INHALANT ANESTHETIC INDUCTIONS:

Before the introduction of modern anesthetics drugs and machine various liquids were used to induce animals into general anesthesia. Early anesthetic agents such as chloroform and ether were often administered using the “open drop” or “open cone” technique. Although this is an old technique it can be useful to immobilize small mammals for euthanasia using isoflurane or sevoflurane. Modern anesthesia machines utilize a precision vaporizer to provide a safe and known inhalant percent delivered through breathing circuits. The “open drop” technique removes many of the safety mechanisms inherent in modern anesthesia machines. To use this technique successfully knowledge of inhalant anesthetics must be reviewed. The following table lists the physical properties of several inhalation anesthetic agents.

Physical Properties of Inhalation Anesthetics

<table>
<thead>
<tr>
<th></th>
<th>Isoflurane</th>
<th>Sevoflurane</th>
<th>Methoxyflurane</th>
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<tbody>
<tr>
<td>Saturated Vapor Pressure</td>
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<td></td>
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<tr>
<td>@ 760 mmHg &amp; 20° C</td>
<td>240</td>
<td>160</td>
<td>23</td>
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<tr>
<td>Blood-Gas Partition Coefficient</td>
<td>1.46</td>
<td>0.68</td>
<td>15</td>
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<tr>
<td>Oil-Gas Partition Coefficient</td>
<td>49</td>
<td>29</td>
<td>902</td>
</tr>
<tr>
<td>MAC in dogs (%)</td>
<td>1.3</td>
<td>2.34</td>
<td>0.23</td>
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Vapor pressure is the amount of pressure exerted by the gaseous form of an inhalant when the gas and liquid portions are in equilibrium. To determine the percent of an inhalant in a closed container the vapor pressure of the inhalant is divided by the barometric pressure. (ie. Isoflurane \[240/760\] x 100 = 31.6%, where 760 mmHg is the barometric pressure at sea level). From this example an “open drop” technique using isoflurane would produce an inhaled anesthetic concentration of 31.6 percent. The minimum alveolar concentration (MAC) of isoflurane is 1.3 percent. The MAC of an anesthetic agents is a measure of potency. In other words 1.3 percent inhaled isoflurane will keep 50 percent of dogs anesthetized for a light surgical stimulus. Using an open drop technique provides an inhalant concentration approximately 15 times that need to safely keep most patients anesthetized. The MAC of an agent is different for each species. For example the MAC of isoflurane for the rat is 1.17 percent.

TIME CONSTANT:

For a volatile anesthetic agent the time constant (TC) is defined as the time it takes to fill a defined volume. It is used to give the anesthetist a rough idea of how long it will take for change in anesthetic concentration to occur when using a circle system “cat” box induction. It is calculated by dividing the total volume of the breathing circuit or box by the oxygen flow rate. It takes approximately five time constants after the vaporizer dial setting is changed for the breathing system to reach the new anesthetic concentration. See the following example:

Volume of anesthesia circuit (circle system) = 8 liters
Fresh gas flow set at 2 liters per minute

Q. What is the time constant?

8 liters divided by 2 liters per minute = 4 minute time constant

Q. How long would it take the circuit concentration to match the vaporizer dial setting?

4 minutes times 5 = 20 minutes to reach new concentration

Q. How can you decrease the time constant?

Increase the oxygen flow rate or decrease the volume of the circuit

Q. What is the benefit of decreasing the time constant?

Decreases the amount of time needed to match the vaporizer dial setting.
SELF TEST:

An 8lb injured ground hog presents to your practice for euthanasia. You are asked to box down (chamber induction) the animal because it is aggressive. The induction chamber is a Tupperware box you bought at Meijer. Its volume is approximately 10 liters. You want to get the ground hog asleep as fast as possible because it keeps trying to escape from the Tupperware box by pushing the lid off the top.

a. Describe how you would perform a chamber induction. In your answer include which inhalation agent you would select, the vaporizer setting (% inhalation agent) you would select and the oxygen flow rate you would use. Indicate why you choose these settings.

Additional info: Isoflurane vaporizer settings can be set as high as 5%. Sevoflurane vaporizer settings can be set as high as 8%. The oxygen flow can be set as high as 10 liters per minute.

Answer: Select sevoflurane with vaporizer set at 8% and oxygen flow rate at 10 liters per minute. Sevoflurane has a lower blood-gas coefficient and therefore a faster time to unconsciousness. Select the highest % possible to increase the speed of induction. Setting the oxygen flow rate to 10 liters per minute produces a one-minute time constant. Remember it takes approximately 5 time constants to reach the selected percent of inhalant agent. A fast time constant equals a fast induction time.

b. What anesthesia circuit or system would you use to connect the box to the anesthesia machine?

Answer: Connect the box to the anesthesia machine using a nonrebreathing circuit such as a Bain system or hook the fresh gas line directly to the box.

c. Why did you select this circuit or system?

Answer: A rebreathing circuit such as a Circle system has an inherent volume that would increase the time constant of the 10 liter box plus the volume of the circle system. By attaching the Bain system or fresh gas line directly to the box the additional volume of the circle system is avoided.