

CASE REPORT**The fractured capnography sampling line - a great pretender**

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*Correspondence Email: timdawes@yahoo.co.uk**SUMMARY**

We report a fault in the gas sampling line of a monitor at our hospital and the readings which occurred as a result.

CASE REPORT

A 54-year-old man underwent emergency laparotomy under general anaesthesia. The patient received a rapid sequence induction including administration of suxamethonium in the anaesthetic room and, following intubation, ventilation for approximately two minutes on isoflurane 2% while a second peripheral cannula was inserted. The patient was then transferred to theatre and connected to the circle breathing system of the anaesthetic machine in theatre. Peripheral nerve stimulation confirmed recovery from suxamethonium and a non-depolarising muscle relaxant (rocuronium 30mg) was given. Shortly afterwards, the monitor appeared as shown in Figure 1, with the following abnormalities seen: a low end-tidal percentage of inhalational anaesthetic within the circle system, a low end-tidal carbon dioxide partial pressure and an irregular capnograph trace. No immediate explanation was found for these unexpected readings and senior help was summoned. Close inspection of the gas sampling tubing revealed a fracture of the tubing at the 'patient end' (Figure 2). This was replaced and all measurements returned to more anticipated values. The operation proceeded without further incident.

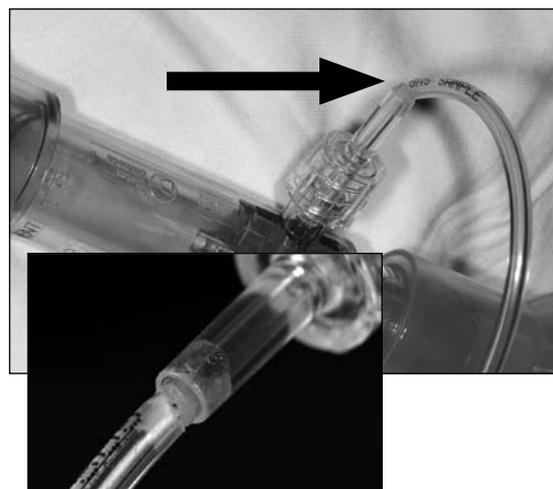


Figure 2. Gas sampling line incorrectly attached. The arrow marks the site of the fracture (shown inset in close-up)

DISCUSSION

We report this case to make anaesthetists more aware of this potential equipment problem which we feel is important for a number of reasons. First, the fault has occurred several times at our hospital and, although easily rectified, in each case this fault has been missed during standardised pre-anaesthetic checks, and despite clear instructions from the manufacturer. Second, the fault affects all aspects of gas monitoring (capnography, agent and oxygen monitoring) both in terms of the numerical value and waveform displayed. In addition, the fault may occur intermittently and with sudden onset during anaesthesia if the sampling line is disturbed. Third, the resulting appearance mimics serious conditions, such as sudden reduction in cardiac output, which may lead to inappropriate management with potential harm to the patient.

The gas sampling line is designed with a ninety degree 'elbow' connector at the patient end to avoid stress at the connector. However, the sampling line may be reversed and the elbow connector may be erroneously attached to the gas sampling inlet of the monitor leaving the straight Luer connector attached to the sampling port of the breathing system. Our experience is that this arrangement predisposes to kinking of the sampling line which affects gas monitoring. With repeated use in

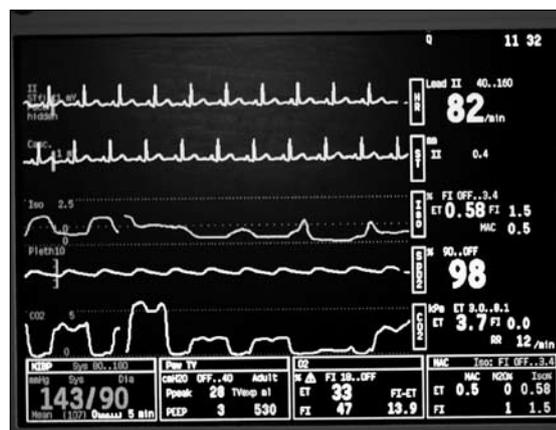


Figure 1. Monitor appearance during intermittent positive pressure ventilation

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this manner, a fracture may develop at the Luer connector end which can allow air to be entrained into the gas sampling stream. The size of the hole varies according to the position of the sampling line. Small changes in the aperture of the fracture easily occur if the sampling line or breathing system are moved, leading to sudden changes in monitored end-tidal CO₂ and agent levels. A sudden fall in end-tidal CO₂ or agent might lead to a diagnosis of an abrupt fall in cardiac output (for example such as that found in pulmonary or air embolus) or an inadequate level of inspired agent respectively. In addition, an irregular shaped capnograph trace during positive pressure ventilation may suggest incomplete neuromuscular block, leading to further doses of non-depolarising muscle relaxant (see Figure 1).

Gas sampling leaks have been reported in the literature due to presumed manufacturing faults², loose connections^{3,4} and a small hole.⁵ To our knowledge, this is the first example of leak caused by plastic fatigue, due to incorrect placement of the elbow piece, and the first description of a variable leak - simulating a change in the patient's condition. Zupan et al reported a loose connection in a gas sampling line resulting in an unusual capnography waveform (constituting a long duration, low plateau followed by a brief peak) but their findings differ to ours in the waveform seen and do not resemble a curarisation notch.⁴ Our case is also the first to demonstrate a change in the gas analysis during anaesthesia, suggestive of change in the patient's clinical state.

The key to detecting this fault lies in awareness of the potential problem and checking of the breathing system and associated apparatus. More specifically, if the sum of the fractional end-tidal values of gases (i.e. $F_{E}O_2 + F_{E}N_2O + F_{E}CO_2 + F_{E}AA$) is significantly less than 1.0 after even a short period of ventilation at high flows, or is variable, a leak in the system and entrainment of nitrogen from the air should be suspected. We note that anaesthetists who habitually exclude nitrogen from their anaesthetic circuits by using nitrous oxide and oxygen rather than air and oxygen may be alerted to the problem more quickly since an increase in nitrogen partial pressure will be more obvious.

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