ON THE INFLUENCE OF ALTITUDE AND PRESSURE ON THE "VITAL CAPACITY" OF MAN.

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THE influence of altitude upon the spirometric measurements of the expired air (vital capacity of Hutchinson) is a subject that has not met with much attention. Rattray, in his researches on climate, published in the *Proceedings of the Royal Society* (1869-72), incidentally mentions that an ascent of 2,000 feet at Ascension lessened the "vital capacity", as judged of by the spirometer, from 266 to 249 and 243 cubic inches. In seeking to verify these results, I determined, as an opportunity offered, to carry out more extended observations upon the subject. Two officers of H.M.S. *Northumberland* (Lieutenants Campbell and Simpson), whose "vital capacity" had previously been frequently noted, volunteered; observations being taken during a period of three days, the altitude of the place of observation, at Madeira, as determined by an aneroid barometer, corrected for temperature, being 2,950 feet, this agreeing with the altitude given by Dr. Hartung in his *Geologische Beschreibung der Inseln Madeira, etc.* The observations commenced on the morning after the arrival of the party at the mountain, being taken twice daily, morning and evening, before breakfast and before dinner, at about 8 A.M. and 6 P.M. respectively. The vital capacity index is taken from the mean of three trials, the height of the barometer and temperature being noted at the same time.

A.—Previous Vital Capacity=325 Cubic inches.

First Day.			
Mean v. c. in c. in.			
1. 290	}	290.5	
2. 291			
3. 290.5			
1. 290	}	293.6	
2. 291.5			
3. 299.5			

Second Day.			
1. 290	}	293.6	
2. 292			
3. 299			
1. 298	}	295.5	
2. 289.5			
3. 299			

Third Day.			
1. 308	}	310	
2. 312			
3. 310			
1. 314	}	313.8	
2. 327.5			
3. 320			

B.—Previous Vital Capacity=270 Cubic Inches.

First Day.			
Mean v. c. in c. in. Bar. Tem. (F.)			
1. 226	}	241.3	27.78 61
2. 246			
3. 252			
1. 247.5	}	257.5	27.72 57
2. 260			
3. 265			

Second Day.			
1. 267	}	263.6	27.70 55
2. 263			
3. 261			
1. 259	}	257.3	27.65 52
2. 253			
3. 260			

Third Day.			
1. 252	}	258.8	27.64 55
2. 262			
3. 262.5			
1. 254	}	263.5	27.61 52
2. 268			
3. 268			

The previous vital capacity was determined by a series of trials similar to the above; the barometer fluctuating between 30.31 and 30.01 inches; the thermometer between 62 and 69 degrees Fahr.; the maximum variations in the vital capacity being 15 and 19 cubic inches respectively.

If we look at the vital-capacity index under the heading of "trials", we find that there is both in the case of A. and B. a considerable variation in the number of cubic inches registered in each separate series. In the case of A., we find a difference of nine cubic inches between the maximum and minimum indications on the morning of the second day; whilst, in the case of B., there is a difference of six cubic inches. Although, of course, the highest indication registered the true vital capacity, the examination of the whole series of trials leads us to the conclusion that these differences are due to the incomplete filling or emptying of the lungs; and that in a series as the present, where the same cause of error is always acting, for purposes of comparison, the mean of the three trials will be the safest index for our purpose.

Taking, then, the means of the several trials as a fair expression of the vital capacity, we find, in comparing the means, that there is a gradual increase from the morning of the first day to the afternoon of the third. In the case of A., there is a progressive increase from a vital capacity of 290.5 cubic inches to 313.8, or an increase of 23.3 cubic inches; and so, also, in the case of B. (the progression being interrupted on the second day), there is an increase from 241.3 cubic inches to 263.5 cubic inches, or a total increase of 22.2 cubic inches; the amount of increase being strikingly similar in both cases.

Looking now at the thermometric and barometric records, we find that 9 deg. Fahr. and .17 inch embraced the whole of the fluctua-

tions of temperature and pressure, the former ranging between 61 deg. Fahr. and 52 deg. Fahr., the latter between 27.78 inches and 27.6 inches. These changes, being so minute, cannot come to our aid as explanatory of the progressive increase of the vital capacity in both cases, the only explanations remaining being either (1) increased proficiency in the art of "blowing"; or (2) an accommodation of the lungs to the decreased pressure, whatever cause that first occasioned a diminution in the vital capacity being removed or neutralised. The first cannot be explanatory; for, at the sea-level, the vital capacity is almost constant in both cases during a similar series of observations; and, moreover, the steady increase above noted could not be explained by increased proficiency in "blowing", as both had been accustomed to "blow", and had evidently reached their maximum capacity, as evinced by the uniformity of the vital-capacity index during the series of trials at the sea-level.

There only remains the second hypothesis to consider—viz., the gradual removal or neutralisation of some impeding cause to the introduction of air to the lungs. Firstly, are we to consider that the diminution of vital capacity is due to decreased pressure upon the pulmonary tissue, causing the presence of an increased amount of blood in the lungs, and that the diminution of the vital capacity was due to the increased space taken up by the blood, and was an index of the superfluity? and that we are to account for the re-established "vital capacity" by the subsidence of the pulmonary hyperæmia; or, this subsisting, is there compensatory dilatation of the pulmonary air-cells? This latter is most possibly the explanation for the diminished pressure on the lungs still existing; there would be still cause for the hyperæmia, and, therefore, without dilatation of the pulmonary air-cells, still cause for a diminished vital capacity.

Comparing the previous vital capacity with the results of the experiment, we find that, in the case of A. with a previous vital capacity of 325 cubic inches, there was at first a diminution to 290 cubic inches, or a total decrease of 35 cubic inches; which deficit, on the afternoon of the third day, was reduced to only 5 cubic inches. In the case of B., with a previous vital capacity of 270 cubic inches, this was reduced to 241 cubic inches, or a deficit of 29 cubic inches, which deficit was lessened on the third day to 6.5 cubic inches.

From these observations, we may deduce the following conclusions.

1. The vital capacity of man is at first reduced by a diminution of pressure.

2. After a few days, the average capacity is re-established.

ON CEREBRO-SPINAL MENINGITIS.*

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IN the present paper, I propose to sketch briefly, and make a few remarks upon, eight cases which were probably examples of the above-mentioned disease. They were all hospital patients. I am indebted to Dr. Coates for the use of notes of three of them (Cases II, VII, and VIII).

CASE I.—George R., aged 12, a schoolboy, became an in-patient on January 25th, 1875. He cut his finger with a hatchet a month previously. His illness began, two weeks before, with headache, loss of appetite, and vomiting. He got out of bed several times without knowing what he was doing. On admission, he complained of pain in the occiput and left side. He could open and shut the mouth well. The head was thrown back; the muscles of the neck were rather firm; the knees were contracted; the flexor muscles somewhat stiff. During his illness, the tongue was fairly clean, and his appetite good. The bowels for a considerable time were obstinately confined; afterwards the motions were passed involuntarily. Once there was slight difficulty in swallowing. The urine was normal, but often passed in bed. Several times, there was much sweating. The nights were sometimes good, sometimes bad—from pain; at others quiet, but sleepless. There was much retraction of the neck, and great pain on trying to bend the head forward. Opisthotonos existed for many days, with occasional spasm of the legs. Once it was difficult to make him open the mouth. The tongue was always well protruded. At one time, there was blowing with the mouth, also temporary drawing down of its left angle, and, at the same time, right internal strabismus. Twitching of the mouth, and slobbering out of its right corner, also occurred. The pupils were always normal, once rather large. The legs became flaccid, and the arms and hands seemed to lose all power, and eventually the right

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