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2. Severinghaus JW. Water vapor calibration errors in some capnometers: Respiratory conventions misunderstood by manufacturers? ANESTHESIOLOGY 70:996–998, 1989

(Accepted for publication May 1, 1990.)

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73:355, 1990

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.

We rechecked the breathing machine, and there was no apparent leak in the breathing circuit. The wall oxygen source was adequate, and its connection to the anesthesia machine was proper. The oxygen cylinder mounted on the anesthesia machine was full, but when turned on, no more than 200 ml/min of oxygen could be delivered. The oxygen supply failure alarm was not activated. The machine was removed from service until it was repaired. The oxygen flow control valve of the anesthesia machine was later disassembled and examined. The needle of the oxygen flow control valve stem was found to be broken (fig. 1) and was jammed inside the silver seat, obstructing the flow of oxygen to the oxygen flowmeter. Normally, when the oxygen flow control valve is turned on, the needle valve stem moves out of the silver seat allowing oxygen to flow to the flowmeter.

The Ohmeda Modulus I anesthesia machine incorporates Proportion Limiting Control System that links the flow control valves for oxygen and nitrous oxide together, so that in any oxygen–nitrous oxide mixture there will be at least a nominal 25% oxygen concentration.*† To achieve this, the sprocket on the nitrous oxide flow control valve stem is connected to the sprocket of the oxygen flow control valve stem by a chain. Thus, when the nitrous oxide valve is turned on, the chain simultaneously rotates the oxygen flow control valve stem and turns the oxygen on. In our case, when we turned the nitrous oxide flow control valve on, the chain, as expected, rotated the oxygen valve stem for oxygen delivery. But, as the passage of the oxygen to the oxygen flowmeter was blocked, no more than 200 ml/min of oxygen was delivered. We were able to deliver 200 ml/min of oxygen because the oxygen flow control valve stem has, at its end, "a minimal stop"[1] that keeps a small passage patent to deliver 200 ml/min of oxygen once the anesthesia machine is turned on, even when the oxygen flow control valve is in the off position. The needle flow control valve stem, whether it is intact or broken, cannot block that small passage, and thus allows the flow of 200 ml/min of oxygen.

It is important to note that routine machine check of reserve gas supply and integrity of breathing circuit failed to detect the oxygen flow control valve failure, since the oxygen surge bottom used to check the anesthesia circuit worked normally. As part of checking the anesthesia machine, the oxygen flow to the oxygen flowmeter should be checked each time before administering an anesthetic, as we used the same anesthesia machine the day before without problems in oxygen delivery.

* Ohmeda Modulus I Anesthesia Gas Machine Operating Maintenance Manual, volume 480, pp 10 and 28

† Andrews JF: The anatomy of the anesthesia machines. American Society of Anesthesiologists Refresher Course Lectures, volume 74, October, 1989, p 3

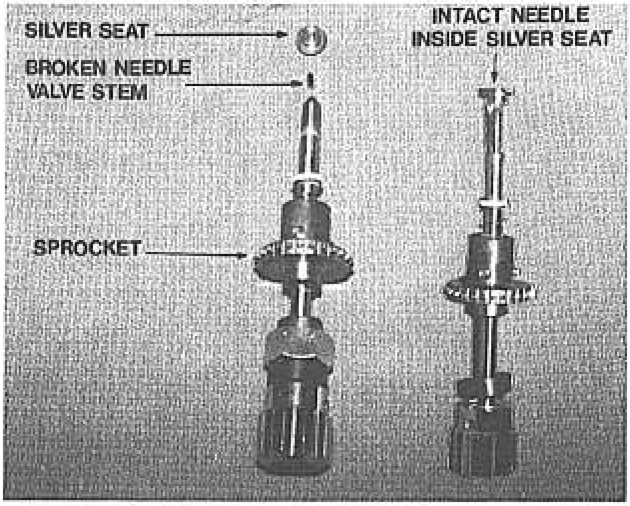

FIG. 1. Two oxygen flow control valves. *Right:* An intact needle, which moves out from the silver seat when the oxygen flow control valve is turned on. *Left:* This oxygen flow control valve has the broken needle that was jammed in the silver seat and thus obstructed the oxygen flow to the oxygen flowmeter.

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In Reply:—The subject valve was analyzed by our research and development and quality control departments. Although Ohmeda was unable to determine the exact cause of the needle valve break, it was observed that excessive forces had, at some point in time, been exerted onto the needle stem.

The breakage apparently had occurred with the needle tip placed in its minimum flow configuration, thus allowing only the minimum flow of 200 ml/min, regardless of knob position. Under expected use condition, this needle valve is designed to operate throughout its range such that the needle's stem is never exposed to excessive force.

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