1. Dyshemoglobins and Vascular Dyes.
- Carboxyhemoglobin and oxyhemoglobin absorb equivalent amounts of red light, so that carbon monoxide poisoning results in a falsely elevated SpO2.
- Methemoglobin causes substantial absorption of both red and infrared light, so that the ratio approaches 1 (estimated SpO2 of 85%).
- Administration of methylene blue or indocyanine green dyes for diagnostic tests causes plethysmography to provide continuous noninvasive monitoring of the oxygen saturation of arterial blood (SaO2).
- In addition, there are two minor hemoglobin species: carboxyhemoglobin (COHb) and methemoglobin (MetHb) which are not measured by standard pulse oximeters but may increase bias, reduce precision, and prolong the detection time for a hypoxic event.

2. Motion Artifact and Low Perfusion.
- Motion artifact and low perfusion are the most common sources of SpO2 inaccuracies.
- Causes of motion artifact include shivering, twitching, agitation, intra-aortic balloon pump assistance, and patient transport. Signs of motion artifact include a false or erratic pulse rate reading or an abnormal plethysmographic waveform.
- Peripheral hyperperfusion from hypothermia, low cardiac output, or vasodilative drugs may increase bias, reduce precision, and prolong the detection time for a hypoxic event.

3. Venous Pulsation and Cardiac Arrhythmia.
- Venous congestion and arteriovenous anastomoses cause the cutaneous veins to pulsate, resulting in a falsely low SpO2.
- Similar artifacts may occur during hypovolemia and high airway pressure ventilation. Cardiac arrhythmias apparently do not affect SpO2 accuracy.

4. Nail Polish and Skin Pigmentation.
- Both dark skin pigmentation and dark nail polish interfere with the absorption of the red light used by pulse oximetry. Pulse oximeters thus have greater bias and less precision in black patients. Whereas an SpO2 of 92% is sufficient to predict adequate oxygenation in white patients, a saturation of 95% is required in black patients.
- Dark nail polish falsely lowers SpO2, whereas red polish does not affect accuracy. When nail polish cannot be removed, mounting the oximeter probe sideways on the finger produces an accurate reading.

5. Ambient Light, Anemia, and Hyperbilirubinemia.
- Although oximeters compensate for the presence of ambient light, the sensor should be shielded from intense light sources with an opaque material. Falsely low SpO2 readings occur when even minor gaps exist between the probe and skin, allowing reflected light to enter the photodiode.
- Under conditions of anemia (Hb 8 g/dL) and severe hypoxia (SaO2 54%), SpO2 bias is markedly increased (-14%).
- Hyperbilirubinemia of any cause does not affect SpO2 directly. However, carbon monoxide is a byproduct of heme metabolism, and icteric patients tend to have higher levels of carboxyhemoglobin, so that SpO2 may be falsely elevated.

- Reflectance pulse oximetry was designed to counter signal detection problems associated with finger probes during hyperperfusion.
- Reflectance oximeters probes work by transilluminating a tissue bed and measuring the forward-scattered light on the opposite side of the finger or earlobe, reflectance probes are constructed with the light-emitting diodes and the photodetector located on the same side. The photodetector measures the back-scattered light from the skin. Reflectance pulse oximetry probes are usually placed on the forehead, which is less susceptible to vasoconstriction.
- Light "shunting" from poor skin contact and direct sensor placement over a superficial artery are associated with artifacts. Reflectance pulse oximetry is also limited by poor signal-to-noise ratio and variability among sites in the arrangement of blood vessels and tissue blood volume.

- Because pulse oximeters themselves cannot be calibrated, their accuracy is highly variable and dependent on both the calibration curve programmed into the monitor and the quality of signal processing.
- The accuracy of the calibration curve depends on laboratory testing conditions (co-oximeter used, range of oxygenation studied, and characteristics of sample subjects).
- Most manufacturers report an accuracy of ±2% at an SaO2 greater than 70% and ±3% when the SaO2 is 50% to 70%. In normal subjects tested at an SaO2 between 99% and 83%, pulse oximetry has a bias and precision that are within 3% of co-oximetry.
- Under hypoxic conditions (SaO2 78% to 55%), when the monitor must rely on extrapolated values, bias increases (8%) and precision deteriorates (5%).

- Because pulse oximeters detect vey small optical signals (and must reject a variety of artifacts), data must be averaged over several seconds, thus affecting response time. Pulse oximeters may register a near-normal SpO2 when the actual SaO2 is less than 70%.
- A prolonged lag time is more common with finger probes than ear probes and is attributed to hypoxia-related peripheral vasoconstriction. Bradycardia also is associated with a prolonged response time.