evidence that HFJV may prevent aspiration, we do not propose to routinely supplant awake intubation with this technique. We assert that multiple strategies are necessary for dealing with patients who have difficult airways. The technique we described is useful in selected circumstances, and should be added to the anesthesiologist's armamentarium.

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Hazards of a New System for Placement of Endotracheal Tubes

To the Editor:—In their report on a technique for placement of endotracheal tubes to prevent endobronchial intubation, Owen and Cheney advocate a position of 23 cm for men and 21 cm for women as marked on the endotracheal tube at the incisor teeth. While no endobronchial intubations occurred in their “study group” with this system, 14 patients (4.6%) were noted to have the tip of their endotracheal tube 9 cm or more above the carina. The authors observed no cases of tracheal extubation. They noted the study by Comardy et al. which showed up to 5.2 cm outward movement of endotracheal tubes on extension of the head; however, Owen and Cheney state that “. . . . migration of the cuff between the cords would be easily recognized by the presence of an airleak with positive pressure ventilation.”

Comardy et al. note the length of the adult human trachea to be 12 ± 3 cm. Thus, the patients found by Owen and Cheney to have high tube placements may be at great risk for accidental extubation after head extension. Such an occurrence would clearly be hazardous and merits the rejection of their system. I have found that accidental extubations are not always quickly recognized, especially if the anesthetist does not have good access to the head.

Interestingly, in Owen and Cheney’s “control group,” consisting of those patients whose endotracheal tubes were not adjusted after intubation, only two patients (0.7%) had the tip of the tube 9 cm or more from the carina. The conclusion that the “control” group is at greater risk for endobronchial intubation must be compared to its potential for fewer extubations. In my practice, I have found the latter to be more dangerous.

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REFERENCES

In Reply:—Dr. Sosis’ letter focuses attention on a potential problem with the technique of securing oral endotracheal tubes, which we recently described. We can only say that accidental extubation was not a problem in 304 patients studied in a prospective fashion in an ICU setting. As mentioned in the article, the tube tip may have been higher in the x-ray than in vivo because of the natural extension of the head when the patient was on an x-ray cassette. This extension would tend to move the tip higher. We disagree in general that accidental extubation is harder to diagnose than endobronchial intubation. Even with a pulse oximeter to make a prompt
diagnosis, intraoperative hypoxemia has a number of causes which must be rapidly sorted out. On the other hand, the diagnosis of an accidental extubation would seem to us to be easier to make by such measures as lack of breath sounds, feel of the breathing bag, ventilator alarms, noise of escaping gas, etc. We agree that the treatment of accidental extubation may be more difficult. The bottom line is that any technique must be used with proper medical judgment. A tall person in whom surgery is being performed where access to the head is limited should have the endotracheal tube taped so that the tip is more than 23 cm from the teeth. The technique for securing the tube in patients who are either taller or shorter than average is referenced in the article.

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Carboxyhemoglobin and Pulse Oximetry

To the Editor—I read with interest the Laboratory Report by Barker and Tremper 1 which showed that the pulse oximeter saturation reading (SpO₂) overestimates oxyhemoglobin (O₂Hb) in the presence of carboxyhemoglobin (COHb). In their introduction, it is stated that the Instrumentation Laboratories IL-282 Co-oximeter "measures the light absorbance of blood samples at six or more discrete wavelengths." This is incorrect. In this particular instrument, absorbance is measured at each of four wavelengths to compute the four measured hemoglobin (Hb) species in the sample (Operator's Manual, IL-282 CO-Oximeter, Instrumentation Laboratory, Lexington, MA, 1978). The IL-282 measures only O₂Hb, COHb, reduced Hb (RhB), and methemoglobin. The total hemoglobin value (THb) is the sum of the four concentrations.

In their discussion, the authors state that "it is interesting that the SpO₂ values in figures 2 and 3 (plots of SpO₂ and O₂Hb versus COHb at Fo₂ = 1.0 and Fo₂ = 0.2, respectively) approximate the sums of the O₂Hb and COHb values," as measured by the IL-282. I would suggest that this approximation might be predictable based upon the principles of operation of the pulse oximeter and the spectrophotometric characteristics of the hemoglobins involved. The pulse oximeter continuously compares the pulse-added light absorbance signals at 660 nm with those at 940 nm, and, from the ratio, estimates SpO₂ using an algorithm. Because the millimolar extinction coefficient (light absorbance) of RHb (0.8) is much greater than that of O₂Hb (0.08) at 660 nm, whereas the coefficients are less dissimilar at 940 nm (RHb 0.2; O₂Hb 0.3), 2 the ratio of pulse-added absorbances at 660/940 is more directly related to desaturation, i.e., RHb/THb. Oximeter saturation readings (SpO₂) would, therefore, normally be based on the assumption that what is not RHb is O₂Hb. In this study, what was not RHb was O₂Hb plus COHb. At 660 nm, COHb has an extinction coefficient of 0.07 and is, therefore, almost indistinguishable from O₂Hb at this wavelength. 3 Because COHb does not affect the light absorbance due to RHb at 660 nm, the "desaturation ratio" (RHb/THb) would essentially be read correctly. The error in the SpO₂ estimation of O₂Hb in the presence of COHb therefore arises when it is generated, in effect, as [1 − (RHb/THb)] × 100%.

The algorithm used in the pulse oximeter is such that when the ratios of the pulse-added absorbances (660/940 nm) are 3.4, 1.0, and 0.43, the SpO₂ readings are 0, 85, and 100%, respectively; thus, the higher the ratio, the lower the SpO₂ reading. At 940 nm, COHb has an extinction coefficient of zero, i.e., it does not absorb light at this wavelength. Increasing amounts of COHb therefore tend to decrease the denominator (total absorbance at 940 nm), increase the ratio, and cause the SpO₂ to show a slight decreasing trend, as was observed (figs. 2, 3) in this study.

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* How Does A Pulse Oximeter Work? Informational publication, Ohmeda, Boulder, CO.