4. HYPERVENTILATION AND BREATHHOLD DIVING *

A large number of children and skin divers have found that they can extend the duration and distance of underwater swimming by a practice termed hyperventilation. Their aim may be to surpass their colleagues' efforts with an ability to perform breathhold diving, longer, deeper or further, or perhaps it was found necessary to obtain an elusive angler's prize. Most cases of drowning occur during participation in recreational activities, and over half occur in young adults and children.

A puzzling problem, up till the last decade, has been the unexplained drowning of good swimmers. The paradox of healthy young swimmers drowning in the apparent safety of a swimming pool is now able to be explained by recent work on hyperventilation. Hyperventilation may be defined as a voluntary increase in depth or rate of respiration. The would-be record breaker then takes a full inspiration, and performs his task.

Under normal conditions, when the swimmer does not hyperventilate, the following physiological changes occur during breathholding: the oxygen tension within the alveoli of the lung (100mm Hg) decreases, because of oxygen consumption; carbon dioxide level rises above normal (40mm Hg); the arterial blood reflects the alveolar gas tensions. The normal stimulus to respiration is the rise in the carbon dioxide tension. The drop in oxygen tension is a much less powerful stimulus, and before this drops to a dangerous level, respiration has been recommenced due to the rising carbon dioxide tension. Although factors influencing the gas exchange cycles under water are far more complex than this, the basic concept of a rising tissue carbon dioxide stimulating respiration and preventing loss of consciousness due to oxygen lack is still applicable. This is a physiological safety mechanism of considerable benefit to us.

Hyperventilation before diving results in the following sequence: the alveolar oxygen tension is increased (from 100mm Hg to approximately 140mm Hg); the amount of oxygen carried by the blood is slightly increased; the carbon dioxide level of the alveolus falls considerably (from 40mm Hg to as low as 15mm Hg).

Now the swimmer is able to commence his dive with a slight increase in this arterial oxygen tension, but a considerable drop in his carbon dioxide tension. Because of the carbon dioxide debit, he is able to swim a much greater distance and depth without the usual desire for air. Unfortunately, the oxygen continues to be consumed at the normal rate, and thus he may enter a zone of oxygen tensions that is below that required to sustain consciousness. There may be little

or no warning of this impending loss of consciousness, and the subsequent series of events, usually leading to a coroner's report on drowning, is well known.

This situation is particularly dangerous because of: the adventuresome and active spirit shown by young swimmers; the difficulty in explaining the physiological changes which occur; the irresponsibility of some diving instructors who have not appreciated the consequences of this practice; and finally the absence of specific pathological findings at autopsy, apart from the effects of drowning.

There has been a considerable number of typical cases of this syndrome in Australia, with well recorded clinical data available. The number of vocal protagonists of hyperventilation has diminished subsequent to their diving accidents, over the last few years.

Without necessarily attempting to explain the physiology involved, it is recommended that swimmers and divers, in schools or clubs, be strongly discouraged to attempt hyperventilation, otherwise, in an attempt to gain endurance of depth in diving, they may succeed beyond their wildest dreams. By performing hyperventilation, the swimmer reduces one of nature's safety mechanisms - the stimulus to breathe. The price he may pay is sudden loss of consciousness due to oxygen lack. Unconsciousness under water is likely to lead to drowning.

* Compiled for a lay audience. Dr R Thomas will present a report on the complex physiological sequence of events in a later Newsletter.