Title: Application of a valveless anesthesia circuit for deep diving

Authors: Zwingelberg, KM
Jaeger, MJ

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Abstract: The Mapleson E breathing circuit used in anesthesia has no valves or CO2-absorbent canisters and thus entails low resistance to breathing and has low requirements for fresh gas flow (FGF). The authors investigated whether these advantages would make a circuit, modified for hyperbaric use, able to support ventilation during heavy work on the surface and at deep depths with reduced FGF rates. The current recommended FGF for free-flowing diving circuits is 170 liters/min. Six Navy divers participated in 10-min graded exercise sequences, peak workload 220 W. Measurements were made of inspired and end-tidal concentrations of CO2, tidal volume, respiratory rate, and CO2 production at both sea level and 2.7 MPa dry environment. At sea level, all six divers were able to finish their exercises using the modified circuit with all tested rates of FGF. At 2.7 MPa the exercise sequence could be finished by all subjects when FGF was 170 liter/min and by five subjects when FGF was 127.5 liter/min, but high end-tidal CO2 measurements and hypercapnia symptoms were common at 127.5 liter/min. None of the subjects was able or allowed to finish the exercise sequence when FGF was 85 liter/min. Lower work-loads of 75 and 150 W for up to 4 min were completed easily by all subjects at all three rates of FGF. We conclude that this circuit concept warrants further study

because it requires lower FGF than is currently used with open-circuit helmets and is valveless; how much of a reduction in FGF could be tolerated with heavy work at depths such as 2.7 MPa requires further study.

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