Techniques of Vital Signs
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Objectives
- Define “normal” in several ways
- Describe correct technique of measuring vital signs
- Describe correct technique for evaluating pulses
- Understand that different populations (children, elderly), may have different normal values for vital signs

What does “Normal” mean?
- Average
  - Population (sample) mean
  - Gaussian distribution
  - 95% confidence interval (+/- two standard deviations)

- “Healthy” - Appropriate physiologic function
  - What is best for organism
  - Best defined by population based studies that determine association between a measured level of physiologic function and patient oriented measures of health, such as mortality
- These two definitions can be incompatible

Temperature
- Oral
  - glass (mercury)
    - use sheath
    - shaken down to $35.5^\circ C$ ($96^\circ F$)
    - insert under tongue, hold between lips for 3 to 5 minutes
    - check for stability (read, reinsert for 1 minute, read again until no change)
• Electronic
  - use sheath
  - watch read-out - 10 seconds
• Caution Point
  - Hot or cold liquids can alter temperature
  - Wait 10 to 15 minutes before reassessment

Rectal temperature
• Glass (mercury)
  - use rectal temperature (stubby tip] sheath, and lubrication
  - insert into anal canal, pointing towards umbilicus
  - read after three minutes, or after stabilized
• Electronic
  - use probe cover and lubrication

Axillary
• Measure with glass or electronic thermometer
• Do not correlate well with rectal temperatures
  - Mercury mean difference 0.25°C (-0.15°C to 0.65°C]
  - Electronic mean difference 0.85°C (-0.19°C to 1.90°C]
  - BMJ 320, 29 Apr, 2000
• Don’t use if accurate temperature measurement important
  - neonates may be exception, mean difference = 0.17°C (-0.15°C to 0.5°C)

Tympanic
• measures core temperature
• Caution Point
  - Must use correctly – point at TM; no wax

Temperature - Normal Values
• Oral - 37.0°C (98.6°F), range 35.8°C (96.4°F) to 37.3°C (99.1°F)
• Rectal 0.4°C to 0.5°C (0.7°F to 0.8°F) higher than oral
  * Tympanic 0.8°C (1.4°F) higher than oral

In elderly patient, increase of temperature of 2.4°F (1.3°C) over baseline indicates fever

Respiratory Rate
• Respiratory cycles per minute
  • respiratory cycle = inspiration + expiration
• Observe rise and fall of chest
  • in infants, observe abdomen
• Depth, effort of breathing, rhythm
  • accessory muscle use, retractions, nasal flaring
• For infants, count for 60 seconds, or two thirty second intervals
• Patients may change rate if they are conscious that you are watching them.
Normal Values
- Normal adult - 12 to 20
- Children:
  - newborn: 30 - 80
  - 1 year: 20 - 40
  - 3 years: 20 - 30
  - 6 years: 16 - 22
  - 17 years: 12 - 20

Pulse
- Number of cardiac cycles per minute
- Palpable pulses result from ventricular systole
  - produces a pressure wave in arterial system
- Pulse affected by:
  - Volume of blood ejected (stroke volume)
  - Distensibility of aorta and large arteries
  - Viscosity of blood
  - Rate of cardiac emptying
  - Peripheral arteriolar resistance

Palpation of pulses
- Pads of second and third fingers
- Gentle pressure
- Assess rate (15 or 30 seconds), multiply by 4 or 2. If pulse irregular, count for 60 seconds
- Rhythm (regular, irregular, irregularly irregular)
  - regular rhythm - what you can observe
  - normal sinus rhythm – specific electrical rhythm (need EKG)
- Amplitude
  - 0 (absent)
  - 1 or 1+ (diminished)
  - 2 or 2+ (normal, expected)
  - 3 or 3+ (increased, but may be normal in young individuals)
  - 4 or 4+ (bounding)
- Contour (upstroke, peak, descending)

Location of pulses
- Radial - Radial and ventral side of wrist
  - most commonly used for measuring pulse
- Carotid - In neck, medial to and below angle of jaw
  - used in CPR, timing of cardiac sounds, assessment of pulse quality
- Brachial - medical to biceps tendon
  - used for blood pressure
Femoral - Inferior and medial to inguinal ligament
  • used to locate femoral vein for access in a “code.”
Popliteal - Popliteal fossa
  • prone with knee flexed
Dorsalis pedis (DP)- Medial side of dorsum of foot (lateral to extensor hallucis longis)
  • foot should be slightly dorsiflexed
  • absent in 8% of extremities
Posterior tibial (PT) - Posterior and inferior to medial malleolus
  • Absent in 3% of extremities

Normal Pulse Values
  60 to 100 (90)

Children:
  • Newborn 120-170
  • 1 year 80 - 160
  • 3 years 80 - 120
  • 6 years 75 - 115
  • 10 years 70 –110

Abnormal Pulses
Bounding pulse (3+)
  • does not “fade out”, cannot be easily obliterated by examiner
  • fever, exercise, anxiety, hyperthyroidism
Decreased pulse (1+)
  • decreased amplitude
  • hypovolemia, peripheral vascular disease
Sinus Arrhythmia
  • Rate increases on respiration, decreases on expiration
  • normal finding
Alternating Pulse (Pulsus alternans)
  • alternating small and large amplitude
  • left ventricular failure
Water-hammer pulse
  • greater amplitude, sudden descent
  • aortic regurgitation

Auscultation of Arteries
Bruit (BROO-ee) - a murmur or unexpected sound over an artery
  • Caused by obstruction, aneurysm, or radiation of murmur
Low pitched, swishing or whooshing sound
  • use bell
Place bell over artery
  • carotid - anterior to sternocleidomastoid, ask patient to hold breath.
- Femoral - inferior and medial to inguinal ligament
- Aorta, iliac, renal - covered in abdominal exam lectures.

Does Your Patient have Peripheral Vascular Disease?
- History of claudication (pain in leg), and other risk factors (DM, HTN, CAD)
- Absent or decreased pedal (DP and PT) pulses
- Femoral artery bruit
- Unilateral cooler leg
  - (Arch Int Med, 158, PP 1357-1364, 1998)

Measurement of Blood Pressure
- Blood Pressure is peripheral measurement of cardiovascular function.
  - Systolic pressure is force exerted against arterial wall with ventricular systole, and is function of cardiac output and blood volume
  - Diastolic pressure is force exerted when heart is filling, and is function of peripheral vascular resistance
- Blood Pressure measurement is usually measured indirectly with a sphygmomanometer.
- Technique of blood pressure measurement
  - Choose an appropriately sized blood pressure cuff.
  - Size of cuff based on size of inflatable bladder within the cuff. Bladder width should be about 40% of the circumference of the limb, and length about 80% of limb circumference where blood pressure will be measured. (Most cuffs have markings)
    - Cuff that is too large underestimates blood pressure, too small cuff overestimates blood pressure
  - Place the blood pressure cuff on the limb
    - Don’t’ use limb with arteriovenous fistula or on side of radical mastectomy
    - No clothing on upper arm, or very light sleeve.
    - usually the upper limb, with lower edge of cuff 2 to 3 cm above antecubital fossa
    - Place cuff snugly about the limb. Loose cuff leads to inaccurate diastolic blood pressure measurement
      - Cuff centered over brachial artery (look for markings on cuff)
      - Support the patient’s arm with your arm, desk, etc., with elbow slightly flexed, and brachial artery at elbow at heart level (4th intercostal space)
  - Measure the palpable systolic blood pressure
    - Palpate brachial or radial artery, rapidly pump up cuff until pulse no longer palpable.
    - Pump up blood pressure cuff another 20 mm Hg.
    - Release blood pressure cuff at rate of 2 to 3 mm Hg per second, until pulse is felt. Remember this value.
    - Rapidly release pressure from cuff.
    - Wait 30 seconds
• **Measure the blood pressure**
  - Place bell of stethoscope (diaphragm also acceptable) over the brachial artery (vascular sounds are low pitched)
  - Rapidly pump up blood pressure cuff to 20 - 30 mm Hg over the palpable systolic blood pressure.
  - Release the pressure in the cuff at rate of 2 to 3 mm Hg per second, and listen for the Korotkoff sounds:
    - **Phase 1** - first two consecutive beats heard (sharp thud) - the systolic blood pressure
    - **Phase 2** - blowing or swishing sound - may disappear altogether - the auscultatory gap
    - **Phase 3** - crisp thud, softer than phase 1
    - **Phase 4** - transition from crisp to muffled sounds - best indirect measure of diastolic blood pressure (may have to be used in children)
    - **Phase 5** - Disappearance of sounds signals Phase 5 - by convention recorded as diastolic blood pressure
  - Record blood pressure as systolic/diastolic (120/80)
  - Repeat in other arm. The higher reading of the two arms is the patient’s blood pressure.
    - Readings may vary by up to 10 mm Hg between arms

• **Blood pressure can be measured at (almost) any palpable artery**
  - At the wrist using the radial artery
  - At the knee using the popliteal artery, patient usually in prone position.
  - At the ankle using the dorsalis pedis or posterior tibialis artery
  - In each instance, use appropriately sized cuff placed above the artery

• **Important considerations in accurate measurement of blood pressure**
  - Aneroid sphygmomanometers should be calibrated every 6 months.
  - Sphygomanometer dial should be at eye level.
  - Patient should be seated, preferably with back supported and feet on the floor
  - Patient should rest for 5 minutes before blood pressure measurement, and should refrain from caffeine or nicotine ingestion for 30 minutes.
    - JAMA, 273; pp 1211-1218, 1995

• **Pitfalls in measurement of blood pressure**
  - Arrhythmia can produce variations in pressure and result in unreliable measurements. Average several measurements and note the irregular rhythm.
  - Venous congestion – can lower systolic pressure and raise diastolic pressure in affected limb. Can be caused by repeated, slow inflation of the cuff (“blue arm syndrome”), following mastectomy.
  - Korotkoff sounds do not disappear – heard all the way to 0. May occur with aortic regurgitation or valve replacement. Estimate diastolic pressure using phase 4 Korotkoff sound – when sound first becomes muffled.
• Does This Patient Have Hypertension?
  – Diagnosis should be based on average of two or three readings
  – individual variation in blood pressure
  – regression to the mean
  – repeated measurements useful, especially in patients near diagnostic cut point

Normal Blood Pressure Values

Children
• 1 year: 102/55
• 5 years: 112/69
• 10 years: 119/78

Joint National Commission VI Classification of BP Values in Adults

<table>
<thead>
<tr>
<th>Category</th>
<th>Systolic (mmHg)</th>
<th>Diastolic (mmHg)</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimal</td>
<td>&lt; 120 and</td>
<td>&lt; 80</td>
<td>2 years</td>
</tr>
<tr>
<td>Normal</td>
<td>&lt; 130 and</td>
<td>&lt; 85</td>
<td>2 years</td>
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<tr>
<td>High Normal</td>
<td>130 - 139 or</td>
<td>85 - 89</td>
<td>1 year</td>
</tr>
<tr>
<td>Stage 1</td>
<td>140 - 159 or</td>
<td>90 - 99</td>
<td>2 months</td>
</tr>
<tr>
<td>Stage 2</td>
<td>160 - 179 or</td>
<td>100 - 109</td>
<td>1 month</td>
</tr>
<tr>
<td>Stage 3</td>
<td>≥ 180 or</td>
<td>≥ 110</td>
<td>1 wk</td>
</tr>
</tbody>
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Orthostatic vital signs

• Measuring pulse and blood pressure in different positions can help assess volume status – is the patient dehydrated or have they suffered blood loss?
• Measure supine vital signs after patient is lying down for two minutes, and measure standing vital signs 1 minute after patient has stood up.
• Blood loss
  • A postural pulse increment ≥ 30 bpm predicts blood loss
  • Severe postural dizziness (unable to stand for vital signs) predicts blood loss
• Dehydration
  • Data are not as clear as for blood loss, reasonable to use same criteria (JAMA, 281(11);1022-1029)