cyanosis

• Bluish discoloration of the skin and mucous membranes due to the high levels of deoxygenated hemoglobin or its derivatives, including methemoglobin and sulfhemoglobin.

• Defined as the presence of 5 gm/dL of deoxygenated hemoglobin.

  - Hb level = 15 gm/dL, 5 gm/dL release O2
    which leaves 10 gm/dL of oxyhemoglobin
  - SaO2 = OxyHb / (OxyHb + DeoxyHb)
    = 10 / (10 + 5)
    = 66%
  - SaO2 of 66% corresponds to PaO2 of 35mmHg.
• In severely anemic patients, oxygen saturation at which cyanosis is detectable will be lower than in normal patients.
  - Hb level = 10 gm/dL, 5 gm/dL release O2
  - SaO2 = OxyHb / (oxyHb + DeoxyHb)
    = 5 / (5 + 5)
    = 50%
  - SAO2 of 50% corresponds to PaO2 of only 27 mmHg.

• Under optimal conditions, the earliest that cyanosis can be appreciated is at an oxygen saturation of 85% (PaO2 of 55mmHg).
• At a SaO2 of 70% (PaO2 of 40mmHg) most clinicians will be able to detect cyanosis.
O2-Hb dissociation curve

Left shift
- Decreased temp
- Decreased 2-3 DPG
- Decreased [H+]
- CO

Right shift (reduced affinity)
- Increased temp
- Increased 2-3 DPG
- Increased [H+]
• Sigmoidal in character- describes the relationship between oxygen tension (PaO2) and binding (saturation).

• When PaO2 is low (PaO2<60%), the hemoglobin affinity to oxygen falls rapidly, explaining the sharp sloping.

• Shifting in the curve is a normal process depending on the site of circulation.
  • Right shift: Hb releases oxygen to tissues; muscles and placenta, more rapidly.
  • Left shift: Hb has a higher affinity for oxygen in the lungs.

• Causes of shifting Include changes in PaCO2, Ph, temperature and [2,3 DPG].

• The lowest acceptable O2 saturation level is 90%
Conditions Affecting Oxygen Carrying Capacity: Oxygen Hb Dissociation Curves

<table>
<thead>
<tr>
<th></th>
<th>left shift (high affinity for O₂)</th>
<th>right shift (low affinity for O₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>decrease</td>
<td>increase</td>
</tr>
<tr>
<td>2.3-DPG</td>
<td>decrease</td>
<td>increase</td>
</tr>
<tr>
<td>p(CO₂)</td>
<td>decrease</td>
<td>increase</td>
</tr>
<tr>
<td>p(CO)</td>
<td>increase</td>
<td>decrease</td>
</tr>
<tr>
<td>pH (Bohr effect)</td>
<td>increase (alkalosis)</td>
<td>decrease (acidosis)</td>
</tr>
<tr>
<td>type of haemoglobin</td>
<td>fetal haemoglobin</td>
<td>adult haemoglobin</td>
</tr>
</tbody>
</table>

2,3-DPG = 2,3-diphosphoglycerate

- Remember:
  - Left shift = less oxygen to the tissues = tissue hypoxia
  - Right shift = more oxygen to the tissues
monitored parameters

- Vital signs:
  - Heart rate
  - Heart rhythm
  - Respiratory rate and depth
  - Mucous membrane color and skin appearance
  - Capillary refill time
  - Pulse strength
  - Blood pressure
  - Body temperature
- Best indicator for the patients wellbeing
• Reflexes
  • Involuntary response to stimulus
  • Palpebral, corneal, pedal, swallowing, laryngeal, and papillary light reflexes
  • Indicators of anesthetic depth.
• Parameters offer predictable responses to anesthesia at various depths.
• May be affected by drugs, disease, or individual response variation.
• Monitor anesthetized patients as often as possible; continuously is ideal.
Normal adult parameters in general anesthesia

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit 1</th>
<th>Unit 2</th>
<th>Unit 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic Blood Pressure</td>
<td>SBP</td>
<td>85 – 160</td>
<td>mmHg</td>
</tr>
<tr>
<td>Diastolic Blood Pressure</td>
<td>DBP</td>
<td>50 – 95</td>
<td>mmHg</td>
</tr>
<tr>
<td>Heart Rate</td>
<td>HR</td>
<td>50 – 100</td>
<td>bpm</td>
</tr>
<tr>
<td>Respiratory Rate</td>
<td>RR</td>
<td>8 – 20</td>
<td>rpm</td>
</tr>
<tr>
<td>Oxygen sat. by oximetry</td>
<td>SpO₂</td>
<td>95 – 100</td>
<td>%</td>
</tr>
<tr>
<td>End Tidal CO₂ tension</td>
<td>ETCO₂</td>
<td>33 – 45</td>
<td>mmHg</td>
</tr>
<tr>
<td>Skin appearance</td>
<td></td>
<td>warm, dry, pink</td>
<td></td>
</tr>
<tr>
<td>Color</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
<td>36 – 37.5</td>
<td>°C</td>
</tr>
<tr>
<td>Urine Production</td>
<td></td>
<td>&gt;= 0.5</td>
<td>ml.kg⁻¹.min⁻¹</td>
</tr>
</tbody>
</table>
- Central Venous Pressure
- Pulmonary Artery Pressure
- Pulmonary Capillary Wedge pressure
- Mixed venous oxygen saturation
- Cardiac Output
- Mean Arterial Pressure
  *MAP = DBP + 1/3 (SBP – DBP)*

<table>
<thead>
<tr>
<th></th>
<th>CVP</th>
<th>PAP</th>
<th>PCWP</th>
<th>SvO2</th>
<th>CO</th>
<th>MAP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 – 10</td>
<td>10 – 20</td>
<td>5 – 15</td>
<td>75</td>
<td>4.5 – 6</td>
<td>80 – 120</td>
</tr>
<tr>
<td></td>
<td>mmHg</td>
<td>mmHg</td>
<td>mmHg</td>
<td>%</td>
<td>1.Min⁻¹</td>
<td>mmHg</td>
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