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In Reply:—A filling error such as that described by Riegle and Desertspring has never been reported. It is true that if the keyed collar on the halothane bottle should be accidentally installed upside down it would be physically possible to place an enflurane adaptor over the threads of a halothane bottle, but without a threaded connection because of diameter differences. Even in such a situation the practitioner would be made aware of the error by four different warnings: 1) no threaded connection could be made; 2) the mismatch would cause noticeable leakage during filling; 3) the color coding between bottle and filler would not match (enflurane's color is orange; halothane's is red); and 4) the bottles are prominently labeled as to content.

Even so, we regret any possibility of inversion of the collar, and we have redesigned the process of putting the collar on the bottle, with the use of the keyed system itself to insure proper orientation of the collar.

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Capnometer Readings at High Altitude

To the Editor:—This letter is to alert those who work at altitudes much above sea level to a potential problem in misinformation generated by carbon dioxide analyzers not properly calibrated for altitude. While evaluating a prototype clinical mass spectrometer (Paradygm, Boulder, CO) in parallel with our Datascope Multinex 4300 (Datascope, Paramus, NJ), it became obvious that the Datascope unit gave consistently high values, even after field service personnel checked the calibration of the device. During moderate hyperventilation, the mass spectrometer showed end-tidal CO_2 values of 31 mmHg, whereas the Multinex 3400 indicated 38 mmHg. At the end of one case the mass spectrometer indicated an end-tidal CO_2 concentration of 48 mmHg, and the Multinex indicated a value of 64 mmHg.

Further investigation revealed that the manufacturer provided no procedure for altitude compensation when converting from per cent values to mmHg.[1] Specifically:

$$P_{CO_2}\ \text{mmHg} = F_{CO_2} \times (P_B - P_{H_2O})$$

where $F_{CO_2} = \%\ CO_2/100$. The Multinex 4300 calibration instructions call for a 5% CO_2 calibration gas to be injected while an output voltage is adjusted to a fixed level, subsequently displayed as 38 mmHg, *i.e.*:

$$P_{CO_2}\ \text{mmHg} = F_{CO_2} \times (760 - 0)$$

The Multinex 3400 measured a series of calibration gases (Scott Medical Products, Plumsteadville, PA) at a barometric pressure of 630 mmHg (dry gases) (table 1). This error is different from, and at our altitude larger than, the problem of correction for water vapor pressure discussed recently by Severinghaus.[2] Neither the Datascope unit nor the Paradygm unit corrected for alveolar water vapor, although the Paradygm unit now permits either dry or wet gas data presentation.

Severinghaus's summary of the conventions observed by respiratory physiologists surely is correct, with mmHg being reserved for wet gas readings and per cent reserved for dry gas readings. In addition, he is correct that those of us measuring end-tidal CO_2 clinically wish to measure the alveolar (wet gas) partial pressure. Nonetheless, correcting for alveolar water vapor with the somewhat arcane analog-era practice of forcing a measuring instrument to "misread" a dry calibration gas is confusing to many of the clinicians and engineers now concerned with these measurements.[2] There is merit to solving the complex problem of correcting for changes in water vapor content at the time patient data are computed. Clearly, 5% CO_2 in Boulder has a partial pressure of 31.5 mmHg; it is only when the sample has been dried between the alveolus and the measuring instrument that reporting the result as 31.5 mmHg instead of 29.4 mmHg incorrectly estimates the alveolar partial pressure of the gas.

TABLE 1. Calibration Gases Measured by the Multinex 3400 at a Barometric Pressure of 630 mmHg

Calibration Gas %	Calculated Partial Pressure	Measured Partial Pressure (%)
2.0	12.6	14 (2.22)
3.0	18.9	22 (3.49)
4.0	25.2	30 (4.76)
5.0	31.5	38 (6.03)
6.0	37.8	47 (7.46)
7.0	44.1	54 (8.57)

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In Reply:—The Multinex can display CO_2 values in per cent, KPa, or torr units of measure. If partial pressure units of display for CO_2 (KPa or torr) are chosen, the value displayed is the sea level partial pressure equivalent. The measurement and display of CO_2 in per cent units is unaffected by altitude.

If KPa or torr units of measure are chosen and the altitude is below 1,600 feet, the difference between the sea level equivalent displayed CO_2 values and the corresponding value at the given altitude is small, *i.e.*, under 2 mmHg on a nomocapnic patient at 38 mmHg ET_{CO_2}. This difference falls to under 1 mmHg on this patient below 800 feet.

Datascope is in the process of implementing a program to address the needs of those customers, such as Dr. Hilberman, who require CO_2 compensation for altitude as well as a program to address the correction of water vapor pressure, as described by Severinghaus. The program will consist of a simple software upgrade, at no cost, to their existing systems. The software will be available in the very near future.

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Misuse of the Pulse Oximeter by the . . . Patient!

To the Editor:—Pulse oximetry has gained wide acceptance among anesthesiologists. Pediatric patients rarely object to the application of the Band-aid-like probe (Nellcor N-20), and find the analogy to E.T.'s magic glowing red finger entertaining. However, potential misuse of the instrument was limited to medical personnel until these two recent incidents.

A healthy ten-yr-old boy was undergoing an otherwise smooth excision of a cyst from the left leg under local anesthesia. Suddenly, the pulse oximeter alarm went off and the patient exclaimed: "Look, it went down to 78." Upon questioning, the child admitted that he had been trying to decrease the pulse oximeter reading by holding his breath.

A trial by three (relatively young) anesthesiologists in our department was unsuccessful in duplicating these results. The lowest saturation obtained after 45 s of breath holding was 89%. This tends to indicate that our patient held his breath for about a minute.

Another patient tried to "increase" the pulse oximeter reading to over 100 by hyperventilating, but his record-setting attempt was immediately aborted by the anesthesiologist when his breathing pattern was noticed.

Anesthesiologists caring for young children and adolescents should be made aware of the potential for games and record-setting attempts centered around a pulse oximeter. Although it is doubtful that such self-limiting recreational activities would bring serious harm to the patient, they should be discouraged to avoid unnecessary alarms due to decreased saturation, and to avoid the lightheadedness that the patient might experience.

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Failure of an Oxygen Flow Control Valve

To the Editor:—Just before administering a general anesthetic to a patient with an Ohmeda Modulus I anesthesia machine, we found that the machine was unable to deliver more than 200 ml/min of oxygen. We were, nevertheless, able to deliver 10 l/min of nitrous oxide, a situation that could lead to administration of a hypoxic mixture of gases.