
On the Nature and Causes of the Physiological Phenomena: Comprised in the Term
"Mountain Sickness"; More Especially as Experienced among the Higher Alps (Concluded)

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REQUIREMENTS IN METEOROLOGICAL TABLES.

By W. ADDISON, M.D., F.R.S.

THE quarterly returns of marriages, births, and deaths, contain mean readings of the thermometer, barometer, etc.; but, in order to estimate correctly the influence of weather upon sickness and mortality, it seems to be the extremes, which often occur within very short periods, that are required.

It is generally understood, that sudden alterations in the weather are prejudicial to health; nor can there be any doubt of this fact; yet such alterations are frequently obliterated by averages and means. The means of a month or a week may come out nearly alike to those of the preceding week, or of the corresponding month of the preceding year, and yet include very extensive thermometric changes, which are thus placed out of view. Every one, in his own person, is acutely sensible of a change of temperature from 50° to 24° , and *vice versâ*. This may occur, and has occurred, without altering the averages of the month more than 1° or $1\frac{1}{2}^{\circ}$. In projecting a meteorological diagram, the mean curves are rounded off and depressed; whereas, what seems to be required are the extreme limits and the time.

I will give one or two examples of my meaning, from a manuscript meteorological journal now before me, embracing observations made four times a day.

It is at night, when going to bed, and in the morning, when we first encounter the outward air, that sudden changes in the weather are most acutely experienced. Let us take, then, 9 o'clock A.M. for our illustration.

On the 6th of January, 1835, at 9 in the morning, the thermometer out of doors stood at 34° F.; on the 7th, at 27° ; on the 8th, at 24° ; on the 9th, at 40° ; on the 11th, at 48° : the barometer falling, in the same interval of time, eight-tenths of an inch.

Turning to the bills of mortality for the metropolis, to find the effect, if any, of this sudden change, we find, in the week ending January 6th, the deaths from scarlet fever, 7; from measles, 15; and from hooping cough, 15; whereas, in the week ending the 23rd (when the influence of the vicissitudes of temperature between the 7th and 11th of the month might be expected to appear in the mortality table) we find the deaths from scarlet-fever, 14; from measles, 23; and from hooping-cough, 18. In the two former instances, the mortality was doubled. The inference is, that cases of sickness were both aggravated and largely increased.

Again, in April 1835, we meet with another remarkable example of a sudden depression and rise of temperature, and of the dew-point, as ascertained by Daniell's hygrometer. On the 14th of the month, the dew-point, at 9 A.M., was 50° ; on the 16th, at the same hour, it was 25° ; on the 17th, 28° ; and on the 18th, 42° . The thermometer, in the same period, ranged from 61° on the 14th to 28° in the night of the 16th—a range of 33° .

Turning again to the bills of mortality, we find, in the week ending the 28th April, an increase in the burials, as compared with the preceding week, of 332. The deaths from consumption were double: fever, scarlet-fever, measles, hooping-cough, and inflammation, being the other heads under which there was a large increase.

April we expect to be a month of genial, warm, moist, spring weather; but, as above shown, it is subject, for 24 or 48 hours, to a temperature and a dew-point appropriate only to the depth of winter. Sudden and temporary these changes may be, and are: and this is the point of the present communication. They are so sudden and temporary, that they disappear in the monthly means; and may even be lost sight of in the average of a week; but they are not so sudden or short-lived as not to have a powerful influence upon the origin and progress of epidemical distempers.

It is concluded, from the facts stated, not only that sudden atmospheric vicissitudes have a great influence upon the progress of sickness and the amount of the mortality,

but also that meteorological tables do not fulfil their proper function with reference to epidemic diseases, unless they show the full extent or the extreme points of all the most prominent or sudden atmospheric changes, and define or give a measure of the time they include.

Maidstone, Jan. 15th, 1835.

ON THE NATURE AND CAUSES OF THE PHYSIOLOGICAL PHENOMENA

COMPRISED IN THE TERM "MOUNTAIN SICKNESS"; MORE ESPECIALLY AS EXPERIENCED AMONG THE HIGHER ALPS.

By STANHOPE TEMPLEMAN SPEER, M.D.

(Concluded from p. 53 of last number.)

THE abnormal sensations constituting mountain sickness may thus be classed in a tabular form, according as they affect the different functions.

Of the nervous system.	Vertigo. Cephalalgia. Somnolence. Dyspnœa. Increased rapidity of the respiration. Sense of thoracic constriction.
Of the respiratory and circulatory systems.	Occasional oozing of blood from mucous surfaces. Syncope tendency. Cardiac palpitation. Throbbing of the vessels within the cranium. Increased rapidity of pulse.
Of the digestive functions.	Anorexia. Nausea and vomiting. Thirst. Constriction below the epigastrium. White tongue.
Of the locomotive functions.	Muscular pains. Paralysed sensation in the lower limbs.
Of the tegumentary system.	Harsh skin. Suppression of the cutaneous transpiration. Pallor of the surface. Cyanosed appearance of the countenance.

It must not be supposed that all these symptoms are to be met with in every individual, upon his attaining a considerable elevation; but in one instance or another, they have each and all been noticed in ascending the Mont Blanc. While, in the different accounts given by those who have reached its summit, we meet with many different opinions relative to the physiological phenomena there observed, some asserting that nothing unusual was felt, others, that this or that symptom was the most prominent and unpleasant, all such diversities of opinion as regards personal sensation are to be estimated at their real value, and not to be set down as indicative merely of the workings of imagination. No one doubts the influence of the sea upon those unaccustomed to it; but if a given number of such persons be taken promiscuously, there will be a great probability of receiving from them at least three or four different versions of its effect. One individual will complain of excessive nausea, without the relief afforded by vomiting; with another it will be exactly the reverse, fits of vomiting occurring, with perfect ease during the intervals; in a third, diarrhœa and abdominal uneasiness will be the prominent symptoms (of this I know several examples); a fourth will complain chiefly of severe headache, with or without gastric complication; a fifth may suffer from a combination of the above miseries; while a sixth, without obvious reason, will enjoy a complete immunity from them all. But further, these varieties in the effects produced by the motion of a vessel at sea are not only met with in different individuals, but they may occur in the same one, at different times, and under different circumstances, according to the state of health he may have previously enjoyed.

Upon the same principle may be explained the diversity of symptoms, and at the same time the occasional immunity from them, at a given elevation which may exist in differ-

ent individuals. Reference is to be made to their physical peculiarities and antecedents.

The causes which give rise to the phenomena of mountain sickness, next claim attention.

The earliest attempt to explain the occurrence of these symptoms, was made by De Saussure; he asserts that they are due, not to the difficulty of breathing in such an atmosphere, but to the relaxation of the vessels, which arises from a diminution in the compressing power of the air. After ascending the Mont Blanc, he says, "the respiration is inevitably accelerated in a rarefied atmosphere, by the necessity of supplying the lungs with the same quantity of air in a given time", and he adds, "this forced acceleration of the respiration is the cause of the fatigue and distress experienced at great elevations, for, as the respiration becomes quickened, the circulation becomes so likewise." He further says, "the muscular exertion, moreover, produces, in a rarefied atmosphere, an acceleration of the circulation and respiration, extremely annoying to certain temperaments."

In a paper published by M. Brachet, in which he endeavours to elucidate the causes which give rise to certain of the phenomena occurring upon lofty mountains, it is justly observed that, in America and Asia, the effects of a rarefied atmosphere are only first perceived at the limits of perpetual congelation, although these limits differ considerably in point of elevation according to the latitude of the locality. In the opinion of this author, the lassitude and dyspnoea are explicable upon the following theory. "During the act of locomotion, those muscles which are contracting remove the oxygen of the blood which traverses them more rapidly than those which are at rest; hence the necessity for an accelerated respiration, in order to supply the deficiency produced by such movement, more especially in a rarefied atmosphere, and the relief from the dyspnoea thus produced upon taking rest, when the blood, losing less of its oxygen in the muscles, requires less in the lungs."

"On the other hand, as the muscles can contract only under the influence of arterial blood, it follows that, when the blood which reaches them has become venous, they are struck with a certain degree of paralysis; and hence the difficulty, amounting at length almost to an impossibility of locomotion, when on lofty mountains the muscles which perform this function, and consume at the same time a considerable quantity of oxygen, receive at length blood containing but little oxygen, and all but venous in its character."

From the above theory it would appear, that the physiological phenomena in question are attributed solely to changes in the quality of the blood. Such a view, however, is somewhat too exclusive.

It is here worthy of remark that, after attaining a height of 13,000 feet and upwards, the necessity for a frequent halt will arise in one person from extreme dyspnoea, rather than from fatigue, while another will halt less from want of breath than from a loss of power in the lower extremities, and a conviction that a fall would be the result of an attempt to proceed further. Rarely indeed is the dyspnoea so urgent but that it would permit of a few more steps being taken, were it not that muscular power fails entirely.

To those who have known what it is to make protracted extension upon a fractured limb, to compress an artery during a tedious operation, or to engage in the exercise of fencing, this species of muscular incapability will be familiar. While, under the above circumstances, the respiration may be unembarrassed, the individual ere long will perceive in the contracted muscles a painful sense of fatigue, and the fingers would soon refuse to do further service, were their strength not recruited by being allowed to relax somewhat. The same result takes place at a great altitude, only with greater rapidity; but it is possible (as will be seen) to become so accustomed to a rarefied atmosphere, as at length to feel no unpleasant effect therefrom: and were this muscular incapability the result of increased venosity

of the blood, from habitual deficiency of oxygen at such heights, it is doubtful whether it would be so easily and rapidly removed by habit, nor would such a condition be accompanied by actual pains in the limbs.

It is probable, therefore, that this painful species of fatigue depends upon sanguineous congestion, occurring in those muscles which are in the act of contraction: and the general character of the phenomena, which result from rarefaction of the atmosphere, appears to corroborate this view.

In proportion to the rapidity of the circulation, does the tendency to active congestion increase; now, at a great elevation, this increased rapidity does actually take place, as evinced by the greater frequency of the pulse, without any reduction of its strength; in such a case, the liability to congestion is sufficiently evident. Upon refraining, however, from exertion, or at least by diminishing the amount of effort, the proper equilibrium may be recovered and maintained, in persons of a tolerably robust constitution; but upon again moving, the contracted limbs become, *de novo*, the seat of congestion, and this increases in proportion to the acceleration of the circulation. It may here be remarked that, in a rarefied atmosphere, those whose muscles have been most exercised are less liable to these sensations.

That the pains felt in the back and loins under such circumstances are due to congestion, is, I conceive, rendered still more probable by their similarity to those which are felt at the commencement or cold stage of a febrile paroxysm,—a period when there in reality exists a congested condition of the internal organs.

The dyspnoea and semi-paralysed condition of the extremities thus produced, are usually associated with certain other phenomena, the *ensemble* of which alone deserves the appellation of "mountain sickness"; these are nausea, anorexia, a syncopal tendency, experienced especially when the trunk is not inclined forward, severe headache, oozing of the blood from the gums, as noticed by Humboldt, etc., etc.; and these symptoms may (like the dyspnoea and muscular debility) be attributed in a great degree to the same cause—irregularity of the circulation, with congestion of the cranial and abdominal viscera.

The usual result of ordinary muscular effort is to produce a stasis of blood in the capillaries, and a condition of active congestion in the brain, lungs, and muscles. Upon making a series of such efforts without intermission, as, for example, when indulging in violent gymnastic exercise for some minutes consecutively, in running hurriedly up a long flight of stairs, or a steep ascent, the same effect is produced to a still greater extent; and if such exercise be at all prolonged, the sight becomes dim and troubled, giddiness and vertigo supervene, with a painful sensation of lassitude and complete failure of the muscular powers. If, however, repose be taken before the effects of pulmonary and cerebral congestion have attained their maximum, there occurs a reflux of blood towards the heart, evinced by sudden paleness of the countenance, a sensation of faintness, troubled vision, and even complete syncope; unless the precaution of assuming the horizontal posture be immediately taken.

Such are the ordinary consequences of violent exertion, as occurring within the scope of general observation. They are evidently due not merely to the inordinate stimulation of the muscles by a surplus of arterial blood, in their earlier stage, or to the paralyzing effect of venous blood at a subsequent period, but likewise to the cerebral excitement produced by an increased afflux of that fluid towards the brain, its rapid subsidence from which leaves the sensory and motor powers in a state of comparative collapse.

Upon comparing these phenomena, evidently arising from temporary sanguineous congestion and its sequelæ, with those observed at great altitudes, the similarity becomes apparent, and in fact unmistakable; with this difference merely, that the rarefaction of the air, in accelerating the movements of respiration, even during repose, contributes to develop the ordinary results of exertion with greater rapidity than in the plain.

The next most prominent symptom, noticed as occurring

at great altitudes, is a condition of the stomach resembling in a great measure that which is familiar to all who have experienced the pitching motion of a steam-vessel in a short cross sea. It is this phenomenon to which the term "mountain sickness", in contradistinction to that of "sea sickness", is especially applicable, as constituting frequently the most prominent and distressing symptom during the ascent of a lofty mountain. It is true that it seldom attains such a degree of severity as that felt at sea; but it nevertheless produces, when well marked, the greatest prostration, and that sense of general depression which accompanies nervous headache with gastric derangement.

It is evident that the causes giving rise to this condition of the stomach cannot be classed under the same head as those to which the analogous phenomena of sea sickness are attributable. In the latter case, it is probable that the real cause lies in a disturbance of the brain, produced by the continued motion of the vessel, and affecting the sense of vision in a manner to which it had been previously unaccustomed. In sea sickness, therefore, the stomach would appear to be secondarily implicated as the result of a morbid impression transmitted to the brain; and that such is the actual explanation of this distressing affection, seems warranted by the peculiar nature of its premonitory symptoms, which are evidently of cerebral origin, and by the fact that the same phenomena in a modified form are experienced by some individuals, upon looking at an object perpetually moving before the eyes. I have, in my own person, while steadfastly gazing at one of the long moving panoramas so popular at present, perceived at length a dimness of vision, with the same trifling giddiness and even tendency to nausea, which usher in sea sickness. These ceased, however, upon closing the eyes; and the efficacy of this measure at sea, more especially if accomplished through the intervention of sleep, would afford further grounds for presuming that in sea sickness the unaccustomed impressions, received by the eye and transmitted to the brain, should, through the well known sympathy existing between these organs, secondarily affect the stomach.

But while the mountain sickness resembles, in a mild degree, that felt at sea, its explanation must be otherwise sought for; and while saying that the two conditions resemble each other, it is necessary to add that in some particulars they differ. The cerebral symptoms are less prominent in the mountain variety,—there is less nausea, and actual vomiting is not common, unless the stomach have been previously deranged; nor is there that extreme sense of prostration and wretchedness which characterizes severe sea sickness, and which renders the sufferer totally careless, for the time being, as to what may be the result.

In an ordinary state of health, there exists in the intestines a certain quantity of gas, intended to counteract the pressure of the external atmosphere upon the parietes of the abdomen. At a given height this pressure becomes diminished, the gas undergoes gradual dilatation, and, according to the theory of M. Maissiat, by its pressure upwards upon the stomach, produces those symptoms of gastric derangement previously mentioned.

To this theory of Maissiat it might, as M. Le Pileur remarks, be objected, that these gastric symptoms are not accompanied by colicky pains, nor any marked sensation of abdominal uneasiness, such as often occur in ordinary cases of gaseous distension. It should, however, be remembered that those cases of flatulence are the most distressing, in which unaccustomed gases, or those occurring naturally in small quantities, such as sulphuretted and carburetted hydrogen, are largely developed within the intestinal canal; pure nitrogen and hydrogen may exist to a considerable extent without producing much abdominal uneasiness, more especially if, as is usually the case, they are secreted gradually. In the present instance the distension is not the result of the abnormal increase of irritating gases, but arises rather from the suddenly augmented bulk of those innocuous gases, which even in a natural condition are tolerably abundant within the intestines.

It has been by some supposed, that this gastric derangement is attributable to a general condition of the system, analogous to that which precedes an ordinary febrile attack. Others, on the contrary, deny this; they argue that the occurrence of the symptoms at a certain height, without appreciable cause, and their disappearance upon regaining a lower level, prove their non-dependence upon aught of a febrile nature. They assert that, beyond the disordered condition of the stomach, there are no feverish symptoms, the whiteness of the tongue and the acceleration of the pulse excepted; that the latter, moreover, presents no irregularity, or other peculiarity, further than that which occurs after taking moderate exercise, and that the whiteness of the tongue is attributable to the small amount of food taken on such occasions. They who deny the analogy between the two conditions, also affirm that during these ascents, there is never experienced that *malaise, sui generis*, which precedes a febrile paroxysm; and they explain the occurrence of thirst, by the evaporation which takes place with great rapidity in the upper regions of the atmosphere.

It would, I think, appear from this, that those who have advocated the non-identity of the physiological states giving rise on the one hand to the mountain sickness, and on the other to the congestive stage of an ordinary febrile attack, must have shut their eyes to the real facts of the case; for the very attempt to explain away each symptom which is known to attend the incubation period of a fever of non-specific origin, is a proof of the force with which the idea must have suggested itself. The symptomatic analogy between these two conditions may be seen by placing their respective phenomena in juxtaposition. I chose ephemeral fever as being the type of an ordinary febrile paroxysm.

<i>Prodromic Phenomena of Ephemeral Fever.</i>	<i>Phenomena of Mountain Sickness.</i>
1. General feeling of languor and distaste for motion.	1. Prostration with loss of power.
2. Muscular pains in the loins and lower extremities.	2. Muscular pains in the lower extremities.
3. Nausea, anorexia.	3. Disgust for food, nausea and vomiting.
4. Headache, throbbing of temples.	4. Headache, throbbing of carotids; vertigo.
5. Thirst.	5. Thirst.
6. White tongue.	6. White tongue.
7. Dry, rough blanched skin.	7. Cold dry state of the cutaneous surfaces.
8. Acceleration of pulse.	8. Increased rapidity of pulse.
9. Ditto of respiration.	9. Ditto of respiration.
10. Diminished general secretion.	10. Diminished secretion.

The above shews clearly the close resemblance which exists between the early symptoms of an ordinary feverish attack, and those which characterize the mountain sickness; but this is still further demonstrated, when the conditions of the system which accompany each, are taken into account.

In the early stage of ephemeral fever, which, as the type of simple fever, is best suited to the comparison in question, the symptoms point to a deficiency of blood in the external parts of the body, and, as a consequence, its accumulation in the deeper seated organs.

With the predisposing cause of this condition of the circulation in the prodromic period of a fever, we have nothing to do: various theories have been suggested to account for it. What may be looked upon as tolerably certain is that (whatever be the cause) there exists, as the prominent feature in the phenomena of mountain sickness, a congested condition of the internal organs, with a deficient cutaneous circulation; or that, in other words, while the two affections agree as regards symptoms, they each present an analogous state of the circulation sufficient to account for such symptoms.

The idea here suggests itself, that were it desired to produce such a pathological condition in a healthy individual, there could scarcely be a more efficacious mode of doing so than by suddenly removing him from a temperature of between 70 and 80 degrees of Fahrenheit, to one in which

he would be surrounded by fields of snow and masses of ice; in fact, to the regions of perpetual winter; and this in reality occurs in the case of those who attempt to ascend the loftiest of the Alps. At a height of between 1,000 and 2,000 feet, the traveller possibly spends a few days, buried as it were in a deep valley, suffering from intense heat and constant copious transpiration: upon leaving the valley he ascends rapidly, and in a few hours enters upon a region of eternal ice and snow, the vital heat being rapidly abstracted by the frozen material under his feet, and the power of advancing with sufficient rapidity to sustain the equality of the circulation, becoming hourly less and less.

This leads to a consideration of the somewhat singular fact, that the mountain sickness commences only at the limit of perpetual congelation, whatever that limit may chance to be.

Albeit liable to exceptions, the rule holds good in the majority of instances; for it may be seen, by referring to the narratives quoted previously, that among the Andes and Himalaya, the phenomena of mountain sickness are first noticed at an infinitely greater height than among the Alps, where the snow level is considerably lower.

The following is the most probable explanation of this anomaly.

In all mountainous countries, the habitations of men are to be met with, up to within a short distance of the line of perpetual congelation. To reach this limit from the sea-level, often requires, especially in the Andes and Himalaya, some days; upon attaining it, a short time is usually allowed to elapse, previous to entering upon the ice-bound desolate regions which now present themselves, and in this manner, an opportunity is afforded for becoming habituated to the increasing rarefaction of the atmosphere; but as, upon leaving the domain of man, it is necessary to achieve the remainder of the ascent as quickly and with as few stoppages as possible, it is evident that the rapid elevation through 5,000 or 6,000 feet, from a point where already the effects of a rarefied atmosphere were slightly felt, must produce marked results. It must tend at once to develop rapidly those abnormal sensations which had previously remained in abeyance, owing to the more gradual atmospheric transitions experienced in ascending from the level of the plains, across the succession of tablelands and lower mountain ranges, which lie at the foot of the loftiest and steepest summits.

It is for this reason that some of the Alpine passes, the St. Bernard to wit, give rise, not unfrequently, to an amount of mountain sickness and indisposition, scarcely explicable upon the grounds of absolute elevation. In this case, a height of 7,473 feet is attained in one day; and the traveller, a few hours after leaving the valley of the Rhone, sleeps at a height of $1\frac{1}{2}$ mile above the level of his previous night's resting-place. The sudden change in the density of the atmosphere between the two points, is quite sufficient to produce the phenomena in question, more especially in the uninitiated.

That it is not so much the absolute as the relative elevation attained, which causes the mountain sickness to be felt at much lower points among the Alps than among the Andes, is evident from facts, which show the possibility of individuals living without discomfort at heights, where, if suddenly removed to them, they would have experienced the most distressing sensations.

On the Thibet side of the Himalaya mountains, are to be found villages of 13,000 feet above the sea level; and likewise upon the slopes of the Andes, at 11,000 feet; and M. Humboldt mentions the fact of having lived for some time at a height of 12,303 feet, on the Antisana, without suffering in any way from the rarity of the atmosphere, the effects of which he was not sensible, until he had attained an elevation of 16,800 feet upon Chimborazo.

In M. Agassiz's travels and excursions among the higher Alps (*Excursions et Sejours dans les Hautes Alps*), he describes the mode of life led by himself and his companions, at a height of 7,800 feet, during the space of several weeks. From being frequently in the habit of ascending the neigh-

bouring peaks, they were at length enabled to reach the summit of the Jungfrau, without being annoyed by the rarefaction of the air. And D'Orbigny, in speaking of the sufferings he endured among the Andes, tells us that persons born in these lofty regions feel no inconvenience, while those who, after leaving the plains, reside for any length of time among them, suffer, it is true at first, but recover their usual health ere long, of which he himself afforded a personal and convincing proof.

In the accounts which we possess of some of the most remarkable mountain ascents, comparatively little notice appears to have been taken of the condition of the pulse. Not a few have been contented with asserting that it was somewhat quicker than usual, or did not vary to any great degree. Of the value of such loose statements, little need be said.

To the indefatigable De Saussure, however, we are indebted for some interesting remarks upon this subject. After remaining for several hours on the summit of Mont Blanc, he made some observations upon the pulse. His guides, as well as himself, were entirely free from the exhilarating influence of spirituous liquors; they had for some time been in a state of rest, and suffered merely from prostration and nausea. The pulse of De Saussure himself was found to be 100; that of his servant 112; and that of Balmat, his chief guide, 98. At Chamounix, the following difference was noted:—

	Chamounix.	Summit of Mont Blanc.
Saussure	72	100
Servant	60	112
Balmat	49	98

The same observer, at the close of his sojourn upon the Col du G ant, upwards of 11,000 feet in height, examined the ratio between the pulse and the respiration in his own person. In the morning, when at rest, he found the respirations 17, and the pulse 79, per minute. The next day, at noon, the pulse beat 82 in the erect, 83 in the horizontal posture.

Among those who ascended the Mont Blanc in company with Dr. Clark, it is said that the average variation of the pulse was from 4 to 30 pulsations per minute, at a height of 7,299 feet; and that this variation appeared in no way to depend upon the natural muscular powers of the individual.

Dr. Parrot, the well-known Russian traveller, in his ascent of Mount Ararat, reports that his pulse, which in the plains was about 70 per minute, was, at a height of 4,752 feet, 80, and at a height of 11,739 feet, 110 per minute.

In attempting to scale the Monte Rosa, Zumstein, who was accompanied by seven hardy mountaineers, varying from 20 to 60 years of age, found that at a height of 13,662 feet, the mean average for the seven was 85 pulsations per minute. He has unfortunately, however, omitted to mention the average of the pulse in these men before leaving the plains.

In the account given (*Annales de Chimie et de Physique*, vol. lii.) of the celebrated balloon ascent of M. Gay Lussac, we find that in Paris his pulse beat 62 per minute; that of his companion, 79. At a height of 6,786 feet, the pulse of the former beat 80, that of the latter 111 per minute.

In the year 1823, a French traveller, named Roulin, made some observations relative to the variations of the pulse, upon some men who for several months had been living at a height of 7,929 feet, upon the table-land of Santa Fe de Bogota. They were all of sound constitution, and aged respectively, 27, 26, and 23 years. On leaving Santa Fe, their pulses beat, in the above order, 69, 71, and 67 per minute; but upon descending into the plains, the pulse of each, so far from progressively diminishing in frequency, merely varied in an irregular manner, being sometimes even more frequent than at Santa Fe. The result, however, of Roulin's experiments, shows that as the atmospheric pressure between St. Martin and Santa Fe diminishes in the proportion of about 9 to 7, the average acceleration of the pulse between the same localities is as 6 to 7.

It would appear from the experiments of M. Roulin, that while the pulse becomes considerably accelerated at a great elevation, a protracted residence in such a locality has not the effect of maintaining this condition; but that, on the contrary, it ere long regains its natural frequency.

The same observer made another series of experiments upon three individuals, aged respectively twenty-eight, seven, and thirteen years. The two former had inhabited the plateau of Santa Fe for eighteen months previously.

The points of observation chosen by M. Roulin were Guaduas, 3,069 feet, and Santa Fe, 7,929 feet above the sea level; and the periods chosen were, first, the moment of awaking, the individual being in the recumbent position; and, secondly, the interval between the moment of rising and the morning meal—this observation being made in the upright posture.

Between these two stations, the mean of atmospheric pressure was found to be 0.78, and the average of the pulse at each locality shews that there exists no regular definite proportion between the increase of atmospheric pressure and the diminished frequency of the pulse.

In a memoir published by M. Le Pileur, to which I am indebted for much information on the subject in question, there are some excellent observations relative to the frequency of the pulse at great altitudes. These experiments were made during the ascent of the Mont Blanc, and from their accuracy of detail are well worthy of note. The tables containing the results of these experiments are here introduced, as affording at a glimpse a summary of the information thus acquired.

The opposite table contains a series of observations made upon the frequency of the pulse, at different heights, by different travellers.

Experiments upon the Frequency of Pulse at different Altitudes.

Locality.	Name of Observer.	Number of Pulsations per Minute.			Remarks.
Chamounix, 3650 ft. above sea level.	Saussure	Saussure 72	Balmat 49	Tota 60	Four hours after arriving.
Summit of Mont Blanc, 14,700 Fr. feet above ditto.	ditto	100	98	112	Four hours after reaching the summit.
Coldu Géant, 10,578	ditto	79 83			In the morning In the afternoon; recumbent. Ditto, upright.
Grand Plateau, 11,730 feet	Hamel	Hamel 82 128			
Rochers Rouges, 13,600 feet	Clissold	Clissold 100 to 150			While in the act of ascending.
Pierre de l'Echelle, 7,008 feet	Sherwell	Sherwell 108	Guides 84 to 104		After eating.
Monte Rosa, 9,939 feet	Parrot	Parrot 110			
Noversch, 4,752 feet	ditto	80			
In the Plain . .	ditto	70			
Monte Rosa, 12,662 feet	Zumstein	Zumstein 76	Molindi 108	4 Guides, average 84	
Balloon Ascent, 7,866 feet	Biot	Biot 111	Gay Lussac 80		
Paris	ditto	79	62		

The following observations on the frequency of the pulse at different periods of the day and under various circumstances, were made by MM. Le Pileur and Martin at Paris, previous to their expedition to the Mont Blanc, with a view to establish a standard of its comparative frequency between the level of that city and the summit of the mountain.

Experiments on the frequency of the Pulse at Paris, by M. Martin.

BEFORE NOON.

AFTER NOON.

1844	Concurrent Circumstances.	Time.	Pulse per Minute.	REMARKS.	1844	Concurrent Circumstances.	Time.	Pulse per Minute.	REMARKS.
June 7th	In the horizontal posture.	7:29	65	Right radial artery	June 6th	After rapid exercise in the erect posture.	10:44	70-50	Left radial
		:31	61				:47	71	Ditto
		:35	61	Right femoral			:50	69	Ditto
			63				11:3	65	Ditto
		7:39	61	Right radial			:6	63	Right radial
	Ditto, ditto.	:41	59				:8	60	Ditto
		:43	58				:11	60	Ditto
		:46	62				:14	59	Ditto
		7:34	65	Ditto			:18	60	Ditto
		:36	65		8th	After lying down for a quarter of an hour.	10:1	64	Ditto
	In the erect posture.	:39	63	Left radial			:3	63	Ditto
		:43	72	Right radial			:5	64	Ditto
		:49	72				:6	64	Ditto
		:51	72				:8	65	Left femoral
		7:49	74				:10	62	Left radial
17th	In the horizontal posture.	7:38	59	Ditto			:12	64	Right radial
		:41	58	Ditto	16th	In the horizontal posture after smart exercise.	9:35	65	Ditto
		:43	62	Left radial			:39	64	Ditto
		:50	59	Left crural			:42	64	Ditto
		:52	60	Ditto			:44	61	Ditto
	After carriage exercise.	:53	61	Ditto			:45	61	Ditto
		8:0	61	Right popliteal			:47	61	Ditto
		:2	62	Right crural			:49	60	Left femoral
22nd		9:35	71	Right radial			:51	63	Ditto
			72				:52	62	Ditto
	During the course of the morning.		71		19th	In the horizontal posture, a quarter of an hour after taking smart exercise.	:55	61	Ditto
			63				:59	60	Ditto
			64				11:15	60	Ditto
			62				:19	53	Left radial
			60				:21	54	Right radial
July 9th			63				:23	54	Left crural
			61				:25	54	Left radial
			62				:27	55	
							:29	55	
	Average before noon..		63-34			Average after noon . .		61-48	
						Daily average 62:04.			

Experiments on the frequency of the Pulse at Paris, by M. Le Pileur.

BEFORE NOON.

AFTER NOON.

1844	Concurrent Circumstances.	Time.	Pulse per Minute.	REMARKS.	1844	Concurrent Circumstances.	Time.	Pulse per Minute.	REMARKS.
July 3rd	Slept well, rose at 7-15, walked up and down the room, observation made while seated at 11-45; walked for 25 minutes, sat down for five minutes, appetite good.	8-0 -1 11-45 -46 -47 -48	66 58 64 66 68 68	The right radial was alone felt.	May 8th	Retired to rest at 3 in the morning, rose at 7. Average amount of occupation during the day, dined at 6, stimulants in moderation.	10-30 -31	64 68 72	
5th	Retired the night previous at 12, slept well, rose at 7 A.M.; fasting.	11-50 -51 -52 -54 12-0 -1 -2 -5	64 72 68 68 67 67 68 68		25th	Breakfasted at 10-45 A.M., walked to the Institute of France; observation made while sitting.	1-25 -26 -27 -28 -29 -30	72 66 68 66 68 66	
13th	Fasting, walked a hour and a half after rising.	12-0 -2 -8	60 60 66	Pulse feeble and depressible.	July 5th	Observation made after eating.	1-5 -6 -8 -9 -10 -11	70 68 68 70 70 70	
14th	Rose at 6, after a good night, observation made while seated—but after walking about the apartment.	6-45 -47 -54 -55 -56 -57	67 65 60 62 65 64	Pulse strong and full.	13th	Breakfasted at 1-45 P.M., observation made an hour after; sitting posture.	2-45 -46 -47 -48 -49	72 72 68 75 75	
Average before noon ..			65-85		Average after noon ..			69-40	
					Daily average 67-36.				

From the preceding table it appears, that the daily average frequency of the pulse at Paris of these two experimenters, was in the one case 62-04, and in the other 67-36. The following table shews the results obtained

between the level of the village of Servoz, 2,306 feet above the sea, and the summit of the Mont Blanc, 14,760 French feet in height.

Experiments on the frequency of the Pulse at different heights between Servoz and the summit of Mont Blanc.

M. MARTIN (aged thirty-eight).

DR. LEPILEUR (aged thirty-four).

SERVOZ ; 2406 French feet above the sea level.

Date.	Hour.	Concurrent Circumstances.	PULSE		Date.	Hour.	Concurrent Circumstances.	PULSE	
			Before Noon.	After Noon.				Before Noon.	After Noon.
July 27th	11-0	After a day's walking exercise.		60	July 22nd	5-0	From Sallenche to Chede in a char-à-banc, from thence on foot: slept well, rose half an hour before making an observation: fasting.	64 64 62 62 64	
Mean								63-20	

CHAMOUNIX ; 3,650 feet above the sea level.

Date.	Hour.	Concurrent Circumstances.	PULSE		Date.	Hour.	Concurrent Circumstances.	PULSE	
			Before Noon.	After Noon.				Before Noon.	After Noon.
July 28th	11-20	Walked for three hours.		73 70 70	July 23rd	7-8	Arrived here on foot; slight catarrh—slept well; felt a weight in the head on rising: pulse feeble and compressible	60 59 58 56 56	
Aug. 27th	Noon.	After moderate exercise and ten minutes repose in the horizontal posture.	67 69 68 68 69		Aug. 27th	2-25	Breakfasted at 8 A.M.: slight nervous agitation; no exercise.		58 62 62 60
Daily average				69-00	Daily average				60-00

PIERRE POINTUE ; 6207 feet above the sea level.

Date.	Hour.	Concurrent Circumstances.	PULSE.		Date.	Hour.	Concurrent Circumstances.	PULSE.	
			Before Noon.	After Noon.				Before Noon.	After Noon.
					July 30th	10-22	Breakfasted at 7, in moderation ; ascended slowly up to this point ; perspired profusely ; slight dyspnoea : pulse full and regular	88 88 86 86 86	
					Aug. 7th	10-10	Conditions same as above.	78 78 78 80	

LES GRANDS MULETS ; 9252 feet above the sea level.

					July 30th	4-38	Sense of debility, with syncopal tendency, removed by taking a little bread and wine.		92 92 93
							Average	92-93	

LE PETIT PLATEAU.

					Aug. 7th	5-13	Constant ascent since 7 A.M. ; slight fatigue ; no particular indisposition.		100
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LE GRAND PLATEAU ; 11,733 feet above the sea level.

July 31st	4-15	Slept the night previous on the Grands Mulets, arrived here this morning ; felt much indisposed, physically and morally ; posture horizontal : pulse barely perceptible		82 80 78	July 31st	4-0	Very little indisposition ; appetite tolerable ; tendency to sleep ; pulse moderately strong		100 98 98 100
Aug. 28th	3-0	Left Chamounix at midnight, arrived here at 11 A.M. ; posture horizontal.		83	Aug. 28th	2-0	Slight fatigue after cleaning the tent of snow ; observation made in the upright position.		100 101 102 102
29th	6-40	Observations made previous to rising.	78 80 81 84 80 84		29th	6-55	Slept well ; pulse feeble but regular.	88 86 86	
30th	9-0	Gentle ascent for two hours before breakfast. Several alterations of position during the observation.	68 65 65 69 75 79 75 71 66 69 68		30th	7-50	Little sleep, having suffered from sciatica. Sitting posture ; fasting—pulse strong.	90 88 86 84 88	
					30th	1-10	Took some food ; fatigue felt ; no mountain sickness while tranquil ; pulse moderately strong, not very compressible. Sitting posture.		78 80 84 80 82
Sept. 1st	7-15	Observation made in the recumbent posture.	74 70 67 67 66 67 66 68 67						
		Daily average	73-74				Daily average	90-80	

SUMMIT OF MONT BLANC, 14,760 feet above the sea level.

Aug. 29th	4-0	Reached the summit at 1-45 P.M. ; during the first hour experienced nausea and vomiting ; pulse feeble		81 83 84	Aug. 29th	3-0	Observation made in the sitting posture ; pulse strong.		94 88 88 86 85
		Average	82-66				Average	88-20	

It would appear from these tables that, after attaining a certain elevation, the frequency of the pulse is invariably increased. The level, however, at which this acceleration commences, evidently varies in different individuals; while in some, there is reason to believe that the influence of diminished atmospheric pressure may, within certain limits, be counterbalanced by concomitant circumstances capable of reducing the frequency of the pulse even while under such influences.

The pulse of M. Le Pileur was much less frequent at Chamounix than at Paris, although in the former locality there was everything in the approaching expedition calculated to produce nervous excitement. At Chamounix, it beat 60 per minute, and at Paris 67·25, notwithstanding the superior elevation of the valley.

In the case of M. Martin, on the contrary, the average frequency of the pulse was greater at Chamounix than at Paris, being 62·04 in the latter, and 69·00 in the former locality.

These same observers, having likewise made experiments upon the pulse of three guides who accompanied them to the summit, found the following differences in point of frequency between the level of the Valley of Chamounix and the highest point of the mountain:—

Average of the pulse at Chamounix.		Do. at the summit.
Mugnier, aged 36	63·12	94·40
Coutet, " 34	77·75	117·83
Simon, " 27	69·22	111·66

It is worthy of note, that in these men, born among the Alps, the acceleration of the pulse was greater than in the case of MM. Le Pileur and Martin, who were habitually residing on a comparatively trifling elevation above the sea level, and but little accustomed to mountain air and exercise.

A *resumé* of the foregoing remarks may, I conceive, lead to the establishment of a few propositions relative to the affection which I have here designated by the term "mountain sickness".

1st. That in mountainous districts, and upon attaining a certain elevation, a series of physiological phenomena manifest themselves, which differ widely from the standard of health, and exist as long only as the exciting causes are in activity; disappearing upon a return to the ordinary level of human habitation.

2nd. That the discrepancy existing among travellers relative to these phenomena, is to be accounted for by their variability both in nature and degree; this variability being itself dependent upon conditions, referrible on the one hand to the individual, and on the other to the locality.

3rd. That, on the part of the individual, the following circumstances may modify the nature and intensity of the "mountain sickness": idiosyncrasy, previous condition of health, the habit of fatigue (especially that produced by ascents), and previous residence in a rarefied atmosphere.

4th. That, as regards the locality, the phenomena in question are most strongly marked where a considerable elevation above the previous residence of the individual is attained in a short space of time; as on the Pass of the St. Bernard, the Col of the Mont Moro, and the Col de St. Theodule, in the Alps.

5th. That the mountain sickness is characterised by the following symptoms, the entire category of which, however, is seldom, if ever, united in one individual: vertigo, headache, somnolence, dyspnoea, constriction of the chest, palpitation, syncopal tendency, occasional oozing of blood from mucous surfaces, increased rapidity of pulse, anorexia, nausea and vomiting, thirst, febrile tongue, muscular pains, sense of extreme debility in the lower limbs, with general prostration of strength.

6th. That these symptoms may be referred to a threefold source, viz., a gradually increasing congestion of the deeper portions of the circulatory apparatus, increased venosity of the blood, and loss of equilibrium between the pressure of

the external air and that of the gases existing within the intestines.

7th. That these exciting causes of mountain sickness are themselves the result of a change from a given atmospheric pressure and temperature, for one in which both are greatly and suddenly diminished.

Cheltenham, Nov. 24th, 1852.

ON INTERNAL UTERINE HÆMORRHAGE.

By GEORGE KING, Esq., Surgeon.

It may be remembered that I have drawn the attention of the readers of the former series of the *Provincial Medical and Surgical Journal* to the subject of *internal uterine hæmorrhage*, which seems to have escaped the notice of practitioners, as well as teachers and writers on obstetric practice; at least I have, like many others, searched in vain for information on this important subject, and for the records of such cases.*

The case reported in the number of the ASSOCIATION MEDICAL JOURNAL, for January 7th, as a "*peculiar case of accidental uterine hæmorrhage*," by Isaac Harrinson, Esq., of Reading, was, I consider, one of *internal uterine hæmorrhage*. Being, I believe, the first who has directed the attention to this peculiar kind of uterine hæmorrhage, it is natural that such a case as Mr. Harrinson's should attract my notice, and that I should make some remarks on it.

In directing attention to an occurrence which I consider has often till too late been neglected, *internal uterine hæmorrhage* during the period of gestation, I wish it particularly to be understood, that I do not mean to say that there is no external appearance or sanguineous discharge from the vagina: there often is in such cases; but it is so slight, and frequently at such lengthened intervals, that it passes unnoticed by both patient and doctor. This state of things goes on, until the patient herself begins to feel its debilitating effects on her constitution; and the practitioner is unconscious of the mischief going on, until his suspicion is excited by the constitutional symptoms. There is a universal paleness, which is first discovered in the face; the pulse becomes quicker and weaker; the abdomen is discovered to be much distended; the patient becomes restless and faint; her friends are anxious; and the *accoucheur* begins to see the danger, and feels his responsibility. All this may take place at almost any period of gestation, and without there being any *external* discharge. The danger does not so much depend on the quantity of blood lost, as it does on the velocity with which it is lost. In these cases, we cannot, by any means that I know, judge for a certainty either as to the quantity or velocity. All we know is, that frightful external hæmorrhage may occur; floodings may last for days; and even gushes of blood may be poured out from the vagina, without exciting much alarm for the safety of the patient; yet with even the slightest *internal* hæmorrhage, this insidious dripping within the cavity of the uterus may continue some time, and produce the most serious constitutional derangement, demanding the most prompt and energetic treatment, without our having any visible sign, or the slightest indication or knowledge of the cause, or the point from which it is emitted. We have yet to learn why the powers of nature should give way and often sink from such apparently trifling sanguineous discharges, and linger and survive a much more profuse one; and also why the uterus, a muscular substance, an organ only designed for the purpose of generation and the perfection of the fœtus (though it may be very vascular during gestation), should become a sponge to sop up the vital fluid of the mother as well as of the child, so that the life of both frequently is destroyed. As practitioners, we have to do with the symptoms, conse-

* I regret to find on referring to the index of the last volume of the *Provincial Medical and Surgical Journal*, that the word "*internal*" is left out in reference to the cases and treatment published by me.