Low, Minimal and Metabolic Anesthesia Using a Novel Membrane Technology Instead of Chemical Absorbents for Carbon Dioxide Removal – Clinical Data

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Background: Lowering fresh gas flow (FGF) rates in anesthesia circuits reduces the gas volumes vented to the environment.[1] This effort is rapidly gaining importance due to increasing pressure to (a) save cost and (b) decrease the environmental footprint of anesthesia practice, both achievable by lowering FGFs.[1]

While *low-flow* (≤1.0 Lpm), *minimal-flow* (≤0. 5 Lpm), and *metabolic-flow* (≤0.35 Lpm) anesthesia practices have long been technically feasible using chemical absorbents, membrane technology promises a host of advantages including improved simplicity, reliability, safety, environmental stewardship and cost.[2,3] In addition, membrane technology eliminates the concerns that have resulted in vapor manufacturers' recommended minimum FGF rates of 1-2 Lpm (country dependent).[4,5] Last but not least, membrane technology has the ability to automatically satisfy the metabolic oxygen need of any patient simply based on concentration gradient-mediated transmembrane gas transport, eliminating the need for a FGF to maintain a target FiO_2.

Objective: This study aims to investigate the safety and feasibility of using a membrane technology-based product, (memsorb™, DMF Medical Inc., Halifax, NS, Canada) instead of chemical absorbers under *low-flow*, *minimal-flow,* and *metabolic-flow* conditions for carbon dioxide removal. Memsorb™ is designed to function continuously over 10-12 months, significantly reducing (i) absorber waste (ca. 300 absorbers/ year), (ii) carbon footprint from absorber transportation, (iii) cost of storage and disposal, and (iv) safety concerns associated with eliminating dust and other chemical reactions with absorber use and disposal.

Methods: After REB approval, memsorb™ was tested in 129 patients replacing the chemical absorber on Fabius® machines (Dräger, Lübeck, Germany) while standard general anesthesia was practiced using vapors. The flush gas for memsorb™ was set to 15 Lpm and its Air:O_2 ratio was adapted to match the target oxygen concentration of the anaesthesia system. Cases with FGF ≤ 1.0 Lpm were selected and divided into low, minimal, and metabolic FGF groups. Vapor consumption was determined using photo-volumetric analysis of the fill degree on the vaporizer.

Results: As main result the $EtCO_2$ value for each FGF group divided into sevoflurane and desflurane cases are shown in Table 1. The consumption of vapor was investigated under different fresh gas flows.

Table 1. Study results.

FGF Group	FGF [median (SD)]	Agent	N	$EtCO_2$ [median (SD)]
Low ≤ 1.0 Lpm	0.78 (0.14) Lpm	Sevo	23	4.89 (0.46)
		Des	9	4.96 (0.47)
Minimal ≤ 0.5 Lpm	0.43 (0.05) Lpm	Sevo	4	5.13 (0.46)
		Des	5	5.44 (0.32)
Metabolic ≤ 0.35 Lpm	0.21 (0.05) Lpm	Sevo	6	5.83 (0.18)
		Des	4	5.12 (0.52)

Conclusions: memsorb™ showed physiologically safe $EtCO_2$ data under all studied conditions. This confirms that memsorb™ provides a safe and valid alternative to chemical-based absorbents, while also reducing the environmental impact of CO_2 removal.

Conflict of Interest: Dr. Schmidt is the Founder, Chief Medical Officer and major shareholder for DMF Medical without remuneration. Dr. Roach is the President and major shareholder of DMF Medical. Dr. Wilfart is a Director and shareholder of DMF Medical. Mr. Ford reports personal fees from DMF Medical. Dr. Orlando Hung has independently run this study and recorded the data as principal investigator and reports no conflict of interest.

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