

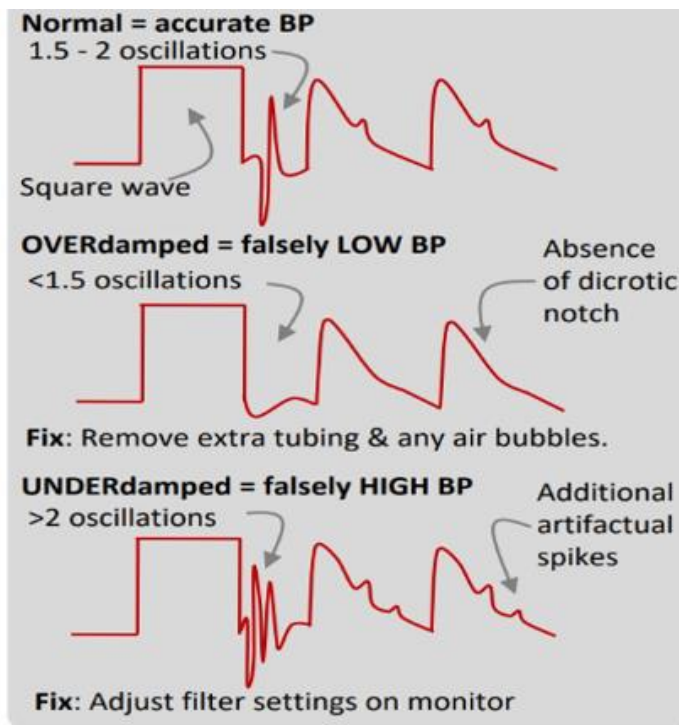
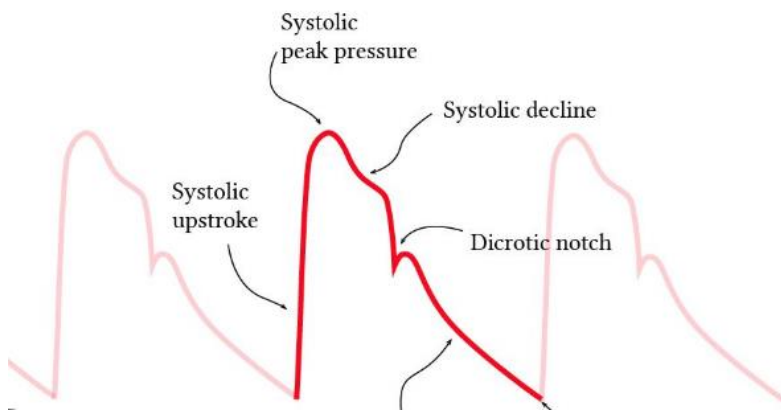
## Arterial waveform damping and pulse pressure analysis

Arterial waveform interpretation is essential for caring critically ill patients. Overdamping and underdamping of the arterial waveform leads to inaccurate SBP and DBP which can lead to miss hypotension or hypertension.

The degree of damping is assessed by the square wave test (rapid flush for approximately 1 second)

- Two oscillations after the end of the square wave are optimal
  - More than two suggests underdamping
  - Less than one and half or none represents overdamping

Figures below show the normal arterial waveform and the potential abnormalities (overdamping and underdamping) identified by the square wave test.



- Overdamping
  - Lose the dicrotic notch that identifies a normal waveform
  - Leads to underestimated SBP and overestimated DBP. However, the DBP on occasions may be not affected so MAP although remains largely accurate is less reliable
  - Causes:
    - Air bubbles in the tubing
    - Clot at the tip of the catheter
    - Tubing kinked or too stiff
    - Positioned against the wall of the blood vessel
    - Inappropriate tubing length
    - Low infusion bag pressure
- Underdamping (also known as catheter “whip”)
  - Multiple dicrotic notch may be present rather than 1 dicrotic notch that identifies a normal waveform
  - Leads to overestimated SBP and underestimated DBP. The MAP remains largely unchanged
  - Causes:
    - Inappropriate filter settings on monitor or defective transducer
    - Tubing excessively long or too elastic
    - Too many stopcocks

### **Pulse pressure**

- Pulse pressure is the BP gradient between SBP and DBP: SBP minus DBP. Normal pulse pressure: 40 to 60 mmHg
- Causes of wide pulse pressure (>100 mmHg)
  - Vasodilatory shock
    - Sepsis
    - Anaphylaxis
    - Liver failure
    - Profound acidemia
  - Aortic valve regurgitation
  - Severe microcytic anemia
  - Hyperthyroidism
  - Increased intracranial pressure with impending herniation
    - Cushing reflex: systemic HTN (increased SBP and decreased DBP , bradycardia, and irregular breathing pattern (slow and irregular)
- Causes of narrow pulse pressure ( <40 mmHg)
  - Heart failure
    - Significantly low pulse pressure (<25 mmHg) is a surrogate of reduced stroke volume and low cardiac output
  - Aortic stenosis
  - Cardiac tamponade
  - POTS (dysautonomia with postural orthostatic tachycardia syndrome)
    - Sustained HR increase >30 beats/min and decrease in SBP >20 mmHg when standing