CO_2 Absorption

Anesthetic Pearls: Anesthetic Implications of CO_2 Absorption

The circle system is the most popular anesthesia breathing circuit in the United State. This arrangement allows rebreathing of some exhaled gases but not CO_2. Advantages of the circle system include minimizing OR pollution, conserving heat/moisture, and allowing low fresh gas flows. Rebreathing of CO_2 is avoided by absorption from exhaled gas before it is re-inspired.

Soda Lime Equation: Calcium hydroxide, $Ca(OH)_2$ (about 75%), Water, H_2O (about 20%), Sodium hydroxide, NaOH (about 3%), and Potassium hydroxide, KOH (about 1%).

$CO_2 + H_2O \rightarrow H_2CO_3$
$H_2CO_3 + 2\text{-}NaOH \rightarrow Na_2CO_3 + Heat$
$Na_2CO_3 + Ca(OH)_2 \rightarrow CaCO_3 + 2\text{-}NaOH$

Chemical Process

The absorption of CO_2 is a chemical process that occurs very rapidly. Two compositions are commonly used Soda Lime and Baralyme. Sodium hydroxide and barium hydroxide are the active components respectively. The chemical reactions are exothermic in nature. The size of the granules is a compromise between resistance to flow and absorptive efficiency. Initial formulations of soda lime degraded its ability to absorb CO_2 after being used for short periods of time however this no longer occurs to a significant degree due to improvements in the product.

Indicator

Ethyl violet is a pH indicator added to both absorbents. It changes from colorless to violet when the pH decreases secondary to CO_2 absorption. The indicator is not always reliable because fluorescent lights can deactivate the dye so it remains white even though it has become exhausted. Furthermore, channeling of gas can occur which allowing rebreathing (although the granules on the periphery remain white). Other signs of absorbent exhaustion include increasing $EtCO_2$ and the absorbent cannister losing warmth. If rebreathing occurs from exhaustion of absorbent, change circuit to semi-open by increasing fresh gas flows.

Compound A

Compound A is a potentially nephrotoxic breakdown product generated by Sevoflurane interacting with CO_2 absorbents. It is believed to be worse with Baralyme and at low flow rates of fresh gas. The current recommendations are to use Sevoflurane with fresh gas flows > 2.0 LPM.

Carbon Monoxide

Prolonged exposure of desflurane / enflurane / isoflurane to CO_2 absorbents can lead to the production of carbon monoxide. Dry absorbent, Baralyme, higher temperatures, and higher concentrations of inhaled agents produce more CO. There are no known reports of harm to patients from this phenomenon, but potential for injury exists. Preventing excessive drying of the absorbent may minimize degradation of anesthetic agents. This can be accomplished with low fresh gas flows or adding water to the top of the absorbent. If there is a suspicion of increased carbon monoxide levels, request carboxyhemoglobin level from ABG, which requires the lab to run the sample through a co-oximeter.