Sodalime Absorber versus Membrane CO_2 Filter Performance during Automated Closed-Circuit Anesthesia: A Case-Report

Co-Authors: S.A. Eerlings, M.D.[1,2], R. Carette, M.D.[1,2],G. Vandenbroucke, M.D.[1],
A. M. De Wolf, M.D. [3,] J. F.A. Hendrickx, M.D., Ph.D.[1]
Depts. of Anesthesiology of the OLV Hospital, Aalst, Belgium[1], KU Leuven, Leuven, Belgium[2],
and Feinberg School of Medicine, Northwestern University, Chicago, IL, USA[3]

Introduction: Sodalime CO_2 absorbents are safe but not ideal for reasons of ecology (production and disposal), ergonomics (need to refill or replace), economy (discarded before used to full potential), and dust accumulation in sensitive machine parts. These issues are absent with the Memsorb™ (DMF Medical, Halifax, NS, Canada), a new device for gas-to-gas exchange and separation that uses technology similar to oxygenator membranes for cardiopulmonary bypass machines: the sweep flow determines CO_2 removal, and the sweep gas O_2 concentration the O_2 transfer across the fiber wall (which depends on the prevailing O_2 gradient across the fiber wall.) We present a case report in which we alternated the Memsorb™ with sodalime absorbent (Drägersorb 800+) during target-controlled closed-circuit anesthesia (TCCCA) with desflurane in O_2/air with the Zeus IE (Dräger, Lübeck, Germany).

Materials and Methods: IRB approval and written informed consent were obtained in a 75 year old ASA PS III patient (73 kg, 164 cm) undergoing robotic abdominal wall hernia repair. After induction of anesthesia and intubation of the trachea, TCCCA with the Zeus IE was used with the following settings: target inspired O_2 (F_IO_2) 39% in O_2/air; target end-expired (F_A) desflurane 4.2%; controlled mechanical ventilation, adjusted to F_ACO_2 5.2-5.8%; and 5 cmH_2O PEEP. An O_2/air blender (Scanatron Technics, Affoltern-am-Albis, Switzerland) delivered the sweep gas (40% O_2) to the inlet of the Memsorb™ canister. Sweep O_2% was set 1% above target F_IO_2. The sweep flow was titrated to keep $F_ICO_2 \leq 0.8\%$. Forty minutes after applying the CO_2 pneumoperitoneum (CO_2PP), a Drägersorb800+ canister was inserted for 30 min, after which the Memsorb™ was inserted for the remainder of the procedure (see Figure 1). RUGloop (DEMED, Temse, Belgium) collected the following data: F_IO_2, $F_A$desflurane, F_ICO_2, F_ACO_2, minute ventilation (MV); O_2 and air FGF; sweep flow; and cumulative desflurane usage (Vdes). A linear curve fit to the cumulative Vdes data during the last 50 min of the first Memsorb™ period, the 30 min Drägersorb800+ period, and the second (and final) Memsorb™ period. The initial maintenance phase (0-25min) and the first few min after changing the CO_2 scrubbers were excluded from analysis. Losses of O_2, CO_2, desflurane and N_2 (calculated as balance gas) from the Zeus' exhaust prior to switching to the Drägersorb800+ gases were calculated by measuring the amount of exhausted gases collected for 15 min into a 6 L breathing bag (volumetrically with 250 mL glass syringes) and by analyzing the gas content (M-CAiOV, GE, Madison, WI, USA).

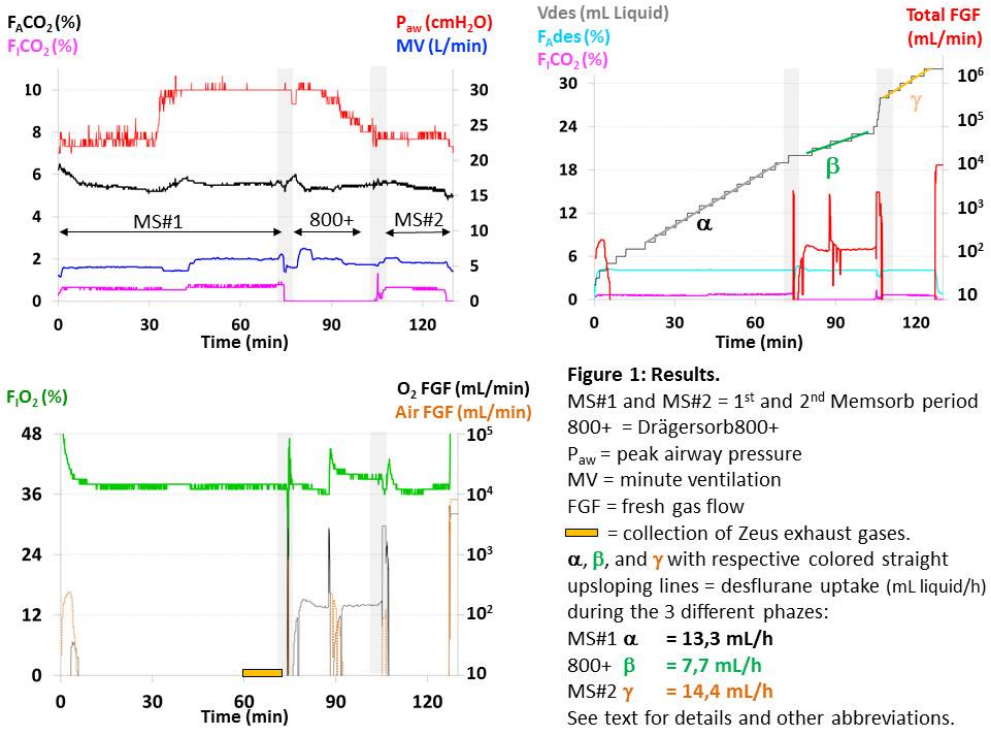

Figure 1: Results.
MS#1 and MS#2 = 1st and 2nd Memsorb period
800+ = Drägersorb800+
P_{aw} = peak airway pressure
MV = minute ventilation
FGF = fresh gas flow
= collection of Zeus exhaust gases.
α, β, and γ with respective colored straight upsloping lines = desflurane uptake (mL liquid/h) during the 3 different phazes:
MS#1 α **= 13,3 mL/h**
800+ β **= 7,7 mL/h**
MS#2 γ **= 14,4 mL/h**
See text for details and other abbreviations.

Results: See Figure 1.
$F_A$desflurane and F_IO_2 targets were maintained within a very narrow range. Liquid Vdes during TCCCA was higher with Memsorb™ (13.3 and 14.1 mL/h during the first and second run, respectively) than with Drägersorb800+ (7.7 mL/h). FGF was zero with Memsorb™ and 156 mL/min O_2 with the Drägersorb800+. Using the Memsorb™, a total of 162 mL/min gas lost via the Zeus' exhaust consisted of 52 mL/min O_2, 1.6 mL/min CO_2, 4.9 mL/min desflurane vapor (= l.4 mL liquid/h) and 104 mL/min N_2. This suggests 156+52 = 208 mL/min O_2 is transferred from the Memsorb™ to the breathing system (under the prevailing study conditions and assuming minimal leaks). Of the extra amount liquid desflurane used during Memsorb™ use (13.3-7.7=5.6, and 14.1-7.7=6.4 mL/h during run 1 and 2, respectively), 4.2 (=5.6-1.4) to 5.0 (=6.4-1.4) mL/h were lost via the Memsorb™ exhaust (approximately 1 mL/h liquid per 1% $F_A$desflurane). F_ICO_2 was 0 with Drägersorb800+ and ranged between 0.5-0.8% with Memsorb™ with the use of sweep flows ranging from 15 to 23 L/min.

Discussion: During TCCCA, Memsorb™ removes CO_2 well under conditions of high CO_2 elimination (adult patient with prolonged CO_2PP). The small increase in F_ICO_2 is inconsequential because its effect on F_ACO_2 can easily be overcome by a small increase of minute ventilation. The amount of O_2 transferred from the Memsorb™ to the circle breathing system sufficed to cover patient O_2 consumption. Approximately 1 mL/h liquid per 1% $F_A$desflurane is lost via the Memsorb™, with an additional small amount lost via the Zeus exhaust due to O_2 and N_2 transfer in excess of patient uptake from the Memsorb™ into the breathing circle.