Cardiology – Hypoxia and Cyanosis: What you need to know

Whiteboard Animation Transcript
with Jon Silberberg, MD aka Prof. Montage

Hypoxia is a low oxygen concentration in the blood. Cyanosis is visible blueness, due to increased levels of deoxygenated haemoglobin. They may go together, but they're not the same thing.

Peripheral cyanosis – that is blue extremities – **MAY** be a normal finding, especially if you're cold.

Central Cyanosis – that's when inside the lips, tongue, or mucosal membranes are blue – is **NEVER** normal.

In this case, ≥4g of Hemoglobin per 100 ml is deoxygenated, due to: low blood oxygen concentration or a right to left shunt – A hole in the heart that allows systemic venous blood to bypass the lungs and enter the left heart, mixing with the systemic arterial blood.

So… what about hypoxia? Why doesn't cyanosis appear whenever the oxygen concentration in blood is low? Recall the hemoglobin-oxygen dissociation curve – the sigmoid shape tells us that hemoglobin will stay relatively well saturated, >90% in fact, until the partial pressure of oxygen in the blood falls below 70 mmHg. So, while blood oxygen concentrations are low, there isn't enough deoxyhemoglobin to cause cyanosis. **So we use a finger oximeter to monitor oxygen saturation, and alert us to hypoxia before the clinical signs of cyanosis appear.**

Approach to hypoxia. If someone is hypoxic, they are usually breathless as they increase respiratory effort. Always take a respiratory rate – if it isn't high, there's something seriously wrong! If the patient is hospitalized, consider excessive sedation, or narcotics used for pain. Outside hospital, head injury may also reduce respiratory drive. Underventilation is a medical emergency, it needs to be recognized and treated quickly.

How to correct hypoxia. Most importantly, treat the underlying cause. You can increase the inspired oxygen content by low-flow nasal prongs or even a high-flow mask. This usually improves arterial hypoxia because whatever the cause, some alveoli are relatively underventilated.

If administering oxygen is ineffective, there is likely an extreme mismatch between ventilation and perfusion, such as with collapsed lung, or major pulmonary embolism. In these cases, mechanical ventilation will be required.

Finally – a word of caution. In patients with chronic airflow limitations, the drive to breath comes from falling oxygen saturation levels, i.e. they have a hypoxic drive. Giving these patients high flow oxygen may depress their ventilation, so be careful. Low-flow oxygen by nasal prongs at 2L/min is unlikely to cause harm.

References

Chapter 23.5: Transport of Oxygen and Carbon Dioxide. In: Tortora GJ, Derrickson B, eds. *Principles of Anatomy of Physiology.* 13th ed. Hoboken, NJ: Wiley; 2012:946-949.

Chapter 42: Respiratory Insufficiency – Pathophysiology, Diagnosis, Oxygen Therapy. In: Guyton A, Hall J, eds. *Textbook of Medical Physiology*. 11th ed. Philadelphia: Elsevier Saunders; 2006:530-531.

Feller-Kopman DJ, Schwartzstein RM. The evaluation, diagnosis, and treatment of the adult patient with acute hypercapnia respiratory failure. In: Post T, ed. *UpToDate*. Waltham, MA.: UpToDate; 2018. www.uptodate.com. Accessed April 24, 2018.

Johnson DC. Disorders of ventilatory control. In: Post T, ed. *UpToDate*. Waltham, MA.: UpToDate; 2018. www.uptodate.com. Accessed April 24, 2018.

Sarkar M, Niranjan N, Banyal PK. Mechanisms of hypoxemia. *Lung India.* 2017;34(1): 47-60.

Theodore AC. Oxygenation and mechanisms of hypoxemia. In: Post T, ed. *UpToDate*. Waltham, MA.: UpToDate; 2018. www.uptodate.com. Accessed April 23, 2018.