American Red Cross
Scientific Advisory Council

American Red Cross Scientific Advisory Council Advisory
Voluntary Hyperventilation Preceding Underwater Swimming

Overall Recommendation:

Standards:
Voluntary hyperventilation prior to underwater swimming and underwater breath holding is a dangerous activity. Swimmers should not engage in hyperventilation prior to either practice. Aquatic managers, lifeguards, and swim instructors should prohibit all persons from hyperventilating prior to underwater swimming and breath holding activities. All aquatic facilities should have a policy of actively prohibiting hyperventilation.

Questions to be addressed:
Does the evidence available on voluntary hyperventilation preceding underwater swimming support the conclusion that over breathing can lead to a sudden loss of consciousness with or without exercise, and therefore must be prohibited at aquatic facilities?

Introduction/Overview:
Grimaldi J. (1993) notes that over breathing or hyperventilation is breathing at rate and depth higher than necessary to meet the metabolic needs of the body. Voluntary hyperventilation dangerously deregulates brain's control of breathing and perilously lowers the blood's carbon dioxide level. Hyperventilation does not increase the oxygen level in the blood. After a person takes a series of rapid and deep breaths and then attempts to swim a long distance, oxygen is quickly used up. The person will then become unconscious before the CO_2 level raises to the level that triggers the urge to breathe. Drowning then occurs if the person is not rescued.

Summary of Scientific Foundation:
Control of breathing originates in the respiratory centers of the brain. The main function of the respiratory system is to take oxygen (O_2) from the air that enters the lungs, transport it to the body's tissues, and remove excess carbon dioxide.

There are two major physiological sensors for detecting oxygen and carbon dioxide levels. Oxygen sensors detect low arterial oxygen (PO_2) concentration. The oxygen level indicator is a weak signal and is easily suppressed especially during competition like underwater swimming or breathe holding.

The carbon dioxide level, rather than the oxygen level, is the major signal for drawing air into the lungs. Sensors in the human brain make certain that an increase in carbon dioxide level beyond normal limits triggers the urge to breathe before a decreased oxygen level leading to unconsciousness occurs.

Sensors in the brain constantly sample the blood for CO_2 levels. The CO_2 sensors respond to rising carbon dioxide levels and trigger the urge to breathe. This process ensures that the blood oxygen level is adequate to provide the brain with sufficient oxygen to maintain consciousness and not drop below levels that cause unconsciousness.

Either voluntary or involuntary hyperventilation affects the body in many negative ways. It interferes with the functioning of the breathing centers in the brain, increases blood pressure, and reduces the blood flow to the brain. Decreased brain blood flow causes lightheadedness and a decreased ability to concentrate. Hyperventilation can also cause double vision, epileptic like seizures, and EEG and EKG changes.

There is undeniable evidence that hyperventilation prior to underwater swimming can lead to a sudden loss of consciousness and death due to decreased carbon dioxide level. Even though this dangerous practice has been identified as a contributing factor to drowning, it is still attempted in varying degrees at aquatic facilities by swimmers unaware of the dangers of hyperventilating before swimming underwater or breath holding. Hyperventilation is dangerous and must be prohibited through signage and active intervention by aquatic facility managers, lifeguards and swim instructors.

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