CORRESPONDENCE

Low oxygen content in medical air outlets mounted on movable ceiling pendants

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To the Editor,

We recently found that the oxygen concentration in the medical air supplied from the piping system in our newly built operating rooms was markedly low (e.g., < 10%), albeit only briefly and sporadically. Repeated checks conducted on different days and from different outlets revealed that the phenomenon could be observed only from the less frequently (e.g., the first time in several months) used outlets mounted on movable ceiling pendants. The low oxygen concentration (as confirmed by a hand-held oxygen analyzer [XO326-BC, New Cosmos Electric Co., Ltd., Osaka, Japan]) returned to a normal level usually within about ten seconds, although the time required depended on the flow rate during sampling from the outlet. We could not replicate the phenomenon from any of the wall medical air outlets.

In our facility, medical air is produced from ambient air using air compressors. It is not sourced from on-site mixing of oxygen and nitrogen from their liquid sources (i.e., “synthetic air”). The supply pressure of the air entering the operating room suite has been continuously monitored and maintained within a preset range of 46–70 psi (0.32–0.48 MPa) since the opening of our facility.

The piping system manufacturer and medical gas distributor who had participated in constructing our facility investigated the causes of the low-oxygen medical air. They found that the pressurized air is supplied through solid copper piping directly connected to the wall outlets. In the pendants, however, there is an

additional flexible hose that runs through each pendant connecting the copper piping with the pendant outlet (Figure). The flexible hose, which has a 13.5 mm outer diameter and 7.0 mm inner diameter, is composed primarily of resin layers with a braided reinforcement layer. The resin layers are composed of polyvinyl chloride (PVC) and an acrylonitrile butadiene rubber (NBR)/PVC blend, each of which is widely used in the composition of medical gas hoses.

It is well known in the field of polymer chemistry that the gas permeation properties of synthetic resins vary widely depending on the resin. The gas permeation flux through the polymer membrane depends on the gas permeability coefficient, pressure gradient between the two membrane sides, and membrane thickness. One of the drawbacks of PVC is its known gas permeability, which can be reduced by blending NBR with PVC. It is noteworthy, however, that both PVC and the blended material have approximately two- to three-fold greater permeability to oxygen than to nitrogen.¹ This difference in permeability means that oxygen molecules in the hose can permeate through the walls of the hose more quickly than the nitrogen molecules.

Data concerning changes in the oxygen concentration and fill pressure of compressed air over time in an isolated hose with a composition similar to that in the pendant revealed that, over the course of one month, the oxygen concentration decreased from 21% to 13%, and the fill pressure decreased from 61 to 36 psi (0.42 to 0.25 MPa).² Based on these data and the circumstantial evidence, the most likely explanation for the low-oxygen air is that the materials used in the gas hose have greater permeability to oxygen than to nitrogen.

This phenomenon does not seem to be widely known, and it likely has negligible impact on anesthetic

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Figure The differences in the mounting structures for the medical air outlets on the wall and on the movable ceiling pendants are shown. Panel A shows that the terminal portion of the copper piping (painted the colour of the gas it carries) for direct connection with the wall outlets is located immediately behind the wall. (Note that the wall panel was detached to allow for the photograph to be taken.) Panel B

shows the movable pendant with the front panel removed to expose the additional flexible gas hoses that run through the pendant for connecting copper piping with the pendant outlet. It is from this flexible tubing that the oxygen differentially diffused out of the medical air hose, thus reducing the oxygen concentration at the medical air outlet

management because the low oxygen levels are transient. If clinicians discover the low-oxygen air, however, the lack of knowledge regarding gas permeation through the hose might lead to confusion, resulting in an expended effort to identify the cause. Therefore, even though it might not be of great clinical significance, we think it is important for anesthesiologists to be aware of the phenomenon.

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Conflicts of interest None declared.

Editorial responsibility This submission was handled by Dr. Hilary P. Grocott, Editor-in-Chief, *Canadian Journal of Anesthesia*.

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