Title: Anesthesia Machine Oxygen Analyzer Error Margins

Presenting Author: James Xie[1], MD (Email: jxie@stanford.edu; Twitter: @JamJX)
Co-Author: R J Ramamurthi[1], MD FRCA
1: Stanford University School of Medicine, Stanford Children's Health

Introduction: Inspired oxygen concentration analysis is a cornerstone of safe anesthesia delivery[1]. Anesthesia machines use O2 sensors that convert current flow to a proportional O2 concentration readout. At our institution we use Dräeger Apollo and Perseus anesthesia machines (Lübeck, Germany) which have a baseline +/- 2.5% error margin for O2 measurement[2, 3].

Methods: Each machine had a full checkout test performed prior to testing. A MaxO2 ME oxygen analyzer device (Maxtec, Salt Lake City, UT) was calibrated with 100% O2 in the same room as the machines immediately prior to testing. All three analyzers use galvanic cell technology. The machine's adjustable pressure limiting valve was fully closed and the oxygen analyzer was attached via a tee-piece adaptor to the Y-piece of the anesthesia circuit. Testing was performed with the end-piece of the analyzer open to room air unless otherwise noted. A minimum of 3-minute equilibration time was allowed to elapse or until O2 analyzer readout was no longer changing prior to measurement.

Results: Table 1 summarizes the differences in O2 concentrations measured by each anesthesia machine's built-in analyzer vs the external analyzer. Neither machine reported an O2 concentration of higher than 98%, regardless of flow rate of 100% O2. At lower flows, both machine's built-in analyzers and external analyzer O2 readings began to decrease.

Discussion: As our empirical testing demonstrates, the anesthesia machine's built-in oxygen analyzer reported oxygen concentration has a flow dependent difference compared to measurements made by an independently calibrated oxygen analyzer at the Y-piece. Accurate measurement of inspired oxygen concentration is important in a variety of clinical scenarios: lower FiO2 may be desired when risk of airway fire is high[4] (e.g., use of electrocautery or laser), avoidance of oxidative stress (e.g., to avoid retinopathy of prematurity in neonates), and an accurate measure of FiO2 is critical for safe use of low flow anesthesia[5]. Higher FiO2 may be desired in patients with poor oxygenation (e.g., ARDS) or requiring additional reserve (preoxygenation). Clinicians should be aware that there is a margin of error of measurement in the anesthesia machine's built-in oxygen analyzer and titrate flows appropriately based on desired clinical effect. Additionally, the measured oxygen concentration is flow dependent and can be influenced by dilutional effects. It may be of value to compare other makes and models of anesthesia machines in their range of accuracy to monitor FiO2 at different clinically relevant flow rates.

Table 1: Comparison of anesthesia machine's built-in O2 concentration measurements vs external oxygen analyzer measurements with 100% O2 at varying flows

O2 Flow (L/min)	Dräeger Apollo O2 (%)	O2 at Y-Piece (%)	Dräeger Perseus O2 (%)	O2 at Y-Piece (%)
15, circuit fully occluded	-	-	98	100
8	98	100	97	100
4	98	99.8	96	99
2	98	99.5	94	96
1	98	99.0	95	96
0.5	97	98.4	94	95
0.2	96	96	92	82
0.2, circuit fully occluded	-	-	93	96

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