Flow through the Copper Kettle Flowmeter

To the Editor:—Although the copper kettle has been in use for over 30 years,\(^1\) calculating the flow of oxygen through the kettle flowmeter that will deliver a certain percentage of a volatile agent still may present a challenge. This is even more evident when one is teaching residents new to anesthesia. I employ formulae that are condensations of a standard formula, easy to calculate, and allow any total flow desired, viz:

\[ VF \approx TF \times 20 \times \% \text{ for halothane and isoflurane, and} \]

\[ VF \approx TF \times 30 \times \% \text{ for enflurane,} \]

where \( VF \) = flow of oxygen to the copper kettle from the flowmeter in ml·min\(^{-1}\) and \( TF \) = total gas flow in l·min\(^{-1}\).

These are derived as follows:

\[ \% = \frac{VF(\text{ml} \cdot \text{min}^{-1}) \cdot [P_a / P_b - P_a] \times 100}{TF(\text{l} \cdot \text{min}^{-1})} \]  
\[ = \frac{VF(\text{ml} \cdot \text{min}^{-1}) \cdot [P_a / P_b - P_a] \times 100}{TF(\text{l} \cdot \text{min}^{-1}) \times 1,000 \text{ ml} \cdot \text{l}^{-1}} \]  

where \( P_a \) = the vapor pressure of the volatile agent and \( P_b \) = the barometric pressure, both in mmHg.

Thus, for halothane at 20°C at sea level:

\[ \% = \frac{VF \cdot [243/760 - 243] \times 100}{TF \times 1,000} \]

\[ = \frac{0.47 \text{ VF}}{10 \text{ TF}} \simeq \frac{0.5 \text{ VF}}{10 \text{ TF}} \]  

and therefore

\[ VF \approx TF \times 20 \times \% \]  

The vapor pressure of isoflurane at 20°C and sea level is 238 mmHg; very close to that of halothane so that equation (5) holds.

For enflurane at 20°C and sea level:

\[ \% = \frac{VF \cdot [175/760 - 175] \times 100}{TF \times 1,000} \]

\[ = \frac{0.3 VF}{10 TF} \simeq \frac{0.33 VF}{10 TF} \]  

and therefore

\[ VF \approx TF \times 30 \times \% \]  

The results obtained from equations (5) and (8) are, of course, approximations but prove accurate enough for clinical application.

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Reference


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Brain Stem Anesthesia Following Retrobulbar Block

To the Editor:—Anesthesia personnel should be alerted to the rare occurrence of accidental brain stem anesthesia following retrobulbar nerve block for ophthalmic surgery. This unusual, but life-threatening, complication has been described previously during stellate ganglion block\(^1\) and extraoral trigeminal block.\(^2\) Smith\(^3\) referring to several cases of apnea after retrobulbar bupivacaine suggested that the local anesthetic gains access to the subarachnoid space as one possible explanation. At our institution we have observed seven cases of suspected brain stem anesthesia following retrobulbar blocks over the past 5 years. One of these cases is described below.

Report of a Case

A 74-year-old 78-kg man was scheduled for a left scleral buckle procedure. Arterial blood pressure 130/80 mmHg and heart rate 62 bpm. Following 50 µg of fentanyl iv, a left retrobulbar nerve block was performed using 8 ml of 0.75% bupivacaine without vasoconstrictor. A separate injection for lid akinesia was not necessary, as the amount of local anesthetic used filters up into the lido to produce adequate akinesia and also propostes the globe, which is desirable for retinal surgery. Five minutes after the block, the patient became agitated and confused. Arterial blood pressure increased to 180/110 mmHg. Seven minutes after the block, the patient became unresponsive and apneic. Ventilation with 100% oxygen via face mask was initiated. At this time the blood pressure was 220/120