SNS COLLEGE OF ALLIED HEALTH SCIENCE

Affiliated to The Tamil Nadu Dr MGR Medical University, Chennai

DEPARTMENT OF CARDIOPULMONARY PERFUSION CARE TECHNOLOGY

COURSE NAME: CPB and Perfusion Technology

UNIT II – Perfusion Flow Pressure & Acid Base Balance & Adequacy

TOPIC: Oxygen Toxicity

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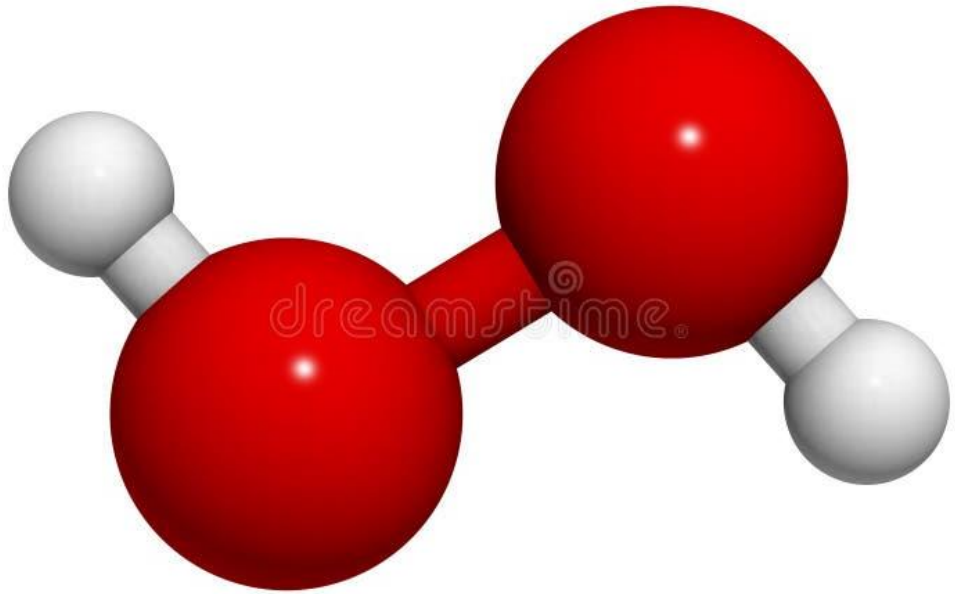
Empathize: Clinical Context

- CPB exposes patients to high oxygen tensions, risking oxygen toxicity.
- Patients, especially those with lung disease or undergoing prolonged bypass, are at higher risk.
- Perfusionists must balance adequate oxygenation with avoidance of oxidative injury.

Define: Problem Statement

- Hyperoxia during CPB increases production of reactive oxygen species (ROS), causing lung injury, myocardial dysfunction, and systemic inflammation.

- Oxygen toxicity manifests as lung damage, neurological injury, and worsened organ function.



Define: Mechanisms of Oxygen Toxicity

- High FiO_2 and PaO_2 increase ROS formation, overwhelming antioxidant defenses.
- ROS damage lipids, proteins, and DNA, leading to cellular injury.
- Ischemia-reperfusion injury is exacerbated by oxygen toxicity.

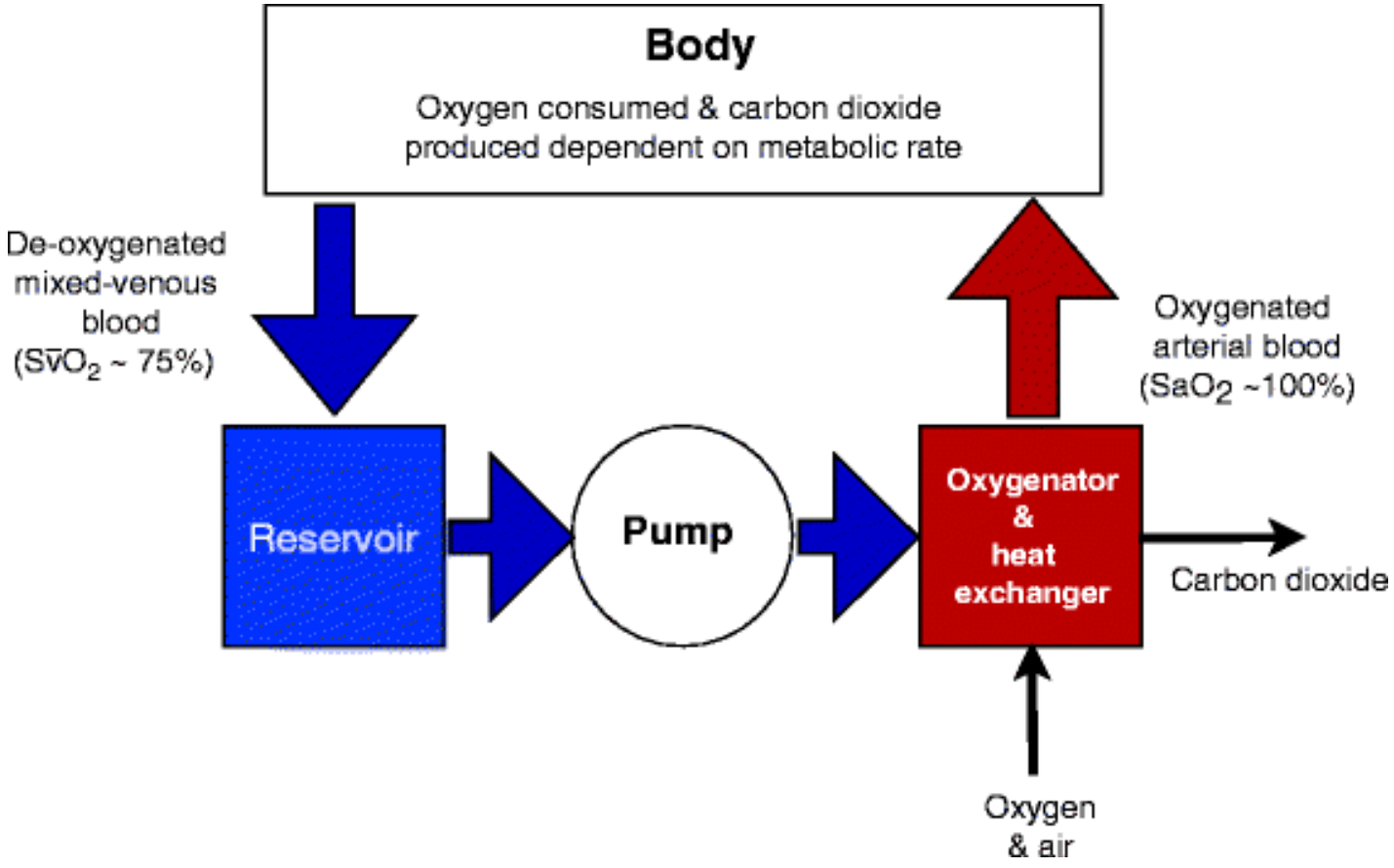
Ideate: Sweep Gas and FiO_2 Management

- Maintain PaO_2 between 150–250 mmHg during CPB for most adults.
- For normoxic strategy, aim for PaO_2 100–150 mmHg, especially in pediatric or cyanotic patients.
- Adjust FiO_2 to achieve target PaO_2, typically starting at 30–50% and titrating as needed.

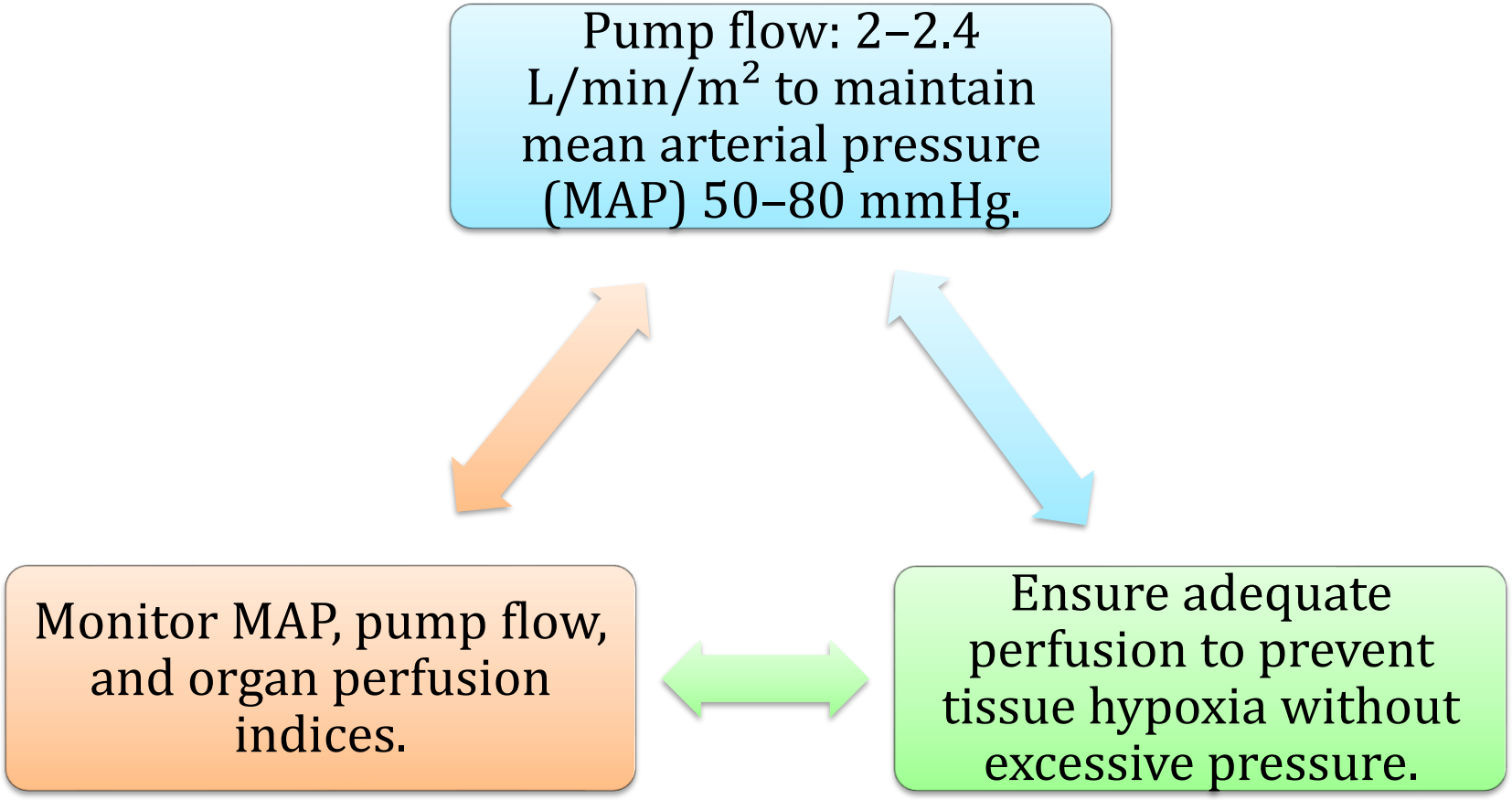
	Arterial Blood	Venous Blood
pH*	7.40 (7.35–7.45)	7.36 (7.33–7.43)
Po_2†	80–100 mm Hg	35–40 mm Hg
Pco_2‡	35–45 mm Hg	41–51 mm Hg
HCO_3§	22–26 mEq/L	24–28 mEq/L
O_2 saturation‖	≥ 95%	70% - 75%
Base excess¶	–2 to +2	0 to +4

Ideate: Sweep Gas Flow and V/Q Ratio

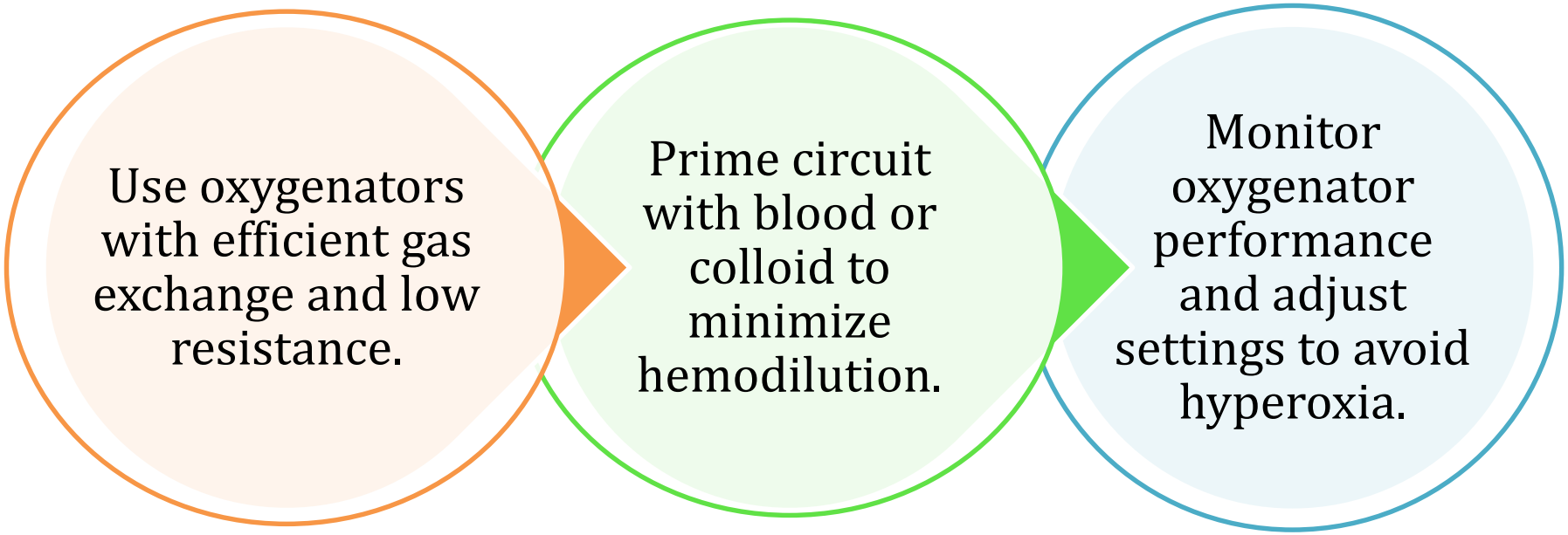
- Optimal sweep gas to blood flow ratio (V/Q) is 1:1, but 0.6–0.9 is often sufficient.
- Typical sweep gas flow: 1.35–1.60 L/min/m^2 to avoid hypocapnia and alkalosis.
- Adjust sweep gas flow to maintain $PaCO_2$ 35–45 mmHg



Ideate: Perfusion Flow and Pressure Targets



Prototype: Oxygenator and Circuit Settings



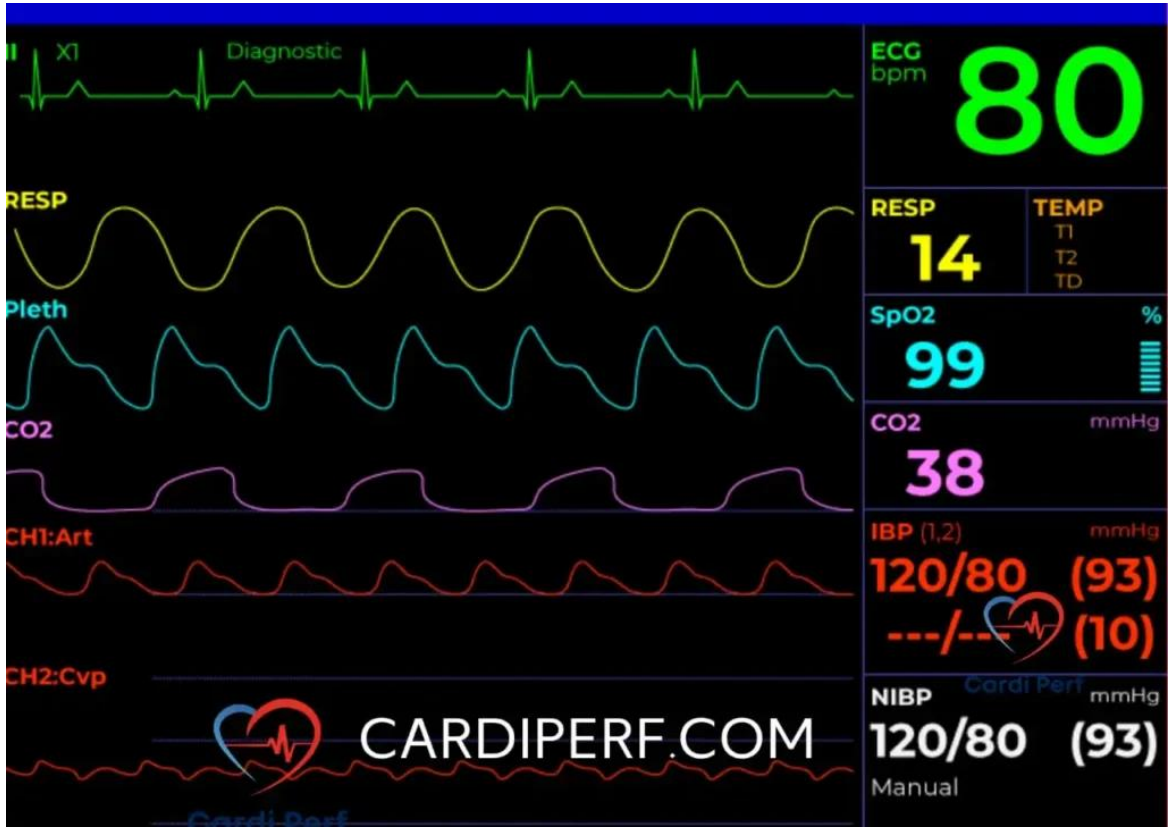
Prototype: Intraoperative Monitoring and Adjustment

- Measure arterial blood gases every 15–30 minutes.
- Titrate FiO_2 and sweep gas flow to maintain PaO_2 and $PaCO_2$ within target ranges.
- Adjust pump flow and pressure as needed for optimal perfusion.

Parameter	Normal Value	Normal Range	Clinical Significance
pH	7.40	7.35–7.45	Acid-base balance
PaO_2 (mmHg)	80–100	75–100	Oxygenation status
$PaCO_2$ (mmHg)	40	35–45	Respiratory status
HCO_3^- (mEq/L)	24	22–26	Metabolic status
Base Excess/Deficit	0	-4 to +2	Metabolic acid-base buffer
O_2 Saturation (%)	95–100	94–100	Hemoglobin oxygen saturation
O_2 Content (mL/dL)	20	18–20	Total oxygen in blood
Hemoglobin (g/dL)	14–18 (male)	12–16 (female)	Oxygen-carrying capacity

Prototype: Post-CPB and ICU Management

- Continue monitoring oxygenation and ventilation post-CPB.
- Wean FiO_2 gradually, aiming for normoxia.
- Address complications such as acute lung injury or neurological dysfunction



Test: Case Study Application

A patient develops acute lung injury post-CPB due to prolonged hyperoxia.

Management includes reducing FiO_2, optimizing ventilation, and supportive care.

Emphasize the importance of protocolized oxygen management.

Test: Summary and Key Takeaways

PaO_2

- Maintain 150–250 mmHg (adults)
- 100–150 mmHg (paediatric/cyanotic).

sweep gas flow

- 1.35–1.60 L/min/m^2

FiO_2

- 30–50%, adjusting to blood gas results.

Ensure pump flow

- 2–2.4 L/min/m^2

MAP

- 50–80 mmHg for optimal perfusion.

References

- https://pmc.ncbi.nlm.nih.gov/articles/PMC3932148/
- https://www2.ccasociety.org/newsletters/2016winter/Oxygen%20Toxicity.html
- https://pmc.ncbi.nlm.nih.gov/articles/PMC4557568/
- https://repository.up.ac.za/bitstreams/cca5624c-c4d5-4a3c-9d4a-cfd2cfd52bd7/download
- https://pmc.ncbi.nlm.nih.gov/articles/PMC7332162/

THANK YOU