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An Unusual Capnogram

To the Editor:—We recently encountered an abnormal capnogram with an elevated inspired CO_2 and a depressed expired CO_2 from a cause not previously described.

A 38-yr-old, 70-kg man was undergoing an otherwise uneventful general anesthetic with a 7.5-mm intradermal cuffed endotracheal tube. Tracheal intubation had been confirmed by direct visualization of the endotracheal tube, auscultation of both lungs, and the presence and persistence of exhaled CO_2 on the capnogram. Anesthesia was maintained with inhaled isoflurane and nitrous oxide in oxygen. The following ventilatory settings were applied: tidal volume = 750 ml, respiratory rate = 10/min, fresh gas flow/oxygen = 1 l/min, and nitrous oxide = 2 l/min. Ten minutes after intubation, it was noted that the CO_2 monitor (POET II Criticare Systems, Waukesha, WI) indicated an elevated end-inspired CO_2 (8 mmHg), a prolonged expiratory upstroke, and a lower than expected end-expiratory CO_2 (25 mmHg; fig. 1A).

Systematic evaluation of the patient and circuit revealed normal arterial blood gases but failed to identify the cause of the abnormality until the water trap was changed. The capnogram immediately reverted to a normal pattern (fig. 1B). The inspired CO_2 was 0, and the expired CO_2 was 30. The remainder of the operation was uneventful.

Side-stream capnographs aspirate respiratory gas from an airway sampling site and transport the gas sample through a tube to a remote CO_2 analyzer. Water traps and filters have been designed to protect the measuring chamber from moisture that may damage the control board. The POET uses a system that divides the tubing just proximal to the water trap. One segment passes through the water filter. This now dry gas enters a small chamber in the right upper corner of the water trap, proceeds to the measuring chamber, and exits the device through the exhaust port. The other segment connects the moist gas to a large water trap, which collects precipitated water. The accompanying gas bypasses the measuring chamber and exits the device at the exhaust port.

After consultation with the manufacturer, we believe there was a leak in the water trap between the corner of the trap and the larger water collection chamber, causing inspiratory and expiratory gases to mix. The manufacturer says this is a rare occurrence not related to any given production lot, and they have changed their manufacturing process to reduce the risk of future occurrences. We have since noted this problem with other old model water traps but not with the new model.

This pattern of capnography has been previously described with a rapid ventilatory rate (60/min), a long sample line (3.7 m), and a low sample rate (66 ml/min).[1] None of these conditions existed with this patient. We are unaware of any formal standard which would identify this problem prospectively. Preoxygenating a patient will not necessarily reveal this problem because one often sees some gas mixing when using a mask. We found that the pattern can be detected by exhaling multiple times into the anesthetic circuit, but was not apparent after only one or two breaths.

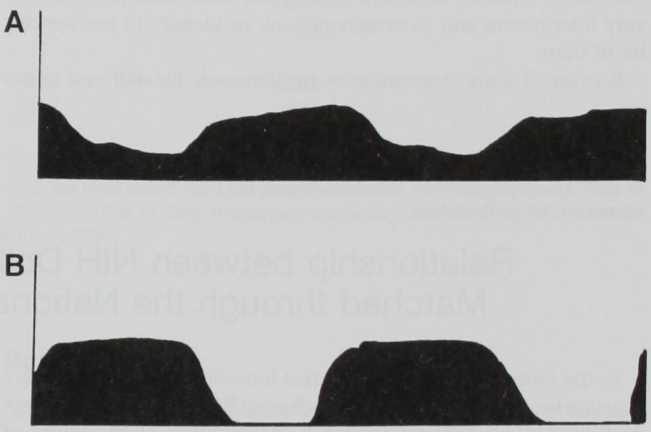

Fig. 1. Capnograms before (*A*) and after (*B*) replacement of faulty water trap. Capnogram (*A*) 10 min after induction of anesthesia had wave forms indicating an increase in the end-inspired CO_2 and an unexpected low end-expiratory CO_2. There was continuous sampling *via* the water reservoir of mixed inspiratory and expiratory gas. Capnogram (*B*) after replacement of the water trap had a normal waveform.

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