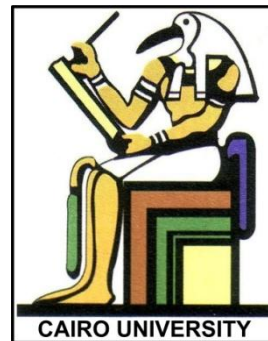


Medical Equipment I - 2009

Part II: Patient Monitor

Professor Yasser M. Kadah

Web: <http://ymk.k-space.org/courses.htm>



Patient Monitor Modules

- ECG
- Temperature
- Respiration
- PPG (SpO₂)
- Noninvasive BP
- Invasive BP
- ETCO₂



[Oximetry]

- Oximetry refers to the colorimetric measurement of the degree of oxygen saturation (SO_2), that is, the relative amount of oxygen carried by the hemoglobin in the erythrocytes.
- The measurement is based on the variation in the color of deoxyhemoglobin (Hb) and oxyhemoglobin (HbO_2).
- A quantitative method for measuring blood oxygenation is of great importance in assessing the circulatory and respiratory status of a patient

[Pulse Oximetry]

- Noninvasive monitoring of SaO₂ by pulse oximetry is a rapidly growing practice in many fields of clinical medicine
- The most important advantage of this technique is the capability to provide continuous, safe, and effective monitoring of blood oxygenation.



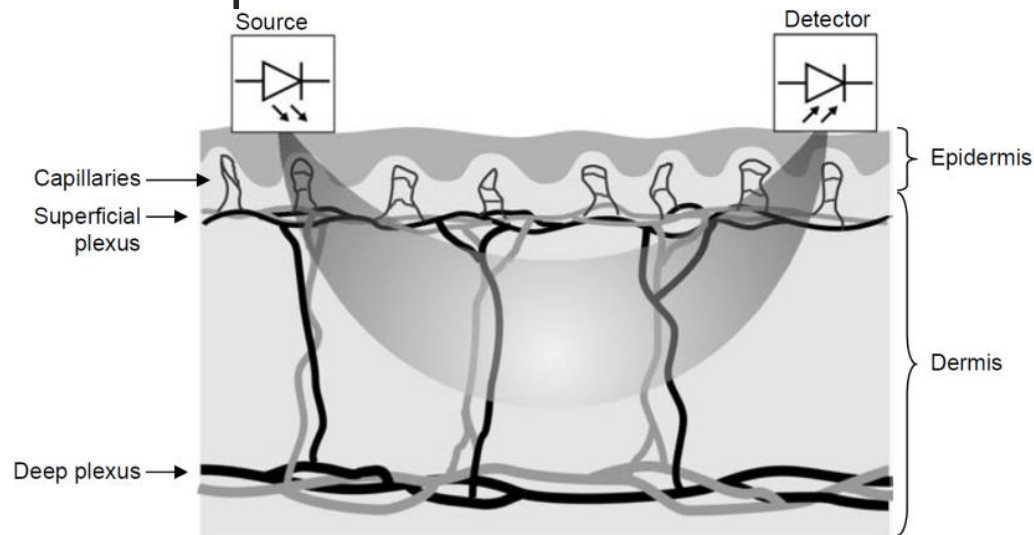
[Pulse Oximetry]

- Pulse oximetry relies on the detection
- of time-variant photoplethysmographic (PPG) signals, caused by changes in arterial blood volume associated with cardiac contraction.
- The SaO₂ is derived by analyzing the time-variant changes in absorbance caused by the pulsating arterial blood at the same R and IR wavelength used in conventional invasive-type oximeters.



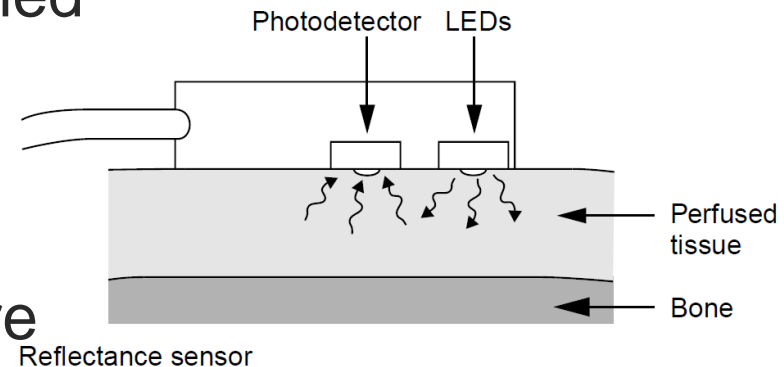
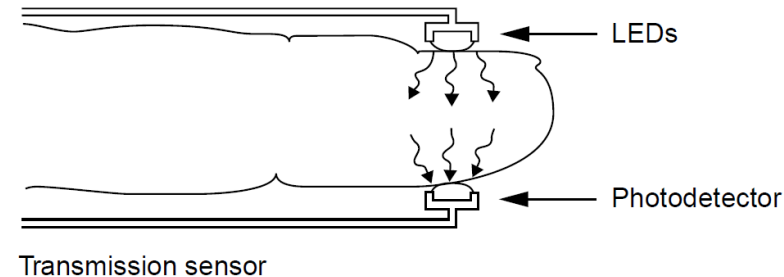
Pulse Oximetry Probe

- Pulse oximeter sensors consist of a pair of small and inexpensive R and IR LEDs and a highly sensitive silicon photodiode.
- Components are mounted inside a reusable rigid spring-loaded clip, a flexible probe, or a disposable adhesive wrap



Pulse Oximetry Probe Types

- Majority of the commercially available sensors are of the transmittance type in which the pulsatile arterial bed (e.g., ear lobe, fingertip, or toe) is positioned between the LEDs and the photodiode.
- Other probes are available for reflectance measurement, where both the LEDs and photodetector are mounted side-by-side facing the skin



[Pulse Oximetry Concept]

- The concept of oximetry is based on the simplified assumption that a hemolyzed blood sample consists of a two-component homogeneous mixture of Hb and HbO₂, and that light absorbance by the mixture of these two components is additive.
- Hence, a simple quantitative relationship can be derived for computing the oxygen saturation of blood based on two absorption measurements at two different light wavelengths.

$$SO_2 = K_1 - K_2[OD(\lambda_1)/OD(\lambda_2)]$$

[Wavelengths]

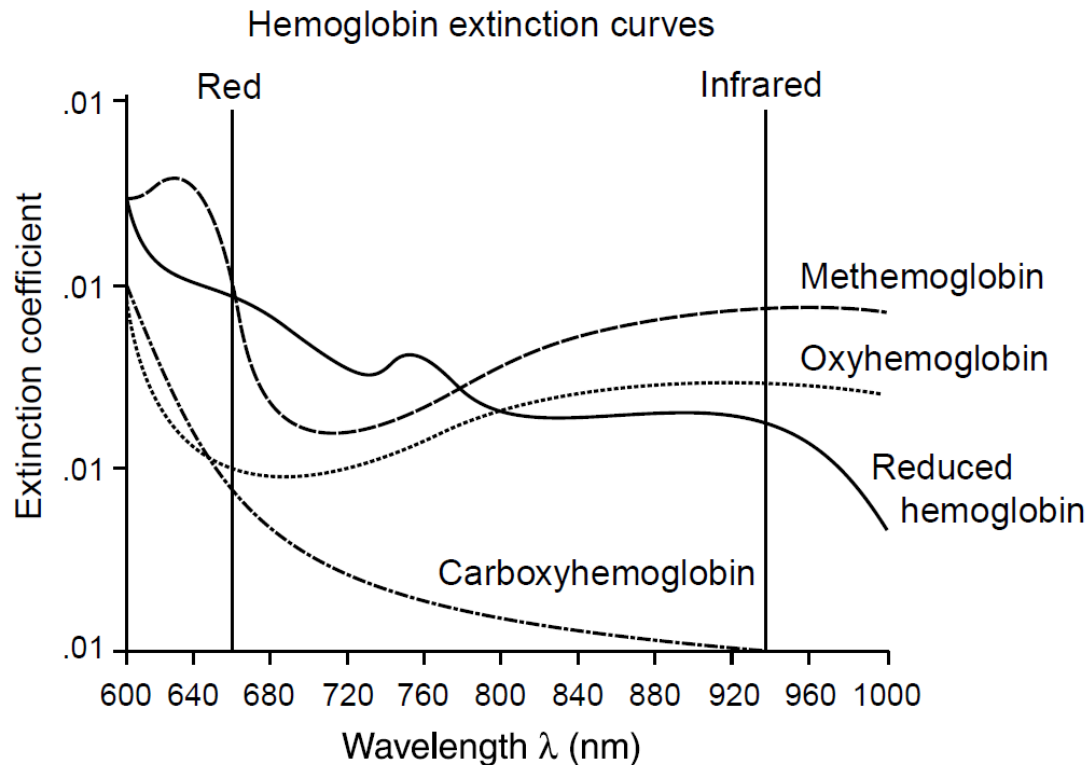
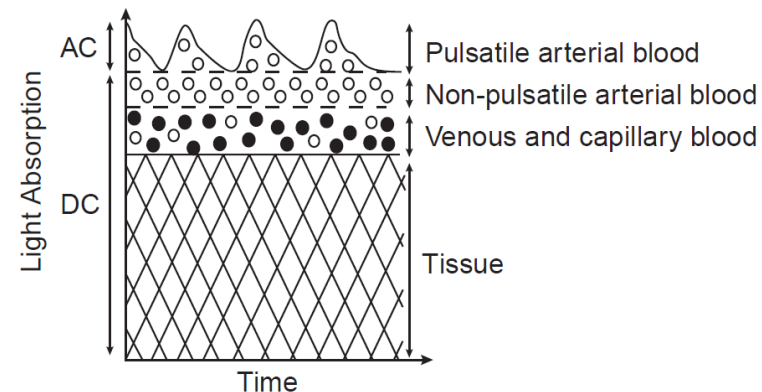


Figure 3. Extinction coefficient (or light absorbance) versus wavelength of light for four different hemoglobins. reduced Hb, O₂Hb, COHb, and MetHb. The two wavelengths used by most pulse oximeters (660 nm, 930 nm) are indicated by vertical lines.

Pulse Oximeter: Normalization

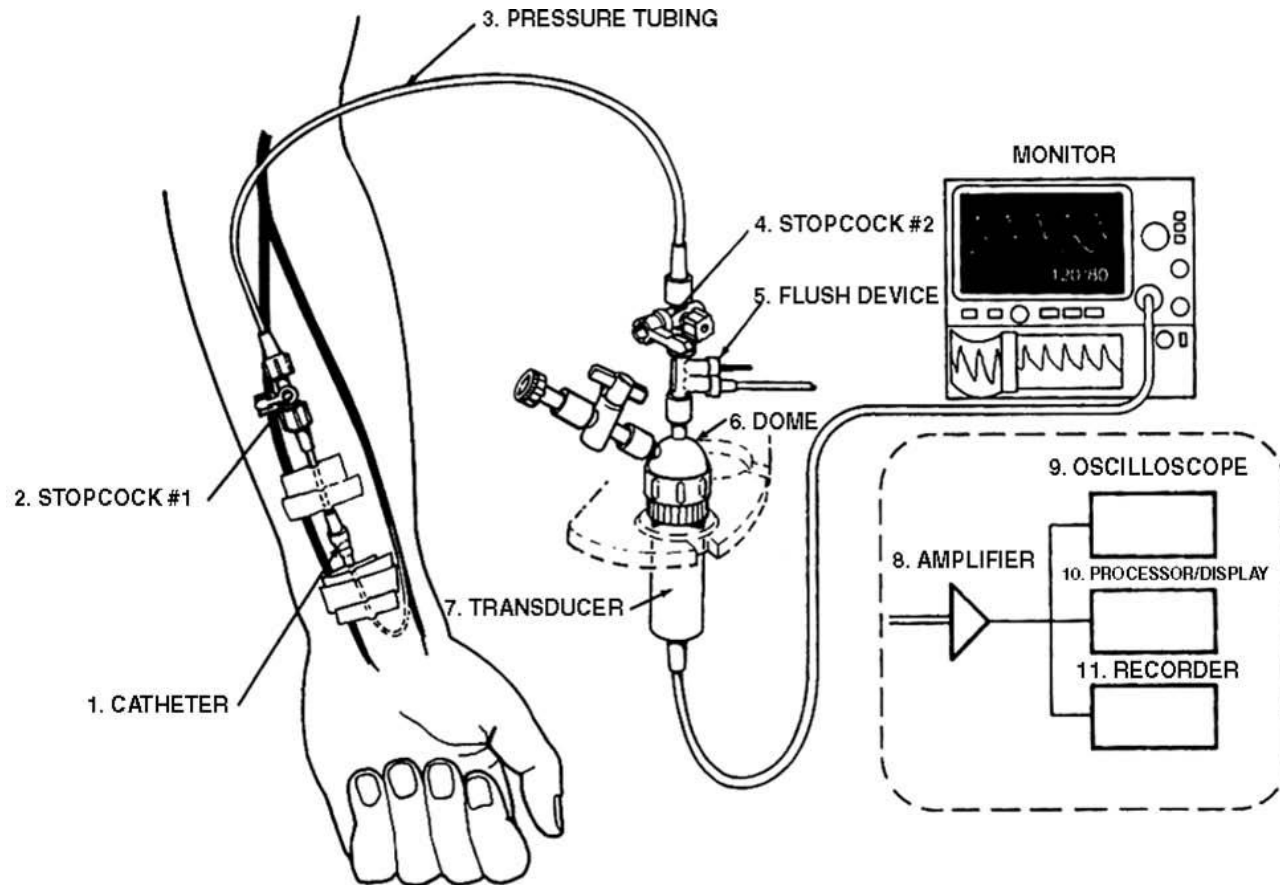
- Pulsatile (ac) component at each wavelength, is divided by the corresponding nonpulsatile (dc) component of the PPG
 - composed of the light absorbed by the blood-less tissue and the nonpulsatile portion of the blood
- Scaling results in normalized R/IR ratio
 - Dependent on SaO₂, but is largely independent of the incident light intensity, skin pigmentation, tissue thickness, and other nonpulsatile variables.



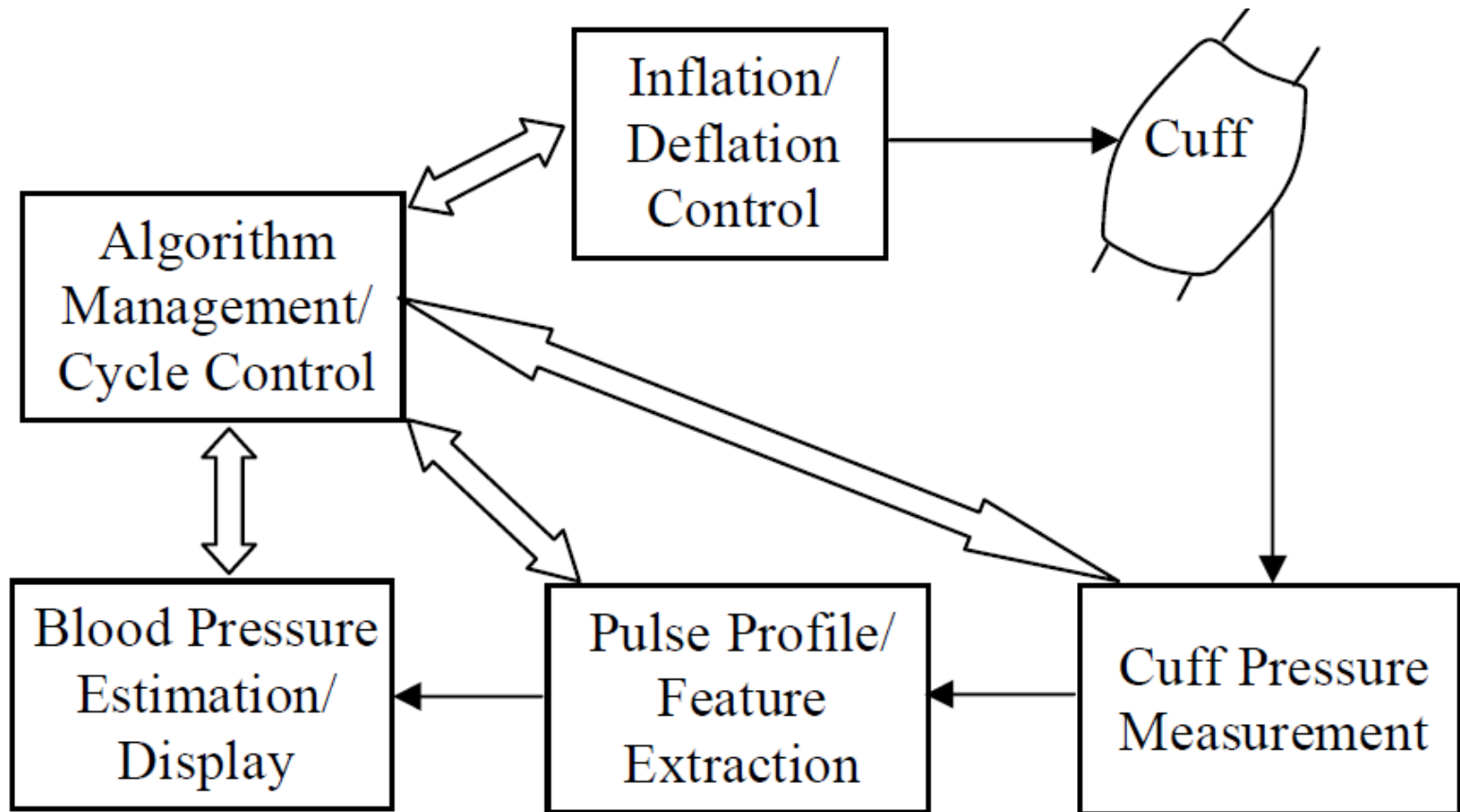
[Pulse Oximeter: Accuracy]

- Most pulse oximeters are accurate to within 2–3% in the SaO_2 range between 70 and 100%.
- Besides SaO_2 , most pulse oximeters also offer other display features
 - pulse rate and pulse waveform
 - Useful to detect artifacts such as motion

Invasive Blood Pressure



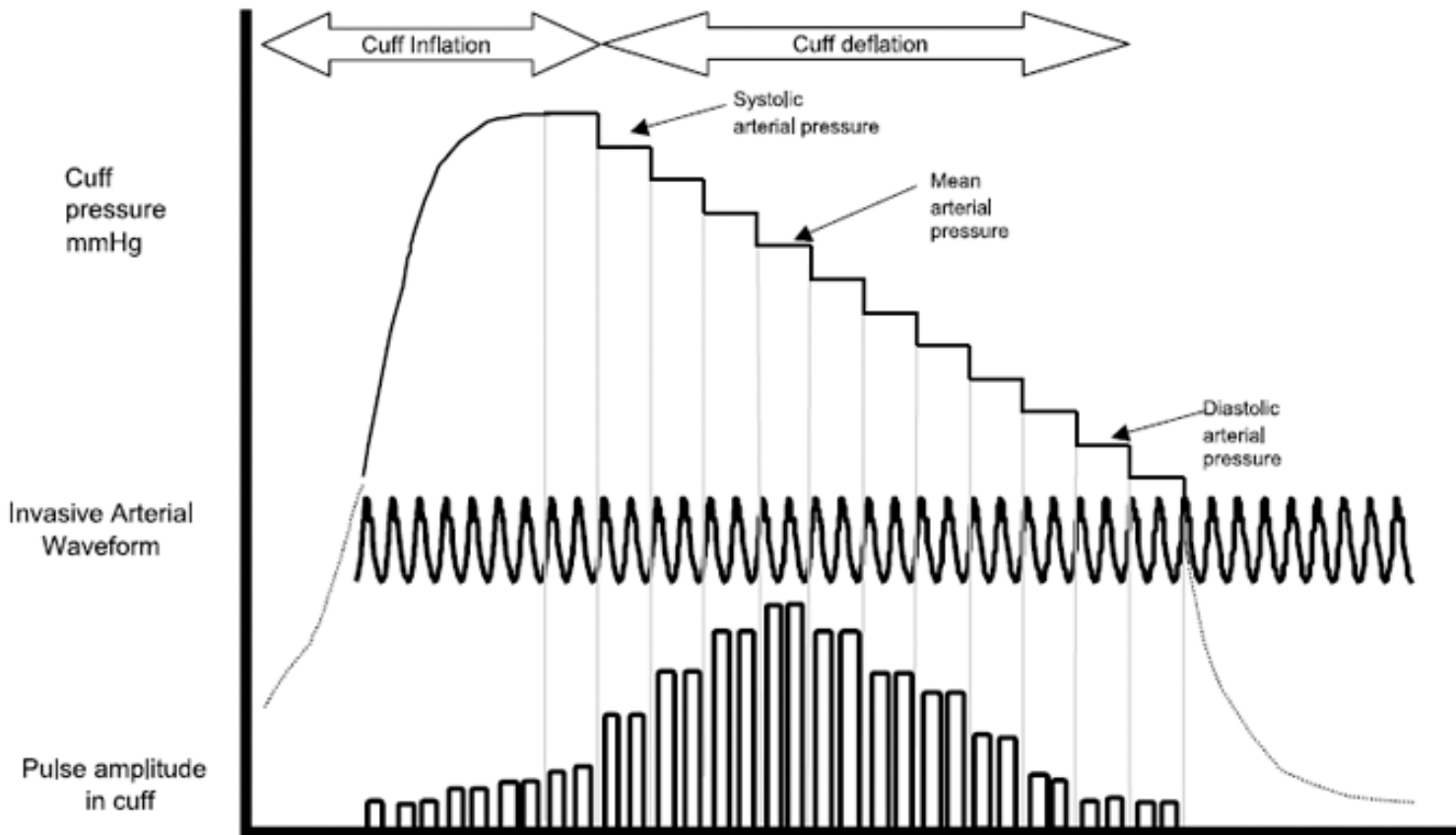
Noninvasive BP



Noninvasive BP: Oscillometric Method

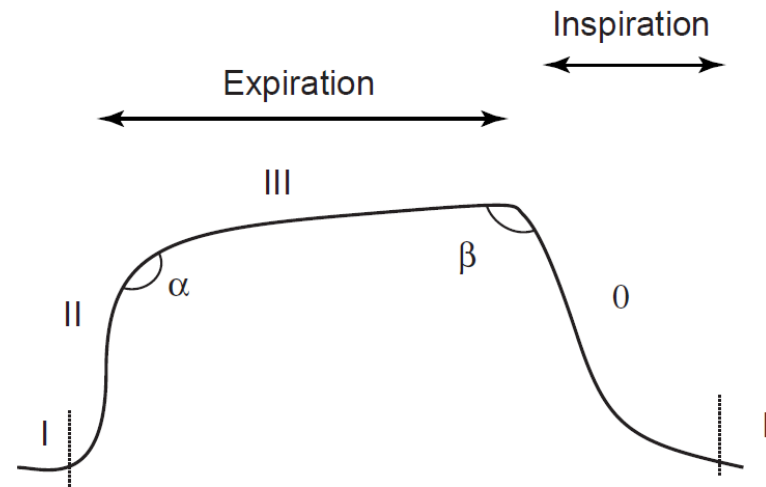
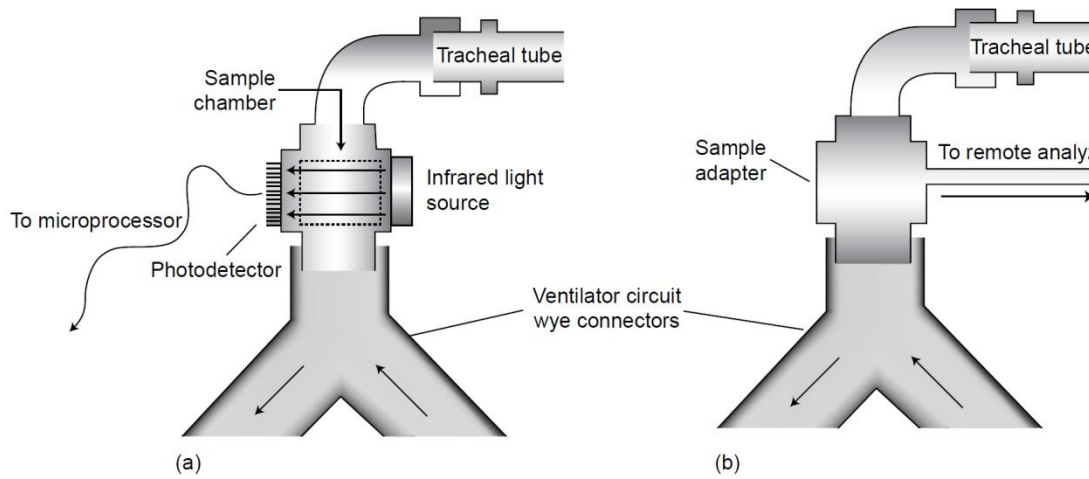
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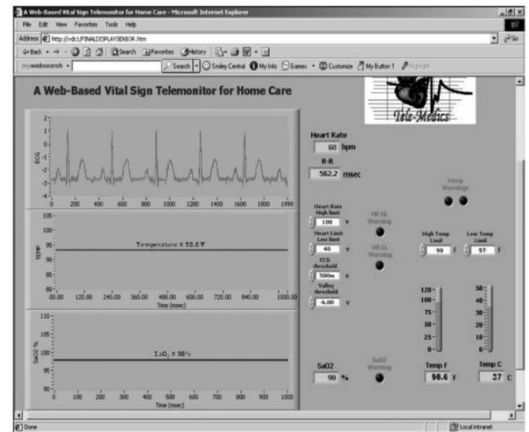
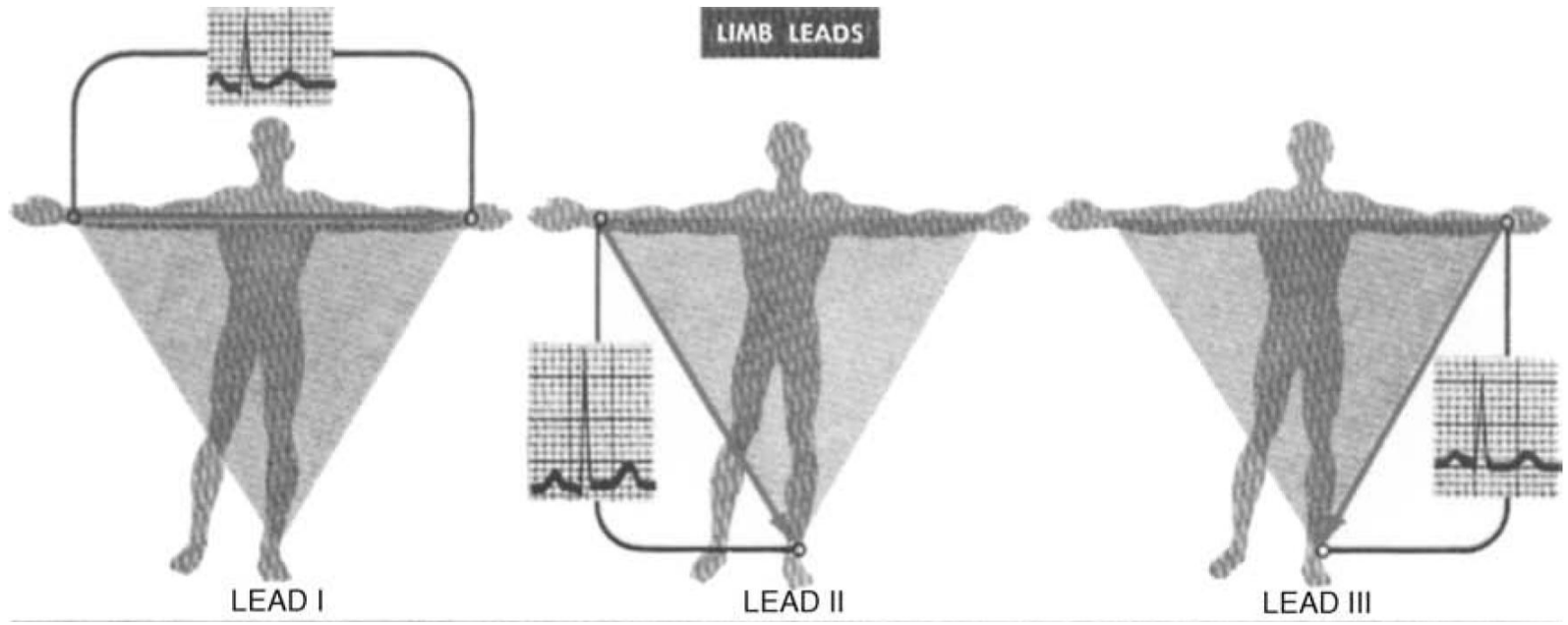


Source: Adv Neonatal Care © 2005 W. B. Saunders

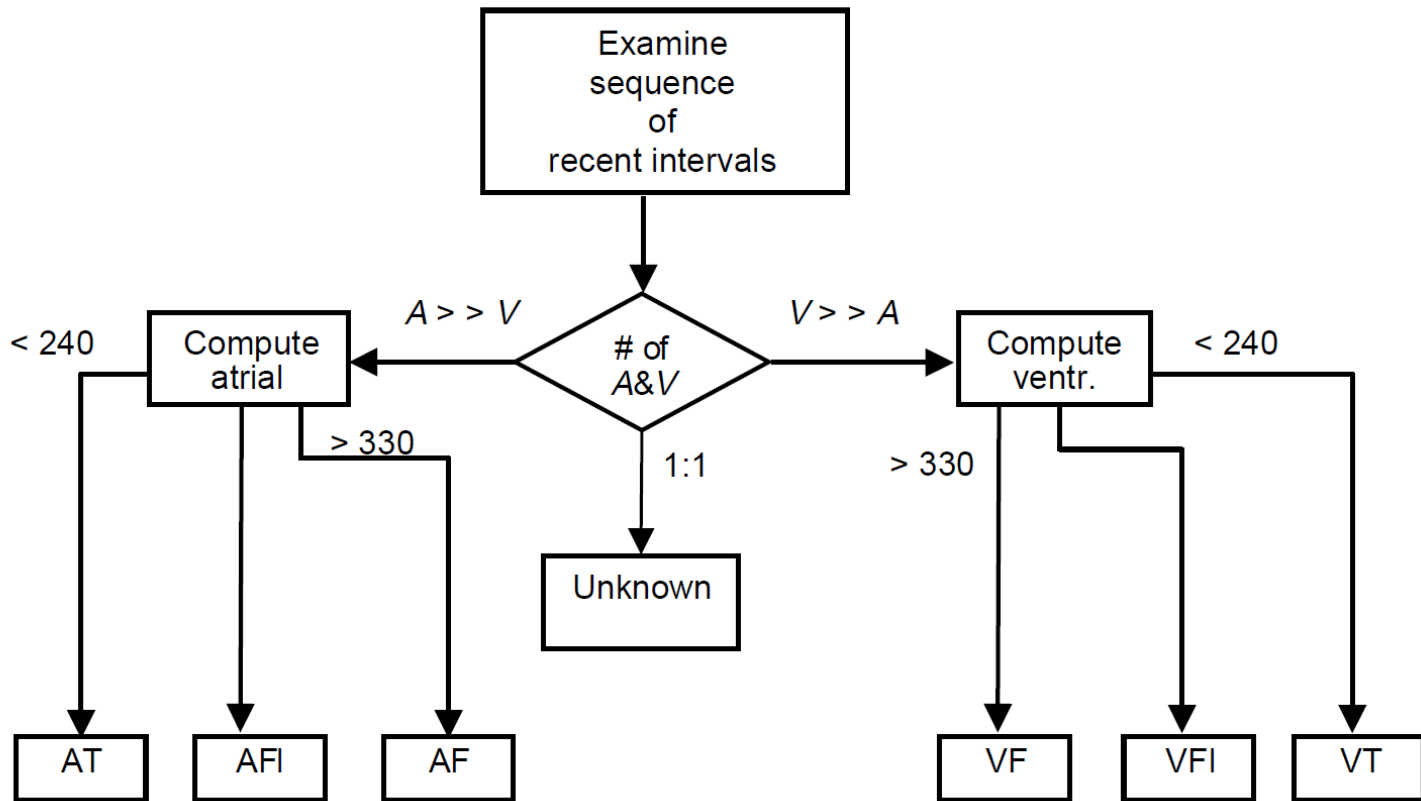
End-Tidal CO₂ (ETCO₂) (Capnography)



[ECG]

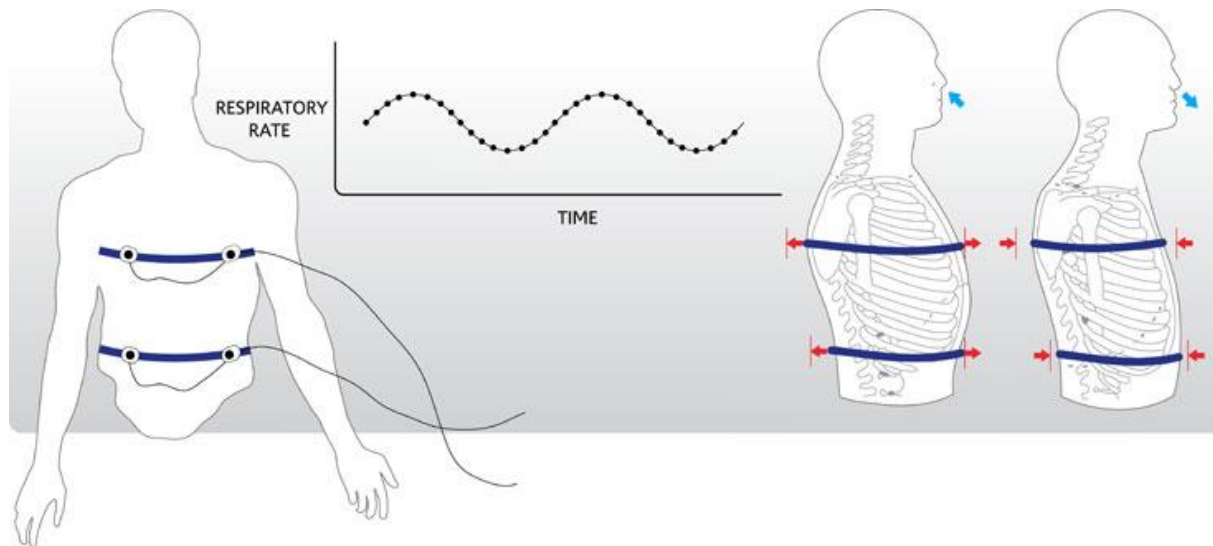


Arrhythmia Detection



[Respiration]

- Directly from ECG electrodes
 - Injection of small current and measurement of chest resistance
- Respiration belt



[Modularity]



[Ambulatory Monitoring]



[Presentation Download]

- Posted on class web site
- References also posted there
- You are required to study only what was given in the lecture

Web: <http://ymk.k-space.org/courses.htm>