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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:*

$VF \simeq TF \times 20 \times \%$ for halothane and isoflurane, and

$VF \simeq TF \times 30 \times \%$ for enflurane,

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

These are derived as follows:

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

$$= \frac{VF(ml \cdot min^{-1}) \cdot [P_a/P_b - P_a] \times 100}{TF(l \cdot min^{-1}) \times 1{,}000\ ml \cdot l^{-1}} \quad (2)$$

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:

$$\% = \frac{VF \cdot [243/760 - 243] \times 100}{TF \times 1{,}000} \quad (3)$$

$$= \frac{0.47\ VF}{10\ TF} \simeq \frac{0.5\ VF}{10\ TF} \quad (4)$$

and therefore $VF \simeq TF \times 20 \times \%$ (5)

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:

$$\% = \frac{VF \cdot [175/760 - 175] \times 100}{TF \times 1{,}000} \quad (6)$$

$$= \frac{0.3\ VF}{10\ TF} \simeq \frac{0.33\ VF}{10\ TF} \quad (7)$$

and therefore $VF \simeq TF \times 30 \times \%$ (8)

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

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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 lids to produce adequate akinesia and also proptoses 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

mmHg and the heart rate 120 bpm. Endotracheal intubation then was performed without the use of any additional medications. The patient began spontaneous respiration 30 min after intubation. Auscultation of the lungs revealed rales in the left lung field. A chest film demonstrated unilateral pulmonary edema of the left lung, which rapidly was resolved with iv furosemide. The trachea was extubated 2 h later. Follow-up ECGs essentially were unchanged from the pre-operative ECG. A neurological examination several hours later revealed no deficits. The patient had his surgery successfully performed at a later date under general anesthesia with no complications.

The gradual onset of unconsciousness and apnea over the course of 7 min without any accompanying seizures and/or cardiac collapse tends to minimize the likelihood that the observed complication was due to accidental intravascular local anesthetic injection. A more plausible explanation is that accidental brain stem anesthesia was produced. The clinical course of our case has many similarities to that described in other reported cases of brain stem anesthesia.[1,2] Accidental access to the cerebrospinal fluid during retrobulbar nerve block could occur by perforation on the meningeal sheaths that surround the optic nerve. Lombardi[4] reported the presence of contrast medium in intracranial subdural spaces in three out of 150 patients following retrobulbar injections of contrast for orbitography.

Brain stem anesthesia is a potentially life-threatening complication that can occur after a retrobulbar injection. Awareness and recognition of this emergency is important for all personnel involved. Individuals trained in airway maintenance and ventilatory support should be immediately available whenever retrobulbar nerve block is utilized.

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Safety of the Sitting Position

To the Editor:—Within the neuroanesthesia and neurosurgical community there seems to be considerable concern about the safety of the sitting position. Much of the negative rhetoric about the sitting position is based on anecdotal experience rather than even rudimentary epidemiologic work.

From the years 1966 through 1983, we have performed 3,827 anesthetics for cervical laminectomy or posterior fossa surgery in the sitting position. Of these there has not been a single death in the operating room due to air embolism. One patient died postoperatively from "adult respiratory distress syndrome," which may have been related to air embolism occurring during the operative procedure. Another patient had paradoxical air embolism with severe neurologic sequelae. The only intraoperative death in our neurosurgical practice during that time period directly related to air embolism was a patient having surgery in the prone position.

Perhaps these figures can help put the risk of the sitting position into some general perspective.

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