Original Communications.

ON THE PHYSICAL CHARACTER OF THE URINE IN RELATION TO DISEASE AND ATMOSPHERIC CONDITIONS.

By THOMAS MOFFAT, M.D., F.R.A.S., etc., Hawarden, Flintshire.

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FROM meteorological observations taken at Hawarden during five years, in connexion with the phenomena of disease, it would appear that the maximum of diseases takes place with decreasing readings of the barometer and thermometer, and with directions of the wind from points between S.E. and N.W. by way of south; that the maximum of deaths occurs with similar readings of the barometer, but with directions of the wind from points between N.W. and and S.E. by way of north; and that the maximum of ozone corresponds with the atmospheric conditions which give the maximum of diseases, and the minimum with those which give the maximum of deaths.

Seeing these results, it was thought highly important, both in a scientific and practical sense, to ascertain whether any changes in the animal functions could be discovered during atmospheric variations; and, if so, to conduct a series of observations on such functional changes in connexion with meteorological phenomena. Believing that variations in the physical character of the urine are sure and certain indications of functional derangement in the animal economy, I commenced examinations of the density and quantity of that fluid daily, and continued them for a time. On applying these to my meteorological register, the results were so encouraging that I determined upon conducting a regular series of investigations. The observations from which the results are deduced extend over a period of eighteen months.

The person whose urine was examined is a healthy man, of bilious temperament. He was actively employed, both in body and mind, in and out of doors, during the whole period of investigation. His time out of doors, freely exposed to the weather, was on an average six hours daily, namely, from 11 A.M. to 5 P.M.; and the quantity and character of his urine, for these hours, and for twenty-four hours, were daily ascertained. As the density of urine, like that of all other fluids, varies with its temperature, it was necessary to fix a standard temperature, and to apply a correction, plus or minus, as the the case might be; and, as 62° F. is the standard heat of water by which the specific gravity of liquids is compared, I took that number for the standard temperature of urine, and reduced all observations in this inquiry to that degree.

From frequent examinations of urine, while passing from higher to lower, and from lower to higher degrees of temperature, I found that the mean increase of density of the liquid, in passing from 95° to 65° F., is 0·001 for every ten degrees; and that, in increasing the temperature from 40° to 60°, the decrease of density is about the same value; so, if the density of urine be increased 0·001 for every ten degrees of Fahrenheit above 62°, and reduced 0·001 for every ten degrees between 40° and 62°, it will be found that the correction is sufficiently accurate for all practical purposes.

In conducting examinations of the urine, it must be borne in mind, that the quantity of *liquid* evacuated is no measure of the quantity of urine secreted. The *solids* excreted are the "real urine"; and it is by ascertaining the amount of these, that the depurating power of the kidneys can be estimated.

In calculating the quantity of solids, I used the formulæ of Drs. Christison and Golding Bird.

The following table shows the percentage of diseases, with variations in the readings of the barometer and thermometer, with the quantity of ozone, and directions of the wind, for a period of four years; and it also gives the mean daily quantity of solids in the urine, with similar variations, for a period of eighteen months.

	Percentage of disease.	Mean daily quantity of solids in urine. grs.
Barometer:—Increasing readings	26·8	1386
„ Decreasing readings	73·2	1460
Thermometer:—Increasing readings	37·7	1366
„ Decreasing readings	61·8	1439
Ozone:—Absent	28·1	1395
„ Present	71·1	1450
Winds:—North points of compass ..	47·1	1284
„ South points of compass ..	50·3	1368
Calms	49·5	
Calms and variable breezes	....	1427

By this table it appears, then, that the maximum of solids in the urine, corresponds with those atmospheric conditions which give the maximum of diseases. The quantity is greater in dry than in moist air; the numbers being, on days of decreasing degree of humidity, 1506 grs., while there are 1354 grs. on days with increase of humidity.

Believing that the animal economy adapts itself to existing atmospheric conditions, and that it is owing to frequent changes of the weather that functional derangement and diseased action are produced, I ascertained the quantity of solid urinary products on all the days on which periods of increasing readings of the barometer commenced, and on those on which periods of decreasing readings began. The following are the mean quantities for these two sets of days.

	grs.
Mean at commencement of increasing periods	1413·5
Mean at commencement of decreasing periods	1547·7

giving a mean daily quantity of 134·7 grains greater on days at the commencement of periods of decreasing readings, than on days on which periods of increasing readings commence.

Taking the mean quantity of solids on days on which diseases occur, and on days of no disease; and on days on which deaths take place, and on days on which there are no deaths; we find that the mean quantity is 29 grs. greater on days of disease than on days of no disease; and 74 grs. less on days of deaths than on days of no deaths. Thus we find that the maximum of solids in the urine corresponds with the atmospheric conditions which give the maximum of ozone and disease; and the mininum with those which afford the minimum of ozone and the maximum of deaths. The quantity of solids is 69 grs. greater than the mean daily quantity on days on which attacks of rheumatism and gout take place.

The mean daily quantity of urine from which the above results are deduced is 72 ozs., and a mean daily density 1·019; which, according to Golding Bird's formula, gives the mean daily quantity of solids 1418·4 grs.

The mean daily quantity of urine evacuated from 11 A.M. to 5 P.M. was 11 ozs., the mean density of the same 1·020; which gives for six hours a mean quantity of solids 227 grs.

The mean quantity of liquid for one hour in twenty-four hours, is 3 ozs.; and the mean quantity of solids for one hour in the same period is 59·1 grs. The mean quantity of liquid for one hour from 11 A.M.* to 5 P.M. is 2 ozs. (1·8); and the mean quantity of solids for the same period in six hours is 37·8 grs.; giving a mean of 21·3 grs. less per hour daily, while a person is exposed to the open air, than the mean per hour for twenty-four hours.

According to these results, a man evacuates by the action of his kidneys, in round numbers, three and a half ounces of solids daily; or seventy-three pounds avoirdupois annually. Assuming that these numbers represent the mean quantities evacuated by the inhabitants of these islands, and taking the adult population at twenty millions, we find that they excrete 660,165 tons of solids annually; and

* The urine examined between 11 h. and 5 h., was that of two meals, viz., breakfast and dinner.

by referring to the figures in the table, we find that they evacuate during the year 35,714 tons more on days of decreasing readings of the barometer and thermometer, than on days of increasing readings; 7,142 tons more when the humidity of the air is decreasing, than when it is increasing; 26,785 tons more on days when there is ozone, than on days of no ozone; 35,714 tons more with directions of the wind from south, than from north points of the compass; and 276,785 tons more during calms and gentle variable breezes, than when there is a moderate current of air.

Taking the adult population of London as two millions, and assuming that all the solids secreted by their kidneys are carried into the Thames, that river must hold in solution, or have suspended in its waters, a mean daily supply of 181 tons of solid urinary products. The quantity, however, varies with the weather; for, according to the above results, the Thames will contain ten tons more on days when the readings of the barometer and thermometer are decreasing than when they are increasing; a daily mean of three tons more when the humidity of the air is decreasing than when it is increasing; seven tons more on ozone days than when there is no ozone; about ten tons more with south than with north winds; and a daily mean of seventy-five tons more during calms and gentle breezes, than when there is a current of air. Let agriculturists bear in mind, that from the action of the kidneys alone of a London population, 66,016 tons of British guano are annually swept into the Thames.

The quantity of solids excreted in twenty-four hours ranges between 650 and 1,381 grains, giving a range of 1,181 grains. The greatest quantity of liquid evacuated in twenty-four hours was 115 ounces, and the smallest 20, giving a range of 95 ounces. On the day on which the greatest quantity of solids occurred, the reading of the barometer, which was decreasing, was 29·764 in. The wind was south-east; and ozone was perceived on the previous and following days. On the day on which the smallest quantity of solids was observed, the barometer reading (the commencement of a period of increasing readings) was 30·040 in.; the wind veered from south-east to north-west. There was a trace of ozone, which had not been detected for two days, and it was not again perceived for a week. It then reappeared with the commencement of a period of decreasing readings of the barometer, and an increase of the quantity of solids in the urine from 650 to 1,379 grains.

The mean quantity and density of the urine I have given is above that of Drs. Prout and Golding Bird, and M. Becquerel. By the former, from 30 to 40 ounces are given as the mean daily quantity of fluid, at a mean density of 1,017; by the latter, the average quantity is stated at 45 ounces. I do not know from what number of observations these results were arrived at; but I do not hesitate to say that if they did not extend over a period of at least one year, very little dependence can be placed in them; *for the physical character of the urine is as variable as the wind.* To show how much the quantity of solid urinary products varies at different seasons, I may mention that the mean daily quantity for the three months, April, May, and June 1855, was 1,427 grains; while that for the three months ending September was 1,192 grains, giving a difference of 235 grains. I may also state that the extreme quantities occurred once only in twelve months. To arrive at anything like accuracy, the urine of several persons should be examined daily for a period of two years at least.

The period over which this investigation extends is too short to allow of anything like reliable conclusions; but it may be stated that there is a greater quantity of solids excreted by the kidneys during decreasing readings of the barometer and thermometer than when the readings are increasing; that the quantity is greater during ozone than during no ozone periods, and with directions of the wind from south than from north points of the compass; and that it is greater during calms than when there are atmospheric currents.

It also appears that the quantity is greater with dry than with moist air, which may be owing to the cutaneous exosmosis being increased by the moisture in the atmosphere. We observe, then, that warmth and moisture of the air diminish the quantity of solids in the urine; and it is worthy of remark that Mr. Copland Hutchinson attributed the rarity of calculus among sailors to their sleeping in the lower decks, where the *temperature* and *moisture* of the air are increased to that degree, that the place becomes a vapour bath. The smaller quantity of liquids and solids in the period of the day between eleven A.M. and five P.M., may be attributed to the free action of the skin while the body was exposed to the open air.

It also appears that the quantity of solids is greater at the commencement of periods of decreasing readings than at the period of increasing readings; and it is with the former class of readings that the maximum of diseases takes place.

It also appears that while the urine of one person gives signs of functional derangement, without any apparent disease, under certain atmospheric changes, another person may be seriously ill under similar conditions of the air.

CONSIDERATIONS RESPECTING THE OPERATION OF MALARIA ON THE HUMAN BODY.

By C. Handfield Jones, M.B., F.R.S., Assistant-Physician to St. Mary's Hospital.

[*Concluded from page 724.*]

b. Inflammation. The production of inflammation by malarious poison appears to be sufficiently elucidated by what has been above said. The essential visible circumstance in inflammation is stasis of the blood in the capillaries, while afflux persists. The natural vital power of the part is, at the same time, nullified, and all normal nutrition for the time ceases. Now, if the vital power of a part be weak, it becomes more depressed and overwhelmed at length by excessive hyperæmia, which thus becomes a cause of actual inflammation. This is just what happens when the sympathetic is divided in the neck of a weakly animal, and severe conjunctivitis occurs in consequence; while in a stronger animal, the inflammatory tendency is resisted. If, therefore, the sympathetic plexuses of the liver, the large intestines, or the stomach, be paralysed, we shall have the capillary systems of these organs flushed with blood; and if their vital power and tone be low, phenomena of more or less absolute inflammation will occur, and there will be hepatitis, dysentery, or gastritis. In the same way are produced the febrile pneumonias of which Dr. Morehead speaks. On mucous surfaces, owing to their great vascularity, and the thinness of their epithelial covering, there will be a great tendency to the early occurrence of exudation, consisting of modified liquor sanguinis, sometimes mingled with red globules. Varying conditions of the tissue, which it is impossible to specify, will determine whether the exudation shall be a serous profluvium or a mass of gelatinous mucus. The occurrence of the exudation relieves the hyperæmia; and if the vital power be not too much depressed, or if the determining cause of the congestion cease to operate, the stage of complete inflammation may never be attained. Here, as is continually the case, we find that the majority of instances do not attain the complete and perfect type, but occupy one of the many intermediate grades. It is a very curious thing that in certain conditions of the alimentary mucous surface the sanguine afflux, or the nerve disorder, that mostly issues in serous or mucous discharge, produces instead a copious extrication of gas. I have observed this when dysenteric disorder has been giving way to health.

c. Secretion fluxes are evidently produced much in the same way as the last mentioned phenomena. There is the same hyperæmia, and from the same cause; but instead of its overmastering the vital power of the tissue, the latter remains predominant, and converts the hyperæmic flux into an excessive secretion.

d. There are two common forms of disease which I wish