

Pulsus Paradoxus (paradoxical pulse)**Definition**

- A fall of systolic blood pressure of >10 mmHg during the inspiratory phase

Pathophysiology (result of the following mechanisms operating alone or in combination)

- Limitation in increase in inspiratory blood flow to the right ventricle and pulmonary artery
- Greater than normal pooling of blood in the pulmonary circulation
- Wide excursions in the intrathoracic pressure during inspiration and expiration
- Interference with venous return to either atrium especially during inspiration

Etiology

- Cardiac tamponade (70%-100% of cases)
- Asthma (occurs in 80% of cases)
- Shock (occurs in 50% of cases)
 - Note: increased peripheral resistance and decreased blood volume)
- Effusive/restrictive pericarditis (30%-40% of cases)
- Pulmonary embolism (30% of cases)
- Chronic obstructive pulmonary disease (COPD)
- Infrequent cases:
 - Right ventricular failure
 - Severe congestive failure
 - Right ventricular infarction
 - Patent ductus arteriosus
- Conditions that produce false negatives: (typically pulsus paradoxus would be present; either both ventricles do not fill against a common pericardial stiffness or the respiratory changes alternately favoring the right and left heart do not occur)
 - Far advanced left ventricular hypertrophy
 - Severe left heart failure
 - Atrial septal defect
 - Severe aortic insufficiency
 - Severe tamponade with extreme hypotension (right heart tamponade)
 - Loculated pericardial fluid (prevents equalization of ventricular diastolic pressure)
 - Low-pressure tamponade

Equipment

- Stethoscope and manual blood pressure cuff with sphygmomanometer
- Appropriate size blood pressure cuff
 - Length of the inflatable bladder should be 80% (almost long enough to encircle the arm)
 - Width of the inflatable bladder should be at least 40% of the circumference of the upper arm (about 12-14 cm in the average adult)
 - Recommend cuff sizes based on arm circumference:
 - 22-26 cm, use a small adult cuff (12x22 cm)
 - 27-34 cm, use an adult cuff (16x30 cm)
 - 35-44 cm, use a large adult cuff (16x36 cm)

- 45-52 cm, use an adult thigh cuff (16x42 cm)
- Errors occur when the cuff is too small (measurement is high) or too large (measurement is low)

Assessment Technique

- Cuff sphygmomanometry
 1. Have the patient sit (comfortable, relaxed, legs uncrossed, feet resting on the floor) for 5 minutes before obtaining measurement
 2. Instruct the patient not to breathe too deeply (enough to make the chest movements easily visible)
 3. Arm should be supported at the level of the heart and slightly flexed at the elbow
 4. Place the BP cuff with the bladder midline over the brachial artery pulsation
 - a. The lower border of the cuff should be about 2.5 cm above the antecubital crease
 5. To determine the inflation level, palpate the radial artery and rapidly inflate the cuff until the pulse disappears, read this pressure on the manometer and add 30 mmHg to it
 6. Deflate the cuff and wait 15-30 seconds
 7. Place the stethoscope lightly over the brachial artery
 - a. The Korotkoff sounds are best heard with the bell of the stethoscope since they are relatively low in pitch
 - b. Ensure a proper seal is obtained
 8. Inflate the cuff rapidly to the predetermined inflation level
 9. Deflate slowly at a rate of 2-3 mmHg/second
 10. Note the level at which the first sounds can be heard (only during expiration)
 - a. This is the peak systolic pressure
 11. Deflate the cuff very slowly until the sounds become audible during both inspiration and expiration; note the level
 - a. This is the lowest systolic pressure
 12. Deflate the cuff rapidly
 13. Results:
 - a. Normal: difference between the systolic pressure levels ≤ 4 mmHg
 - b. Abnormal: difference between the systolic pressure levels is > 10 mmHg; pulsus paradoxus is present

Alternate Assessment

- Palpation: Best assessed using the radial artery
 1. Have the patient sit comfortably on the exam table; arms at their side and elbow bent; thumb facing up
 2. Palpate the patients wrist (the lateral flexor surface), using the pads of your first and second fingers, for pulsations
 - a. Partially flexing the patient's wrist may help you feel the pulse
 - b. Note the rate, rhythm, volume, and character of the beat
 3. Results:
 - a. Normal: regular rate and rhythm, volume and character of the beat are consistent
 - b. Abnormal: a palpable reduction in the pulse volume during inspiration and a rise during expiration; Indicates severe pulsus paradoxus

- Arterial waveform analysis (e.g. arterial cannulation or pulse oximetry)
 - Visualize changes in systolic pressure tracing during inspiration and expiration

Notes

- The absence of pulsus paradoxus does not rule out the presence of a significant problem
- Must not be considered in isolation but in conjunction with the patient's clinical state

References

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