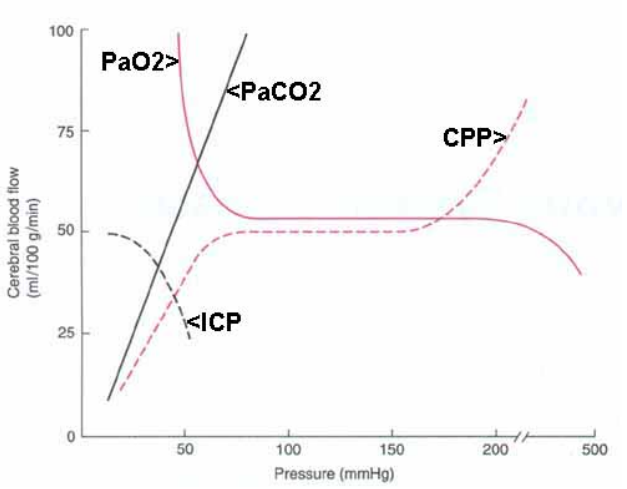
$CMRO_2$ and Cerebral Blood Flow

Anesthetic Pearls: Anesthetic Effects on $CMRO_2$ and CBF

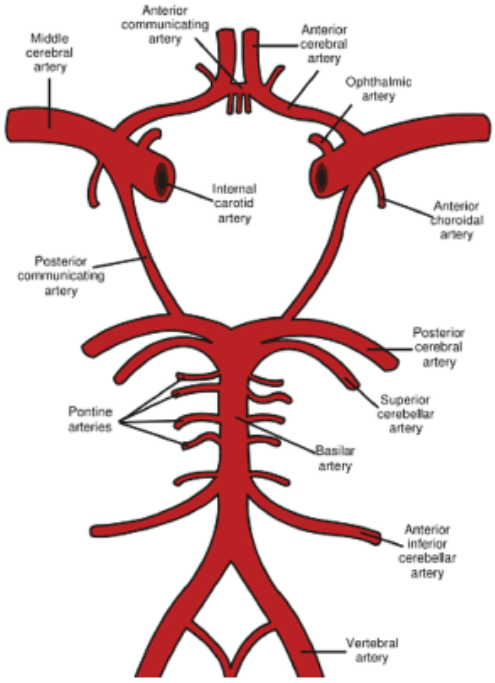
$CMRO_2$ is the cerebral metabolic rate expressed in terms of oxygen consumption. The brain is responsible for 20% of total body consumption of oxygen which is used to generate ATP for neuronal support. Average $CMRO_2$ is approximately 3-4 ml/100gm/min and is greatest in the gray matter of the cerebral cortex.

Cerebral Blood Flow (CBF) averages 50 ml/100gm/min. Flow is greatest in gray matter and is estimated at 80 ml/l00gm/min. In an adult, 15-20% of cardiac output is dedicated to brain perfusion. CBF varies with brain $PaCO_2$, ICP, and anesthetic agent administration.



Anesthetics affecting $CMRO_2$ and CBF:

1. **Volatile Anesthetics** – In general, all of these agents depress cerebral metabolism while producing direct cerebral vasodilatation in a dose dependant manner. This results in increases in cerebral blood volume and intracranial pressure. However, cerebral vasculature remains responsive to CO_2 and hyperventilation can blunt these vasodilatory affects.
2. **Nitrous Oxide** – When given alone or with IV agents, nitrous has mild vasodilatory effects and metabolic effects. The addition of nitrous to volatile agents further increases CBF and therefore increases ICP.
3. **Barbiturates** – Uniformly decrease CMR and CBF to 50% normal in dose dependant manner as EEG isoelectrical point is reached. These drugs also tend to redistribute blood flow from normal to ischemic areas (normal vessels react to barbs by vasoconstricting). Vasculature in ischemic areas is dilated by vasomotor paralysis.
4. **Opioids** – Most opioids have a minimal effect on CBF and CMR unless their use causes respiratory depression and increased $PaCO_2$. These drugs can also cause enough of a decrease in blood pressure to adversely affect cerebral perfusion in patients with increased ICP.
5. **Etomidate** – Decreases CMR and CBF by selectively depressing CMR in the cortex more than the brainstem (this limited effect on the brainstem may be a mechanism for greater hemodynamic stability).
6. **Propofol** – Reduces CBF and CMR but must be used cautiously in patients with tenuous perfusion because of its tendency to decrease blood pressure.
7. **Ketamine** – This is one of the only agents used in anesthesia that can increase cerebral blood flow by 50%. Certain areas are activated (limbic and reticular) while other areas are depressed (somatosensory and auditory) so that the net effect is CMR does not appreciably change.



1. The Circle of Willis, as illustrated here, connects the anterior and posterior circulatory systems.

8. **Benzodiazepines** – Lower CMR and CBF but to a lesser degree than Barbiturates, Etomidate, and Propofol.
9. **Muscle Relaxants** – Histamine releasing relaxants (Tubocurarine, Atracurium, Metocurine, and Mevacurium) can cause vasodilatation with hypotension which has an overall effect of lowering cerebral perfusion pressure. Succinylcholine may increase ICP by increasing muscle spindle activity (may be avoided with adequate dose of induction agent and instituting hyperventilation early).