

Circulatory Vital Signs

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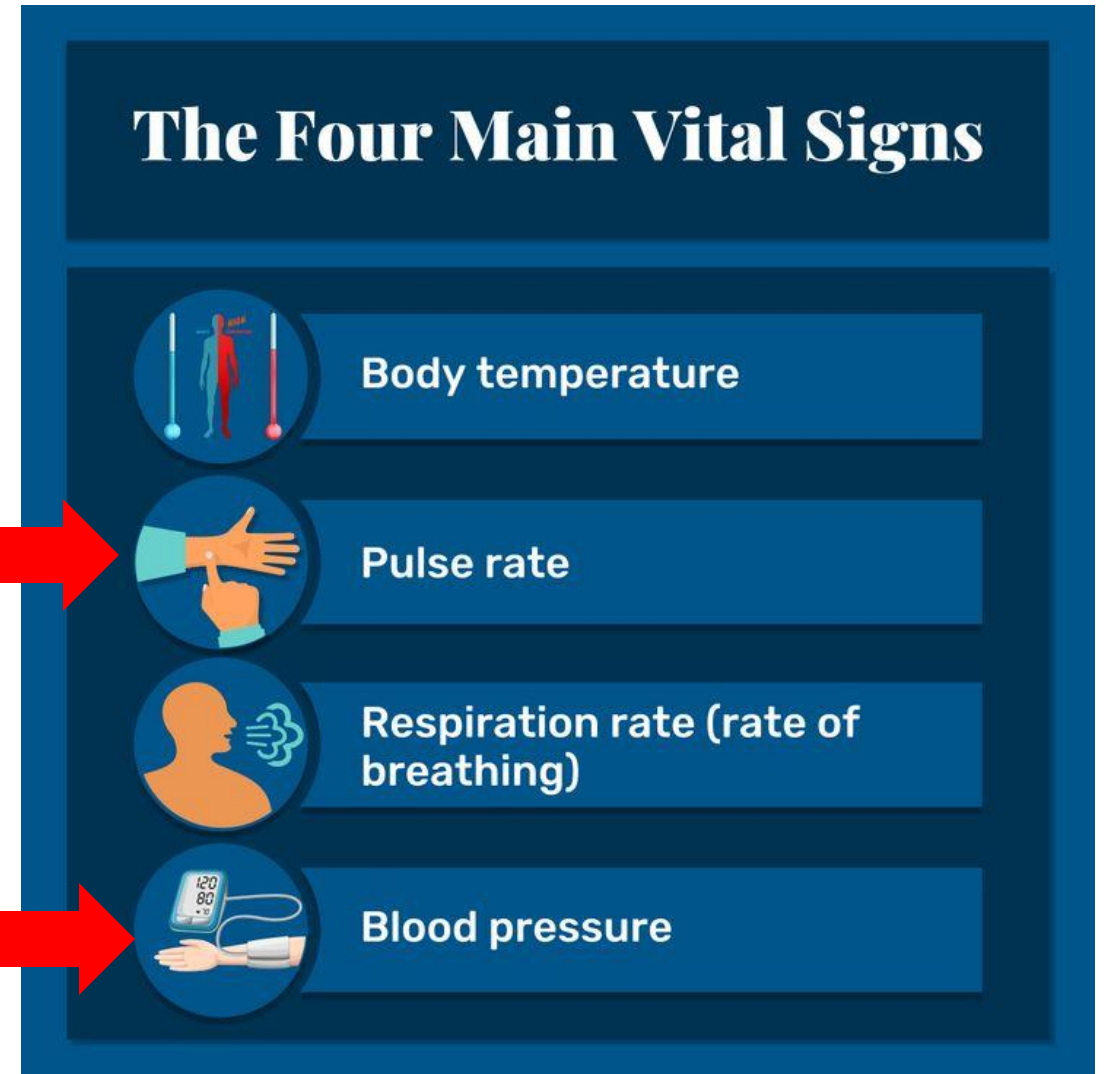
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What Are Vital Signs?

Vital signs are measurements of physiological functioning that indicate the overall health status of a person

There are four “main” vital signs, but some have suggested extending the list:

- 5th: Pain
- 6th: Gait speed



How Can We Measure Heart Rate?

Signal Name	Traditional Sensors	Target Phenomenon
Phonocardiography (PCG)	Stethoscopes, microphones	Sounds produced by the opening and closing of the aortic valve
Electrocardiography (ECG)	Electrodes	Electrical signals in the heart
Ballistocardiography (BCG)	Motion sensors	Repetitive motions caused by the ejection of blood from the heart
Photoplethysmography (PPG)	Light source and optical sensors	Optically detectable blood volume changes in a region of tissue

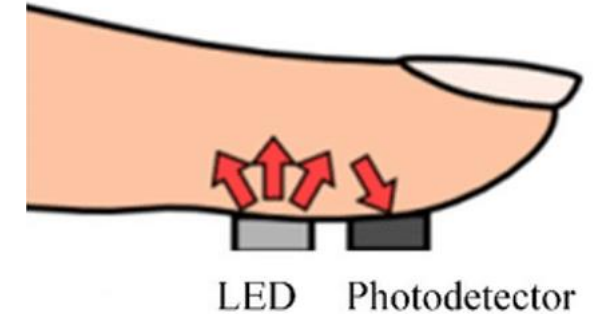
PPG In More Detail

There are two possible PPG sensor configurations:

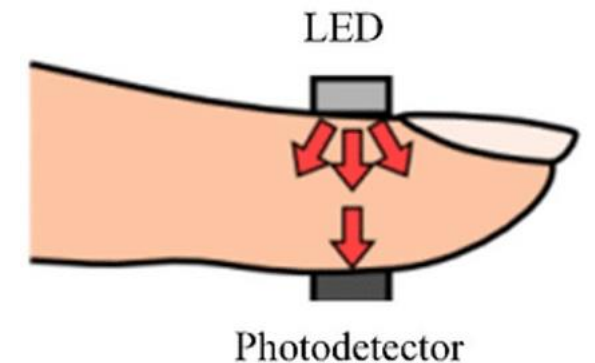
- **Reflective:** Light source and sensor are on the same side; light is shone into the fingertip and reflected back into the sensor
- **Transmissive:** Light source and sensor on opposite sides; light is shone into the fingertip and gets received on the other side

PPG is most often used on extremities like wrists and fingers, but similar principles apply to facial PPG at a distance

Reflective



Transmissive



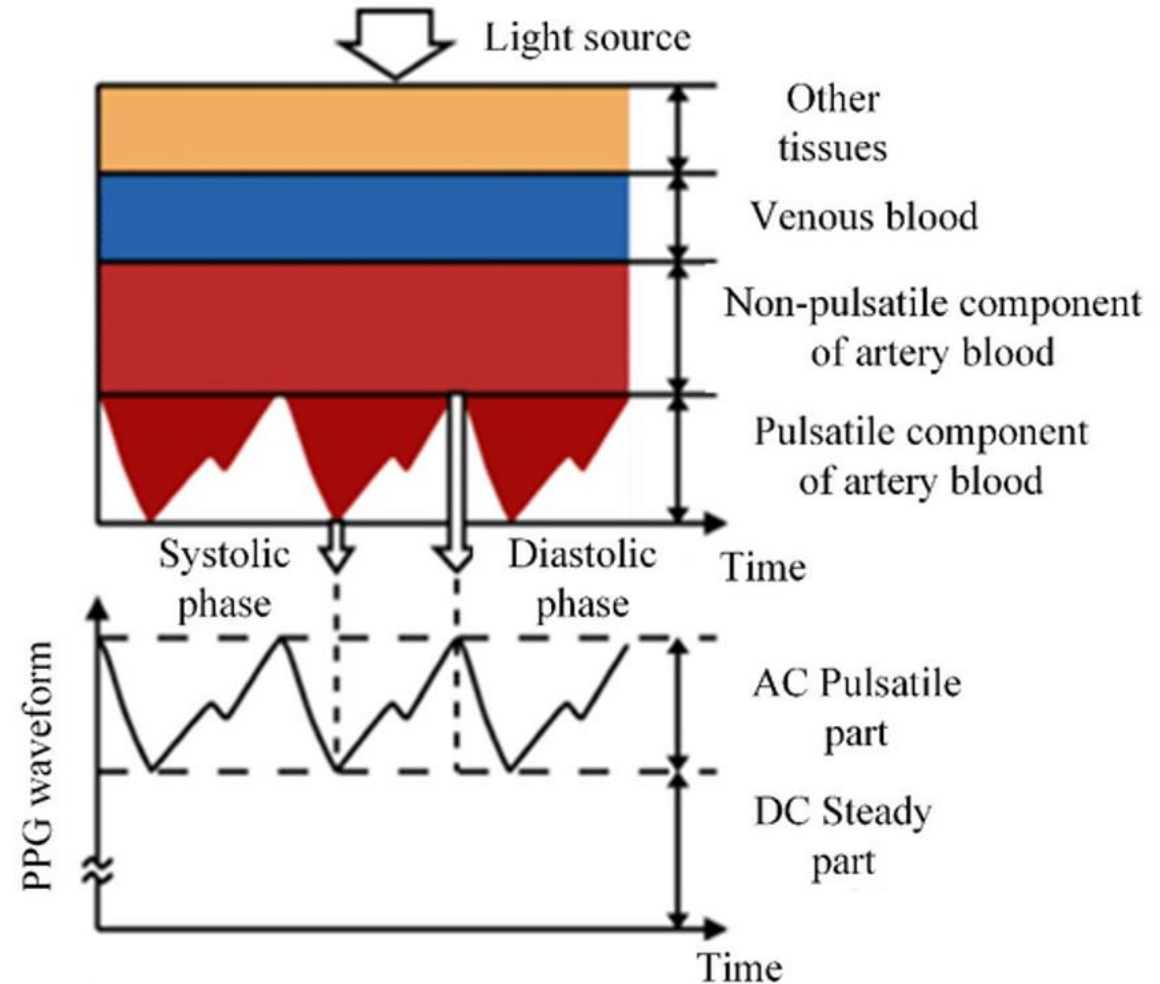
PPG In More Detail

Observed signal depends on:

- Skin tone (constant)
- Venous blood (constant)
- Artery blood (constant + pulsatile)

Shape features *should* only depend on the pulsatile component of the signal, but factors like skin tone will influence signal quality

Comparing constant and pulsatile components across multiple wavelengths can also provide information on the blood's contents (e.g., hemoglobin, oxygen content)



Resources

Photoplethysmography and Its Application in Clinical Physiological Measurement

([Allen '07](#))

Advances In Non-Invasive Blood Pressure Measurement Techniques

([Panula et al. '22](#))