Journal of Chemical Health Risks

www.jchr.org

JCHR (2026) 16(1), 2429-2433 | ISSN:2251-6727

Oxygen Cylinder On/Off Valve Stuck Due to Maximum Opening During Cylinder Pressure Checking: A Case Report

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(Received: 05 December 2025 Revised: 15 January 2026 Accepted: 10 February 2026)

KEYWORDS

Oxygen cylinder, Equipment safety, Near-miss event, Anaesthesia, Patient safety

ABSTRACT:

Background: Safe handling of oxygen cylinders is a critical component of anaesthesia practice. Equipment-related near-miss events, although uncommon, may pose significant patient safety risks if unrecognized.

Case description: During routine pressure assessment of an E-type oxygen cylinder of Anaesthesia machine in the operating theatre on a scheduled cleaning day, the cylinder valve was inadvertently opened to its maximum limit, resulting in valve free. No patient was present at the time, and oxygen delivery was not interrupted. The malfunction was identified before clinical use, and the cylinder was safely replaced without further incident.

Conclusion: Although no patient harm occurred. This near-miss highlights an avoidable equipment hazard associated with improper valve handling. Adherence to standardized cylinder opening techniques and staff training are essential to prevent similar incidents and enhance perioperative patient safety.

Introduction

The medical gas cylinders are of different sizes and colour coded. They are checked at regular intervals by the manufacturer using impact, tensile and hydraulic tests. The top part of the cylinder is fitted with an on/off valve with a variety of number and markings stamped on it. Some common valve types include: Pin index valve, bull nose, hand wheel and integral valve. The type of valve different with cylinder size. Small cylinders have a pin index valve while large have a bull nose type. Safety features in the cylinder are: Colour coding, pin index, pressure relief device, Bodok seal, and label attached etc, Safety rules and guidelines regarding cylinders must be followed during storage, installation and use of medical cylinders to ensure safety of patients, hospital personnel and the environment.[1]

Invention of oxygen cylinder was one of the most important developments in the field of medical practice. Cylinders attached to the back of the machine must be present to provide a back-up supply of gases. The gases pass through pressure-regulating valves into the 'back bar' of the machine.

Oxygen has an important role in anaesthesia. Without oxygen supply we can't start operation theatre. So, every operation theatre is equipped

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with gases like oxygen, air and nitrous oxide. Generally, we use centralized pipe line gases for anaesthesia workstation but E-type oxygen cylinder is placed back side of workstation for any emergency when central oxygen supply is failed. so, E-type oxygen cylinder is essential for anaesthesia workstation.

Pin index safety system

It has a unique configuration of holes and pins which match precisely to eliminate connection of the wrong cylinder to equipment, thus prevents delivery of wrong gas to patients. [2,3,4] This system is also used by supplier to fill correct gas in the cylinder.[5] It incorporates two holes in specific positions on the cylinder valve below the outlet port. The cylinder can only be connected to a yoke or pressure regulator with a matching pair of pins. The holes in the cylinder valve accept pins 4 mm diameter by 6 mm long. [3] Unless pins and holes are aligned, the port will not seal and gas will not pass to the anesthesia machine. Each gas or combination of gases has a specific pin arrangement. Pin index valves are fitted in small cylinders which are commonly connected directly to the anesthesia machine. Side spindle pin index valves are fitted in large cylinders of medical O2, air and Entonox for pipeline manifold and to F size Entonox cylinders.[2] Pin index cylinders require a seal between cylinder valve outlet and yoke. The seal is called as Bodok washer. It is a gasket with metal rim manufactured from a non-combustible material.

Case report

As part of our daily routine checklist before starting an operation, we check the oxygen cylinder pressure by turning the cylinder's spindle (knob) counterclockwise with a key. After checking, we turn the spindle (knob) clockwise to turn off the pressure. One day, an anesthesia intern student checked the oxygen cylinder pressure using the routine checklist at the anesthesia workstation. While checking the oxygen cylinder pressure, he turned the cylinder's spindle counterclockwise and checked the pressure, which was fine. Then, he wanted to turn off the cylinder pressure, as is routine with centralized pipeline gases. Confused, he turned the spindle clockwise again to turn it off. After turning the spindle clockwise two or three times, he realized he needed a few more turns to completely turn off the cylinder, so he turned it clockwise a few more times. The oxygen cylinder's spindle then became completely free, and he failed to release the pressure. He then informed his superior and explained what had happened. The superior checked the cylinder's spindle, which was completely free. He wanted to release the pressure but was unable to do so. A jammed valve was then discovered. The affected E-type oxygen cylinder, which was continuously connected to the anesthesia workstation as a backup source, was not immediately replaced. The cylinder assembly consists of three parts: the main part contains the screw and pin index for the cylinder, while the second and third parts contain the spindle and gland nut. The spindle and gland nut are threaded, and a gland nut is installed to lock the spindle. In this situation, the spindle's thread was completely free. A failure of the gland nut could have caused a mishap. Therefore, for safety reasons, he attempted to open the cylinder from the workstation so that it could be transferred to the oxygen plant for inspection. But as soon as they released the yoke assembly nut, oxygen

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JCHR (2026) 16(1), 2429-2433 | ISSN:2251-6727

pressure began to leak rapidly. So, they tightened the yoke assembly nut again. The situation became critical because the spindle was completely free and oxygen was filled at very high pressure. A loose cylinder gland nut could cause a major mishap. There's only one way to empty the oxygen cylinder as quickly as possible, but releasing 100% oxygen into the operating theater could turn the operation theater into a fireball from any spark. Therefore, safely releasing oxygen into the operating theater was crucial. Therefore, they decided to release the oxygen cylinder pressure into the air conditioning outlet through a long circuit (three interconnected breathing circuits). After connecting one end of the long circuit to the workstation and the other to the air conditioning outlet, release the oxygen cylinder pressure by pressing the oxygen flush button switch on the workstation (Figure 1). To ensure safe handling, any remaining oxygen was slowly released by opening the oxygen flush and venting the gas through a pipe into an air-conditioning duct under controlled conditions. Once the cylinder was completely depleted, the cylinder was safely disconnected and replaced with a working backup cylinder. No fatalities occurred during this process. The oxygen cylinder was emptied within minutes. Extra precautions were taken, as no electrical switches were turned on/off while emptying the cylinder, and the operation theatre door was kept open at all times.

Fig-1: **Release the oxygen cylinder pressure into the air conditioning outlet through a long circuit**

Discussion

It is very important to understand that oxygen can be dangerous if not used correctly. Oxygen makes things burn more easily and can even explode. When to change your oxygen cylinder check your pressure gauge often to make sure you don't run out of oxygen. Always check the gauge when the valve is turned on. When the needle gets to the lower part of the red section on the gauge, it is time to change the cylinder. Be sure to change the cylinder before the needle gets below 200 psi. It is important to keep a sufficient supply of full cylinders in your workstation in case of an emergency. It is very important to check the pressure of the oxygen cylinder daily so that oxygen can be provided to patients even if the central supply is unavailable or failed. Table: 1 shows about how long a cylinder will last if you use your oxygen all the time. Use this chart to help you plan when to order more cylinders.

Flow rate (Litre)	Full Tank 2000 PSI	¾ Tank 1500 PSI	½ Tank 1000 PSI	¼ Tank 500 PSI
1/10	100 hours	75 hours	50 hours	25 hours
1/8	83 hours	62 hours	41 hours	20 hours

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¼	41 hours	30 hours	20 hours	10 hours
½	20 hours	15 hours	10 hours	5 hours
1	13 hours	9 hours	6 hours	3 hours
2	5 hours	3.5 hours	2.5 hours	1.1 hours
3	3.4 hours	2.3 hours	1.5 hours	0.7 hours
4	2.5 hours	1.75	1.1 hours	0.5 hours

Table:1 E- type Oxygen Cylinder Use Timeline

We all know that oxygen cylinders have very high pressure and are highly flammable, so we should always check the cylinder pressure very carefully before starting surgery. It is often found that rotating the valve 3 to 4 times/1 cm (fig.3) counter-clockwise makes the full cylinder pressure visible on the anaesthesia machine's pressure gauge. If we rotate the valve too much more then 1-1.3 cm (fig-4), there is a possibility of the spindle getting stuck or free. In case the valve is free or stuck, we should never remove the cylinder from the anaesthesia machine because the cylinder is fully open. If we remove an open cylinder from the machine, any accident can happen due to the high gas pressure. If such a situation ever arises, we should first completely release the gas from the cylinder into the external environment with the help of oxygen flush button and long circuits that attached with each other, and only then should we remove and replace that cylinder from the machine. The removed cylinder should be sent to the gas plant for inspection. The main hazard arises from a large amount of stored energy the cylinders contain due to high pressure of gases, wrong contents, improper maintenance or human error. The hazards have the potential to harm the patients and health care providers. Therefore, proper precaution should be taken and backup plans must be instituted to minimize impact of any hazard.[4]

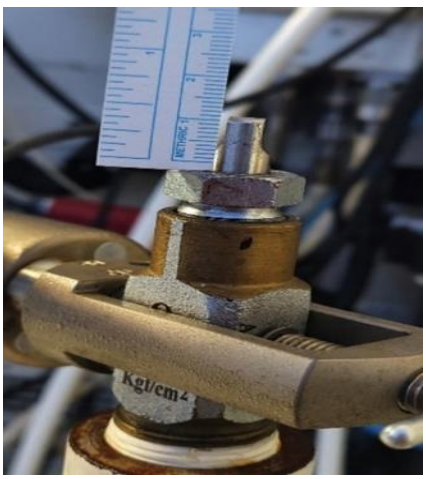

Fig-3: Correct Opening

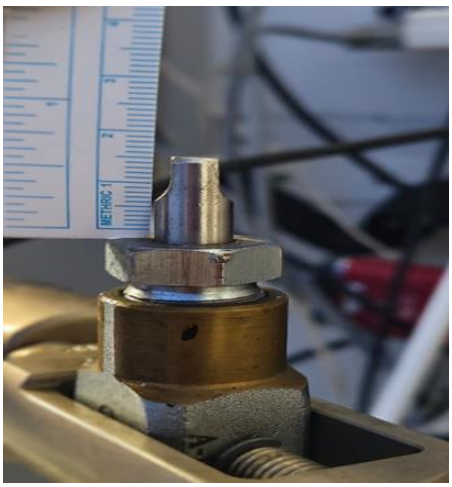

Fig-4: Incorrect Opening

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JCHR (2026) 16(1), 2429-2433 | ISSN:2251-6727

Conclusion

As we know, the pressure in medical gas cylinders is very high, so we should open and close the on/off valve very carefully. When opening the valve, make sure to open it only 0.8 cm to 1.2 cm, which is sufficient for the gas supply. If we open the valve more than 1.4 cm, there is a possibility of the valve becoming loose or stuck.

If such a situation ever arises, we should first completely release the gas from the cylinder into the external environment with the help of oxygen flush button and long circuits that attached with each other, and only then should we remove and replace that cylinder from the machine.

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