatures than older children and adults. This relates to the greater surface-area-to-body-weight ratio and the higher metabolic rate of infants and small children.
- In the newborn period (age 0 to 28 days), the mean normal temperature (measured rectally) is 37.5°C, with an upper limit of normal (ie, two standard deviations above the mean) of 38ºC (100.4ºF)

RESPIRATORY RATE

- Deep breathing:hyperpnea
- Shallow breathing :hypopnea
- when lying supine *has retractions of soft tissue* :*orthopneic*
- Short of breath :*dyspneic*
- *Absence breathing: Apnea*
- An abnormally fast or slow respiratory rate may reflect a disturbance in the respiratory or cardiovascular system or in the central nervous system (CNS) control of breathing.

TABLE 10–1 NORMAL VALUES OF PULSE AND BLOOD PRESSURE IN THE FIRST YEAR OF LIFE

Age Group	*Pulse Rate (beats/min)*			*Blood Pressure (mm Hg)*	
	Lower Limits of Normal	Average	Upper Limits of Normal	Systolic	Diastolic
Premature	80	120	170	60 (50-75)	35 (30-45)
Neonate	80	120	170	75 (60-90)	45 (40-60)
1-12 mo	90	120	180	90 (75-100)	60 (50-70)

From Moller JH, Neal WA: *Heart disease in infancy*, New York, 1981, Appleton-Century-Crofts.

- Estimate the ease of respiration by observing whether the child appears short of breath (*dyspneic), is distressed* or sternum, has flaring of the alae nasi, or uses accessory muscles of respiration.
- Labored respiratory efforts reflect the increased work of the respiratory muscles and often are caused by airway obstruction.
- The duration of apnea considered to be abnormal varies with age.
- Apnea lasting up to 20 seconds is normal in premature infants, whereas shorter apneic periods may be significant in the older child.

Puls rate

- Assessment of the arterial pulse characteristics is an integral part of the cardiovascular examination.
- Carotid, radial, brachial, femoral, posterior tibial, and dorsalis pedis pulses should be routinely examined bilaterally to ascertain any differences in the pulse amplitude, contour, or upstroke.
- Popliteal pulses should also be examined when lower extremity arterial disease is suspected.

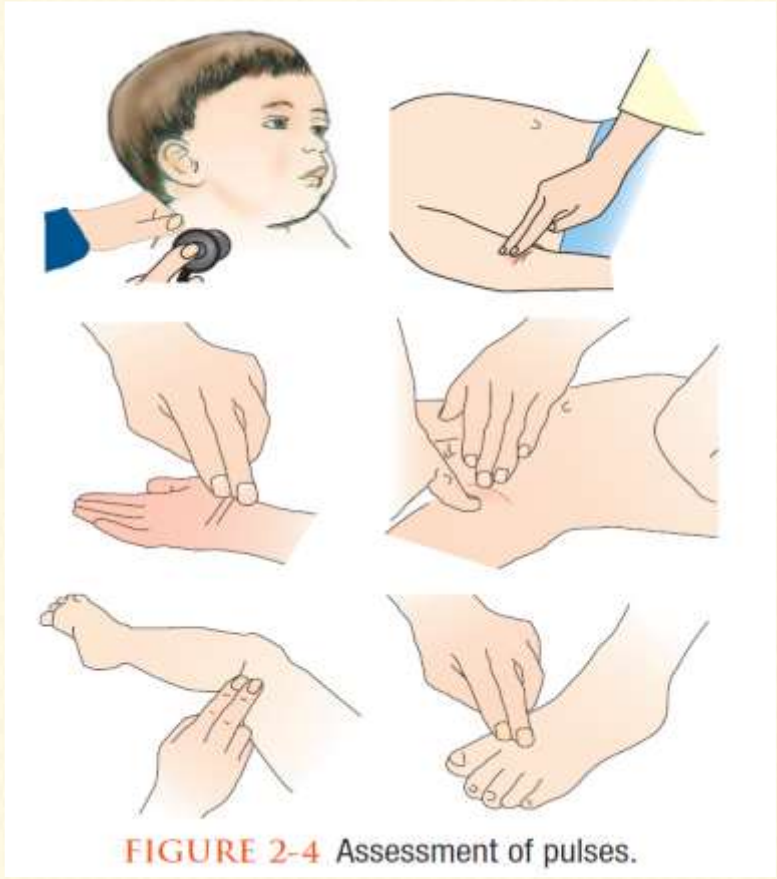


FIGURE 2-4 Assessment of pulses.

- Pulses should be assessed for the quality of rate, rhythm, and volume or strength.
- Children under 2 years of age require apical pulse (AP) measurements.
- Readings should be taken when the child is quiet.
- AP measurements are taken with the stethoscope placed over the heart below the nipple at the apex.
- For children over 2 years of age, the radial pulse is a satisfactory measurement.
- In infants and young children,the pulse should be counted for a full minute to account for irregularities in rhythm.

TABLE 2-5 STRENGTH AND QUALITY OF PULSES

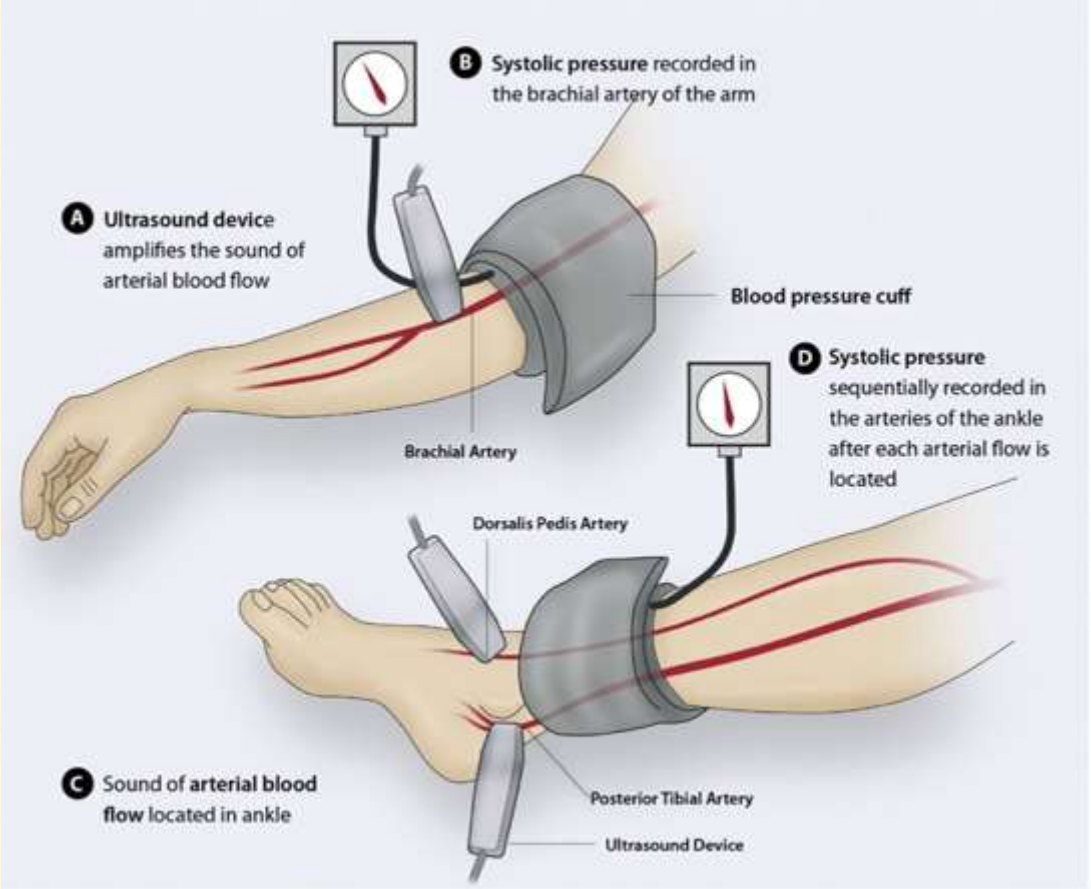
Strength	Quality
0	Not palpable
1+	Difficult to palpate, thready, obliterated by pressure
2+	Weak, difficult to palpate, may obliterate with pressure
3+	Palpable, normal strength
4+	Strong, bounding, not affected by pressure

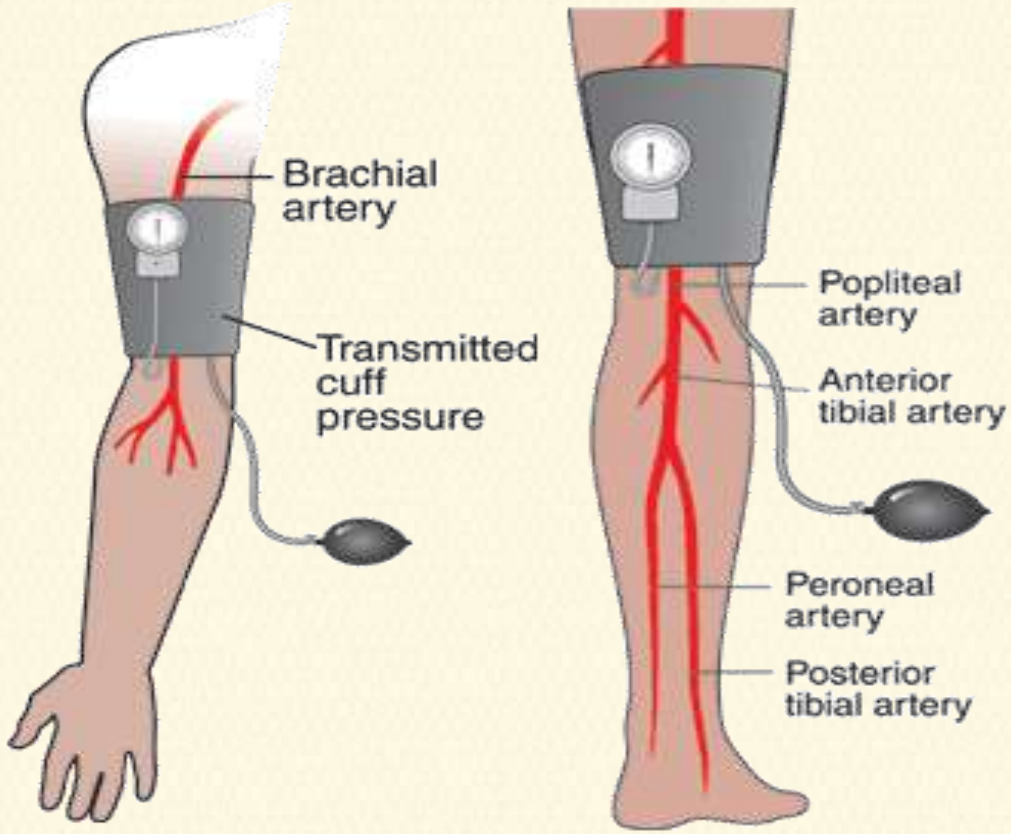
- It is important to detect any differences in pulse between the upper and lower extremities.
- The radial and femoral pulses should be evaluated and compared for strength and quality.
- Detecting the femoral pulse in newborn and young infants requires focus and concentration by the examiner.
- The femoral pulse is located in the mid-inguinal area over the head of the femur.
- An absent or weak pulse in the lower extremities compared to the upper extremities is diagnostic of *coarctation of the aorta.*

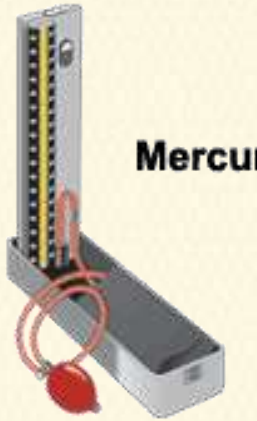
Blood pressure

- Children less than three years old should have their BP measured if they have a history of neonatal complications requiring neonatal intensive care, congenital heart disease, recurrent urinary tract infection, hematuria, proteinuria, known renal or urologic disease, family history of congenital renal disease, solid organ or bone marrow transplantation, malignancy, treatment with drugs known to raise BP, other systemic illnesses associated with HTN, or evidence of increased intracranial pressure .

- All children greater than three years old should have their BP measured during routine and emergency visits .


B Systolic pressure recorded in the brachial artery of the arm
A Ultrasound device amplifies the sound of arterial blood flow
Blood pressure cuff
Brachial Artery
D Systolic pressure sequentially recorded in the arteries of the ankle after each arterial flow is located
Dorsalis Pedis Artery
C Sound of arterial blood flow located in ankle
Posterior Tibial Artery
Ultrasound Device


Brachial artery
Transmitted cuff pressure
Popliteal artery
Anterior tibial artery
Peroneal artery
Posterior tibial artery



Mercurial

Aneroid

Electronic

Technique of BP measurement

- The following steps are recommended to accurately measure BP and compare values to normative data :

- Prior to BP measurement, stimulant drugs or food should be avoided.

- The BP should be measured after five minutes of rest in a quiet environment. The child should be seated with his/her back and feet in a supported position. In infants, BP is measured in a supine position.

- Because anxiety acutely raises both the heart rate and BP, the most reproducible readings are obtained when the pulse rate is both steady and within the normal range.

- Because BP normative data are based upon BP measurement recorded by auscultation, the preferred method of BP measurement is auscultation. Although the mercury sphygmomanometer is the most accurate instrument, its availability is restricted because of the potential risk of mercury poisoning. The aneroid manometers are accurate but need to be calibrated on a semi-annual basis and should be used if a mercury manometer is not available.

MEASUREMENT OF BLOOD PRESSURE

- **Cuff size** — A variety of different cuff sizes are available, including adult, large adult, and thigh cuffs. The correct choice of cuff is important for accurate BP measurement. If too small a cuff is used, the pressure generated by inflating the cuff may not be fully transmitted to the brachial artery. In this setting, the pressure in the cuff may be considerably higher than the intraarterial pressure, leading to overestimation of the systolic pressure. On the other hand, too wide a cuff may produce lower readings than the actual intraarterial pressure.

- The cuff size should have a bladder width that is approximately 40 percent of the circumference of the upper arm, measured midway between the olecranon and the acromion .The length of the cuff bladder should encircle 80 to 100 percent of the circumference of the upper arm midway between the olecranon and the acromion .The bladder width-to-length should be at least 1:2 .

- Cuff widths using the 40 percent upper arm circumference criterion gave comparable readings to intraarterial measurements for systolic BP but overestimated diastolic BP by a mean of 7 mmHg. In comparison, cuffs with widths chosen by the previously recommended criteria (equal to two-thirds to three-fourths of the length of the upper arm) resulted in substantially and significantly lower values compared to intraarterial measurements for both systolic BP (15 to 17 mmHg) and diastolic BP (6 to 7 mmHg) because of the larger cuff.

- The BP is measured by auscultation using a stethoscope placed over the brachial artery pulse in the cubital fossa .The BP should be taken with the patient's right arm supported at the level of the heart.

- Allowing the arm to hang below the heart will elevate BP levels by the added hydrostatic pressure induced by gravity (as much as 10 to 12 mmHg in adults) .

- The cuff should be inflated to 20 to 30 mmHg above the anticipated systolic BP and then deflated slowly at a rate of 2 to 3 mmHg per heartbeat. The systolic BP is equal to the pressure at which the brachial pulse can first be heard by auscultation (Korotkoff phase I). As the cuff is deflated below the SBP, the pulse continues to be heard until there is abrupt muffling (Korotkoff phase IV) followed by disappearance of sound (Korotkoff phase V) .

- Phase V is recommended for DBP determination in children as well as adults . If phase V is still very low, phase IV (muffling) should be recorded as the DBP .

- new diagnosis of HTN should not be made until the systolic and/or diastolic BP measurement is ≥95th percentile on at least three separate visits, separated by days or weeks apart .

DEFINITION

- Normal BP — Both systolic and diastolic BP <90th percentile .
- Prehypertension — Systolic and/or diastolic BP ≥90th percentile but <95th percentile or if BP exceeds 120/80 mmHg (even if <90th percentile for age, gender, and height .
- Hypertension — Hypertension is defined as either systolic and/or diastolic BP ≥95th percentile measured upon three or more separate occasions. The degree of hypertension is further delineated by the two following stages .
- - Stage 1 hypertension — Systolic and/or diastolic BP between the 95th percentile and 5 mmHg above the 99th percentile.
- - Stage 2 hypertension — Systolic and/or diastolic BP ≥99th percentile plus 5 mmHg .

Hypotension

- Less than 60 mmHg in term neonates (0 to 28 days)
- Less than 70 mmHg in infants (1 month to 12 months)
- Less than 70 mmHg + (2 x age in years) in children 1 to 10 years
- Less than 90 mmHg in children 10 years of age or older

Hypertensive emergency — A severe symptomatic elevation in BP WITH evidence of acute target organ damage defines a hypertensive emergency . The most commonly involved organs are the brain (seizures, increased intracranial pressure), kidneys (renal insufficiency), eyes (papilledema, retinal hemorrhages, exudates), and heart (congestive heart failure).

(The absolute degree of BP elevation is less important than whether end organ symptoms and/or damage is present.)

Hypertensive encephalopathy — Hypertensive emergencies in children usually manifest as hypertensive encephalopathy: severe BP elevation with cerebral edema and neurological symptoms of lethargy, coma, and/or seizures.

Malignant hypertension — This term describes marked hypertension with retinal hemorrhages, exudates, or papilledema.

Hypertensive urgency — A severe elevation in BP WITHOUT severe symptoms or evidence of acute target organ damage describes a hypertensive urgency

Pulsus paradoxus.

- Some respiratory variation of pulse amplitude should be observed during examination of the arterial pulse.
- Systolic arterial pressure normally falls during inspiration, although the magnitude of decrease usually does not exceed 8 to 12 mmHg. These changes in pulse amplitude are not usually appreciated by palpation but can be established with the sphygmomanometer.
- A more marked inspiratory decrease in arterial pressure exceeding 20 mmHg is termed pulsus paradoxus. In contrast to the normal situation, this is easily detectable by palpation, although it should be evaluated with a sphygmomanometer. When the cuff pressure is slowly released, the systolic pressure at expiration is first noted. With further slow deflation of the cuff, the systolic pressure during inspiration can also be detected. The difference between the pressures during expiration and inspiration is the magnitude of pulsus paradoxus.

Mechanism of pulsus paradoxus —

- The mechanism for the marked inspiratory decrease in arterial pressure with pulsus paradoxus appears to be related to the inspiratory decline of left ventricular stroke volume due to an increase in right ventricular end-diastolic volume and decreased left ventricular end-diastolic volume.
- In cardiac tamponade, the interventricular septum shifts toward the left ventricular cavity during inspiration a result of the normal increase in venous return to the right side, thereby decreasing left ventricular preload .
- An inspiratory decrease in pulmonary venous return to the left side of the heart also has been thought to contribute to decreased left ventricular preload

Pediatric respiratory rate and heart rate by age*

Age group	Respiratory rate	Heart rate
	Median (1st-99th percentile)	Median (1st-99th percentile)
0 to 3 months	43 (25-66)	143 (107-181); term newborn at birth: 127 (90-164)
3 to 6 months	41 (24-64)	140 (104-175)
6 to 9 months	39 (23-61)	134 (98-168)
9 to 12 months	37 (22-58)	128 (93-161)
12 to 18 months	35 (21-53)	123 (88-156)
18 to 24 months	31 (19-46)	116 (82-149)
2 to 3 years	28 (18-38)	110 (76-142)
3 to 4 years	25 (17-33)	104 (70-136)
4 to 6 years	23 (17-29)	98 (65-131)
6 to 8 years	21 (16-27)	91 (59-123)
8 to 12 years	19 (14-25)	84 (52-115)
12 to 15 years	18 (12-23)	78 (47-108)
15 to 18 years	16 (11-22)	73 (43-104)

* The respiratory and heart rates provided are based upon measurements in awake, healthy infants and children at rest. Many clinical findings besides the actual vital sign measurement must be taken into account when determining whether a specific vital sign is normal in an individual patient. Values for heart rate or respiratory rate that fall within normal limits for age may still represent abnormal findings that are caused by underlying disease in a particular infant or child.

Data from: Fleming S, Thompson M, Stevens R, et al. Normal ranges of heart rate and respiratory rate in children from birth to 18 years of age: a systematic review of observational studies. Lancet 2011; 377:1011.

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THANKS FOR YOUR ATTENTION