Oxygen Transport Physiology
Overview of Basic Technology
Clinical Considerations

The pulse oximeter measures the oxygen content by determining the amount of dissolved oxygen in plasma (PO$_2$) and the amount of oxygen chemically combined with hemoglobin (SO$_2$).

Factors that are considered include:

1. The amount of:
   - hemoglobin
   - oxygen bound to hemoglobin (SaO$_2$)
   - oxygen dissolved in plasma (PaO$_2$)

2. Oxygen affinity, which is the ability of the hemoglobin to bind and unbind oxygen under varying physiologic conditions. Factors affecting O$_2$ affinity include:
   - patient's pH
   - patient's temperature
   - partial pressure of arterial CO$_2$
   - amount of 2,3 diphosphoglycerate (2,3 DPG)
     
     ** 2,3 DPG affects the binding capacity of oxygen to hemoglobin. The lower the levels of 2,3 DPG, the higher the O$_2$ affinity; the higher the levels of 2,3 DPG, the lower the O$_2$ affinity. 

Factors that increase 2,3 DPG include:
   - anemia
   - chronic hypoxemia
   - hyperthyroidism
   - chronic alkalosis
   - some hormones

Factors that decrease 2,3 DPG include:
   - stored bank blood
   - hypothyroidism
   - hypophosphatemia
   - chronic acidosis
3. Oxygen delivery (DO$_2$)

Factors that affect the delivery of O$_2$ include:

- hemoglobin count
- O$_2$ saturation of hemoglobin
- dissolved O$_2$ in plasma
- adequate blood volume

The pulse oximeter works in the following ways:

- receives signals from photoconductors
- filters the signals received
- looks for maximum and minimum data points for transmission of light (red or infrared)
- calculates the arterial hemoglobin O$_2$ saturation as measured by the pulse oximeter (SpO$_2$)

Factors that can interfere with the interpretations made by the pulse oximeter are:

- methemoglobin - dysfunctional species of hemoglobin (O$_2$ is unable to bind with hemoglobin)
- liver failure
- chronic use of sodium medications
- carboxyhemoglobin - carbon monoxide will bind more readily to hemoglobin than O$_2$; it has greater affinity

External factors that can affect pulse oximeter readings are:

- a change in pulse oximeter assumptions, such as:
  - all that pulses is arterial blood
  - all light passes through pulse-like beds
  - there is adequate hemoglobin concentration
  - there are no extraneous dyes present

- motion, such as:
  - shivering
  - seizures
  - restlessness
  - anesthesia induction/emergence

- low perfusion, as in:
  - intense vasoconstriction
  - severe peripheral vascular disease
  - hypothermia
  - hypovolemia
  - severe anemia

- ambient light interference:
  - excessive sunlight
  - infrared warming devices
  - lights, such as fluorescent, phototherapy, surgical

- optical shunt:
  - loosely applied sensor
  - old, worn adhesive
inappropriate size for the patient

$\$ \text{optical cross-talk:} \\
\quad \text{two sensors placed close together}

$\$$ \text{venous pulsation} \\
\quad \text{negates the assumption that all pulsations are arterial}

$\$$ \text{electrical interference:} \\
\quad \text{electrocautery} \\
\quad \text{other electrical devices used by or applied to the patient}
Pulse oximetry is used everywhere none invasive, continuous blood O2 monitoring is needed. It can reduce the risk of adverse patient outcomes.

Types of sensors:
- adhesive, patient-dedicated sensors
- reusable sensors

Components include a LED light source, which has sensitivity to red and infrared light and photodetectors.

Application is important in that if the sensor is not properly placed, readings will be invalid.

Use of nasal sensors may be interfered with by the presence of oxygen masks, N/G tubes, and motion.

Pulse oximeter readings can be particularly important in evaluating patients with cardiopulmonary, respiratory, and IV epidural pain management therapy. Neonatal patients benefit immensely from the use of these sensors.

The skin under the sensor should be checked every eight hours. If skin irritation is present, the site of the sensor should be changed.

Application factors that must be considered are choosing the type and size of the sensor that is appropriate for the patient. Level of activity, weight, size, and correct application must be included when choosing a sensor.

Pulse oximeters can have reduced effectiveness due to:
- optical interference
- increased motion
- venous pulsation
- low perfusion
- site considerations