

Override of an N₂O/O₂ machine fail-safe mechanism: case report

Curt Goho, DDS Paul Kittle, DDS

Introduction

Nitrous oxide-oxygen (N₂O/O₂) sedation is used widely in pediatric dentistry, partly because of its relative safety (Duncan and Moore 1984). The primary danger inherent in N₂O/O₂ use is hypoxia. Fail-safe mechanisms on the delivery machines are designed to prevent hypoxia by ensuring a minimal oxygen flow, thus limiting the amount of nitrous oxide that can be given. Clinical N₂O/O₂ machines are limited to either a 50% N₂O/50% O₂ or an 80% N₂O/20% O₂ delivery. Another fail-safe mechanism halts the delivery of nitrous oxide if oxygen flow stops. Pin indexes on the cylinder head and machine portal prevent the accidental attachment of a nonoxygen cylinder to the oxygen attachment portal.

Despite safety systems, incidents of hypoxia have been reported involving incorrect equipment installation (e.g., wall delivery unit pipes cross connected, Lebourdais 1974) or equipment damage (e.g., loss of pins from the index system, Upton and Roberts 1977). This report documents the override of properly maintained, fully functional safety systems on a portable nitrous oxide-oxygen delivery machine.

Case Report

Immediately before sedating a patient with N₂O/O₂, nitrous oxide tanks were discovered securely attached to both the nitrous oxide and oxygen portals of the delivery machine. All N₂O/O₂ settings, including 100% oxygen flow, resulted in the delivery of 100% nitrous oxide.

Fail-safe mechanisms were functioning properly and the pin index system was intact. However, two washers — instead of a single plastic washer — were present between the gas cylinder head and the machine attachment portal. This “double washer” moved the nitrous oxide tank away from the pin-index system, and the pins did not engage the holes of the cylinder head. However, the gas portals on the machine and cylinder head were patent and connected securely (Fig 1).

Discussion

Several safety issues are noted in this incident, primarily complacent acceptance of any fail-safe devices.

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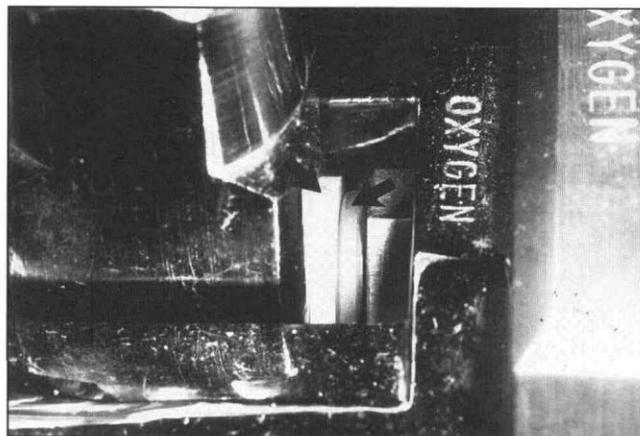


Fig 1. Override of the pin-index system due to two washers (arrows) between the N₂O cylinder head and the machine oxygen portal.

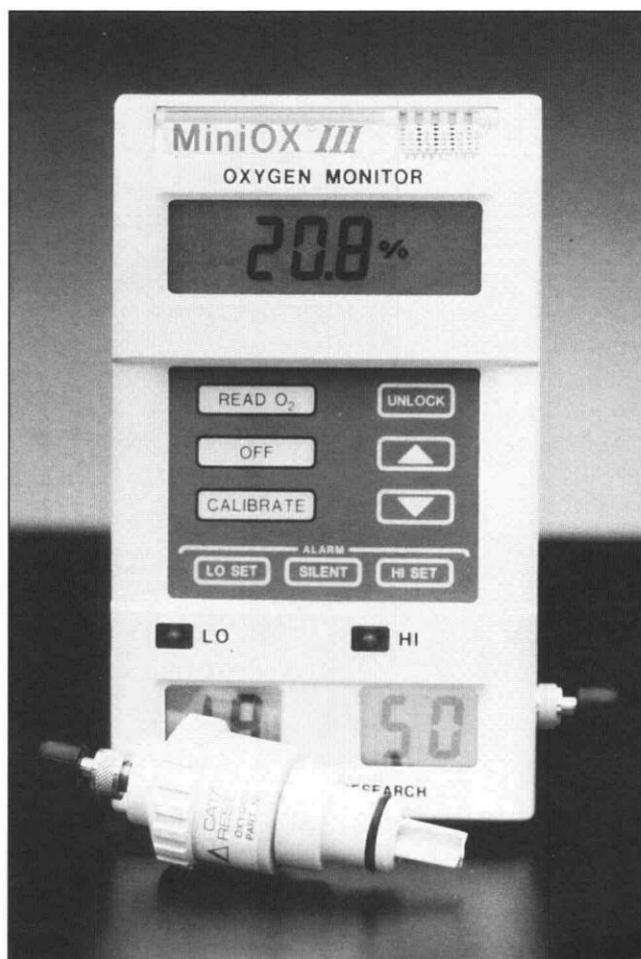


Fig 2. Representative portable qualitative oxygen monitor and sensor for in-line monitoring on N₂O/O₂ delivery machines (MSA Catalyst Research, Owings Mill, MD).

Even functional, well-maintained safety devices can be overridden accidentally. This incident indicates the need to ensure that attachment portals are free of foreign objects. E-type gas cylinders often come from the supplier with plastic washers on the cylinder heads. When an empty tank is removed from the machine, the washer may remain on the machine portal. When a new tank, also with a washer, is attached to the machine, two washers lie between the cylinder head and the machine attachment portal, circumventing the pin index and allowing the attachment of any gas cylinder to the oxygen portal. During attachment of a new cylinder, the machine should be examined to ensure that only one washer is present.

N₂O/O₂ machine safety mechanisms evaluate gas flow quantity — not oxygen quality. Any gas entering the oxygen portal provides a positive flow through the oxygen circuit safety mechanism. The machine “assumes” that the gas flowing through the oxygen portal is oxygen. This oversight suggests that qualitative oxygen monitoring should be incorporated into N₂O/O₂ machines. Battery operated oxygen sensors utilizing a

microprocessor and a galvanic sensor to monitor oxygen concentration can be inserted into N₂O/O₂ machine tubing with a “T” adaptor (Fig 2). Qualitative oxygen monitoring reduces the likelihood of erroneous delivery of another gas through the oxygen lines.

This incident proves that no safety system is perfect and diligent examination of equipment before use is essential to guard against human error. In-line qualitative oxygen analysis of the gases delivered through N₂O/O₂ machines is now available, and its use on all N₂O/O₂ delivery machines would safeguard our patients.

Major Goho was a resident and Lieutenant Colonel Kittle is assistant director, Pediatric Dentistry, Fort Lewis, WA.

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