Reducing Volatile Anesthetic Waste Using Activated Charcoal

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**Introduction:** Volatile anesthetics are largely unmetabolized in the body, and as a result the exhaled gases can be redelivered back to the patient. Current anesthesia machines attempt to accomplish this through a rebreathing circuit with limited success as the rate of exhaled anesthetic gas must be removed from the system at the same rate as the incoming fresh gas flow. This waste has both financial and environmental consequences, costing a mid-sized hospital approximately $500,000 in anesthetic waste annually and a 2% contribution to ozone depletion. Thus, creating an alternative method to capturing and redelivering anesthetic gases would be highly beneficial. The porous surface of activated charcoal has been shown effective in absorbing and removing anesthetic gases from anesthesia machines for patients susceptible to malignant hyperthermia. This study aimed to determine if activated charcoal under different conditions could also be a suitable material in both absorbing and desorbing anesthetic gases to ultimately reduce anesthetic waste.

**Methods:** A 5 liter per minute flow of oxygen and 5% isoflurane (Piramal Healthcare Limited, Andhra Pradesh, India) was delivered through a cylindrical vessel containing 42 grams of activated charcoal (Oxpure 1220C-75, Oxbow Activated Carbon, West Palm Beach, FL) until 0.5% isoflurane pushed through the charcoal. Flow was then reversed through the vessel at 2 liters per minute with pure oxygen and the concentration of isoflurane leaving the vessel was monitored using a standard side stream infrared gas bench (Datex-Ohmeda, Helsinki, Finland).

**Results and Discussion:** Isoflurane was released at concentrations suitable for anesthesia maintenance for a significant amount of time, approximately 10 minutes. Once saturated, the activated charcoal had absorbed approximately 60% of its total weight in isoflurane, and was capable of repeatedly reflecting 10% of its total weight in isoflurane or about 3.2 mL of liquid isoflurane. This volume of isoflurane capable of being reflected is the equivalent of anesthesia maintenance at 1 MAC for 1 hour at a fresh gas flow rate of 1 liter per minute. Based on these results, activated charcoal has proven to be a feasible material in reflecting and conserving anesthetic gases. Future work will include creating a system using this material that is able precisely deliver a set concentration based on the principles shown here.
Figure 1 - Average concentration of isoflurane released when flow was reversed through vessel. The concentration released was above 1.0 MAC for approximately 10 minutes.