A critical incident during anaesthesia in the operation theatre

In this article, we describe a critical incident which occurred in our operation theatre involving an anaesthesia machine. The oxygen flowmeter broke into three pieces and completely shut down the oxygen flow during anaesthesia. A brief review of the literature on equipment failure during anaesthesia is also given.

Anaesthetic equipment failure can contribute to anaesthetic morbidity and mortality. Problems such as damaged needle valves, cracked flowmeters[1] that cause gas leakage, and dirty columns that are responsible for stuck bobbins, lead to delivery of hypoxic mixtures or low tidal volumes. However, these will not result in a complete shutdown of oxygen.

The literature describes cases of a complete shutdown of the machine when there is a blockade or leakage in the pipelines in the high-pressure system, jammed check valves in the closed position, a blockade of the filter in the hanger yolk, disconnection of the pipelines in the machine and stuck oxygen flush valves.

Leakages and misconnections from the vaporiser connections and from the ventilator itself can cause a shutdown in the low-pressure system. Malfunctioning of the ventilator valves is another contributory factor.

We searched the literature in the archives of journals and on the Internet for any reports on the breakage of the oxygen flowmeter. We could not find any. Therefore, this is the first report on an incident of oxygen shutdown because of sudden breakage of the oxygen flowmeter while anaesthesia and surgery were in progress.

Case report

A 45-year-old man, with a body weight of 58 kg (American Society of Anesthesiologists II), who had carcinoma of the urinary bladder, was undergoing a total cystectomy, prostatectomy and creation of an ileal conduit under epidural and general anaesthesia.

When the anaesthesia was first administered, it was observed that the bobbin in the oxygen flowmeter was either sticking to the side or rotating sluggishly. Two hours into the operation, the oxygen level started to drop. The reserve oxygen cylinder in the machine was found to be empty. A technician was alerted to open one side of the central oxygen manifold. In our hospital, the changeover from one side of the manifold to the other is carried out manually. The bobbin was falling and the needle valve was adjusted to keep the bobbin level at two litres. When the cylinders in the central manifold were opened, the bobbin suddenly shot up to the top of the flowmeter. Before the oxygen knob could be adjusted, the rotameter broke into three pieces, making a low-intensity sound. It resembled the sound of an ampoule being broken. The breathing circuit was immediately disconnected from the endotracheal tube and ventilation of the patient commenced with an Ambu bag. Another anaesthesia machine was brought in from the adjoining operation theatre and connected to the patient. The rest of the anaesthesia and surgery proceeded uneventfully.

Our machine is a Boyle® Basic, serial number 0571/A1/02/2002, manufactured by Azez Engineering. The flowmeter assembly was made by Datex-Ohmeda. The machine is approximately 10 years old and is regularly serviced by authorised personnel. The servicing is outsourced by the manufacturer and the last service was carried out two months prior to the incident.

Discussion

The following day, when the flowmeter was removed by the service engineer, dust particles and dirt were found inside the broken tube. The pressure regulator of the machine and the pressure-reducing valves of the central manifold were found to be undamaged. The stopper at the top of the oxygen flowmeter and the pressure pop-off valve were also found to be normal.

Our machine does not have a second-stage regulator or a flow restrictor upstream of the oxygen flowmeter. Oxygen pressure that is delivered from the wall supply is usually 60 psig, but not always. Fluctuations do occur, based on hospital demand, in particular.[2] When all of the anaesthesia machines are working, the pressure can drop to below 60 psig, and when only one machine is working, it can rise to above 60 psig. Our incident occurred at approximately 15h00. Of 11 theatres, only ours was operating. Therefore, the sudden surge of pressure might have affected our machine directly.

Because dirt and dust were found inside the broken flowmeter, it is possible that some of dirt might have settled in the valve seat and diaphragm of the pressure regulator of the machine. This might have caused a steady build-up of pressure in the apparatus.[3]

One possible cause of the accident is that the high pressure that had developed was transmitted directly to the flowmeter (in the absence of a second-stage regulator and flow restrictor in the machine). The needle valve was almost fully open because of constant adjustment for the flow of oxygen. The sudden surge of high-pressure oxygen could have caused the breakage. The pressure-release valve might not have been working properly at that moment. Another possibility is that there was an existing crack in the flowmeter. The sudden increase in the pressure might have opened it up.

The stopper at the top of the flowmeter was found to be intact. If it had been broken, the bobbin might have partially blocked the exit of oxygen, leading to a pressure build-up in the flowmeter, which would have caused breakage.

Figure 1: The broken oxygen flowmeter

Accidents never occur because of a single factor, but rather when there is a complex interplay of many influences. We postulate that increased pressure in the pipeline of more than 60 psig (because of lesser demand and transient nonfunctioning of the machine regulator and the pressure-release valve owing to dust and dirt), as well as the fully open oxygen needle valve (in the absence of a second-stage regulator and flow restrictor), caused breakage of the oxygen flowmeter (Figure 1).

Abraham AA, MD, DA, Associate Professor
Ghazi I, DA, Postgraduate Student
Department of Anaesthesiology, Yenepoya Medical College, Mangalore, Karnataka, India

Correspondence to: A Abraham, e-mail: jljaa@hotmail.com

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