

# Cerebral Oxygenation and Neurological Problems During Prolonged Breath-Holds



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## Abstract

### CEREBRAL OXYGENATION AND NEUROLOGICAL PROBLEMS DURING PROLONGED BREATH-HOLDS

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**BACKGROUND:** Competitive breath-holding (Static Apnea) is practiced in swimming-pools around the world. Neurological problems such as loss of motor control (called "Samba") are sometimes seen during training and competition. Noninvasive near-infrared spectroscopy has been used to monitor cerebral hypoxia in different hypoxic conditions (1,2) but, to date, there are no data on cerebral oximetry in competitive breath-hold divers. This study looks at cerebral oximetry during hypoxia induced by prolonged breath-holding, and its relationship to neurological signs and symptoms.

**MATERIALS AND METHODS:** After 2 warm-up breath-holds, four competitive breath-hold divers (one female and 3 males) performed up to 3 prolonged breath-holds at large lung volumes, with (wet) and without face immersion (dry) in cool water. Regional brain hemoglobin oxygen saturation was recorded from each side of the divers' forehead (R and L) using near-infrared spectroscopy (Invos 5100, Somanetics), while neurological sign and symptoms were recorded.

**RESULTS:** Duration of breath-holds in the 4 divers ranged from 176 to 366 s and from 173 to 366 s, in dry and wet condition respectively. No difference was seen in rate of cerebral oxygen desaturation between dry and wet breath-holds. Facial twitching and 2 episodes of fainting were noted at following levels of cerebral oxygenation: 0% R and 33% L and; 45%R and 51%L; 37%R and 40%L.

**CONCLUSIONS:** This study suggests that neurological signs and symptoms during breath-holding occur when cerebral oxygen saturation falls below 45%. However, the effects of carbon dioxide in the arterial blood and immersion of the diver's body on near-infrared spectroscopy need to be studied, before the use of this monitor can be advocated to prevent neurological problems during breath-holding.

**References:** 1) Hadolt I, Litscher G. Noninvasive assessment of cerebral oxygenation during high altitude trekking in the Nepal Himalayas (2850-5600 m). *Neurol Res* 2003; 25:183-8. 2) Pollard V et al. Validation in volunteers of a near-infrared spectroscope for monitoring brain oxygenation in vivo. *Anesth Analg* 1996; 82:269-77.

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## Materials and Methods

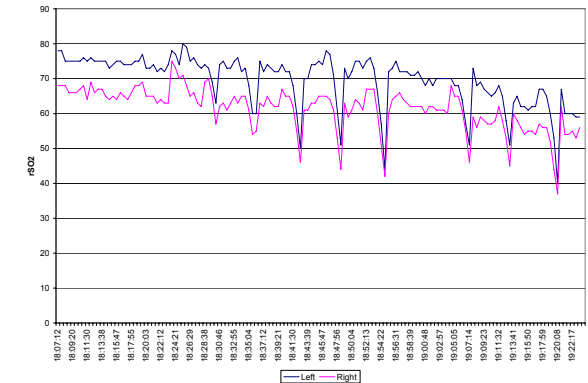
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## Results

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**Fig. 1.** One of our subjects, getting ready to start a breath-hold, with bilateral electrodes on his forehead used to record regional brain hemoglobin oxygen saturation.



**Fig. 2.** Tracings of cerebral oxygen saturation, recorded from right and left forehead of one of our subjects. Starting from the left of this graph, the troughs correspond to 2 warm-up breath-holds, followed by 3 dry and then 3 wet breath-holds.

## Conclusions

This study suggests that neurological signs and symptoms during breath-holding occur when cerebral oxygen saturation falls to or below 45%. However, the effects of carbon dioxide in the arterial blood and immersion of the diver's body on near-infrared spectroscopy need to be studied, before the use of this monitor can be advocated to prevent neurological problems during breath-holding.

## References

- 1) Hadolt I, Litscher G. Noninvasive assessment of cerebral oxygenation during high altitude trekking in the Nepal Himalayas (2850-5600 m). *Neurol Res* 2003; 25:183-8.
- 2) Pollard V et al. Validation in volunteers of a near-infrared spectroscope for monitoring brain oxygenation in vivo. *Anesth Analg* 1996; 82:269-77.