



Pulse Oximetry

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Disclosure Statement

- I have no financial disclosures or commercial interests relating to the content of this presentation.

Objectives

- Review the physiology of pulse oximetry
- Understand the limitations and pitfalls of pulse oximetry
- Familiarize and discuss common patterns seen using a pulse ox monitor in the clinical environment



How the pulse ox monitor works

- Often referred to as the 5th vital sign (temp, HR, BP, RR)
- Determines the proportion of hemoglobin in the arterial bed that is oxygenated
- Absorbs light at different wavelengths (deoxygenated at 660 nm and oxygenated at 940 nm)
- Uses the Beer-Lambert law to estimate the SpO₂

The Probe

- Emitters emit the light at the different wavelengths (660 nm and 940 nm)
- Detectors absorb the light from the exposed tissue
- Response time varies in placement and probes, but generally vary between 94-100 seconds for desaturation and 23-29 seconds for an increase in saturation



Advantages

- Rapid measurement of hypoxia. Visual hypoxia doesn't become evident until arterial oxygenation is $\sim 67\%$
- Non-invasive compared to arterial blood gases
- Provides continuous monitoring



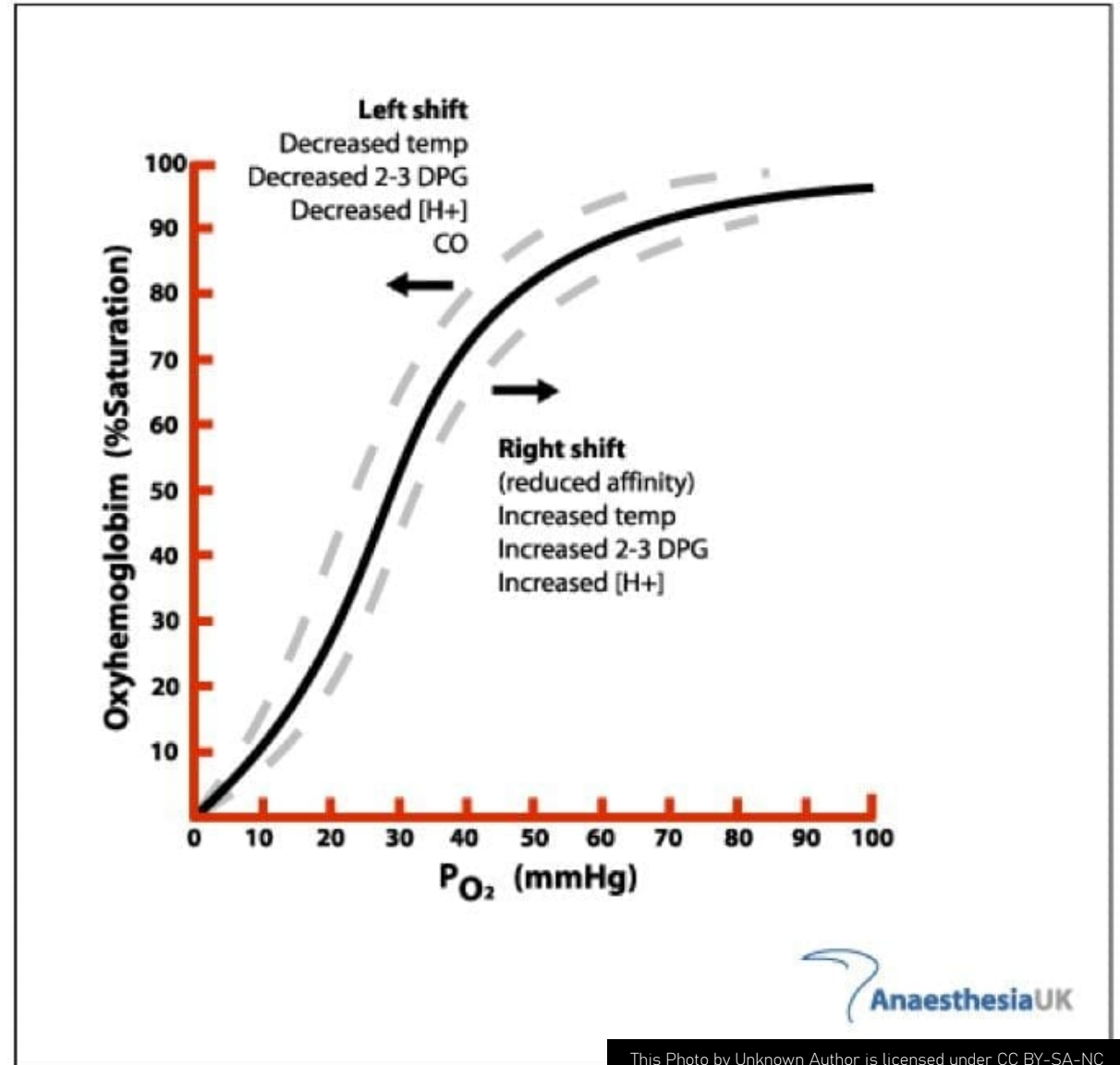
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Disadvantages

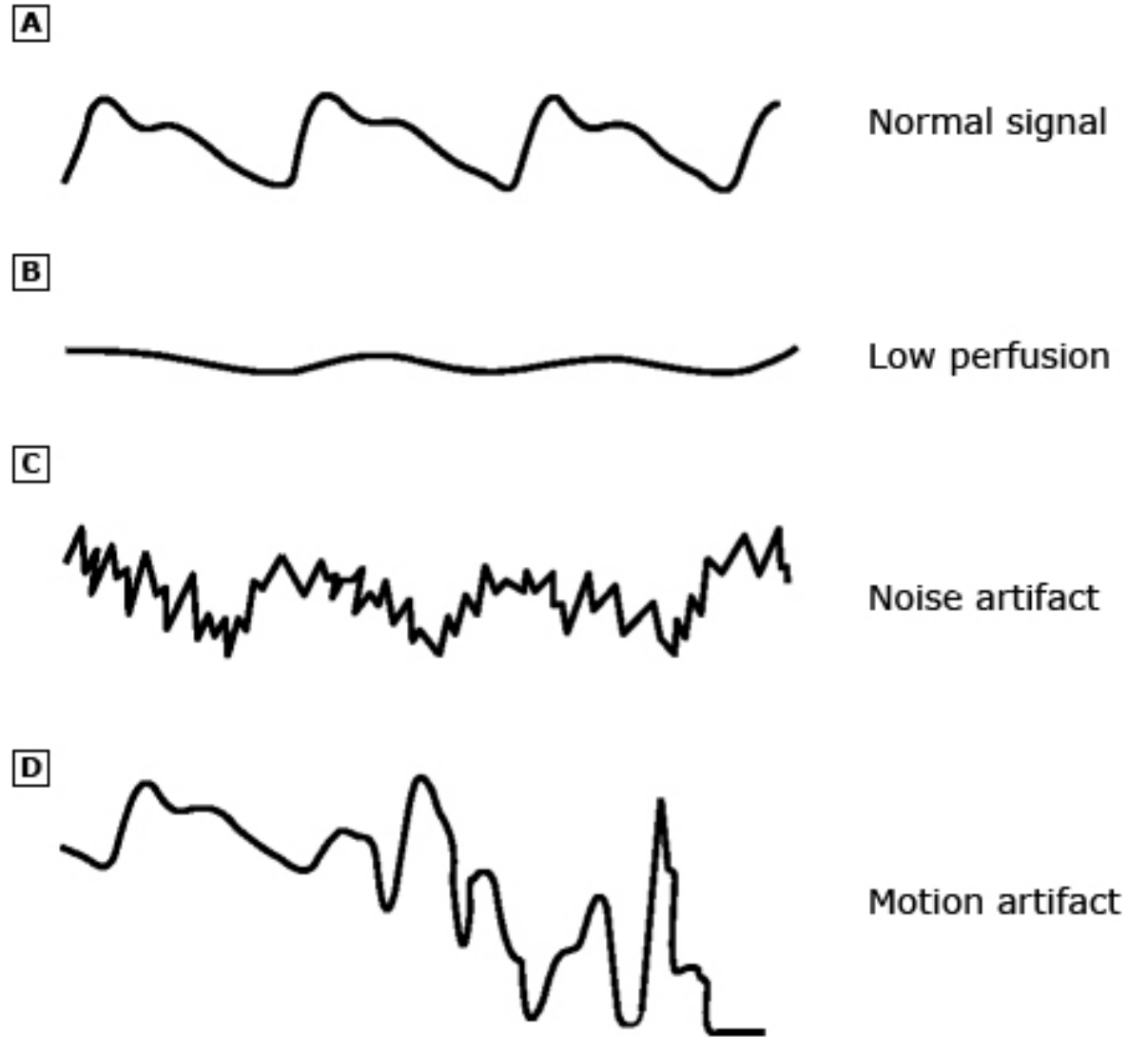
- Inability to detect hyper-oxemia above 100%
- Inability to measure arterial oxygen tension
- Inability to measure ventilation



Correlation with Arterial Oxygen Saturation



Normal and Abnormal Waveforms



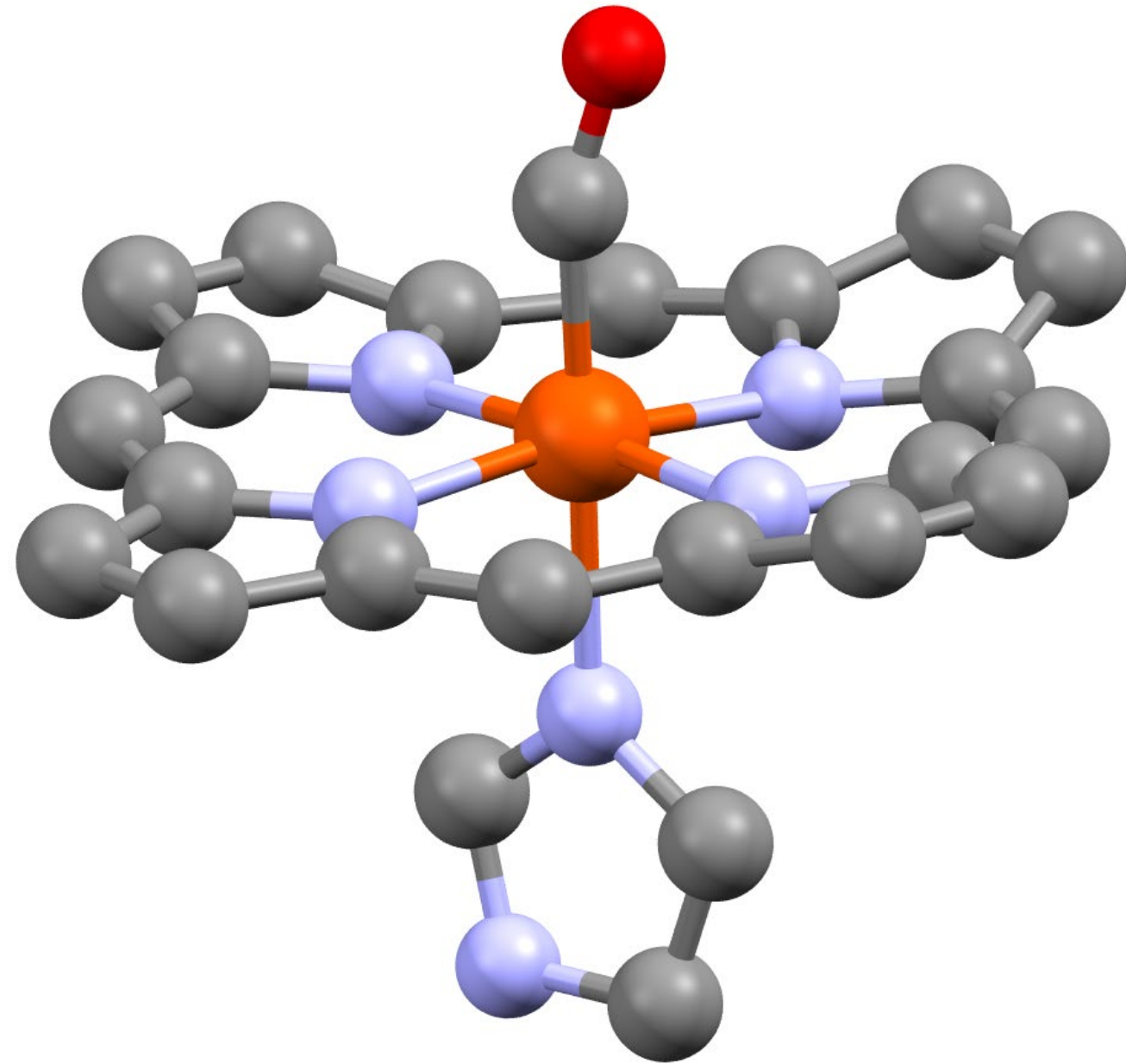
Inadequate Waveforms

- Malposition of the probe
- Motion artifact
- Hypoperfusion
- Hypothermia
- Skin pigment/nail polish



Falsely normal (elevated)

- Carboxyhemoglobin
- High levels of hemoglobin A1c
- Ambient light
- Skin pigment



Falsely low

- Inadequate waveform
- Met and Sulf hemoglobin
- Hemoglobin S
- Severe anemia
- Venous pulsations
- Ambient light
- Vital dyes or nail polish



Co-oximetry

- Instead of using only two waveforms, co-oximetry uses multi-wavelengths to measure oxyhemoglobin, deoxyhemoglobin, carboxyhemoglobin, and methemoglobin
- Samples whole arterial blood



Clinical Examples of Pulse Ox Variability



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Accuracy varies amongst manufactures

- Study by Blanchet et al (2023) examined the use of 4 different brands of oximeters in stable critically ill patients with arterial catheters
- Exclusion criteria was poor SpO₂ signal and SpO₂ > 96%
- Nonin, Masimo, Phillips, and Nellcor
- 193 subjects with light pigmentation were measured
- Phillips overestimated, whereas the other 3 underestimated SaO₂
- Overall, the study found significant bias and moderate accuracy between tested oximeters

Effect of skin pigmentation on accuracy

- Study by Bickler et al in 2005 studied 21 subjects with arterial oxygen saturations ranging from 60-100%
- At the ranges of 60-70% darkly pigmented subjects were found to have an over estimation of SaO₂ compared to lightly pigmented subjects ($p < 0.0001$)
- There were significant differences between the three different pulse oximeters used, but overall there was an overestimation of arterial saturation during hypoxia

Questions?

THANK YOU

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