Case Report

Unanticipated catastrophe during pre-operative routine check of anaesthesia workstation - Water in rotameter

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Abstract

Medical gas production, supply and distribution is a closely regulated process with its intrinsic safety designs and procedure along with this anaesthesia work station designed with utmost safety for delivering anaesthetic gases to patients during the peri-operative period. The ingress of condensed water into anaesthesia machine from central medical gas pipeline can lead to catastrophic incidents.

Keywords: Central supply, gas cylinders, medical air, medical gas pipeline system, oxygen

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INTRODUCTION

Anaesthesia workstation is designed, installed and becomes operable with utmost safety while delivering anaesthetic gases for patients, and this safety is maintained throughout the peri-operative period without fail. The quality and safety features of modern anaesthesia workstations are made to deliver anaesthetic gases with precision and to avoid delivery of hypoxic mixture,[1] but there can still be a possibility in the medical gas distribution system or anaesthesia workstation itself leading to catastrophic results. We report a critical incident on influx of condensed water into rotameter assembly of anaesthesia workstation during routine pre-operative machine check-up.

CASE REPORT

This critical incident of influx of liquid into rotameter assembly occurred while preparing the operating theatre for the day in the morning in a general surgery theatre complex anaesthesia workstation where preoperative routine check-up of anaesthesia delivery workstation was commenced according to the protocol of the Association of Anaesthetists of Great Britain and Ireland 2012 machine checkout recommendations[2] while adhering to guidelines, we faced this incidence of appearance of liquid in rotameter (Figure 1) as the rotameter knob was turned on to check the gas flow for oxygen, gas flow began and bag filled constantly at both high and low flows. Later, rotameter knob of the medical air was opened at low flow the gases started flowing, to our surprise, there was sudden influx of liquid started in the air flow meter (Thorpe's tube) from the needle valve and its level started raising and got filled with liquid, which was simultaneously followed by erratic movement of bobbin which got struck in the rotameter, and thus there was no flow of gases. Immediately, all the central connection

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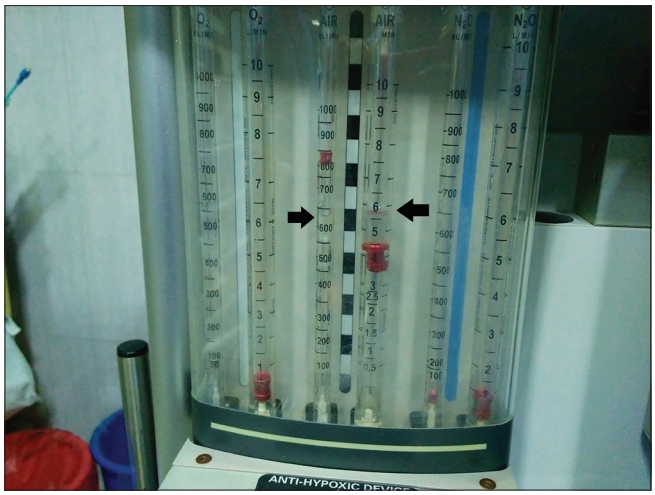

Figure 1: Markers indicating the water level present in Thrope's tube (air column) of workstation

supplies of oxygen, nitrous oxide and compressed medical air were disconnected from its gas wall outlet ports. The gas outlets were inspected, moisture was found at the air outlet and found to be dampened. This critical alarming situation on start of the day was informed to higher authorities and colleagues and emergency was declared, medical gas supply pipeline station was warned regarding the alarming situation in the operating theatre. After disconnecting the workstation from its central gas supplies biomedical engineers were informed about the situation. The biomedical engineers had performed the pipeline purge test of the gas wall outlet leading to water discharge from the central medical gas supply port of medical air (Figure 2). This purging continued with intermittent gas discharge from the wall mount and it was clear that the piped supply line for medical air in the operating theatre had been contaminated with water. To avoid any kind of delay in surgeries in that theatre complex, a standby Boyle's anaesthesia machine (British Oxygen Company India Limited) was used in the theatre uneventfully with cylinders. There was no other similar incidence in any of the other operating theatres.

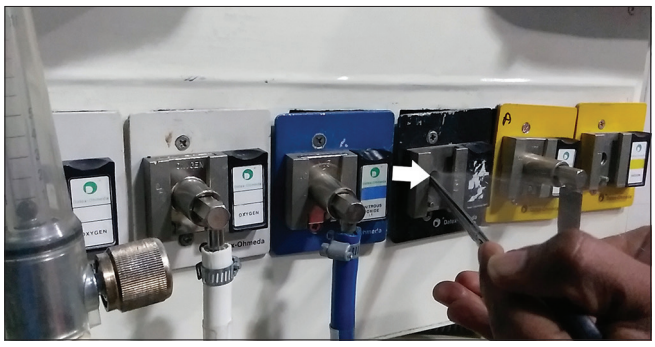

Figure 2: Water being purged from central supply system (arrow)

DISCUSSION

The medical gas distribution systems are made such that it is reliable, safe and bound to National Fire Protection Association requirements[3] and the quality of standards maintained in modern anaesthesia workstation, and its pipeline system reduces errors in delivering medical and anaesthetic gases to the patient.[4] However, still, there can be minimal to major flaws in the medical gas distribution system (central pipeline supply) or anaesthesia workstation itself. To avoid or minimise these flaws, a preoperative functional precheck of workstation are followed as per the protocol every time when used.

Medical Air prepared by three methods: compressed air, synthetic air and cylinder manifolds. Compressed medical air is formed by drawing ambient air into the compressors, medical air compressor system absorbs the atmospheric air and has 2.5 g/m^3–40 g/m^3 of water vapour depending on the climatic conditions and produces compressed air with the help of compressors designed for medical applications. There are three major types of air compressors: (i) centrifugal; (ii) reciprocating; and (iii) rotary screw. The reciprocating and rotary screw is positive displacement type while centrifugal is dynamic type compressor. Compressors provide compressed air to a receiver through a series of filter driers and separators which removes the condensed water, particulate matter and lubricating oil before it enters the pipeline system.[5] The quality medical air should be maintained according to the standards laid by the European pharmacopoeia which restricts to 0.5 mg/cc^3 of particulate oil mist, 5.5 mg/cc^3 of carbon monoxide and 900 mg/cc^3 of carbon dioxide in air for medical use with no moisture. Air drawn into the compressor intake has 2.5 g/m^3–40 g/m^3 of water vapour depending on climatic conditions. After cooler removes the condensed moisture by cooling the air should be free from any bacterial contamination before being delivered.[6] Integral dryers, filters and dew point monitor control the humidity to its allowable limits of 67 mL/m^3 and it must pass odour test and cause no discernible liquid accumulation on stainless steel mirror in testing for water and oil.

On retrospective probing, in our case, it was found that the air dryer was damaged, which usually removes the water at the compressor level in manifold has led to this critical incident (in our hospital, we have medical gas distribution system for medical air with reciprocating compressors and desiccant type of air dryers), along with that air filter in that particular anaesthesia workstation was also damaged leading to this catastrophic incident. Technically, contamination of anaesthetic gases can occur anywhere

from the source point to the delivery system, i.e., from the compressors, distribution system (pipeline) or outlet assembly, anaesthesia workstation. Appearance of water in the rotameter workstation does restrict the functional capacity of the workstation and can jeopardise the safety of patient leading to critical incidents. In our case, water was noticed in rotameter during the preoperative check of the anaesthesia workstation which made us to replace it with Boyle's apparatus with cylinders. Further examination by the biomedical engineer's revealed water in the whole gas supply system − Air tubing's, rotameter and gas pipeline system due to dust and debris accumulation which could be due to failure of air dryer and filters at the central supply and inbuilt metal serrated filter in workstation which was then replaced by the placement of water trap with drain and filter in the air hose. A similar kind of incident was reported where moist air was detected while connecting the hose to the gas wall outlet from compressed air.[7]

Problems to be anticipated in this kind of scenario are shown in Table 1.

Table 1: Problems to be anticipated

Equipment (workstation) damage due to water contamination;
erratic or jammed or no movement of bobbin in the rotameter resulting in inaccurate flow of anaesthetic gases;
influx of water in a rotameter when the anaesthesia workstation is in use can jeopardise patient safety leading to critical incidents;
spillover can possibly lead to hypoxic mixtures being delivered to patient while work station is in use.
Further this can be a source of infection, can freeze or occlude pipeline system.
Other problems include malfunctioning of ventilator (if the air is driving gas) and water condensation in the mechanical, electrical components of the anaesthesia workstation.

In our case report, the issue was detected by observing the liquid in the rotameter; however, this kind of flows cannot be observed in most modern anaesthesia devices with a digital flowmeter working on solenoid valves, therefore, the problem can go unnoticed in the case of the use of a device with a digital flowmeter. Hence, the gas flow system control mechanisms should be present to determine such breakdowns and prevent reach of the fluid to the device.

Preoperative routine check should include anaesthesia workstation check before its utilization for each case, along with periodical check of medical gas pipeline system under the direct supervision of anaesthesiologist to avoid untoward consequences.

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Conflicts of interest

There are no conflicts of interest.

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