Acapnia due to decompression / by W.D.M. Paton.

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Acapnia due to decompression.

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From accounts of unaided submarine escape, it is clear that it is easier to refrain from inhaling during ascent through water than might be expected. One contributing factor would be the loss of CO_2 from the lungs by venting air during the ascent. For an ascent at rate S, with lung volume V, and surrounding pressure P, the rate of venting is $(V \times S)/P$, and the amount vented in an ascent from depth D to the surface (by integration) is $V \log_e D$. For $V = 5$ l. and $D = 60$ ft., amount vented $= 5{\cdot}2$ l. If the subject's minute volume before the ascent was about 5 l./min., there should thus be a lengthening of breath-holding time of about 1 min.

To test this, the subject (W.D.M.P.) determined his breath-holding time (in these conditions, the time during which it was possible to refrain from inspiration) at zero pressure, under pressure and during decompression. A mouthpiece connected to two water valves was used, with which it is easy to avoid unintentional inspiration, yet the lungs can vent freely in decompression. Decompressions took about 2 min. and ended shortly before breaking-point. In the last series, at the breaking-point, alveolar air samples were taken to verify that the end-point was constant.

Results are shown in the following table; O_2 and CO_2 tensions are given in percentage of an atmosphere:

Pressure (ft. of water)	Breath-holding time (sec.)	Remarks
0	68·2, 70·4, 79·3	(Breath-holding time determined after a maximum inspiration in all tests)
30	122·8, 123·1	
60	115·6, 127·1	
Decompression 60 to 10 ft.	223	Breath held 90 sec. before decompression started
Decompression 60 to 10 ft.	182	Breath held 60 sec. before decompression started
0	(*a*) 59·1	(*a*) —
	(*b*) 74·7	(*b*) CO_2 7·10%; O_2 11·65%
60	(*a*) 111·5	(*a*) CO_2 7·81%; O_2 49·3%
	(*b*) 111·5	(*b*) CO_2 7·75%; O_2 49·6%
Decompression 60 to 11 ft.	178·2 (breath held 60 sec. first)	CO_2 7·94%; O_2 15·01%
Decompression 60 to 10 ft.	205·2 (breath held 90 sec. first)	CO_2 7·98%; O_2 13·2%

These results show that the breath-holding time under pressure is roughly double that at the surface, and that the breath-holding time with interposed decompression is roughly doubled yet again. This further increase thus cannot be due to the increase in oxygen tension while under pressure, and is also shown not to have involved any extension in the physiological breaking-point. It is of interest that a greater advantage is obtained the longer the breath is held before the decompression; the concentration of CO_2 in the air vented and hence the total loss of CO_2 is thereby increased. Taking this effect into account, the increases in breath-holding time due to decompression (60–100 sec.) are of the order expected, if they were due to a partial acapnia resulting from loss of CO_2 in the air vented from the lungs during decompression.