In Vitro Performance of CO_2 Absorbents

Presenting Author: Jan FA Hendrickx, M.D., Ph.D., OLV Hospital, Aalst, Belgium

Co-Authors: Yan Jiang, M.D., Chongqing University Cancer Hospital/Chongqing Cancer Institute/Chongqing Cancer Hospital, Chongqing, China, Hongliang Liu, M.D., Chongqing University Cancer Hospital/Chongqing Cancer Institute/Chongqing Cancer Hospital, Chongqing, China, Geert Vandenbroucke, M.D., OLV Hospital, Aalst, Belgium, Jan Poelaert, M.D., Prof., VUB University, Brussels, Belgium, Andre AM De Wolf, M.D., Prof., Northwestern University, Chicago, IL, USA

Goals: CO_2 absorbent that scrubs CO_2 from rebreathed gas during low flow anesthesia is provided either as loose fill (to be used in refillable canisters) or in prepacked, disposable, and machine specific plastic canisters (prepacks). The absorbent contained in the canister (prefilled or refillable) is considered exhausted once the inspired CO_2 (F_ICO_2) reaches 0.5%. The performance of (CO_2 absorbent in) prepacks of different brands for 2 different anesthesia machines has recently been tested in vitro under standardized conditions [1,2]. However, the results of these studies cannot be used to directly compare the performance of the absorbent of the different brands per se because different canisters contain different amounts of absorbent and because the type of anesthesia machine and canister shape are confounding factors affecting performance themselves. We therefore compared CO_2 absorbent performance of 9 different brands of $Ca(OH)_2$ based absorbents using the same anesthesia machine and the same refillable canister in identical CO_2 loading conditions.

Methods: Nine absorbents (Table 1) obtained from either jars containing loose fill or from opening prepacks were tested as follows. A plastic cup (200 mL, measured by H_2O displacement) weighing 2.5 mg was filled with each absorbent and weighed (Mettler Toledo XP1002 Columbus, OH; accuracy 10 mg), and the weight (g) per 100 mL calculated. Next, the absorbent was poured into a refillable canister (700 mL internal volume) that was weighed before and after filling it up to determine the weight (g) of fresh absorbent; the volume of fresh absorbent was calculated using the weight/100 mL volume data. One brand, the SpiraLithCa, was tested in a separate plastic canister specifically molded for the product because it cannot be fitted into the other canister by nature of its composition, i.e. a synthetic polymer binder sheet (13.0 g) coated with absorbent wrapped around a central plastic hollow core (9.2 g), resulting in a cylinder bloc (cartridge) with preformed longitudinal channels. The filled canister was placed in a circle breathing system of an ADU anesthesia machine (GE, Madison, WI) that ventilated a 2L bag; 160 mL/min CO_2 (flow meter accuracy 2 mL/min; MEDEC, Aalst, Belgium) flowed into its tip. Tidal volume was 500 mL, rate 10/min, I:E 1:1, and fresh gas flow 300 mL/min O_2/air (60% O_2). Gases sampled by the gas analyzer (M-CAiOV module (GE, Madison, WI) were redirected into the expiratory limb. For each product, 4 test runs (all of the same lot) were performed; the study ended when F_ICO_2 had reached 0.5% (defined as exhaustion). ANOVA was used to compare average CO_2 inflow, time to exhaustion, time to exhaustion per 100 g, and time to exhaustion per 100 mL of product, with $p < 0.05$ denoting a significant difference. Results are expressed as average (standard deviation).

Results:

Table 1. One FLOW-i test was deleted (CO_2 inflow too low).

Product	LithoLyme	LoFloSorb	SoLo	Draegersorb Free	SpiraLithCa	Spherasorb	Sofnolime	FLOW-i	Draegersorb 800+	Statistics
Manufacturer	Allied Healthcare	Intersurgical	Molecular Products	Draeger	MicroPore	Intersurgical	Molecular Products	Molecular Products	Draeger	
NaOH content	LiCl	+	+	+	+	+++	+++	+++	+++	
Granular shape	broken cylinders, heteromorph	round pellets	broken cylinders, heteromorph	disc	wrap with preformed channels	round pellets	broken cylinders, heteromorph	broken cylinders, heteromorph	disc	
Number of test run	4	4	4	4	4	4	4	3	4	
CO2 inflow (mL/mi	161 (1)	161 (3)	161 (1)	160 (1)	162 (1)	161 (2)	161 (1)	162 (2)	161 (2)	A
Fresh volume (mL)	691 (26)	687 (7)	689 (21)	709 (12)	1069	686 (18)	721 (12)	684 (2)	702 (5)	B
Fresh weight (g)	464 (17) ∏	461 (5) ∏	444 (13) ∏	544 (9) * ##	808 (6)	517 (14) ❣	561 (9) v *	529 (2) ## ❣	578 (4) v	C
Min per 100 g until FICO2 = 0.5%	88 (4)	75 (3)	92 (9)	89 (3)	110 (3)	92 (1)	99 (2)	108 (2)	110 (0)	D
Min per 100 mL until FICO2 = 0.5%	59 (3) †	50 (2)	59 (5) †	69 (2) §	83 (2) ¶	69 (0) §	77 (1)	83 (2) ¶	90 (0)	E

Table 1. Study results
A: no difference between groups
B: SpiraLithCa differs (by study design)
C: all differ EXCEPT those with identical symbol beneath them
D: see inserted grid - the symbol ≠ indicates they differ
E: all differ EXCEPT those with identical symbol beneath them

	LithoLyme	LoFloSorb	SoLo	Draegersorb Free	SpiraLithCa	Spherasorb	Sofnolime	FLOW-i	Draegersorb 800+
LithoLyme		≠			≠		≠	≠	≠
LoFloSorb	≠		≠	≠	≠	≠	≠	≠	≠
SoLo		≠			≠			≠	≠
Draegersorb Free		≠			≠		≠	≠	≠
SpiraLithCa	≠	≠	≠	≠		≠	≠		
Spherasorb		≠			≠			≠	≠
Sofnolime	≠	≠		≠	≠				≠
FLOW-i	≠	≠	≠	≠		≠			
Draegersorb 800+	≠	≠	≠	≠		≠	≠		

Conclusions: CO_2 absorbents differ in the time until they exhaust. Results differ depending on whether time until exhaustion is calculated on a per weight or per volume basis. NaOH content and granular shape affect the time until exhaustion.

References

[1] J Clin Mon Comp, 2016, 30:193-202 [2] J Clin Monit Comput, 2017, Dec 13. doi: 10.1007/s10877-017-0088-x. [Epub ahead of print]