

Rebreathing Caused by a Plugged Manifold Filter in the Absorber Insert of a Carbon Dioxide Canister

Taylor Dontino, DO, *Jennifer Labrecque, MS-4*, and Carlos J. Lopez III, MD
SUNY Upstate University Hospital Syracuse, New York, USA`



Case Description

The patient, a 55-year-old male, underwent general anesthesia for ablation of atrial fibrillation. Shortly after induction, an inspired carbon dioxide (CO₂) of 21 was noted. The CO₂ canister absorbent was not visually exhausted, and the expiratory and inspiratory valves appeared to be functioning well.

A malfunction between the delivery of exhaled gas to the CO₂ absorber and return to the inspiratory limb was suspected. The patient was placed on total intravenous anesthesia, ventilated by hand, and we inspected the delivery system into the CO₂ canister. It was noted that the fenestrated filter at the top of the insert to the CO₂ canister was plugged with absorbent granules. The insert was removed; the granules were scraped off the insert and then reinserted into the canister with the absorbent. The canister was placed back into the anesthesia machine, and after reinitiating gas flow through the circuit, the inspired CO₂ was down to the usual 0 to 1.

Background

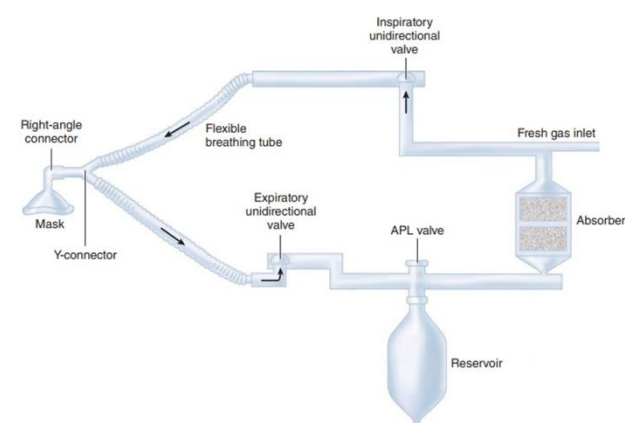
A semi-closed anesthesia machine is a type of anesthesia delivery system that allows partial rebreathing of exhaled gases after CO₂ has been removed. Fresh gas flowing from the anesthesia machine is lower than the patient's minute ventilation, so part of the exhaled gas—after CO₂ absorption through a soda lime canister—is recirculated back to the patient.

Rebreathing CO₂ occurs when a patient inhales previously exhaled gases containing CO₂ that had not been removed, and thus it can lead to hypercapnia. One possible cause of rebreathing CO₂ in a semi-closed anesthesia system is a plugged manifold filter in the CO₂ absorber.

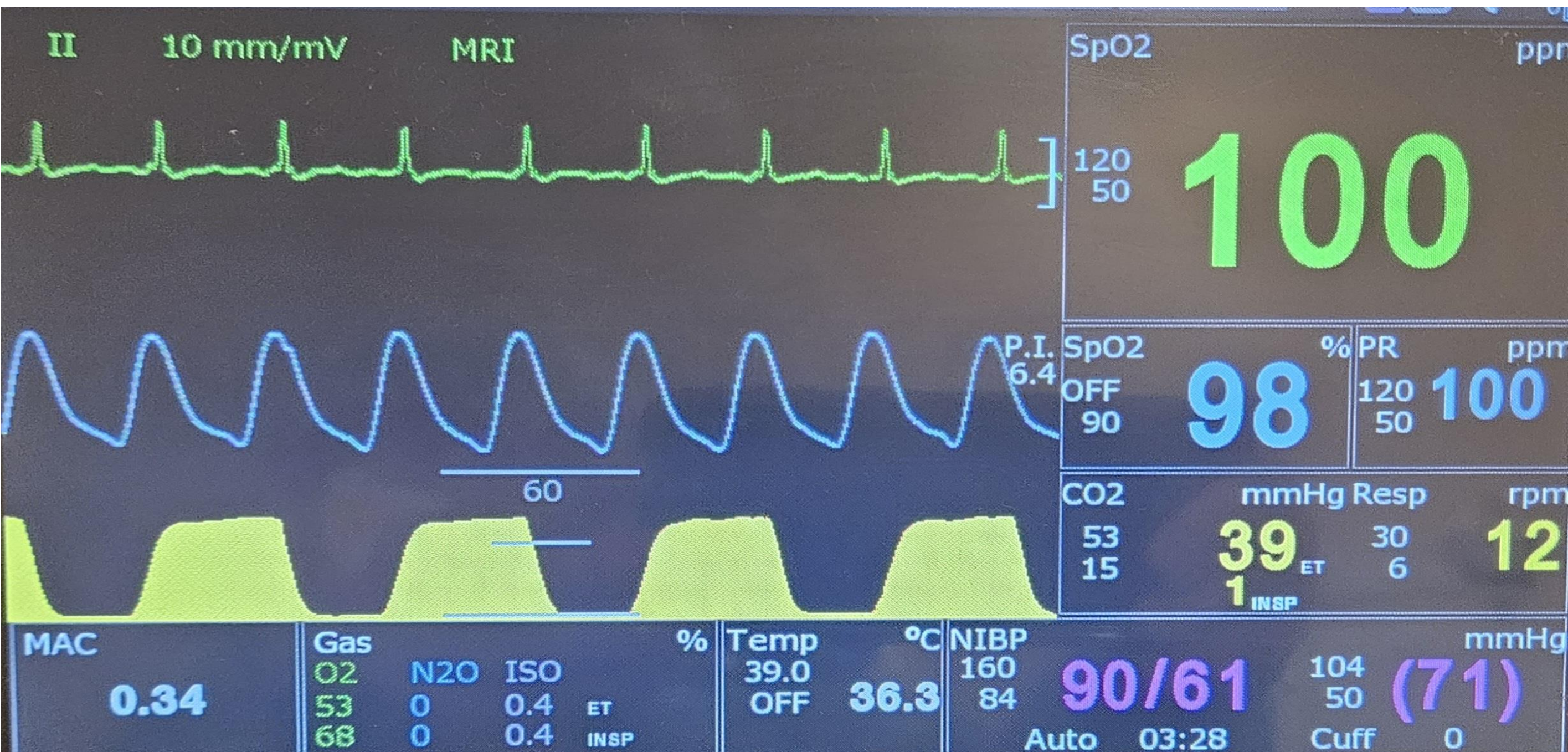
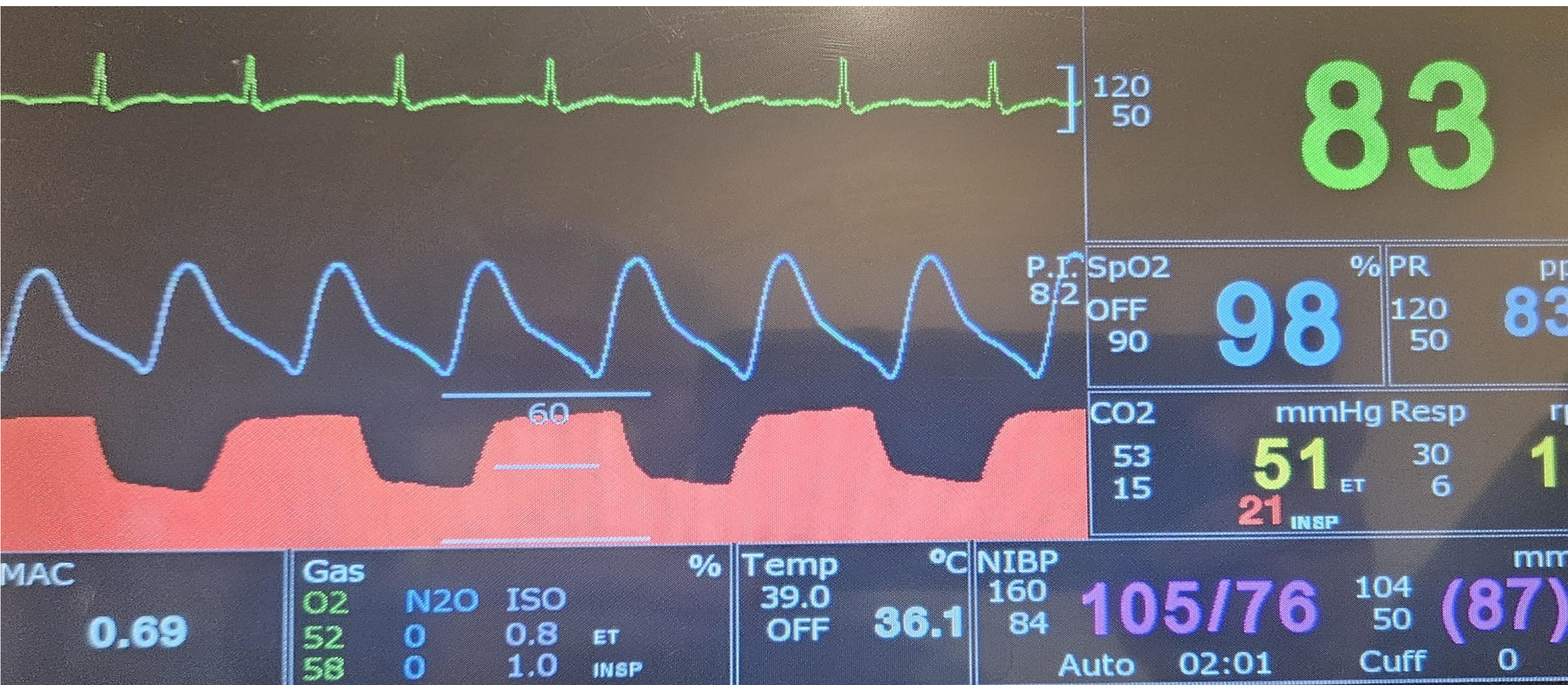
The manifold filter is designed to prevent dust or soda lime particles from entering the channel in which exhaled gas eventually percolates. However, if this filter becomes obstructed, it restricts gas flow through the absorber canister, preventing proper passage of exhaled gases through the soda lime. As a result, CO₂ is not adequately absorbed, and the exhaled gases—still rich in CO₂—are redirected back into the inspiratory limb of the circuit. Clinically, this results in a rising inspired CO₂ level, an increase in end-tidal CO₂ (ETCO₂), and potentially tachypnea, hypertension, or arrhythmias in the patient.

Learning Objective

Causes of rebreathing extend beyond exhausted CO₂ absorbers and faulty expiratory and inspiratory valves. Knowing how the different anesthesia breathing circuits are set up is critical for troubleshooting malfunctions.



Monitor & Manifold



Discussion

The detection of carbon dioxide rebreathing, as indicated by end-tidal readings, is critical information since carbon dioxide can be harmful. In a modern anesthesia semi-closed circuit, which is a circle system, the carbon dioxide absorbent canister with its carbon dioxide absorbent, the expiratory valve, and the inspiratory valve are features that minimize rebreathing.

Exhausted carbon dioxide leads to rebreathing when the absorbent can no longer neutralize it, and as such, manufacturers add an indicator dye to the system that changes color when the absorbent is exhausted. Faulty expiratory and inspiratory valves can result in rebreathing when they fail to shut during their inspiratory and expiratory phases, respectively. This can occur due to condensation within the system, and manufacturers often provide visual windows into the valves for quick inspections.

In this case, we show how the cause of rebreathing was due to the inability of the exhaled gas to go down the central part of the carbon dioxide insertion tube to the bottom of the canister and subsequently percolate upwards through the carbon dioxide absorbent and then feed into the inspiratory limb. The exhaled gas here was inadequately neutralized and fed straight into the inspiratory limb. This malfunction could have been prevented with proper maintenance and cleaning of the anesthesia machines.

Summary / Conclusion

This case demonstrates the importance of consistent servicing and routine maintenance of the anesthesia machines. The manifold filter was plugged with absorbent granules. This prevented CO₂ from being adequately absorbed, and thus exhaled gases with high amounts of CO₂ were able to be sent through to the inspiratory limb, causing hypercapnia.

References

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