XXIX. *On the Elimination of Urea and Urinary Water, in relation to the Period of the Day, Season, Exertion, Food, Prison Discipline, Weight of Body, and other influences acting in the Cycle of the Year.*

By Edward Smith, *M.D., LLB., F.R.S., Assistant Physician to the Hospital for Consumption and Diseases of the Chest, Brompton, Corresponding Fellow of the Academy of Sciences and Arts of Montpellier, and of the Natural History Society of Montreal, &c.*

Received April 18,—Read May 30, 1861.

I purpose in the following communication to state the results of two series of experiments in reference to urea and urinary water in the healthy human system, with a view chiefly to show their relation to exertion, food, nutrition, period of the day, and season of the year, and to enable me to contrast these relations with those of carbonic acid, which I had the honour to lay before the Royal Society in 1859, and which have been published in the Philosophical Transactions.

The first series of inquiries was made upon myself, and was continued from January 18, 1860, to March 18, 1861, and numbered 1633 observations upon the urinary water, and 1073 analyses for urea on 336 days. The observations were fewer in the months of September and October than in the other months; but from January to the end of July 1860, throughout nearly the whole of October, and from the early part of November until the end of the inquiry, the observations were not intermitted.

[The inquiries were continued daily until March 18, 1862; so that the whole series comprehends a period of two years and two months, with 635 days of actual daily observation, and nearly 1400 analyses for urea*.]

The ordinary food was taken during this period; and each part of it was weighed and recorded, except in some of the summer months. It was of a simple kind, consisting of coffee and bacon for breakfast, at about 9 A.M.; one kind of meat, with vegetables and pudding, at 2 to 3 P.M.; tea with bread and butter at 6 P.M., and coffee with bread and butter at 9 or 10 P.M. On Tuesdays and Fridays coffee and bread and butter were taken at 1½ P.M., and dinner, with tea, at 5 to 6 P.M. No kind of alcoholic liquor was ordinarily taken; and whenever any unusual kind or quantity of food was eaten, or the hour of dining was changed, it was duly recorded. The following is an average example of the dietary used daily:—cooked meat, 3 oz.; cooked bacon, 2 oz.; butter, 1 oz.; bread, 14 oz.; pudding, 9 oz.; potatoes, 7 oz.; sugar, 2 oz.; milk, 6 oz.; coffee, 35 oz.; tea, 15 oz.; water, 10 oz.

The general habits were not interfered with. There was a fair amount of activity, both of body and mind, except on Sunday, when the rest was almost perfect. The

* The portions of the following paper which are enclosed in brackets have been added since the paper was read.

amount of exertion was duly estimated. The month of August and part of September were spent at the sea-side, when there was a little increase of food and exertion.

The aim in this part of the inquiry was to determine the amount of urea and urinary water eliminated throughout the year, under the ordinary conditions of a uniform and active life, and therefore under those to which the mass of mankind are subjected.

The urine was passed at three prescribed periods, viz. on going to bed, on rising, and again immediately before breakfast, and also at other periods of the day as necessity required. The greatest care was taken that not the least portion was lost at any time; and during the alvine evacuation a separate vessel was used. It was commonly passed into tall graduated glasses, and the quantity read off to ·1 fl. oz., either immediately or on recording the whole quantity emitted to a certain period; but when travelling ·1 part of each quantity was reserved, and a mixture of the whole was submitted to examination. The record was commonly completed on the following morning, including the quantity, appearance, specific gravity, and temperature of the urine and the temperature of the air; and the analyses for urea, chloride of sodium, and free acid were then made, but sometimes they were deferred to the second, and in winter occasionally to the third day. The quantity in each twenty-four hours was made up to 8 A.M., and an addition or subtraction was made when the night urine was passed before or after that hour, according to the rate at which it was then secreted.

The weight of the fæces was recorded, with the hours of evacuation; and during a part of the inquiry the weight of the naked body was ascertained, after the emission of urine, night and morning. Certain experiments were made during fasting, as to the influence of water and other ingesta over the excretion of urine and urinary water in the morning, and the dates and results of such experiments were recorded. Hence this series of inquiries furnishes the amount and kind of ingesta, the quantity of urea and urinary water, and certain other characteristics of the urine, the weight of the fæces and of the body, and the relations of these to each other, and to the cycle of the day and year, with the effect of certain special articles of food upon the urine. I am 5 feet $11\frac{1}{2}$ inches high, about 190 lbs. weight, in good health, and fleshy, and was forty-one years of age in the middle of the inquiry.

The second series of experiments were made upon four prisoners in Coldbath Fields Prison (by the courtesy of the Board of Visiting Justices, and with the valuable aid of Mr. LAMBERT, one of the officers of the prison), who worked the treadwheel on three days per week, and did light and routine work on the alternate days. They had been some months in prison, and were in fair health. Their ages varied from twenty-two to forty-two years, their weight from 115 to 133 lbs., and their height from 5 feet $2\frac{1}{4}$ inches to 5 feet 7 inches. They had long been placed upon the full prison dietary, consisting of cocoa and bread for breakfast, meat, potatoes, and bread for dinner, and gruel and bread for supper, and three of them gained weight a little during the inquiry.

The urine of each prisoner was collected separately up to certain prescribed hours, and the weight of the fæces, with the hour of evacuation, was recorded.

The usual food was allowed throughout the inquiry, with the following variations:—

1. The salt was reduced from the indefinite quantity of about 1 oz. daily to $\frac{3}{4}$ oz. daily (besides that contained in the bread and gruel), on the sixth day.

2. From the tenth to the thirteenth day no salt was allowed, except that contained in the bread and gruel.

3. From the thirteenth to the sixteenth day extra fat was given.

4. From the sixteenth to the nineteenth day tea was given.

5. From the nineteenth to the twenty-second day coffee was given.

6. From the twenty-second to the twenty-fifth day alcohol was given.

During the whole period the men were under the immediate observation of Mr. LAMBERT, who most carefully noted the prescribed period for the collection of the urine, the weight of the fæces, the weight of the food, the due admixture of the ingredients in the gruel, the weight of the fat and the lean meat, and the weight of the men, and ascertained that all the food was eaten; and as the men entered willingly into the inquiry (for a trifling pecuniary advantage), I feel assured that the most trustworthy results have been obtained.

Mr. MANNING most kindly undertook the laborious analyses of the food, urine, and fæces, so far as relates to the nitrogen and the mineral matter; and to him I am greatly indebted. An admixture was made of the whole urine passed in the twenty-four hours, and also of the fæces, by all the men; and from these two quantities samples were taken for analysis. Five ounces of the fæces were evaporated to dryness in a water-bath, and the nitrogen was determined in one-third of the dry matter, and the ash from 300 grains of the dry matter.

This series of experiments has therefore given the amount of urea, chloride of sodium, and urinary water, the weight and the chemical composition of the fæces, the nature and amount of the ingesta, and the total nitrogen and ash in the ingesta and egesta, and the relation of each to the other and to well-defined labour and rest. The whole number of analyses of urea was 248, and a similar number represents the inquiries into the chloride of sodium and urinary water.

The method of analysis of urea and chloride of sodium was that recommended by LIEBIG. The chloride of sodium was not removed, but its amount was determined and duly allowed for in estimating the urea. The measures employed were decimal parts of the fluid ounce, and the quantities recorded are those of fluid ounces. The solution of protonitrate of mercury was made and graduated by myself in one large quantity of 10 gallons, and was continuously used in all the experiments made since April 13, 1860; but I am indebted to Mr. DUGALD CAMPBELL for the solution used at an earlier period, and for many other acts of kindness. All the analyses of urea and chloride of sodium were made by myself. The tubes and pipettes employed were rigorously graduated by the balance; and as every effort was made to proceed in a most uniform and accurate manner, and the practice has been very extended, I trust that the errors attending so large an inquiry have been reduced to a minimum.

[In June 1861 another set of this series of inquiries was prosecuted, similar to those already detailed at Coldbath Fields Prison. They were made conjointly with Mr. W. R. MILNER, Surgeon to the Wakefield Gaol, and upon the prisoners entrusted to his care.

Mr. MILNER took the general supervision of the prisoners in reference to their dietary, excretions, and weight, whilst Mr. MANNING kindly determined the nitrogen and dry matter in the fæces and urine, and I made the analyses for urea and chloride of sodium. The following is an outline of the inquiry:—

Four men, of regular habits and in a good state of health, were selected. Two were weavers of wide-width cocoa-matting, which is a very laborious occupation, and two were tailors. Their ages were 19, 22, 24, and 28 years. Their height was $64\frac{3}{4}$, 66, $66\frac{3}{4}$, and 67 inches; and their weight 118 lbs. 11 oz., 125 lbs. $12\frac{1}{2}$ oz., 146 lbs. $11\frac{3}{4}$ oz., and 146 lbs. $15\frac{3}{4}$ oz. The girth around the nipples was $32\frac{3}{4}$, $34\frac{1}{4}$, $35\frac{3}{4}$, and $35\frac{1}{4}$ inches, giving an average of nearly $34\frac{1}{2}$ inches. The total averages of age, height, weight, and girth were $23\frac{1}{4}$ years, 66·1 inches, 134 lbs. $8\frac{3}{4}$ oz., and $34\frac{1}{2}$ inches.

They had been fed upon the highest class of prison dietary; but as that consisted of too much variety of food for our purpose, it was deemed advisable to give them a uniform daily dietary during one week before the experiments began, and it was thenceforward continued without intermission until the inquiry terminated.

The food supplied daily was in part fixed and in other part variable in quantity. The fixed quantities were those of meat, oatmeal, and potatoes, and the variable ones those of bread, salt, and water. Milk was given in a fixed quantity, but the amount supplied was not uniform in the two classes of prisoners. The meat consisted of 5 oz. of lean and 1 oz. of fat cooked beef without bone. The supply of oatmeal was 2 oz., and of cooked potatoes 1 lb. daily. 20 oz. of skimmed milk were given to the tailors, and 25 oz. to the weavers. The daily quantity of bread eaten was on the average 24·3 oz. by the tailors, and 30·4 oz. by the weavers, or a general total of 27·35 oz. The quantity of chloride of sodium eaten (besides that contained in the bread) was 136·5 grs. daily by the tailors, and 63·5 grs. by the weavers, giving an average of 100 grs. daily. There was considerable variation in the quantity from day to day; for whilst one of the tailors ate an average amount of 199·3 grs., the other tailor ate only 73·8 grs. The quantity of water drunk, besides that contained in one pint of gruel, was only 23·8 fluid ounces on the average; and this with the milk gave a total daily supply of fluid of 66·3 oz. The weavers drank much more than the tailors; and the total daily quantities in the two classes were 80·5 oz. and 52·1 oz. The solid food was 51·8 oz., and the fluid 66·3 oz., or a total ingestion of 118 oz. daily.

The prisoners rose at 6 A.M., and, having passed urine and fæces, were immediately weighed. The scales employed were good ones; and the weight was taken to a quarter of an ounce. The prisoners were weighed naked. The weight of fæces and urine was ascertained daily up to $6\frac{1}{2}$ A.M.; and the degree of consistence of the fæces was recorded under four heads, viz. scybalous, well formed, formed but soon subsiding, soft and liquid. A fair sample of the bread, oatmeal, potatoes, meat, and milk was sent up to Mr. MANNING from time to time as changes in the supply occurred. A portion of the mixed quantities of the fæces and urine of each set of prisoners was most carefully taken and sent for analysis daily; but delay in transmission sometimes occurred, so that the analyses were usually made on the third or fourth day after the evacuation. The greatest care was taken to avoid loss by evaporation or otherwise, and to prevent decomposition. The

observations included thirteen days, besides the week of preliminary dietary and preparatory arrangements.]

I propose to state the results of these several inquiries in the following order:—

1. The absolute amount of urea evolved daily (p. 765).

2. The absolute amount of urinary water (p. 769). [Its relation to weight of body, p. 771.]

3. The relations of the daily amount of urea and urinary water (p. 772). [Contrast of daily quantities during two successive years (p. 802.)]

4. The relations of urea and urinary water to the period of the day with ordinary food, during fasting, and with special articles of food (p. 774).

5. The relations of urea, urinary water, and weight of body to the cycle of the week (p. 793).

6. The relations of urea and urinary water to the cycle of the year, with the influence of temperature and atmospheric pressure (p. 796).

7. The influence of the treadwheel and other prison labour over the excretion of urea, chloride of sodium, urinary water, and fæces, both with an ordinary diet and with the addition of certain special kinds of food (p. 804).

8. Certain relations of urea, chloride of sodium, and urinary water to food (p. 818).

9. The relation of the excretion of urea to headache and stomach-derangement (p. 823.)

10. The relation of urea to carbonic acid (p. 824).

11. The relation of urea to nutrition (p. 825).

The inquiry into the relations of urea is one of extreme complexity; and I premise a scheme of the modifying circumstances which act together and which require consideration.

Relations of Urea.

1. PRODUCTION.
2. ELIMINATION.

1. Production: (chiefly) FOOD.	The amount taken into the blood.
	The nitrogen which it contains.
	The general appetite.
	The temporary variations in the appetite.
	The period of the year.
2. Elimination: (chiefly) FLUIDS.	The emission of urine.
	The general appetite.
	The variations in the appetite.
	The emission by other outlets than the kidneys.
	The atmospheric pressure.
	The atmospheric temperature.
	The state of the health.
	The period of the day.

3. The variation in the vital actions.

4. The habits of the subject of experiment.

TABLE I.—Showing the daily amount of the Ingesta and Egesta and weight of body of the Author, and also the Temperature and Atmospheric Pressure, Plates XXXIII. and XXXVI.

Date.	Ingesta.		Egesta.					Daily number of observations and analyses.		Greenwich.			Weight —13 stones (182 lbs.).		Weather, state of health, and other observations.
				Urea.		Urine.				Temperature.		Barom. daily average.			
	Solids.	Fluids.	Fæces.	Total daily to 8 A.M.	Hourly.	Total daily to 8 A.M.	Hourly.	Urea.	Urine.	Daily average.	Daily range.		Night.	Morning following.	
	oz.	fluid oz.	oz.	grs.	grs.	fluid oz.	fluid oz.			° F.	° F.	inches.	lbs. oz.	lbs. oz.	
1860. Jan. 23.	...	56	...	422·8	17·4	59·44	2·47	7	7	40	11·5	29·190	...	...	Experiments on water.
24.	...	51·5	...	421	17·3	63·87	2·66	7	7	39·7	12	28·583	...	...	Experiments on water and bread.
25.	...	47	...	392·2	16·3	25·87	1·07	8	8	37·9	8·2	29·189	...	...	Experiments on water and coffee.
26.	...	60·5	4·75	446·5	18·6	31·87	1·32	9	9	35·7	18·2	29·562	...	...	Experiments on water and tea.
27.	...	50·5	3	339·5	14·1	45·2	1·88	6	8	42·7	12	29·239	...	...	Experiments on water.
28.	...	69·5	2·75	445	18·5	34·9	1·45	7	9	32·6	10·3	29·901	...	...	Experiments on water; black dose.
Sunday. 29.	...	54	4·25	461	19·2	40·6	1·7	2	6	40·1	9·5	29·463			
30.	...	60·5	2·84	446	18·6	60·37	2·51	6	7	39·8	13·7	28·907	...	...	Experiments on water.
31.	...	66·5	4·5	413·8	17·2	66·4	2·77	2	5	37	8·5	29·440			
Feb. 1.	...	52	4·25	434·4	18·1	57·5	2·4	2	6	32	12·7	29·647			
2.	...	52	4·75	577·3	24	54·65	2·27	2	3	33·1	6·0	29·860	...	...	Dinner party.
3.	...	54	8·5	562	23·4	60·06	2·5	2	5	34·8	9·7	30·156			
4.	...	49·5	3·7	1266	26·3	58·66	2·44	2	4	37·3	14·8	30·113			
Sunday. 5.	...	59	13·8			57·73	2·4	4	4	44·9	7·3	29·809	...	...	Headache.
6.	...	48	3·4	494·7	20·6	67·85	2·82	5	5	37·3	7·7	29·795	...	...	Living on bread and water only.
7.	...	56	3·7	474·3	19·7	41·55	1·73	8	8	36·6	14·5	29·985	...	...	Living on bread and water and tea.
8.	...	48	6·9	465·7	19·2	52·04	2·16	8	8	44·5	9·2	29·509	...	...	Living on bread and water and coffee.
9.	...	55	7·5	382	15·9	51·73	2·15	8	8	33·9	9	29·632	...	...	Living on bread and water until 3 P.M.
10.	...	50·5	9·25	528·9	22	54·35	2·26	3	4	28·5	10	29·944			
11.	...	53	none	469·9	19·5	35·2	1·46	2	4	31	14·3	29·694			
Sunday. 12.	...	50	3·93	467·7	19·4	50·15	2·08	2	5	31	15·3	30·146			
13.	...	58·8	5·8	444	18·5	67·6	2·81	5	6	27·7	10·5	30·391			
14.	...	65·5	5·68	476·7	19·8	67·6	2·81	6	8	29·4	13·5	30·415			
15.	...	56	2·9	455·3	18·8	44·41	1·43	6	6	33·5	16·6	30·292			
16.	...	58	7·2	517	21·5	67·62	2·81	6	6	25·6	10·2	29·991	...	...	Evening party.
17.	...	51	3·35	428·7	17·8	45·15	1·88	6	6	37·4	10·3	30·268	...	...	No meat; took beef tea.
18.	...	61	6	516·4	21·5	53·6	2·23	6	6	40	7·8	30·158			
Sunday. 19.	...	49·5	8·53	506	21	48·2	2·0	5	6	39·1	13·7	29·488			
20.	...	60·5	5·25	380	15·8	82·16	3·42	9	9	33·4	9·5	29·342	...	...	Experiments on water; less food.
21.	...	51·5	12·45	414·8	17·2	46·04	1·91	5	7	36·1	6·4	29·612	...	...	Wine at night.
22.	...	76	1·5	476	19·8	50·1	2·08	9	9	35·5	12·2	29·876	...	...	Experiments on water and gluten bread.
23.	...	60·25	3·85	428	17·8	72	3	8	8	31·8	16	30·076	...	...	Evening party.
24.	...	55	7·1	352	14·6	48·58	2·02	7	7	31·5	16·2	30·057			
25.	...	62	6·4	362·6	15·1	44·84	1·45	6	6	33·8	17·9	29·926			
Sunday. 26.	...	54·75	6·15	430·2	17·9	50·63	2·11	5	5	44·6	18·6	29·206			
27.	40	57	6·25	421·1	17·3	77·54	3·23	9	9	39·7	12·1	29·229			
28.	35·75	48	6·4	552·6	23	55·54	2·31	4	7	42·3	21·3	29·266			
29.	42	56	4·5	510	21·2	41·8	1·74	4	7	38·2	16·6	29·899			
Mar. 1.	35·25	58	4·25	528	22	68·6	2·85	3	7	39·5	18·6	29·916			
2.	38·75	45	6·5	447	18·6	50·27	2·09	4	6	40	13·9	29·860			
3.	43·5	50	0	555	23·1	56·27	2·34	4	6	41·8	20·2	29·917			
Sunday. 4.	46	52·5	4·0	561	23·3	41·57	1·73	2	5	41·4	13	29·596			

	5.	51·25	48	4·7	523·9	21·8	55·6	2·31	4	6	40·1	12·7	30·145			
	6.	41·25	51	4·9	456	19	53·8	2·44	4	5	37·9	17·8	30·295			
	7.	50	48	0	527	21·9	44·3	1·43	4	6	33·7	11·6	30·088			
	8.	...	55·5	6·65	651	27·1	57·68	2·4	5	6	35	10·7	30·081	...	...	Public dinner.
	9.	42	43	5·15	737·3	30·6	44·98	1·45	5	6	33·2	12	30·014			
	10.	32	...	...	...	...	...	...	2	6	30·9	6·5	29·747			
Sunday.	11.	37·75	...	...	...	...	...	...	3	6	35·6	17	29·437			
	12.	37	...	...	...	...	...	...	4	8	37·6	11·8	29·571			
	13.	41·25	...	...	...	...	...	...	4	6	39·3	14·9	29·416			
	14.	34	...	...	...	...	...	...	4	6	40·5	12·5	29·327			
	15.	35·5	...	...	...	...	...	...	4	6	38·1	16·5	29·723			
	16.	39·5	...	...	...	...	...	...	3	5	42·3	19·3	29·888			
	17.	38	...	...	...	...	...	...	4	7	48·3	7	29·936			
Sunday.	18.	55·25	...	...	...	...	...	...	3	5	46·2	12·7	29·885			
	19.	41·75	50	6·15	452·9	18·87	73·71	3·04	3	6	44·9	17·5	30·012			
	20.	37·5	52·5	4·5	481·1	20	50·35	2·09	3	5	46·5	13·3	29·750			
	21.	44	51	5·3	499·6	20·8	41·5	1·98	3	6	43·7	11·1	29·374			
	22.	42·25	53·5	3·3	488·7	20·36	41·59	1·98	3	6	39·8	16·8	29·679			
	23.	...	54	3·3	499·1	20·8	57·37	2·38	3	6	40·8	12·7	29·293	...	...	Dinner party.
	24.	44·5	53	8·25	502·3	20·93	52·1	2·17	3	6	39·8	15·7	28·904			
Sunday.	25.	44·5	50	2·85	581·7	24·2	54·41	2·26	3	6	42·1	14	29·221			
	26.	40·5	44·5	...	471·3	19·65	63·65	2·65	3	6	40·3	13·3	29·529			
	27.	44	50·5	15·5	435·2	18	49·24	2·06	3	5	41·6	13·7	29·556			
	28.	42	55·25	...	421·7	17·56	28	1·16	3	5	50	16	29·565			
	29.	38·25	54	8·5	404·5	16·85	40·95	1·7	3	6	50·6	12	29·385			
	30.	39·5	56·5	2·5	375·1	15·6	60·4	2·5	2	4	45·3	9·8	29·529			
	31.	36	49·5	3·8	384·8	16	50·3	2·09	2	5	47·2	7·5	28·864			
Sunday.	Apr. 1.	41·5	48	...	389·3	16·2	60·05	2·5	3	6	47	14·1	29·052			
	2.	45·5	48	7·2	355·9	14	50·84	2·11	3	6	38·8	13·3	28·998			
	3.	39	42	...	376·9	15·7	45·48	1·89	3	5	44·1	9·1	29·426			
	4.	40·25	51·5	6·0	429·5	17·9	45·85	1·9	2	5	43·4	12·3	29·625			
	5.	...	...	3·4	445·9	18·5	33·5	1·4	1	4	46·1	17·5	29·720	...	...	
	6.	...	...	7·25	589·9	24·5	47·5	1·99	1	2	48	19·4	29·700	...	...	
	7.	...	...	5·5	544·3	22·6	44·25	1·82	1	2	52·2	14·1	29·770	...	...	
Sunday.	8.	...	...	5·4	604·8	25·2	44·7	1·83	1	2	49	15·6	29·543	...	...	In the country.
	9.	...	...	11·75	511·3	21·3	58·7	2·44	2	2	46·8	15·3	29·408	...	...	
	10.	...	...	3·1	463·1	17·6	46·7	1·94	3	4	39·3	18·6	29·684	...	...	
	11.	40·5	57	3·5	419·8	17·2	61·45	2·55	6	6	37·1	17·8	30·041			
	12.	41	49·5	13·8	410·8	17·1	46·83	1·95	6	6	40·5	12·2	29·974	...	...	Evening party.
	13.	38·75	51	1·65	503	20·9	57·37	2·39	5	5	40·9	15·8	29·857			
	14.	...	57·5	5·4	509	21·2	77·3	3·2	7	7	37·6	15·2	30·053			
Sunday.	15.	44·75	50	...	419·5	17·5	42·4	1·78	4	4	44·5	22	30·128			
	16.	39·5	58	6·4	461·6	15	61·35	2·56	6	7	46·3	20·7	30·138			
	17.	41·5	57·5	4·2	513·9	21·4	64·69	2·69	6	6	44·9	23·1	30·059			
	18.	41	65·25	6·65	518·4	21·6	64·07	2·66	6	6	45	19·7	29·933			
	19.	39	77	8·9	534·9	22·2	88·82	3·7	17	17	37·3	10·9	29·918	...	...	Experiments on water; evening party.
	20.	27	54	3·75	484·3	20·1	42·35	1·76	6	6	39·6	9·2	29·704			
	21.	44·25	39	...	538·8	22·4	57·03	2·37	6	6	38·7	19	29·605	...	...	Soirée.
Sunday.	22.	52	53	4·2	473	19·7	54·14	2·24	4	4	38	22	29·674			
	23.	36·5	61	...	518·2	21·6	67·76	2·81	7	7	39·9	17·9	29·571			
	24.	38·75	47	9	483·5	20·1	64·6	2·69	7	7	36·6	9·5	29·619			
	25.	34·75	57	4·35	535·2	22·2	76·7	3·39	7	7	44·4	16	29·812			
	26.	28	45·75	...	611	25·4	47	1·95	6	6	43·6	15·5	30·026	...	...	Evening party.
	27.	37	43	4·4	565·6	23·3	41·94	1·74	5	6	42·3	18	30·120			
	28.	...	...	...	511·9	21·3	29·46	1·22	2	5	43·4	27	30·160	...	...	
Sunday.	29.	...	...	...	713·7	29·7	42·7	1·73	1	4	47·4	32·2	30·204	...	...	In the country; black dose; purged.
	30.	...	...	...	684·6	28·5	64·77	2·7	4	5	50·4	27	30·273	...	...	

TABLE I. (continued).

Date.	Ingesta.		Egesta.							Greenwich.			Weight —13 stones (182 lbs.).		Weather, state of health, and other observations.
				Urea.		Urine.		Daily number of observations and analyses.		Temperature.		Barom. daily average.			
	Solids.	Fluids.	Fæces.	Total daily to 8 A.M.	Hourly.	Total daily to 8 A.M.	Hourly.	Urea.	Urine.	Daily average.	Daily range.		Night.	Morning following.	
	oz.	fluid oz.	oz.	grs.	grs.	fluid oz.	fluid oz.			°F.	°F.	inches.	lbs. oz.	lbs. oz.	
1860. May 1.	35·5	58·5	11·7	545·7	22·7	35·6	1·48	5	6	53·1	27·6	30·125	...	...	In the country; black dose; purged.
2.	35	57·25	34·7	528·4	22	25·2	1·05	5	7	54·8	25·3	29·951			
3.	36·5	58	6·1	505·5	21·6	37·1	1·54	5	5	52·4	25·6	30·037			
4.	37	49·5	7·25	473	19·7	39·8	1·65	5	5	51·3	30·2	30·034			
5.	36·5	55	1·6	576·7	24	50·4	2·1	6	6	45·7	14·7	30·009			
Sunday. 6.	35·75	49	...	655·2	27·2	52·5	2·18	4	4	43·7	21	29·964	...	...	Experiments with gluten bread.
7.	32	58	6·25	562·2	23·4	49·6	2·06	7	7	48·6	30·5	29·621			
8.	37	48·5	3	553	23	40·5	1·7	5	5	52·8	20·3	29·449			
9.	34·5	57·5	3·2	599·7	25	48·9	2·0	6	6	53·3	18·1	29·555	...	...	Eggs and bacon.
10.	31·75	59·5	5·25	595·3	24·8	57·2	2·38	7	7	52·7	25·7	29·686			
11.	41	49·5	3·4	454	19	37·4	1·55	5	6	56·3	10·9	29·630	...	...	Ale and full supper.
12.	37	63	...	595·7	24·8	44	1·41	5	5	58·3	15·0	29·567			
Sunday. 13.	39·75	46	8·3	531	22	60·9	2·54	6	6	55·2	16·2	29·630			
14.	35·5	65	4·15	509	21·2	55·1	2·29	7	7	54·1	16·5	29·705	...	...	Experiments on alcohol.
15.	41	50	4·1	516·7	21·5	43·5	1·8	4	5	56·6	20·1	29·720			
16.	...	...	2·6	560	23·4	53·5	2·2	6	6	51·9	18·6	29·745	...	...	Public dinner.
17.	32·25	41·5	6·8	485	28·45	25·3	1·05	3	4	53·2	7·5	29·459			
18.	42·5	46	10·4	517·3	21·5	24·9	1·04	4	5	54·2	19·2	29·269			
19.	36	62	3·6	504·4	20·96	43·5	1·6	5	7	55·3	26	29·669	...	...	Experiments on alcohol.
Sunday. 20	37·75	49	1·5	574·6	24	45·1	2·3	4	5	59·5	26·3	30·046			
21.	...	52·5	...	520·3	21·7	60·7	2·53	5	5	60·3	29	30·208	...	...	Experiments on alcohol.
22.	...	58	8·15	486·4	20·2	44·3	1·89	6	6	61·4	26·9	30·083			
23.	40	56	...	423·2	17·6	36·8	1·53	3	3	60·6	31	29·786			
24.	37·25	54·5	5·25	532·2	22·5	49·1	2·04	5	6	59·3	22·9	29·857	...	...	Experiments on alcohol.
25.	41·75	46	4·6	594·8	24·76	61·6	2·56	2	5	55·9	20·1	29·703	...	...	Went to country until 30th.
26.	...	...	4·6	539·6	22·45	34·9	1·04	1	...	56·3	16·7	29·268			
Sunday. 27.	...	...	...	599·2	25	36·7	1·5	1	...	50·4	20·4	29·639			
31.	42·5	72·5	4·8	655·7	27·26	84·5	3·0	3	6	49·7	11·2	29·555			
June 1.	33·5	57	3·75	519·6	21·68	65·5	2·62	5	6	55·4	18·8	29·542	...	...	Experiments on alcohol.
2.	30·25	54	5·5	642·2	26·7	72·5	3·0	3	7	52·7	15·3	29·144			
Sunday. 3.	35·75	52·5	0·8	517	21·58	54·1	2·25	3	6	52·7	9·7	29·322			
4.	34·75	...	5·4	497·2	20·7	69·8	2·9	4	6	53·7	16·4	29·805	...	...	Ill; headache; vomiting.
5.	29·75	68·5	13·9	596·8	24·84	35·6	1·48	3	5	52·5	15·8	29·696	...	...	} Milk.
6.	38	58·5	1·5	555·7	23·08	58·3	2·42	3	6	50·1	19·1	29·636	...	...	
7.	39	71	2·5	520	21·7	63·3	2·64	3	6	49·6	13·5	29·634			
8.	36·25	51	3·7	507·5	21·1	61·6	2·56	3	6	53·3	19·5	29·712			
9.	43·5	65·5	...	541·8	22·5	67·4	2·8	4	7	51·2	8·8	29·522	...	...	Milk; experiments on oxygen; not well.
Sunday. 10.	37	55·75	3·4	590·8	24·6	59·6	2·48	3	6	51·9	16·5	29·576	...	...	Milk.
11.	40·5	68	3·9	583·5	24·31	68·2	2·84	6	7	54·2	21·7	29·696	...	...	Milk.
12.	28·5	51·4	4·8	601·3	25	66·1	2·75	3	6	54	9·3	29·353			
13.	35·5	59·5	6	553·3	23·05	50·1	2·14	3	5	53·9	16·5	29·474	...	...	Milk.
14.	34·25	49·5	...	498·7	20·78	58·5	2·44	3	6	53·2	20·9	29·590			
15.	37·25	53	4·2	547	22·8	52·3	2·18	2	4	53	23·4	29·541	...	...	Milk.
16.	...	...	lost	547·3	22·8	32·4	1·35	2	4	57	18·6	29·502	...	...	} In the country.
Sunday. 17.	...	...	„	638·4	26·6	59·3	2·47	1	...	50·8	6·8	29·412	...	...	

	18.	...	...	„	475	19·8	31	1·29	1	3	56·6	21·1	29·669			In the country.
	19.	...	...	7·5	446	18·5	25·5	1·06	2	...	53·7	17·2	29·617			
	20.	29·75	68·5	8·1	522·6	21·76	34·5	1·44	3	4	58·6	14·8	29·510			
	21.	40·75	53.	...	510·4	21·2	59·1	2·46	3	5	57·6	9·7	29·669			
	22.	37	57.	4·6	416·2	15 6	40·7	1·7	3	5	58·1	20·1	29·856			
	23.	35	61.	...	404·9	16·75	39·9	1·66	3	5	60·5	18·3	29·795			
Sunday.	24.	35·5	53·5	4·0	480·5	20	53·5	2·21	3	6	62·6	16·7	29·813			
	25.	25·25	72	7·3	487	20·28	52·1	2·2	2	4	57·4	15·8	29·622			
	26.	37	44	12·1	489·6	20·4	67·8	2·82	3	8	57·3	20·2	29·785			
	27.	....	...	lost	528	22	32·9	1·37	2	5	56	12·9	29·731			
	28.	...	...	„	674·5	28·14	44·4	1·43	1	3	57·6	17·6	29·843			In the country.
	29.	....	...	„	551·7	22·98	27·8	1·16	1	3	55·8	16·9	29·726			
	30.	....	...	„	512·2	21·34	27·9	1·17	1	3	53	12·9	30·047			
July	3.	....	...	„	526·2	21·92	39·8	1·66	1	4	61·7	15·7	30·178			In the country.
	4.	38	59	„	535·3	22·3	34·9	1·45	2	...	61·7	21·1	30·019			
	5.	39·5	57·5	3·75	510·5	21·27	38·5	1·6	1	...	56·3	31·7	30·079	...	...	Milk.
	6.	40	58	4·75	473	19·4	60·5	1·48	1	5	57·2	15·8	30·163			
	7.	38	51·5	3·55	524·6	21·83	62·4	1·6	2	4	55·1	24	30·145			
Sunday.	8.	40·75	69	6·2	518·9	21·62	74	3·08	2	4	54·8	27	30·075	...	...	Milk.
	9.	29·25	59	4·6	502·6	20·94	47·6	1·98	2	4	56·8	18·4	29·984	...	...	Milk.
	10.	42·25	63	7·35	509·2	21·21	61·4	2·55	2	5	53·9	10·7	29·897	...	...	Milk.
	11.	39·5	52·75	2·1	466·8	19·45	54·2	2·24	4	5	59·5	20·2	29·866	...	...	Soirée.
	12.	33·25	52·5	3·1	465	19·37	62·2	2·6	1	...	57·9	23·8	29·836			
	13.	30	60	4·7	456	18·16	46·7	1·84	2	...	58·2	24·6	29·768			
	14.	39	57	4·6	548	22·83	50·3	2·2	2	...	60·4	21·8	29·668			
Sunday.	15.	42	60	...	617·1	25·71	55·6	2·31	2	...	62·7	18	29·745	...	...	Milk.
	16.	34·75	48	11·5	463·3	19·3	51	2·12	2	...	58·4	8·5	29·771			
	17.	37	50	2·8	482	20·13	54	2·25	2	...	62·3	19·5	29·738			
	18.	38·25	54	3·0	464	19·33	40·3	1·7	2	...	58·1	4·8	29·700			
	19.	34	58	3·6	464·7	19·34	47·2	1·96	2	...	57·4	16·5	29·552	...	...	Headache.
	20.	41·5	67	15·7	500·3	20·84	47·4	1·97	2	...	58·9	19	29·704	...	...	Well; purged.
	21.	30·5	52	....	420	15·83	50·6	2·1	2	...	55·6	16·7	29·567			
Sunday.	22.	35·75	65	2·15	520·4	21·6	52·3	2·18	2	...	58·5	18·8	29·595			
	23.	37·75	52	5·9	509·6	21·19	68·4	2·83	2	...	53·8	14·7	29·600			
	24.	34	53	4	482·4	20·13	61·4	2·55	1	...	54·4	16·7	29·674			
	25.	39	58·5	6·2	505·2	21·08	47·3	1·96	2	...	53·6	15	29·855			
	26.	34·5	56	4·75	537·1	23·32	62	2·58	2	...	54·8	22·3	29·806			
	27.	37·5	53·5	5·8	487·2	20·3	60·3	2·5	2	...	57·5	19·6	29·663			
	28.	26·25	57	3·6	499	20·8	56·4	2·35	3	...	56·4	15·2	29·601			
Sunday.	29.	36	...	...	534·4	22·26	54·2	2·25	2	...	57·5	19·5	29·776			
	30.	....	...	20·4	515	21·5	55·5	2·31	2	...	56·9	16·3	29·688	...	...	Went into country.
Aug.	10.	....	...	...	623	27	59·4	2·47	1	4	57·5	21·7	29·716			
	11.	....	...	...	725	30·21	76·5	3·18	1	4	58·3	15·9	29·428			
Sunday.	12.	...	...	...	614	25·5	77·5	3·18	1	4	57·9	11·9	29·595			
	13.	...	...	...	604·3	25·15	56	2·33	1	4	58·3	17·1	29·605			
	14.	...	...	...	732·5	30·5	59·6	2·48	1	5	59·2	16·2	29·549			
	15.	...	...	...	534·5	22·27	49·9	2·08	1	5	59·3	16·7	29·518			
	16.	...	...	...	748·5	31·18	61	2·54	1	4	61·1	14·6	29·232			
	17.	...	...	...	575·4	24	73·1	3·04	1	4	56·2	15·4	29·394			At Scarborough.
	18.	...	...	...	....	...	...	...	1	...	52·9	11·2	29·448			
Sunday.	19.	...	...	...	717·8	25·74	63·8	2·65	1	3	58·7	11·1	29·702			
	20.	...	...	...	591	24·6	44·0	1·83	1	3	59	12·8	29·688	...	...	Walked eleven miles extra.
	21.	...	...	...	621·3	25·9	52·8	2·2	1	3	58·9	16·6	29·791			
	22.	...	...	...	659·9	27·5	37·5	1·81	1	3	56·1	11·8	29·393			
	23.	...	...	...	lost	...	lost	...	1	...	55·6	19·4	29·703			
	24.	...	...	...	714	29·77	43·6	1·81	1	3	54·4	13	29·591			

Date.	At Scarborough. Temperature. Daily average.	Temperature. Daily range.	Barom. daily average.
1860.	°F.	°F.	inches.
Aug. 10.	57	7·7	29·700
11.	56·2	3·5	29·600
12.	56	2·0	29·795
13.	56·9	4·0	29·805
14.	55·8	5	29·775
15.	54·8	5·2	29·745
16.	57·6	2	29·450
17.	58·9	7·9	29·425
18.	54·2	6·5	29·500
19.	56·9	6·5	29·730
20.	59·4	11·5	29·725
21.	58·2	6·5	29·905
22.	56·5	5	29·637
23.	54·9	8·3	29·705
24.	53·8	13	29·650
25.	53·9	11	29·675
26.	57·9	6	29·755
27.	53·6	12	29·800
28.	52·8	11·2	29·760
29.	56·9	6	29·400

TABLE I. (continued).

Date.	Ingesta.		Egesta.					Daily number of observations and analyses.		Greenwich.			Weight —13 stones (182 lbs.).		Weather, state of health, and other observations.
				Urea.		Urine.				Temperature.		Barom. daily average.			
	Solids.	Fluids.	Fæces.	Total daily to 8 A.M.	Hourly	Total daily to 8 A.M.	Hourly.	Urea.	Urine.	Daily average.	Daily range.		Night.	Morning following.	
	oz.	fluid oz.	oz.	grs.	grs.	fluid oz.	fluid oz.			°F.	°F.	inches.	lbs. oz.	lbs. oz.	
1860. Aug. 25.	...	...	...	575	24	56·5	2·35	1	4	59·8	5·7	29·581			At Scarborough.
Sunday. 26.	...	...	...	643	26·8	62·9	2·62	1	4	59	16·9	29·688			Walked 14 miles extra.
27.	...	...	...	579	24·12	46	1·91	1	3	56·8	17·3	29·713	...	...	Dinner party.
28.	...	...	...	602	25·16	32·6	1·35	1	3	57·2	16·6	29·664	...	...	
29.	...	...	...	...	...	lost	...	...	...	59·7	16·5	29·391			
30.	...	...	...	...	...	lost	...	...	...	59·2	14	29·225			
31.	...	...	...	...	...	lost	...	...	...	57·4	17·6	29·425			
Sept. 1.	...	...	...	633·4	26·4	61·3	2·55	1	3	56·9	22·8	29·652			At Southport.
Sunday. 2.	...	...	...	739·3	30·8	77·6	3·23	1	4	53·7	24·7	29·788			
3.	...	...	...	693·8	28·9	80	3·3	1	4	55·2	18·5	29·953			
Oct. 8.	...	...	...	556·8	23·11	65	2·7	1	4	49	13·5	29·995	...	...	At home.
9.	...	...	...	434·1	18·1	49·6	2·06	2	4	45·9	10·5	29·880			
12.	...	...	...	465·5	18·98	53·4	2·22	1	...	38·6	14·6	29·747			
15.	...	...	...	529·7	22·07	61·4	2·55	1	...	49·7	17·5	29·521			
16.	...	...	...	620·2	25·84	72·8	3·03	2	...	49·5	11·7	29·468			
17.	...	...	...	546·8	22·7	65·8	2·74	2	...	50·5	11·1	29·832			
18.	...	...	...	462	19·25	40·2	1·71	1	...	54·6	12·3	29·498	...	...	Headache; deranged stomach; black draught.
19.	...	...	...	350	14·6	30·3	4·26	2	...	58·9	12·7	29·524	...	...	Still some headache.
20.	...	...	...	581·5	24·23	45·4	1·9	2	...	46	13·5	29·909			
Sunday. 21.	...	...	...	621	25·87	67·7	2·82	2	...	50	15	30·068			
22.	...	...	...	640	22·5	61·2	2·55	1	...	50·5	20	29·913			
23.	...	38	6·75	461·8	18·82	50·9	2·12	4	6	54·6	13·3	29·954	...	...	Felt as if could not take more fluid.
24.	...	61	2·5	520·4	21·7	39	1·62	4	4	56·4	10·3	29·907			
25.	...	...	4·9	523·6	21·81	50	2·15	3	...	56·5	11·7	29·907			
26.	...	...	...	608	25·32	67·3	2·80	...	...	54·7	11·1	29·806			
27.	...	...	...	603	25·12	79·2	3·3	1	...	53·4	12	29·819			
Sunday. 28.	...	...	...	...	...	...	...	1	...	57	18	29·920			
Nov. 12.	...	...	...	437	18·62	58·3	2·43	2	...	40·4	15·6	29·553			
13.	...	...	...	482	20·08	56	2·33	2	...	42·4	12·3	29·430			
14.	...	...	...	418·7	17·44	36·1	1·5	1	...	43·7	13·8	29·404			
15.	...	...	...	457	17·37	60·4	2·51	2	...	45·8	10·8	29·218			
16.	...	...	...	478	19·91	56·4	2·35	3	...	42·6	11·9	29·473			
17.	...	...	...	433	16·37	44·8	1·45	2	...	48·3	10·5	29·176	...	..	Constipated.
Sunday. 18.	...	...	...	485	20·21	41·4	1·71	2	...	36·6	6·4	29·752	...	...	
19.	...	...	...	413	15·54	49	2·04	4	...	37·8	9·5	29·967			
20.	...	...	...	428·7	17·86	55·4	2·3	4	...	41·1	13·6	29·857			
21.	...	...	...	446·3	18·6	53·4	2·22	2	...	41·7	13·8	29·550			
22.	...	...	...	489·8	20·41	62	2·58	3	...	43·5	12·1	29·364	...	...	Evening party.
23.	...	...	...	548	22·83	50·1	2·08	3	...	37·6	13·1	29·536	...	...	Colocynth; purged.
24.	...	...	...	403	17·62	48·1	2·0	2	...	39·9	5·3	29·588			A little headache and irritability.
26.	...	...	...	487·9	20·32	57·5	2·4	2	...	37·3	4·5	29·265			
27.	...	...	...	804·3	16·73	59·2	2·44	6	...	42·3	11·6	29·313			
28.	...	...	...			47·4	1·97			40·4	5·0	29·615	...	...	Milk.

	29.	...	...	...	424·7	17·7	49·7	2·04	3	...	41·7	6·5	29·606	...	...	Public dinner.
	30.	...	...	...	447·9	18·66	35·8	1·49	3	...	45·3	9·1	29·502			
Dec.	1.	...	...	6 55	539·6	22·48	49·2	2·05	3	...	45·5	12·2	29·639			
Sunday.	2.	...	...	...	425·8	16·07	45·6	1·9	4	...	45	7·3	29·473			
	3.	...	...	10·1	453	18·87	54	2·25	3	...	43·6	5·1	29·303	...	...	Purged; unwell from stomach derangement; less food.
	4.	...	...	5	436	19	37	1·54	3	...	44·6	5·6	29·215	...	...	A little better.
	5.	...	...	...	463	19·3	62·3	2·6	4	...	44·6	7·4	29·286	...	...	Headache; bad appetite; took colocynth.
	6.	...	...	25·25	449	18·71	44·1	1·84	3	...	49·8	8·5	29·108	...	...	Purged.
	7.	...	...	2·75	461	19·21	60·4	2·51	3	...	49·9	4·9	29·974	...	...	Well; good appetite; black draught.
	8.	...	...	15·75	380	15·83	46·3	1·93	2	...	44·8	6·6	29·702	...	...	Purged.
Sunday.	9.	...	...	5·0	398·6	16·61	38	1·58	3	...	42·7	6·7	29·858	...	...	Colocynth and black draught; purged.
	10.	...	...	21·2	455·7	18·98	60·2	2·5	2	...	41·4	9·5	29·356	...	...	Well.
	11.	...	...	5·2	420·3	17·51	57·7	2·4	4	...	39·6	10·2	29·528			
	12.	...	...	...	445·2	18·66	53·3	2·22	5	...	40·8	4·8	29·880	...	...	Evening party.
	13.	...	...	...	530·3	22·1	62·4	2·6	4	...	40·4	5·6	29·981			
	14.	...	...	4·0	561	23·3	51·6	2·15	3	...	38·8	5·1	30·120			
	15.	...	...	4·5	554·3	23·1	44	1·83	3	...	36·2	9·9	30·113			
Sunday.	16.	...	...	16·0	526·5	21·93	44·7	1·86	4	...	38·4	5·8	29·811	...	...	Bacon and coffee supper.
	17.	...	...	...	498·5	20·7	65	2·7	16	20	35·4	4·5	29·513			} Quarter-hourly experiments on urine.
	18.	...	...	...	473·1	19·71	65·38	2·71	15	15	30·5	7·9	29·414			
	19.	...	...	...	401	16·61	30·9	1·28	3	...	30·1	13	29·289	...	...	Frost began.
	20.	...	...	5·5	464·5	19·35	75·4	3·14	3	...	29	7·6	29·663			
	21.	...	...	...	364·9	15·2	30·3	1·26	3	...	30·6	5·9	29·724			
	22.	...	...	2·7	433	18·87	40·9	1·7	2	...	31	3·8	29·683			
Sunday.	23.	...	...	...	528	22	40·7	1·7	3	...	26	9·2	29·467			
	24.	...	...	6·8	506·3	21·1	49·0	2·46	3	...	22·4	11·7	29·313			
	25.	...	...	26·0	298	12·41	45·9	1·91	2	...	20·2	22	29·226	...	...	Headache; could not do anything; colocynth and black draught.
Sunday.	30.	...	...	...	476	19·83	30·3	1·26	3	...	38·3	12·7	29·290	...	...	Rapid thaw; hands swollen; feel full; fæces solid.
	31.	...	...	2·50	504·9	21·03	70·8	2·95	4	4	35·5	6·3	29·511			
1861. Jan.	1.	...	...	4·0	485·4	21·22	64	2·66	3	6	39·9	15·4	29·228			
	2.	...	...	6·0	470·2	19·6	61·9	2·58	2	...	29	7·2	29·918	...	...	Frost again.
	3.	...	...	12·5	559·1	23·3	55·6	2·31	2	...	28·7	9·9	30·143			
	4.	...	...	5·5	492	20·5	62·8	2·61	2	...	28	13·7	29·983			
	5.	...	...	1·5	503	21	38	1·58	2	...	27·5	10·7	29·928	...	...	Not well.
Sunday.	6.	...	...	15·6	451·5	18·4	47·1	1·86	3	...	23·6	10·3	29·932	...	...	A little headache; colocynth; purged.
	7.	...	...	5·1	427·5	17·81	68·1	2·83	4	...	26·4	12	29·966			} Experiments on alcohol; French test.
	8.	...	...	...	429	17·83	47·7	2·07	4	...	24·5	18·8	30·182			
	9.	...	...	5·5	436·6	18·2	49·6	2·07	3	...	25	18·2	30·179			
	10.	...	...	6·75	480·5	20·02	40·5	1·68	3	...	21·7	12·8	30·204			
	11.	...	...	...	495	20·62	42·5	1·77	4	...	28·7	19·7	30·184			
	12.	...	...	9·5	492·4	20·51	37·6	1·56	3	...	34·8	5·7	29·958	...	...	A little headache and stomach derangement; black draught.
Sunday.	13.	...	...	8·8	467·5	19·5	26·6	1·10	2	...	31	6·6	29·596	...	...	Bacon and coffee supper.
	14.	...	...	12	461	18·83	54	1·25	2	...	28	7·6	29·636	...	...	Well; frost again.
	15.	...	...	3·45	441	18·75	36·3	1·51	3	...	27·6	3·4	29·921	...	...	Experiments on alcohol at Society of Arts.
	16.	...	...	...	495·8	20·66	45	2·29	2	...	26·9	7·9	30·048			
	17.	...	...	8·2	552	23	49·5	2·04	1	...	33·5	6·7	30·134			} Thaw; heavy; tired; full; better at night.
	18.	...	...	8·75	441	18·5	41·4	1·89	1	...	32·9	6·1	30·129			
	19.	...	...	...	408	17	39·1	1·63	2	...	33·8	4·2	30·088			} Bacon and coffee supper.
Sunday.	20.	...	...	4·25	472·3	19·67	32·8	1·36	2	...	39·5	9·3	30·221			
	21.	...	...	15·5	418	18·25	61·5	2·56	3	...	39·9	6	30·238	...	...	Well.
	22.	...	...	1·25	408·3	17·01	60·6	2·52	4	...	35·6	7·3	30·230			
	23.	...	...	11·25	452·7	17·2	48·6	2·02	2	...	36·3	5·7	30·086	...	...	Felt as if I had taken too much tea, coffee, and bread.
	24.	...	...	...	487·9	20·32	33·9	1·83	2	...	40·6	15·9	29·896			} Milk.
	25.	...	...	...	609·4	25·4	51·1	2·13	3	...	48·5	10·4	29·790			
	26.	38	52·5	6	498	20·76	44·6	1·85	2	...	46·8	10·4	30·160	...	...	Frosty; fine; feel cheerful.
Sunday.	27.	36·25	53·5	4·5	510·1	21·25	49·4	2·05	4	...	47·1	12·3	30·124	...	...	Feel full.
	28.	36	58·5	...	586	24·41	70	2·91	3	...	41·7	14·4	30·107	...	...	Experiments on alcohol.
	29.	...	43·1	5·6	413	15·54	43·1	1·8	3	...	40·6	25·5	30·006			
	30.	...	...	3·7	500	20·83	39·6	1·65	2	...	37·8	12·5	30·016			
	31.	...	...	8·5	649	27·04	49	2·04	2	...	43·8	12·5	30·029	...	...	Dined out; strong wine; bad headache; vomiting; took aperient.

TABLE I. (continued).

Date.	Ingesta.		Egesta.					Daily number of observations and analyses.		Greenwich.			Weight —13 stones (182 lbs.).		Weather, state of health, and other observations.
			Fæces.	Urea.		Urine.				Temperature.		Barom. daily average.			
	Solids.	Fluids.		Total daily to 8 A.M.	Hourly.	Total daily to 8 A.M.	Hourly.	Urea.	Urine.	Daily average.	Daily range.		Night.	Morning following*.	
	oz.	fluid oz.	oz.	grs.	grs.	fluid oz.	fluid oz.			° F.	° F.	inches.	lbs. oz.	lbs. oz.	
1861. Feb. 1.	36·75	49	21·25	472	19·66	25·5	0·98	3	...	46·4	15·4	30·076	...	...	Feeble.
2.	24·75	58	...	507	21·12	60	2·5	2	...	38·6	10·4	30·521			
Sunday. 3.	36	58	...	548	22·83	57·6	2·41	3	...	39·6	12·7	30·253	...	...	Irritable; drinking fine Oolong tea.
4.	45·25	45	5·4	547·5	22·83	64·2	2·67	5	...	41·7	9·5	29·792	10 3	9 6	Well.
5.	...	52·5	6	505	21·04	53·8	2·24	3	...	44·2	5·5	29·492	9 13	8 15	Restless.
6.	33·75	...	10·2	532	22·16	49·8	2·07	3	...	45·7	6·9	29·263	9 14	9 2	Colocynth.
7.	...	46·5	4·75	593	24·71	52·3	2·18	2	...	44	12·2	29·419	8 13½	8 2	Much exertion; less food.
8.	...	51	7·7	508	21·16	40·8	2·72	2	...	43·9	8	29·384	9 2	8 8	
9.	47·75	...	25·15	439·5	18·31	40·8	1·7	2	...	41	5·5	29·547	9 4	8 6	Colocynth and black draught; longing for bacon.
Sunday. 10.	...	...	4·5	526·6	21·94	44·4	1·85	3	...	37	10·9	30·107	10 9	10 1	Bacon.
11.	33·5	61	2·6	584·6	24·36	67·7	2·82	3	...	31·9	11·7	29·736	8 6	7 15	} Hard day's work; frosty.
12.	...	58	3	489	20·37	49·4	2·04	3	...	30·2	13·4	29·517	9 6	8 10	
13.	29·5	58	...	517	21·54	55·7	2·32	2	...	36·1	12·2	29·561	8 3	7 1	Hard day's work; feel full; thaw.
14.	40·5	52	8·8	480·8	20	39·7	1·65	2	...	36·2	16·6	29·859	9 0	8 6½	Very damp.
15.	...	...	...	528·5	22·02	61·2	2·55	2	...	44·5	9·5	29·513	9 4	8 9½	
16.	...	58	6·25	488·4	20·35	63·9	2·66	4	...	47·2	11·3	29·584	8 2	7 6½	
Sunday. 17.	33·75	59	4	427	17·37	31·6	1·31	3	...	46·2	17·3	29·578	9 15	9 2	
18.	32·5	62	...	486·4	20·27	49·2	2·05	3	...	45·5	16·2	29·501	9 13½	9 1½	
19.	...	52·5	6·6	462	19·2	35·5	1·48	4	...	45·5	13	29·523	11 2½	10 6	
20.	33·75	54	5·75	474	19·7	55·6	2·25	5	...	42·6	13·3	29·578	10 6	9 13	Herring disagreed.
21.	34·75	64·5	3·4	543	22·6	87·1	3·62	3	...	48·6	8·5	29·501	8 13	8 5½	Very rainy.
22.	42	60	5·4	552·7	23	32·9	1·37	2	...	46·9	11·3	29·523	9 8	8 13½	
23.	35·5	60	4·5	561·7	23·4	51·3	2·14	3	...	45·6	5·2	29·427	9 14½	9 3	} Very rainy.
Sunday. 24.	43·5	67·5	3·4	477·7	19·9	44·4	1·85	3	...	51·9	4·0	29·781	12 1½	11 5½	
25.	40·25	60	6·5	483·7	20·1	65·1	2·71	7	...	41	6·6	30·039	10 5½	9 13½	A little headache.
26.	42	62	10·6	418·5	17·8	62·7	2·61	4	...	41·8	16·8	30·009	9 15	9 12	
27.	39·5	60	2	360·8	15	40·4	1·7	3	...	40·2	19·6	29·855	11 15	10 13½	
28.	33·75	66	4·2	445	18·5	65·1	2·71	2	...	44·5	12·9	29·684	10 15	10 9½	
Mar. 1.	...	56	3·5	456	19	55·8	2·32	16	...	44·9	14·5	29·491	9 10	9 13	Hourly experiments on the urine.
2.	43	68	7·9	438·8	22·4	63·1	2·63	16	...	45·4	13·5	29·744	10 11	10 0	Ditto; large dinner.
Sunday. 3.	41·75	65	1·5	476·7	19·6	44·6	2·85	3	...	46·2	13	29·553	12 1½	10 9	Black draught; last quantity of fæces had peculiar animal odour.
4.	36	60	28·3	473	19·7	55·4	2·30	3	...	41	11	29·920	10 0	9 14	
5.	37·5	49	3·8	432·8	16·3	61·9	2·57	3	...	41·4	13·8	30·001	9 5	9 6	
6.	...	58	...	467·3	19·4	36·3	1·5	3	...	48·6	9·8	29·636			} Out of town.
7.	...	54·5	lost	631	26·2	57·3	2·4	2	...	44·9	12·9	29·967			
8.	...	54	...	436·4	18·1	36·8	1·53	2	...	50·3	16·8	29·890			
9.	...	...	lost	lost	...	lost	...	...	...	43·9	16·9	30·241	10 8	9 7	
Sunday. 10.	...	59	4·5	496	20·6	31·9	1·33	3	...	46·7	19·9	29·709	12 6	11 14	
11.	38·25	55	...	473·1	19·7	60·5	2·52	3	...	40·6	13·5	29·200	11 15	10 12	
12.	47·25	68	5	444·1	18·4	59·6	2·48	3	...	40·8	15·1	29·240	12 4	11 10	
13.	38·5	72	5·5	574·9	23·9	69·3	2·9	4	...	40·7	13·8	29·771	12 9½	11 8	
14.	36	62·5	16·25	460·7	19·2	92·6	3·94	3	...	41·7	23·7	30·097	9 6	8 13¾	Headache; stomach deranged; great sensibility; aperients.
15.	22·75	70·5	26·75	411·4	17·1	26·5	1·1	2	...	45·5	16·3	29·777	9 13½	9 5	
16.	34	59	1·5	455·6	17·3	58	2·41	2	...	40·8	15·5	30·097	10 12	10 4	Depressed.
Sunday. 17.	36·25	63	1·1	451·8	...	36·2	...	3	...	...	...	...	13 6	12 13	Well; soirée.

* As the weight in the morning is due to the conditions of the previous day, it is inserted opposite the previous day.

	18.	...	...	...	467·1	...	57·3	...	...	...	...	...	...	12 5	12 4	Dined out.
	19.	...	...	...	...	...	...	...	...	...	...	...	...			
	20.	...	...	...	...	...	...	...	...	...	...	...	...	12 10	11 1	
	21.	...	...	...	...	...	...	...	...	...	...	...	...	12 9½	11 7	
	22.	...	...	...	...	...	...	...	...	...	...	...	...	12 10	11 8	
	23.	...	...	...	...	...	...	...	...	...	...	...	...	14 2	12 10	
Sunday.	24.	...	...	...	479	20	44·3	1·84	...	...	48·9	24·4	29·651	14 8	13 10	
	25.	...	...	...	410·7	17·1	59·5	2·5	...	...	42·8	6·5	29·747	13 10½	11 8	Skin dry, hot; headache; colocynth.
	26.	...	...	...	342·8	14·28	49·7	2·07	...	...	47·5	16·9	29·496	12 10	11 10	
	27.	...	...	...	540·9	22·5	40·9	1·7	...	...	49·2	17·6	29·316	14 2	13 6	Dined out.
	28.	...	...	...	537·1	22·3	60	2·5	...	...	46·4	16·5	29·374	14 6	12 13	
	29.	...	...	...	421·6	17·6	52	2·16	...	...	45·0	19·6	29·603	13 14	12 6	
	30.	...	...	...	531·3	22·1	57·1	2·38	...	...	43·4	12·3	29·496	13 6	11 14	A little headache.
Sunday.	31.	...	...	...	535·3	22·3	49·7	2·07	...	...	43·1	17·9	29·490	15 1½	13 6½	
April	1.	...	...	...	514	21·5	65·7	2·74	...	...	41·5	19·1	29·612	13 14	12 10	Very wet; had cold bath.
	2.	...	...	...	442·8	18·4	59·4	2·47	...	...	43·3	18·4	29·558	13 6	12 10	Supped out.
	3.	...	...	...	565·4	23·5	60·8	2·5	...	...	45·2	16·5	29·600	14 0	12 6½	
	4.	...	...	...	561·3	23·3	64·6	2·7	...	...	47·1	15·5	29·667	13 13	11 5	
	5.	...	...	...	366·7	16·1	37·5	1·56	...	...	44·0	17·7	29·785	12 10	11 14½	
	6.	...	...	...	475·2	19·8	33	1·37	...	...	40·2	21·8	30·031	14 0	12 10	
Sunday.	7.	...	...	...	458·7	18·7	69·3	2·98	...	...	42·1	14·2	30·123	14 6	12 10	
	8.	...	...	...	456·4	17·6	64·5	2·6	...	...	41·1	17·1	30·278	12 6	11 4	
	9.	...	...	...	457	19·1	44·4	1·85	...	...	41·7	20	30·396	13 6	12 11½	
	10.	...	...	...	463	19·8	47·8	2	...	...	42·7	22·7	30·364	13 13½	12 8	
	11.	...	...	...	433	18	35·2	1·47	...	...	45·6	32·6	30·297	13 10	12 8	Full; hands and feet swollen; headache.
	12.	...	...	...	486	20·2	43·8	1·82	...	...	49·4	25·2	30·222	12 7	11 4	Out of town.
	13.	...	...	...	500	20·8	38·2	1·6	...	...	46·7	13·8	30·135	12 14	11 15	
Sunday.	14.	...	...	...	489	20·6	44	1·76	...	...	44·2	6·3	30·130	15 10½	14 2½	
	15.	...	...	...	536·2	22·3	74·8	2·1	...	...	45·2	12·4	30·162	13 12	12 6	Dined out.
	16.	...	...	...	513·3	21·3	33	1·33	...	...	49·9	21·7	30·235	14 8	12 9	
	17.	...	...	...	545·3	22·7	53·1	2·2	...	...	46	17·8	30·179	14 8	13 1½	
	18.	...	...	...	461·5	19·1	62·5	2·6	...	...	46·6	15·5	30·056	13 12	11 10¼	
	19.	...	...	...	456·3	19	46·1	1·92	...	...	44·9	12·9	30·067		12 5¼	
	20.	...	...	...	419	17·4	29·3	1·2	...	...	41·3	21·2	30·066	13 13½	13 0	Much oppressed; weary; stiff; aperient.
Sunday.	21.	...	...	...	509·9	21·2	41·8	1·74	...	...	40·2	27·4	29·743	16 0	14 10	Well.
	22.	...	...	...	510·3	21·3	73·6	3·07	...	...	44·1	21·7	29·738	14 3	12 14	
	23	...	...	...	388	16·1	38·8	1·61	...	...	45·1	15	29·733	14 12	13 7	
	24.	...	...	...	493·4	20·5	63·2	2·63	...	...	46·3	27·1	29·866	15 10½	13 15	
	25.	...	...	...	388·7	16·1	68·2	2·8	...	...	49·5	22·1	29·884	13 8	12 10	
	26.	...	...	...	386	16·1	30	1·25	...	...	48·9	19·5	29·957	14 14	13 13	
	27.	...	...	...	...	...	63	2·61	...	...	36·2	6·8	29·960	16 2	14 1	
Sunday.	28.	...	...	...	...	...	...	...	...	...	49·8	24·6	29·915	16 9½	15 4	
	29.	...	...	...	...	...	...	...	...	...	43·1	15·6	30·058			
May	13.	...	...	...	525	22	57	2·37	...	...	45·1	12·6	30·106	...	...	Crab.
	14.	...	...	...	469·1	19·4	47·7	2	...	...	51·5	31·3	30·257	15 6	14 5	
	15.	...	...	...	430·3	17·9	30·4	1·25	...	...	57·7	24·6	30·176	15 7	14 6	First hot day; beer.
	16.	...	...	...	510·4	21·8	55·6	2·31	...	...	61·1	29·6	30·014	15 10	13 13	
	17.	...	...	...	484·2	20	37·5	1·57	...	...	48·7	21·2	30·009	16 8	15 6	Crab.
	18.	...	...	...	556·3	23·1	61	2·54	...	...	46·8	22·7	30·124	16 12	14 13	Milk.
Sunday.	19.	...	...	...	562	24·1	41·5	1·83	...	...	46·9	24·2	30·245	18 1	16 8	
	20.	...	...	...	576·9	22	64·1	2·66	...	...	57·5	34·3	30·218	17 8	15 2	Dined out.
	21.	...	...	...	418	17·4	27·1	1·13	...	...	62·9	29·8	30·187	15 9	14 9	Very hot.
	22.	...	...	...	lost.	...	20·66	0·86	...	...	60·4	15·1	30·042			}
	23.	...	...	...	559	23·2	32·93	1·37	...	...	64·9	28·7	29·902			}
	24.	...	...	...	618·3	25·8	47·8	2	...	...	55·0	16·8	29·831			} Out of town.
	25.	...	...	...	586·4	24·4	55·8	2·32	...	...	54·7	21·3	29·637			}
Sunday.	26.	...	...	...	536	22·3	51·5	2·15	...	...	54·3	16·1	29·745			}
	27.	...	...	...	509	21·2	48·2	2	...	...	58·5	23·7	29·930	18 0¼	17 1	Evening party.

TABLE I. (continued).

Date.	Ingesta.		Egesta.					Daily number of observations and analyses.		Greenwich.			Weight —13 stones (182 lbs.).			Weather, state of health, and other observations.
	Solid.	Fluids.	Fæces.	Urea.		Urine.				Temperature.		Barom. daily average.	Night.		Morning following.	
				Total daily.	Hourly.	Total daily.	Hourly.	Urea.	Urine.	Daily average.	Daily range.					
	oz.	fluid oz.	oz.	grs.	grs.	fluid oz.	fluid oz.			° F.	° F.	inches.	lbs.	oz.	lbs.	oz.
1861. May 28.	...	...	...	424·6	17·6	52·16	2·17	...	...	52·2	7	29·906	17	1	15	14	Full and swollen; patients all worse; dropsy prevails.
29.	...	...	...	441·3	18·4	52·5	2·19	...	...	58·0	23·6	29·799	17	10	16	0	
30.	...	...	...	414·7	17·2	48·3	2	...	...	62·8	23·9	29·790	16	2	14	10	
31.	...	...	...	396	16·4	24	1	...	...	60·1	21·8	29·814	16	13	15	9	
June 1.	...	...	...	480	20	41·4	1·74	...	...	56·5	13·7	29·608	18	8	17	2	
Sunday. 2.	...	...	...	486·8	20·3	55·9	2·33	...	...	54·4	17·5	29·736	19	8	17	9	Very full and drowsy; flesh shakes on movement.
3.	...	...	...	423	17·6	81·7	3·4	...	...	53·4	14	29·884	17	5	16	2	Cooler; lighter; large emission of urine.
4.	...	...	...	420	17·4	38·8	1·61	...	...	53·8	11	29·888	17	10	16	12	Evening party.
5.	...	...	...	538·6	23·7	44·8	1·98	...	...	55·4	17·6	29·833	18	12	16	11	
6.	...	...	...	521·6	21·7	52·5	2·19	...	...	51·3	11·4	29·877	17	14	16	13	
7.	...	...	...	536·4	22·3	47·3	1·97	...	...	52·9	12·7	29·796	18	4	17	2	
8.	...	...	...	459	19·2	38·1	1·6	...	...	52·1	11·3	29·743	18	10	17	3	
Sunday. 9.	...	...	...	496·5	22·3	56·7	2·55	...	...	51·2	18·3	29·563	19	4	18	1	
10.	...	...	...	560·6	23·3	63·1	2·63	...	...	55·8	15·7	29·695	18	7	17	5	
11.	...	...	...	lost.	...	59·3	2·47	...	...	58	22·8	29·944	17	7	16	2	
12.	...	...	...	583·1	24·3	39·9	1·66	...	...	60·1	15·8	30·027	17	10	16	12	Soirée.
13.	...	...	...	637·7	26·5	48·5	2·02	...	...	64·3	26·5	30·034	17	15	16	7	
14.	...	...	...	468	19·5	30	1·26	...	...	67	25·8	29·906	18	12	17	6	Very hot.
15.	...	...	...	512	21·36	36	1·5	...	...	66·9	25	29·848	19	13	18	10	
Sunday. 16.	...	...	...	508·6	21·13	42·6	1·77	...	...	63·2	24·6	29·881	20	12	19	1	
17.	...	...	...	503·5	20·8	68	2·82	...	...	58·9	22·7	29·921	19	0	17	10	Cooler.
18.	...	...	...	399	16·6	34·1	1·42	...	...	60·2	28·2	29·930	18	2	17	2	
19.	...	...	...	462·4	19·6	28·6	1·19	...	...	65·1	28·8	29·867	17	4	15	12	Dined out.
20.	...	...	...	535·6	22·18	28·4	1·18	...	...	64·7	24·3	29·781	17	11	16	6	
21.	...	...	...	430·8	17·86	26·5	1·1	...	...	63·9	20·1	29·759	...		...		Beer at night.
22.	...	...	...	524·5	21·9	35·5	1·48	...	...	64·5	18	29·682	18	6	17	2	Headache all day until night.
Sunday. 23.	...	...	...	517·3	21·54	32·1	1·34	...	...	61·7	20	29·600	19	12	18	2½	Heavy; a little headache.
24.	...	...	...	485	20·48	47·9	2	...	...	62·3	24·1	29·693	18	7	17	2	
25.	...	...	...	lost.	...	...	...	...	...	56·3	7·6	29·606	19	10	17	12	Dined out of town.
26.	...	...	...	471·7	19·7	57·2	2·38	...	...	57·8	19·8	29·492	18	7	17	0	
27.	...	...	...	461·5	19·15	64·1	2·64	...	...	58·5	29·3	29·588	18	10	17	0	
28.	...	...	...	462·2	19·6	41·2	1·71	...	...	61·8	25·3	29·652	19	1½	17	6½	
29.	...	...	...	481	20·3	42·6	1·8	...	...	62·2	15·9	29·680	18	14	17	6	
Sunday. 30.	...	...	...	464·6	19·34	55·7	2·32	...	...	57·4	17	29·915	19	2	17	9	The comet appears.
July 1.	...	...	...	465·8	19·35*	52·5	2·18	...	...	61·8	27·6	29·992	18	1	16	11	
2.	...	...	...	414·8	17·15*	30·7	1·27	...	...	62·5	17·1	29·795	17	1	16	1½	
3.	...	...	...	432·1	17·8	33·1	1·38	...	...	60·7	19	29·762	19	2	17	12	Very close and peculiar weather; exceedingly oppressed until [after sunset; hot tea; longing for fat at night.
4.	...	...	...	462·6	18·8	41·6	1·7	...	...	57·3	16·3	29·324	18	6	17	3	
5.	...	...	...	431·5	18	47·3	1·93	...	...	58·6	16·9	29·198	17	6	15	15	Cooler.
6.	...	...	...	487·3	20·3	39·6	1·65	...	...	59·7	21·8	29·309			16	3	
Sunday. 7.	...	...	...	587·1	24·4	52	2·17	...	...	62·8	16·2	29·449	18	14	16	8	
8.	...	...	...	630	26·2	67·5	2·77	...	...	61·3	22·7	29·567	15	9*	13	11	
9.	...	...	...	539·2	24	59	1·72	...	...	62·1	22·1	29·752	15	12	13	13	
10.	...	...	...	615·2	25·65	39	1·6	...	...	60·7	21·9	29·802	15	12	11	14	Headache; unable to work; dull; aperient.

* Very tired and stiff; very giddy; lost weight, but had lived on calves' head and not flesh meat; all patients complain of giddiness; much skin disease; alkalies required to aid the action of the skin; diseases due to the season.

	11.	...	...	...	664	26·66	34·9	1·45	...	...	59·3	23·9	29·733	13 15	12 3	Two pints of milk; no giddiness.
	12.	...	...	...	500·6	20·85	29·8	1·24	...	...	60·9	23·1	29·506	13 8	12 3	Close weather; taste not natural; well.
	13.	...	...	...	503·5	21	31·6	1·32	...	...	63·3	17	29·381	14 14	13 2	
Sunday.	14.	...	...	...	500	20·8	32·6	1·36	...	...	61·7	16·5	29·458	16 7	15 0	
	15.	...	...	...	512·8	21·3	35·6	1·48	...	...	61·1	18	29·499	14 12	13 15	
	16.	...	...	...	452	21·1	38·3	1·6	...	...	62·1	21·6	29·556	15 14	14 1½	
	17.	...	...	...	452·3	18·76	33·4	1·39	...	...	60·6	24·2	29·764	15 2	13 10	Soirée.
	18.	...	...	...	490·3	24·3	45 4	1·89	...	...	61·0	13·8	29·598	14 12	13 9	
	19.	...	...	...	516·6	21·53	46·5	1·94	...	...	59·6	10·5	29·573	14 9	13 6	
	20.	...	...	...	465	19·3	39·7	1·65	...	...	63·0	14·8	29·572	15 0	13 9	Much oppressed; tongue white; aperient.
Sunday.	21.	...	...	...	553·2	23	55·8	2·32	...	...	61·9	16·3	29·626	14 12	13 4	Milk supper.
	22.	...	...	...	545	22·7	47·3	2	...	...	61·8	14·4	29·613	15 10	13 9	
	23.	...	...	...	...	...	...	...	...	...	62·4	15·6	29·518	...	...	Out of town.
	24.	...	...	...	...	...	...	...	...	...	58·2	16·2	29·649	15 9	14 2	
	25.	...	...	...	...	...	...	...	...	...	63·7	11·8	29·525	16 5	15 5	
	26.	...	...	...	472	19·6	34·5	1·43	...	...	59·9	14·7	29·464	17 10	15 2	Little headache; hands hot and full.
	27.	...	...	...	560·7	23·3	62·3	2·6	...	...	59·6	23·5	29·601	17 7	...	Cheerful; much urine; milk at night.
Sunday.	28.	...	...	...	541	22·5	71·8	2·98	...	...	59·4	22·5	29·767	15 4	14 0	
	29.	...	...	...	497	20·6	66·2	2·75	...	...	59·7	24·2	29·846	14 9	13 8	
	30.	...	...	...	409	13·76	47·8	2	...	...	61·2	17·1	29·721	15 13	14 7	
	31.	...	...	...	446	18·51	36·5	1·52	...	...	60·8	23·1	29·883	15 14	14 3	Hot day; well.
Aug.	1.	...	...	...	527	21·3	47·4	1·92	...	...	63·6	21	29·906	15 16	14 2	
	2.	...	...	...	525	21·2	39·4	1·6	...	...	63·5	29·5	29·593	15 11	14 2	
	3.	...	...	...	499	20·75	45	1·87	...	...	58·7	13·3	29·744	16 5	14 12	
Sunday.	4.	...	...	...	463	22·07	53·2	2·23	...	...	63·3	18·5	29·854	...	...	Out of town.
	5.	...	...	...	...	...	...	...	...	...	66·1	26·7	29·767			
	6.	...	...	...	...	...	...	...	...	...	63·0	3·3	29·930			
	7.	...	...	...	...	...	...	...	...	...	62·8	27·6	29·813			
	8.	...	...	...	611	23·22	35·5	1·35	...	...	63	11·9	29·565			
	9.	...	...	...	640	26·04	34·4	1·4	...	...	64·7	18·8	29·776			
	10.	...	...	...	652	27·36	45·4	1·9	...	...	68·2	21·8	29·927			
Sunday.	11.	...	...	...	649	22·07	45	1·88	...	...	67·7	21·8	29·817			
	12.	...	...	...	695	29	50·4	2·1	...	...	72·9	32·3	29·610			
	13.	...	...	...	715	29·79	37·1	1·52	...	...	67·0	20·4	29·812			
	14.	...	...	...	841	34·18	63·8	2·65	...	...	64·2	28·2	29·838			
	15.	...	...	...	760	30·9	55·1	2·24	...	...	65	13·1	29·671			
	16.	...	...	...	562	22·5	43·5	1·81	...	...	59·4	8·2	29·710			
	17.	...	...	...	641	26·6	56·2	2·39	...	...	60·8	24·5	29·879			
Sunday.	18.	...	...	...	643	26·6	46·5	1·93	...	...	63·8	22·1	29·829			At Scarborough.
	19.	...	...	...	724	30	61·8	2·57	...	...	63·9	20	29·808			
	20.	...	...	...	735	30·4	62·8	2·61	...	...	59·4	23·4	29·933			
	21.	...	...	...	723	30	52·8	2·2	...	...	58·3	22·2	30·068	...	...	Whisky at night.
	22.	...	...	...	547	23·4	46·7	2	...	...	59·9	20·4	30·089			
	23.	...	...	...	839	34·9	68·9	2·87	...	...	64·1	18·6	29·937			
	24.	...	...	...	876	36·45	54	2·25	...	...	59·3	19·1	29·946			
Sunday.	25.	...	...	...	746	34·7	68·9	3·13	...	...	59	22·2	30·029			
	26.	...	...	...	681	28·35	50·4	2·1	...	...	60·7	18·1	30·066			
	27.	...	...	...	668	27·8	33·4	1·39	...	...	65·4	25·3	30·104			
	31.	...	...	...	735	30·5	50	2·08	...	...	60·8	31·1	30·109			
Sunday. Sept.	1.	...	...	...	624	25·94	45·2	1·88	...	...	66·1	27·6	29·888	...	17 2	In town.
	15.	...	...	...	564	23·4	37	1·54	...	...	52·5	14·1	29·607	...	18 5	
	16.	...	...	...	485	20·4	57·7	2·43	...	...	55·1	14·6	29·834	...	18 7	
	17.	...	...	...	464	19·3	69·6	2·9	...	...	53	20·5	30·013	...	17 6	
	18.	...	...	...	450	18·58	45·9	1·9	...	...	54·5	30·3	30·050			
	19.	...	...	...	432	17·94	55·3	2·3	...	...	57·3	24·3	29·960	...	17 5	
	20.	...	...	...	444	18·46	54·7	2·28	...	...	54·6	21·3	29·705	...	17 14	
	21.	...	...	...	lost.	...	...	...	...	...	53·7	18·4	29·568	...	18 6	

Date.	At Scarborough.		
	Temperature.		Barom. daily average.
	Daily average.	Daily range.	
1861.	°F.	°F.	inches.
Aug. 8.	63·9	16	29·650
9.	59·8	6·5	29·800
10.	60·9	10·5	30·025
11.	60·9	9·5	29·875
12.	66·9	12·5	29·850
13.	65·9	11·5	29·950
14.	61·6	15	29·950
15.	62·9	11	29·703
16.	63·8	13	29·710
17.	57·9	10	29·950
18.	58·9	10	29·850
19.	57·9	10	29·800
20.	58·4	12·5	29·810
21.	56·9	19	29·900
22.	59·9	10·5	29·890
23.	58·9	7	29·930
24.	58·7	9·5	29·930
25.	56·9	7	30·095
26.	58·7	3	30·155
27.	54·4	4·5	30·225
28.	58·9	11·5	30·053
29.	56·7	6·5	29·850
30.	49·2	3·5	30·050

TABLE I. (continued).

Date.	Ingesta.		Egesta.					Daily number of observations and analyses.		Greenwich.			Weight — 13 stones (182 lbs.).		Weather, state of health, and other observations.
	Solids.	Fluids.	Fæces.	Urea.		Urine.				Temperature.		Barom. daily average.	Night.	Morning following.	
				Total daily.	Hourly.	Total daily.	Hourly.	Urea.	Urine.	Daily average.	Daily range.				
	oz.	fluid oz.	oz.	grs.	grs.	fluid oz.	fluid oz.			° F.	° F.	inches.	lbs. oz.	lbs. oz.	
1861. Sept. 22.	...	...	...	454	18·9	50·4	2·1	...	...	55·3	9·8	29·380	...	18 14	
23.	...	...	...	523	21·84	67·1	2·8	...	...	55·7	13·7	29·273	...	18 0	Milk.
24.	...	...	...	lost.	...	...	...	...	...	54·7	19·5	29·287	...	17 9	
25.	...	...	...	524	21·75	60·2	2·5	...	...	50·6	10	29·166			
26.	...	...	...	527	21·97	70·2	2·93	...	...	51·5	13·9	29·584	...	17 0	
27.	...	...	...	461	19·15	54·88	2·28	...	...	52·8	28·5	29·807	...	16 8	
28.	...	...	...	...	...	...	...	...	...	55·7	13	29·716	...	16 8	Out of town.
Oct. 3.	...	...	...	526	22·64	36·9	1·53	...	...	57·5	20·2	30·000	...	18 10	
4.	...	...	...	540	22·5	60	2·5	...	...	58·6	16·4	29·956	...	17 1	
5.	...	...	...	491	20·5	42·8	1·8	...	...	57·5	19·0	29·886	...	18 5	
Sunday. 6.	...	...	...	503	20·92	52·3	2·18	...	...	56	3·6	30·021	...	18 4	
7.	...	...	...	542	22·54	76·4	3·18	...	...	60·6	16	29·885	...	16 8	
8.	...	...	...	400	16·66	49·8	2·07	...	...	62·1	25·3	29·688	...	17 4	Very close weather; all patients perspiring and depressed; much diarrhœa.
9.	...	...	...	550	23·36	47	2·04	...	...	58·2	20·3	29·796	...	17 2	
10.	...	...	...	526	21·86	47·4	1·97	...	...	56·5	22·1	29·694	...	18 0	
11.	...	...	...	474	19·66	52·2	2·17	...	...	58	21	29·346	...	17 0	Out of town.
12.	...	...	...	...	...	...	...	...	...	56·4	14·4	29·843	...	19 4	
17.	...	...	...	469	19·47	53·8	2·24	...	...	50·2	21·1	30·135	...	19 7	
18.	...	...	...	523	22·23	51·3	2·18	...	...	50·2	17·5	29·972	...	18 14	
19.	...	...	...	550	22·86	55·5	2·31	...	...	50·1	22·2	29·788	...	17 15	
Sunday. 20.	...	...	...	455	18·84	36·15	1·5	...	...	51·3	14·8	29·723	...	19 14	
21.	...	...	...	534	22·26	63·4	2·65	...	...	54·7	16·6	29·608	...	18 3	
22.	...	...	...	417	17·25	35·9	1·49	...	...	53·9	13·4	29·670	...	18 0	
23.	...	...	...	543	22·57	61·5	2·56	...	...	51·9	12·2	29·901	...	18 2	
24.	...	...	...	633	26·34	68·9	2·87	...	...	56·4	14·7	29·906	...	17 11	
25.	...	...	...	547	22·7	42·4	1·76	...	...	58·6	8·5	29·970	...	17 7	
26.	...	...	...	586	24·31	50·6	2·1	...	...	52·2	14·1	30·001	...	17 14	
Sunday. 27.	...	...	...	539	22·2	48·6	2·0	...	...	48·9	18·1	29·927	...	18 5	Easterly winds prevail.
28.	...	...	...	585	24·36	67·2	2·8	...	...	47	14·6	29·967	...	18 4	
29.	...	...	...	490	20·37	68	2·83	...	...	46·8	15·2	29·843	...	18 2	Very full; purged before breakfast.
30.	...	...	...	566	23·5	67·4	2·8	...	...	47·6	11·6	29·798			
31.	...	...	...	448	19	42·6	1·81	...	...	48·3	12·4	29·615	...	17 15	
Nov. 1.	...	...	...	405	16·83	45	1·87	...	...	41·4	12·6	29·170	...	17 13	Wind changed.
2.	...	...	...	492	20·42	57·3	2·38	...	...	38·2	12·6	29·185	...	18 0	
Sunday. 3.	...	...	...	418	16·77	53·2	2·21	...	...	39·2	13·8	29·668	...	...	Very cold.
4.	...	...	...	420	17·5	51·9	2·16	...	...	40·9	19·6	29·824	...	17 15	Aperient; headache; unable to do anything.
5.	...	...	...	460	18·08	51·12	2·12	...	...	47·9	13·8	29·483	...	...	Much warmer, and better.
6.	...	...	...	408	16·98	36·7	1·53	...	...	45·8	9	29·326	...	18 14	
7.	...	...	...	446	...	67·2	2·8	...	...	42·3	16·7	29·311			Aperient.
8.	...	...	...	400	16·64	35	1·46	...	...	39·4	14·9	29·210	...	18 9	
9.	...	...	...	522	21·75	64·8	2·9	...	...	38·4	14·3	29·397			
Sunday. 10.	...	...	...	447	18·6	48·1	2	...	...	42·2	18·5	29·087	...	19 0	
11.	...	...	...	462	19·18	66·9	2·78	...	...	43·7	13·1	29·527	...	18 6	
12.	...	...	...	402	16·68	49·3	2·06	...	...	42·5	9·4	29·607	...	17 5	

	13.	...	...	...	622	21·75	36	1·97	...	...	39·1	12·2	29·284		18 4	
	14.	...	...	...	440	18·7	58·7	2·5	...	...	40·7	11·5	29·168		17 8	
	15.	...	...	...	507	25·2	46·36	2·9	...	...	37·6	13·4	29·356		17 0	
	16.	...	...	...	439	18·24	45·7	1·9	...	...	32	13·1	29·466		18 4	
Sunday.	17.	...	...	...	401	16·3	46·7	1·9	...	...	30·9	8·9	29·863	...	19 8	Dined out.
	18.	...	...	...	568	23·76	76·9	3·22	...	...	27·1	8	30·247		17	
	19.	...	...	...	433	17·9	30·4	1·26	...	...	34·1	18·6	30·352		18 4	
	20.	...	...	...	426	17·64	42·26	1·75	...	...	41·8	10·7	30·058		18 10	
	21.	...	...	...	441	18·36	49	2·04	...	...	47·3	16·3	29·663		18 5	
	22.	...	...	...	406	17·16	47·33	2	...	...	42·9	8	29·381		18 4	
	23.	...	...	...	418	17·34	40·9	1·7	...	...	38·1	11·3	29·327	...	17 7	Frost; headache; better at night.
Sunday.	24.	...	...	...	507	21·1	54·5	2·27	...	...	30·6	11	29·892	...	17 4	Well.
	25.	...	...	...	345	14·35	49·94	2·08	...	...	43·2	21·5	29·697		16 5	
	26.	...	...	...	392	16·27	27·2	1·13	...	...	53·1	9	29·427		17 10	
	27.	...	...	...	393	16·35	33·85	1·41	...	...	42·1	14	29·698			
	28.	...	...	...	524	21·77	46·4	1·93	...	...	41·1	15·7	29·831		18 12	
	29.	...	...	...	421	17·6	45·2	1·9	...	...	51·9	12	29·646	...	18 4	Dined out.
	30.	...	...	...	516·5	21·4	42·2	1·75	...	...	49·7	12·8	29·681		19 14	
Sunday. Dec.	1.	...	...	...	614	25·2	75·8	3·11	...	...	43·4	14·3	29·911	...	19 0	Cowheel supper.
	2.	...	...	...	485	20·25	59·8	2·5	...	...	36·5	17·4	30·279		19 0	
	3.	...	...	...	482	19·9	53·5	2·22	...	...	37·5	15·1	30·129	...	17 2	Cowheel supper.
	4.	...	...	...	488	20·7	56	2·38	...	...	37	17·9	29·937		18 5	
	5.	...	...	...	486	20·25	64·3	2·7	...	...	39·4	9·5	29·623	...	17 0	Sausages at supper.
	6.	...	...	...	411	17·03	40·4	1·68	...	...	41·8	13·7	29·401		18 0	} A little headache; colocynth.
	7.	...	...	...	448	18·58	71·1	2·95	...	...	48·3	10·8	29·220			
Sunday.	8.	...	...	...	379	15·84	44·9	1·9	...	...	47·6	9·6	29·503	...	18 0	Purged.
	9.	...	...	...	347	14·4	66·4	2·76	...	...	48·7	11·1	29·748		16 15	
	10.	...	...	...	415	17·26	33·7	1·41	...	...	49·1	9·5	29·672	...		Very warm and close.
	11.	...	...	...	424	17·68	31·1	1·3	...	...	45·6	12	29·939	...	18 7	Hot.
	12.	...	...	...	441	18·14	63·78	2·63	...	...	50·3	4	29·720	...	17 10	
	13.	...	...	...	413	16·3	46·3	1·92	...	...	50·6	5·2	29·329		17 4	
	14.	...	...	...	406	13·89	56·4	1·93	...	...	44·7	9·8	29·887	...	17 7	Full.
Sunday.	15.	...	...	...	432	18·43	45	1·92	...	...	46·1	6·6	30·074	...	16 12	Colocynth; purged.
	16.	...	...	...	492	20·43	50·3	2·1	...	...	47·8	7·7	30·083	...	16 11	Dined out.
	17.	...	...	...	477	19·83	57	1·54	...	...	43·3	7·7	30·036		18 4	
	18.	...	...	...	425	17·89	67·5	2·84	...	...	44·2	6·8	29·822			
	19.	...	...	...	423	17·5	35·2	1·46	...	...	39·3	10·5	30·119	...	17 12	Purged.
	20.	...	...						...	...	39·2	6·4	30·278	...		At Manchester.
	21.	...	...						...	...	38·6	4·3	30·196			
Sunday.	22.	...	...						...	...	39·2	2·7	30·147			
	23.	...	...						...	...	41·7	7·5	30·202	...		Very full.
	24.	...	...						...	...	38·4	10·5	30·152	...		Colocynth; purged; very full.
	25.	...	...	...	423	17·13	29·3	1·19	...	...	36·3	10·1	30·057	...	18 15	} Very full.
	26.	...	...	...	419	16·56	46·2	1·94	...	...	31·8	15·5	30·127	...	19 2	
	27.	...	...	...	390	18·22	59·6	2·48	...	...	32·2	15·6	30·400	...	18 8	Better.
	28.	...	...	...	474	19·58	38·7	1·6	...	...	36·7	6·5	30·369		19 0	
Sunday.	29.	...	...	...	424	17·66	48·7	2·03	...	...	29·6	10	30·291		19 2	
	30.	...	...	...	440	18·27	69·8	2·9	...	...	29·9	12·6	30·283	...	17 14	Very cold.
	31.	...	...	...	299	12·64	23·6	1	...	...	36·6	5·6	30·256		18 4	
1862. Jan.	1.	...	...	...	639	26·68	66·5	2·78	...	...	33·3	7·4	30·245		18 13	
	2.	...	...	...	442	18·38	49·7	2·07	...	...	37·1	7·2	30·249		18 10	
	3.	...	...	...	422	17·53	49·9	2·07	...	...	35·4	8	29·857		17 12	
	4.	...	...	...	443	18·46	40·7	1·7	...	...	36·5	9·5	29·702	...	18 12	Black puddings at supper.
Sunday.	5.	...	...	...	443	18·5	42·5	1·78	...	...	39	12·5	29·659		19 6	
	6.	...	...	...	524	21·75	60·2	2·5	...	...	33	7·8	29·967	...	18 12	Frost.
	7.	...	...	...	455	18·7	62·4	2·6	...	...	38·9	12·5	29·912		16 10	

TABLE I. (continued).

Date.	Ingesta.		Egesta.					Daily number of observations and analyses.		Greenwich.			Weight —13 stones (182 lbs.).		Weather, state of health, and other observations.
	Solids.	Fluids.	Fæces.	Urea.		Urine.				Temperature.		Barom. daily average.	Night.	Morning following.	
				Total daily.	Hourly.	Total daily.	Hourly.	Urea.	Urine.	Daily average.	Daily range.				
	oz.	fluid oz.	oz.	grs.	grs.	fluid oz.	fluid oz.			° F.	° F.	inches.	lbs. oz.	lbs. oz.	
1862. Jan. 8.	...	...	...	364	17·5	29	1·2	...	...	44·1	13·5	29·562		18 4	
9.	...	...	...	484	19·87	29·2	1·2	...	...	49·7	7·8	29·540	...		No breakfast; at the Crystal Palace; too little fluid; very full.
10.	...	...	...	556	23	48	2·08	...	...	47·8	5·5	29·630	...	17 0	Purged; drank 2½ pints of fluid without food.
11.	...	...	...	422	18·2	47·5	2·04	...	...	47·7	8·6	29·309	...	17 11	Wet; warm.
Sunday. 12.	...	...	...	401	16·6	39	1·62	...	...	43·6	11·1	29·515		18 11	
13.	...	...	...	457	18·9	50·7	2·1	...	...	39·2	10 7	29·581		17 15	
14.	...	...	...			50·9	2·28	...	...	40·2	7·1	29·497		17 1	
15.	...	...	...	390	16·2	36·1	1·5	...	...	35·9	7·5	29·843		18 3	
16.	...	...	...	417	17·2	60·4	2·5	...	...	32·1	13·0	29·935	...	1 4	Colder; frosty.
17.	...	...	...	386	16·02	42·9	1·78	...	...	27	8·0	29·925	...	17 12	} Very cold; frost.
18.	...	...	...	503	20·7	50·8	2·1	...	...	26·8	10·0	29·936	...	17 11	
Sunday. 19.	...	...	...	420	17·44	40·9	1·7	...	...	25·3	8	29·735		18 7	
20.	...	...	...	432	17·9	59·4	2·47	...	...	28	4·1	29·510		16 15	
21.	...	...	...	400	16·7	32·3	1·34	...	...	30·5	5·1	29·383	...	17 14	Long day's work; no dinner; snow; warmer.
22.	...	...	...	443	18·5	31	1·3	...	...	40·9	16·8	29·358	...	19 4	Thaw.
23.	...	...	...	485	20·2	50·4	2·09	...	...	39·6	7·5	29·424	...	19 6	Evening party; very full.
24.	...	...	...	420	17·4	55·9	2·32	...	...	48·0	10·8	29·350		18 12	
25.	...	...	...	450	18·7	49	2·04	...	...	40·7	10·7	29·627		19 2	
Sunday. 26.	...	...	...	399	16·8	47·5	2	...	...	38·1	14·5	30·132	...		Colocynth; purged.
27.	...	...	...	418	15·45	30·5	1·13	...	...	40·6	11	30·038	...	17 0	Very little food.
28.	...	...	...	472	14·35	37·8	1·15	...	...	42·7	17	29·679		18 4	
29.	...	...	...	382	16	43	1·8	...	...	48·5	9·9	29·582	...	18 6	Sore throat; not well. } Fever with sore throat prevailing.
30.	...	...	...	375	15·64	38·4	1·6	...	...	48	6·7	29·553	...	16 14	Better.
31.	...	...	...	485	20·12	35·2	1·48	...	...	52·1	7·3	29·628	...	18 8	Well.
Feb. 1.	...	...	...	528	21·8	62	2·58	...	...	50·9	4·5	29·798	...	17 15	Soirée.
Sunday. 2.	...	...	...	492	20·45	47·3	1·97	...	...	49	5·7	29·977		18 14	
3.	...	...	...	423	17·6	42·7	1·78	...	...	50·3	7·3	30·031	...	17 4	Very tired.
4.	...	...	...	406	17	29	1·21	...	...	51·2	8·4	30·056	...	19 0	All the patients worse with debility, diarrhœa, and perspiration.
5.	...	...	...	511	20·7	74	3	...	...	49	11	29·881	...	18 0	Cooler.
6.	...	...	...	475	19·44	58·6	2·4	...	...	42·4	12·8	29·827	...	17 6	All the patients better.
7.	...	...	...	477	19·85	56	2·33	...	...	32·4	11	30·090	...	16 15	Cooler; milk supper.
8.	...	...	...	484	20·2	78·3	3·27	...	...	28·1	10	30·466		16 1	
Sunday. 9.	...	...	...	568	23·64	40·1	1·67	...	...	32·3	14	30·425		18 14	
10.	...	...	...	490	20·36	52·7	2·19	...	...	34·4	15	30·318	...	18 6	Much fat food at night.
11.	...	...	...	453	18·86	57·6	2·4	...	...	34·6	15·2	30 079	...	19 1	Evening party; very full.
12.	...	...	...	427	18·6	73·4	3·07	...	...	40·3	7·2	29·898			
13.	...	...	...	365	15·1	31·9	1·32	...	...	36·6	4	29·938		18 2	
14.	...	...	...	520	21·6	54·8	2·28	...	...	36·8	5·9	29·954		18 3	
15.	...	...	...	523	21·7	51	2·12	...	...	38·5	9·2	29·985		18 1	
Sunday. 16.	...	...	...	507	21·8	49·4	2·13	...	...	36·8	11·2	29·313		18 10	
17.	...	...	...	397	16·2	27·1	1·11	...	...	39·1	12·1	29·260			
18.	...	...	...	449	18·6	33·4	1·39	...	...	47·4	15·8	29·399			
19.	...	..	...	...	...	...	...	...	...	49·6	11·5	29·399		18 4	

	20.	...	...	...	397	16·2	27·1	1·11	...	...	50	12·1	29·502	...	18 12	Very full; warm.
	21.	...	...	...	448·7	18·6	33·4	1·39	...	...	47·5	18·4	29·718	...	19 11	
	22.	...	...	...	485	20·1	50·5	2·1	...	...	47·4	15·3	29·627	...	19 5	Fog.
Sunday.	23.	...	...	...	478·1	19·9	53·9	2·24	...	...	45·2	14	29·986	...	19 12	
	24.	...	...	...	...	...	...	...	...	...	38·3	2·4	29·959	...	...	Colocynth; purged.
	25.	...	...	...	483·3	20	44·7	1·86	...	...	33·1	5·6	30·018	...	17 1	
	26.	...	...	...	397·2	16·46	35·45	1·47	...	...	33·6	3·3	30·185	...	18 9	
	27.	...	...	...	428	17·9	69·3	2·9	...	...	34·2	4·4	30·051	...	16 8	Late supper; much fat; very cold; east wind.
	28.	...	...	...	418	17·3	37·66	1·56	...	...	35·9	7·4	29·883	...	18 4	
March	1.	...	...	...	413·7	17·16	48·2	2	...	...	36·6	11·8	29·806	...	17 4	
	2.	...	...	...	477·6	19·95	45·5	1·9	...	...	31·1	11	29·354	...	18 4	
Sunday.	3.	...	...	...	431·8	18	58·6	2·44	...	...	30·8	13	29·134	...	17 4	
	4.	...	...	...	431	17·88	39·3	1·63	...	...	29·9	18·1	29·555	...	...	
	5.	...	...	...	466	19·3	42·4	1·76	...	...	35·5	19·5	29·654	...	...	Wind changed; supped out.
	6.	...	...	...	559	23·2	45·9	1·91	...	...	48·3	16	29·386	...	18 12	
	7.	...	...	...	544	22·57	40·4	1·68	...	...	51·9	10·4	29·323	...	19 14	
	8.	...	...	...	590	24·57	65·8	2·73	...	...	53·3	12·7	29·420	...	18 2	
	9.	...	...	...	503	20·9	39	1·62	...	...	47·2	8·1	29·374	...	19 7	Catarrh.
Sunday.	10.	...	...	...	457	19·11	56·5	2·36	...	...	46·4	11	29·825	...	18 3	
	11.	...	...	...	456	19	29·5	1·23	...	...	46·1	10	29·641	...	18 14	
	12.	...	...	...	503	21	47·8	2	...	...	46·5	12·4	29·561	...	18 10	
	13.	...	...	...	477	20	69·4	2·9	...	...	44·9	12·6	29·842	...	...	Black dose.
	14.	...	...	...	430	17·8	31·6	1·31	...	...	41·8	6·2	30·009	...	19 0	
	15.	...	...	...	533	22·2	60	2·5	...	...	41·5	9·3	29·964	...	19 6	
	16.	...	...	...	443	18·5	62·5	2·62	...	...	41·5	5·9	29·767	...	19 8	
Sunday.	17.	...	...	...	443	18·44	65·3	2·72	...	...	41·7	7·9	29·639	...	17 13	

1. *Urea.*

Absolute quantity evolved.—The daily average excretion of urea, obtained from inquiries usually of a few days' duration, on persons living in their usual manner, has been most variously stated by the best observers. BECQUEREL ascertained it to be 286·1 grs.; PARKES, 371·5 grs.; BÖCKER, 444·9 grs.; BISCHOFF, 541·9 grs.; J. LEHMANN, 551·8 grs.; MOSLER, 558·9 grs.; HAMMOND, 670·6 grs., and GENTH, 688·4 grs.; but the average of all the results collected by Dr. PARKES gives 512·4 grs. per day, or 21 grs. per hour, a quantity which singularly corresponds with the amount obtained by myself on the average of all the months of the year. These inquiries were not only made upon different persons, but upon those living in different climates and at different seasons of the year; and only a very few of them were of such duration as to afford any strong evidence of the very great variations in the excretion of urea which occur in all men during lengthened periods. The amount of urea excreted to each lb. of body-weight was ascertained to be $3\frac{1}{2}$ grs. by LEHMANN and VOGEL; and Dr. PARKES ascertained, from an analysis of the returns of nine men, that it was 3·36 grs.

The average quantity of urea evolved daily in my experiments during the twelve months, from March 18, 1860, to March 19, 1861, was 519 grs., being in the proportion of 2·73 grs. to each pound avoirdupois of weight of body. The extreme quantities which were recorded are very diverse, viz. 298 grs. and 748·5 grs. daily; but the occasions on which any approach to such extreme amounts was observed were very few, as is shown in the following Table. [From March 18, 1861,

to March 18, 1862, the daily quantity was 480 grs.; so that the average daily quantity on the two years was 500 grs.]

TABLE II.—Showing the proportionate number of days on which various quantities of urea were evolved during the year.

Grains per day.	Per cent. of the whole.
200 to 300	·038
300 to 400	3·87
400 to 500	46
500 to 600	39
600 to 700	9·1
700 to 800	2·1

Thus the daily emission of urea was between 400 and 500 grs. in nearly half of the whole period of inquiry, and in only 15 per cent. of the whole were the quantities below 400 and above 600 grs.

The average weekly amount of urea was in no instance below 400 grs., and in only one instance did it exceed 700 grains per day. The quantity in this larger average was between 400 and 500 grs. per day in 49 per cent., and between 500 and 600 grs. per day in 38·3 per cent. of the whole number of weeks.

The monthly averages varied from 451 to 665 grs.; but in 47·1 per cent. the quantity was between 400 and 500 grs., and in 38·4 per cent. between 500 and 600 grs. daily.

Hence the most frequent amount of urea evolved was between 400 and 500 grs. daily, and the usual range extended from 400 to 600 grs.; but as only a few experiments were made at the period of the year when the daily evolution was commonly over 600 grains, it is probable that the true frequency of the higher rates is somewhat understated.

The following Table exhibits the average quantity of the urea, urine, and fæces which were emitted daily, and the amount of the fluid and solid ingesta, on the average of the weeks and months of the year. The thick line introduced into this and some other Tables implies that the part following has been added since the reading of the paper.

TABLE III.—Showing the daily amounts of the Ingesta and certain Egesta, with the Temperature and Barometric indications, in weekly and monthly averages.

Weekly.

Date.	No. of days.	Fluids.	Solids.	Fæces.	Urine.	Urea.	Means, Greenwich.			Weight, naked, without urine, A.M., in lbs. and oz. —182 lbs.
							Temperature.		Barom.	
							Daily.	Range.		
1860.		fluid oz.	oz.	oz.	fluid oz.	grs.	°	°	inches.	lbs. oz.
March 18 to 24.	6	52·33	44¼	5·16	52·77	487	43·1		29·557	
31.	7	52·18	40¾	4·73	49·56	438	45·3		29·378	
April 7.	7	46·87	41½	4·15	46·87	447	45·7		29·740	
14.	7	53·7	40	6·37	56·15	488	40·7		29·805	
21.	7	57·25	39¾	4·27	60·17	495	42·3		29·926	
28.	7	51·12	38	3·13	54·5	428	41·2		29·855	
May 5.	7	55·65	36	8·76	42·2	574	50·7		30·090	
12.	7	54·16	36¾	3	47·16	571	52·2		29·639	
19.	7	51·7	38	5·7	43·96	517	54·4		29·600	
26.	7	52·6	39	3·44	48·8	524	59		29·850	
June 2.	4	60·5	35½	5·14	64·8	604	51·3		29·578	
9.	7	61·1	36¾	3·97	58·6	533	51·9		29·618	
16.	7	56·7	35½	3·7	56·5	560	53·9		29·533	
23.	7	59	37½	4	41·44	487·6	56·6		29·647	
30.	7	56·5	32¾	7·8	43·8	532	57·1		29·767	
July 7.	5	56·5	39	4	47·3	514	58·5		30·126	
14.	7	59·05	37¾	4·6	56·6	495	57·4		29·870	
21.	7	55·5	35½	5·2	49·4	487	59		29·682	
28.	7	56·4	35	4·6	58·3	506	55·6		29·685	
30.	2	...	...	...	54·8	524				
Aug. 10 and 11.	2	...	...	...	68	674				
18.	6	...	...	...	62·8	635	57·8		29·477	
25.	6	...	...	...	49·7	630	57·3		29·638	
September 1.	4	...	...	...	50·7	614				
5.	2	...	...	...	78·8	715				
October 6 to 13.	3	...	...	...	56	485	45·8		29·750	
20.	6	...	35¾	...	52·8	515	50		29·612	
27.	7	...	...	4·72	59·3	554	53·2		29·911	
Nov. 11 to 17.	6	...	...	...	52	451	41·7		29·416	
24.	7	...	...	...	51·3	459	39·7		29·659	
December 1.	6	...	...	...	49·8	444	41·6		29·474	
8.	7	...	...	8·4	49·9	438	46		29·152	
15.	7	...	...	5·7	52·4	481	40		29·691	
22.	7	...	...	3·6	53·7	451	32·1		29·585	
29.	3	...	...	10·9	48·4	444	25·9		29·540	
1861. Jan. 5.	7	...	...	4·57	54·8	498	32·4		29·714	
12.	7	...	...	6·1	47·8	459	26·4		30·085	
19.	7	...	...	6·14	41·2	466	30·5		29·936	
26.	7	...	33¼	5·46	47·6	475	41		30·089	
February 2.	7	52·4	40½	6·22	48·6	520	42·3		30·126	
9.	7	50·6	34½	8·45	57·3	524	42·9		29·593	
16.	7	57·4	37¼	3·6	54·6	516	37·6		29·697	
23.	7	58·5	40¼	4·23	57·6	507	45·9		29·461	
March 2.	7	62·8	38¾	5·43	56·4	454	43·4		29·800	
9.	7	56·7	36	...	48·3	485	43·9		30·241	
16.	7	63·7	...	8·5	56·9	476	40·8		29·811	

Date.	No. of days.	Fluids.	Solids.	Fæces.	Urine.	Urea.	Means, Greenwich.			Weight, naked, without urine, A.M., in lbs. and oz. — 182 lbs.
							Temperature.		Barom.	
							Daily.	Range.		
1861. March 23 to 30.	7	fluid oz.	oz.	oz.	fluid oz. 51·93	grs. 466·2	46°·2	16°·2	inches. 29·526	lbs. oz. 12 9½
April 6.	7				52·9	494·4	43·5	18·1	29·678	12 6½
13.	7				49·1	465	44·2	20·8	29·259	12 0½
20.	7				48·8	488·6	45·4	15·4	30·128	12 11¾
27.	7				54·1	462·7	44·3	19·9	29·840	13 9¾
May 13 to 18.	6				51·5	496	51·9	23·1	30·049	14 8½
25.	6				41·4	553·5	57·5	24·3	30·009	15 6¼
June 1.	7				45·4	457·4	57·5	18·5	29·809	15 14
8.	7				51·32	483·6	53·3	13·6	29·822	16 14¼
15.	7				47·66	543	60·5	21·4	29·859	16 15¼
22.	6				37·6	480·6	62·9	23·8	29·832	17 3
29.	6				47·53	479·8	60·1	20·3	29·609	17 6½
July 6.	7				42·9	451·2	59·7	19·4	29·614	16 12¼
13.	7				42	577·1	61·5	21	29·598	13 5½
20.	7				38·7	484·1	61·3	17	29·574	13 14
27.	4				50	532·7	61·1	16·1	29·571	14 4¼
August 3.	7				50·6	493	61	21·5	29·780	14 1
10.	4				42·1	591·5	64·4	21·2	29·800	
17.	7				50·2	694·7	65·3	21·2	29·762	
24.	7				56·2	726·7	61·2	20·8	29·943	
31.	4				50·2	707·5	62·5	24·2	29·995	
Sept. 14 to 21.	7				53·4	473	54·4	20·5	29·820	17 15
28.	5				60·5	498	53·8	15·5	29·459	17 11¼
October 5.	3				46·6	519	59·3	13·5	29·816	17 10
12.	6				55	499	58·3	17·5	29·753	17 5¼
19.	3				53·5	508·4	54·6	18·3	29·952	18 14
27.	7				51·2	530·7	54·1	13·5	29·826	18 2½
November 2.	7				56·5	503·7	45·5	13·9	29·644	18 1
9.	7				51·4	436·2	42	14·6	29·460	18 5¼
16.	7				50·1	474·1	39·7	13	29·356	17 15¼
23.	7				47·7	441	37·5	11·7	29·842	18 3¼
30.	7				42·7	442·5	44·5	13·7	29·696	17
December 7.	7				60·1	487·5	40·5	14·1	29·786	18 1
14.	7				49	403·1	48·1	8·7	29·685	17 9½
21.	5				51	450	42·6	7·1	30·087	17 5¾
28.	4				43·4	426·3	36·6	9·8	30·208	18 14¼
1862. Jan. 4.	7				49·8	444	34·1	8·6	30·126	18 6½
11.	7				45·5	463·8	42·9	9·7	29·654	17 15
18.	6				47·3	425·5	35·0	9·6	29·747	17 15
25.	7				47·1	435·4	36·1	9	29·484	18 14½
February 1.	7				42	437	45·8	10·1	29·772	17 13
8.	7				55·1	466·7	43·2	9·5	30·047	17 10¼
15.	7				51·6	477·8	36·2	10·1	30·085	18 7
22.	5				40·1	459·4	45·4	13·8	29·507	18 14¾
March 1.	6				48·2	436·4	37·4	7·0	29·984	17 14¼
8.	7				48·3	500	40·1	14·4	29·404	18 7¼
15.	7				47·6	480	44·9	9·9	29·745	18 13
18.	3									

Monthly.

Date.	No. of days.	Fluids.	Solids.	Fæces.	Urine.	Urea.	Means, Greenwich.			Weight.
							Temperature.		Barom.	
							Daily.	Range.		
1860.		fluid oz.	oz.	oz.	fluid oz.	grs.	°	°	inches.	lbs. oz.
March	13	52·25	40½	4·99	51·16	462	44·2		29·467	
April	28	54·02	40	4·49	54·42	489	42·9		29·796	
May	28	53·52	37½	5·22	45·53	547	53·8		29·746	
June	32	58·76	35½	4·92	53·03	541	54·8		29·613	
July	28	56·86	37	4·6	55·3	505	57·6		29·845	
August	14	.....	...	...	60·1	646	57·7		29·556	
September	6	.....	...	...	64·6	665	56		30·023	
October	16	.....	35¾	...	56	518	50		29·791	
November	13	.....	...	...	51·7	455	40·35		29·537	
December	30	.....	...	7·15	50·6	451·6	36·3		29·491	
1861.										
January	28	.....	33¼	5·56	47·87	475	32·7		29·706	
February	28	54·7	38	5·62	52·9	515	41·2		29·959	
March	21	61·1	37	...	53·8	471·9	42·7		29·984	

1861.		fluid oz.	oz.	oz.	fluid oz.	grs.	°	°	inches.	lbs. oz.
March	7				51·93	466·2	46·2		29·526	12 9½
April	28				51·2	477·5	44·3		29·955	12 10½
May	18				46·1	502·3	53·4		29·955	15 4¼
June	26				45·9	496·5	59·2		29·780	17 2
July	32				44·8	507·4	60·7		29·623	14 7
August	22				49·6	680·3	63·3		29·875	
September	12				57	485·5	54·1		29·639	17 13
October	26				52·5	512·2	54·3		29·789	18 0
November	28				48	448·4	40·9		29·588	17 3¾
December	23				50·8	441·7	41·9		29·941	17 15½
1862.										
January	34				46·1	441·1	38·8		29·796	18 3¼
February	25				48·7	460·1	40·5		29·905	18 3¼
March.....	17				48	490	42·5		29·574	18 10

2. *Urinary Water.*

Absolute amount evolved.—The observers to whose names I have referred in reference to urea (p. 765), state the average daily elimination of urine to be 44 oz., 40 oz., 81 oz., 54 oz., 67 oz., 65 oz., 39½ oz., and 47 oz., in their order; so that there is much diversity in the amount recorded, and also in the relation between the amount of urea and urine in their several inquiries. PROUT recorded the amount as only 35 oz.; but the average of all the recorded observations collected by Dr. PARKES is 52½ oz. per day, which is almost identical with that evolved by myself on the average of the whole year.

There was very great diversity in the daily amount of urinary water excreted by myself, so that the extremes recorded were 23·5 and 92·67 fluid ounces in the twenty-four hours. On the average of the whole year, from March 1860 to March 1861, the daily quantity was 53·1 fluid ounces; but it exceeded 60 oz. on the average of two of the months, and fell below 40 oz. on the average of two other months. [From March 1861 to March 1862 the average was 49·2 fl. oz.; so that the average of the two years was 51·2 fl. oz.]

The following Table shows how frequently the decades of ounces of urine were emitted throughout the year.

TABLE IV.

20 to 30	fluid ounces in	3·8	per cent. of	the	whole observations.
30 to 40	„	14·4	„	„	„
40 to 50	„	26·2	„	„	„
50 to 60	„	26·5	„	„	„
60 to 70	„	22·4	„	„	„
70 to 80	„	4·8	„	„	„
80 to 90	„	1·3	„	„	„
90 to 100	„	·34	„	„	„

There was not, therefore, any decade which was recorded so frequently as half of the whole number of observations; but the two medium decades of 40 to 60 oz. somewhat exceeded half of the whole. The larger quantity of 60 to 70 oz. was present in no fewer than one-fifth of the whole, and the extremes of below 30 and above 70 oz. were found in 10 per cent. of the whole.

There was a close proximity in time in the emission of the extreme quantities; so that an unusually large quantity immediately succeeded to or was immediately succeeded by a small one, and *vice versâ*, as is illustrated by the following observations:—

1860. Mar.	19.	70	ounces were	followed by	50 and 41	ounces on	succeeding days.
	26.	63	„	„	49 and 28	„	„
April	14.	77	„	„	42	„	„
	19.	88	„	„	42	„	„
	25.	76	„	„	47, 41, and 29	„	„
	30.	64	„	„	35 and 25	„	„
June	11.	69	„	„	35	„	„
	26.	67	„	„	32, 44, 27, and 27	„	„
Dec.	20.	75	„	„	30	„	„
1861. Jan.	28.	70	„	„	43 and 39	„	„
Feb.	2.	60	„	preceded by	23	„	„
	21.	82	„	followed by	32	„	„
Mar.	9.	61	„	„	36	„	„
	14.	92	„	„	26	„	„
[Apr.	15.	74	„	„	33	„	„
May	20.	64	„	„	27	„	„
June	4.	81	„	„	38	„	„
Nov.	18.	76	„	„	30	„	„
Dec.	1.	75	„	preceded by	42	„	„
	12.	63	„	„	31	„	„
	30.	69	„	followed by	23	„	„
1862. Jan.	7.	62	„	„	29	„	„
Feb.	8.	78	„	„	40	„	„
	12.	73	„	„	31	„	„]

In numerous instances there was a marked alternation in the quantities evolved on succeeding days, as was noticed by Dr. PARKES, and is well shown in the following instances:—

		oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	
1860. Jan.	10 to 15.	57	37	62	44	60	46			} Plate XXXII.
1861. Dec.	3 to 8.	44	67	49	55	39	61			} fig. 1.
[May	18 to 21.	61	41	64	27					
Nov.	5 to 12.	51	36	67	35	64	48	66	49	
Dec.	5 to 10.	64	40	71	44	66	33]			

A wave extending over a period of several days was of common occurrence. The following are examples:—

	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	
1860. March 19 to 26.	73	50	41	41	57	52	54	63	} Plate XXXII. fig. 2.
April 25 to 30.	76	47	41	29	42	64			
Apr. 30 to May 6.	64	35	25	37	39	50	52		
May 21 to 25.	60	43	36	49	61				
June 18 to 21.	59	31	25	34	59				
Aug. 10 to 14.	59	76	77	56	59				
16 to 21.	72	65	41	30	45	67			
[1861. April 16 to 20.	33	53	62	46	29				
May 13 to 18.	57	47	30	55	57	61			
20 to 25.	64	27	20	32	47	55			
29 to June 3.	52	48	24	41	55	81			
June 14 to 19.	30	36	42	68	34	28			
Oct. 5 to 9.	42	52	76	49	47]				

In a few instances there was a progressive decline through many days. Thus—

	oz.	oz.	oz.	oz.	oz.	oz.	oz.
1860. Jan. 7 to 13.	68	49	49	40	42	37	26

On several occasions there was a progressive and marked increase. Thus—

	oz.	oz.	oz.	oz.	oz.
1860. Feb. 19 to 21.	35	55	87		
Oct. 15 to 27.	50	67	79		
Mar. 10 to 14.	31	60	59	69	92
July 4 to 8.	34	38	60	62	74

In a few instances the quantity remained very high for some days. Thus—

	oz.	oz.	oz.
1860. May 31 to June 2.	84	65	72

Owing to the complexity of the attendant circumstances, it is not possible to assign the precise cause to each variation; but the relation of temperature and barometric indications will be considered further on.

[*Relation of Urinary Water to Weight of Body.*

A reference to Plate XXXVI. will show that there is a very marked and an inverse relation between the variations in the quantity of urine evolved and those of the weight of the body on the same day. There is not an exact correspondence between the two, since the weight of the body must be influenced by many other circumstances than that of the loss of urine; but a selection of the instances in which there was a large and sudden variation in the quantity of urine will suffice to prove the close relationship referred to, and shown in the following Table.

TABLE V.

Date.	Increase of urine.	Decrease of weight.	Date.	Decrease of urine.	Increase of weight.
	fl. oz.	oz.		fl. oz.	oz.
1861. April 1.	16	12½	1861. April 23.	35	14½
15.	30	28½	26.	38	19
22.	32	28	May 31.	24	15
June 3.	26	23	June 3.	43	10
17.	26	23	28.	23	6½
July 6 to 8.	28	30	Oct. 5.	18	20
26 to 28.	37	21	8.	27	12
Sept. 15 to 17.	32	15	Nov. 19.	46	13
October 3.	23	25	26.	22	21
6.	24	28	Dec. 31.	46	6
21.	27	27	1862. Jan. 8.	33	23
November 18.	30	33	21.	27	15
December 1.	33	14	Feb. 2.	15	15
12.	32	13	4.	13	28
1862. February 5.	45	16	9.	38	45]
8.	22	14			

3. *Relation of the quantities of Urea and Urinary Water.*

The relation of urea to urinary water may be ascertained by arranging the daily emissions of urine in decades of fluid-ounces, and determining the quantity of urea which was contained in each decade. The following Table is constructed in this manner; and, in addition, the whole year is divided into monthly periods.

TABLE VI.—Showing the amount of Urea, ascending with each decade of ounces of urine emitted daily, during every month of the year.

Urea emitted daily (omitting decimals).

Urine.	1860.										1861.		
	Mar.	April.	May.	June.	July.	Aug.	Sept.	October.	Nov.	Dec.	January.	Feb.	March.
fluid oz. 90 to 100	grs. ...	grs.	grs.	grs.	grs.	grs. ...	grs.	grs.	grs.	grs.	grs.	grs.	grs. 460
80 to 90	...	534	655	.....	.....	...	693	.....	.....	.....	.....	543	
70 to 80	452	509 535	.....	642	518	575 614 725	739	603 620		464 504	586		
60 to 70	375 471	389 513 419 518 460 483	520 531 594	489 520 497 541 507 583 519 601	465 509 473 509 482 524 487 537	617 643 748	633	529 608 540 621 546 556	489 557	455 489 461 530 463 473	408 470 418 492 427 485	418 507 445 528 483 547 488 584	432 473 538 574
50 to 60	384 480 499 502 580	355 473 511 503 538	509 646 560 574 576 595	487 555 498 563 517 580 547 590 553 633	420 515 463 520 466 534 482 548 499 617	604 621 623 732	.....	461 468 523	428 487 437 548 446 478 482	420 445 453 506 561	461 559 609	474 561 505 517 548 593	441 455 456 473 631
40 to 50	404 431 488 499	376 544 410 565 419 589 429 604 463 713 484	486 595 504 599 516 532 553 562	416 674	456 464 464 500 502 505	534 591 579 714	.....	434 462 581	403 413 424 433 485	298 528 380 539 425 554 433 449 526	413 495 429 495 436 498 444 510 451 552 452 649 480	360 532 439 477 486 489 508 526	470
20 to 30	421	511	485 528 517	446 551 512	.....	...	.....	.....	.....	.....	467	472	411
30 to 40	...	449	432 539 454 545 473 592 505	404 547 475 596 522 528	510 526 535	602 659	.....	350 520	418 447	364 476 398 401 436	408 492 441 500 472 503 487	427 462 480 552	436 451 467 496

There is so great a variation in the amounts of urea recorded, in every part of the Table, that at first sight it appears to be impossible to eliminate any general law. In every decade of ounces of urine the variation in the amount of urea, in even the same month, extends to from 50 to 200 grains; and this is equally true whether we regard the medium or the extreme quantities. When, however, we make an average of the whole observations in each month and under each decade, we find that they arrange themselves on a general plan. The following Table contains the average of all the observations made during each month, arranged in the order of the ascending decades of ounces of urine.

TABLE VII.—Showing the average relation of the amounts of Urea and Urinary Water at each month of the year, and in every decade of ounces of urine (omitting decimals).

	1860.										1861.		
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
fluid oz.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.
90 to 100	...	...	...	...	...	...	...	...	...	...	...	...	460
80 to 90	...	534	655	...	...	...	693	...	...	...	...	543	
70 to 80	452	522	...	642	518	638	739	611	...	484	586	...	
60 to 70	423	465	546	532	473	669	633	566	473	468	450	500	504
50 to 60	489	476	576	552	505	645	...	463	472	496	543	533	491
40 to 50	455	545	543	545	479	...	...	469	431	463	525	489	470
30 to 40	...	449	505	512	527	635	...	485	432	415	471	480	460
20 to 30	421	511	510	503	...	...	...	...	...	...	467	472	411

Omitting any reference to the unique instance of the emission of upwards of 90 fluid ounces of urine in one day, we find that the following unbroken order occurs as we ascend in each decade, commencing with the second. Thus—

TABLE VIII. (Plate XXXII. fig. 3.)

Urine (fluid oz.)...	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90
Urea (grs.).....	470	490	492	520	531	577	606

The decade from 50 to 60 fluid ounces represents the average quantity of urea and urinary water evolved daily throughout the year, whilst the superior decades represent the larger, and the inferior the lesser quantities of urea.

But although the lines of urinary water and urea run parallel to each other, there is not a precise correspondence in the daily excretion of these two substances, as the following Table shows:—

TABLE IX.—Showing the weight of Urea in each fluid ounce of Urine, arranged in the ascending order of the middle of each decade of ounces of the latter (Plate XXXII. fig. 4).

Urinary water (fluid oz.)...	25	35	45	55	65	75	85
Urea (grs.)	18·8	14	10·9	9·4	8·1	7·7	7·1

There was thus a progressive decrease in the amount of urea found in each ounce of urine as the quantity of the latter evolved daily increased; but the quantity of urea in the lowest was proportionately greater than in the higher decades, and the decrease was more rapid in the ascent from the two lowest decades. If the decade between 50 and 60 fluid ounces be accepted as the central point of this variation, it will be observed that the degree of divergence differs greatly at the two extremes, although equidistant; so that it is the greatest in the upper and the least in the lower decades. In reference to the total daily quantity of urea evolved, the difference was an increase of $16\frac{1}{2}$ per cent. with the highest, and a decrease of 9·6 per cent. with the lowest decades; but in reference to the quantity of urea in each ounce, the increase with the lowest decade was 100 per cent., whilst the decrease with the highest decade was only 24 per cent.

Thus with increase of urinary water there was a greater increase in the urea than there was a decrease of urea with decrease of urinary water, and the least difference in the amount of urea in each ounce of urine. The average proportion of urea and urinary water throughout the year was 9·77 grains of the former in each fluid ounce of the latter; and assuming the average specific gravity of the urine to be 1020, the proportion of urea to urinary water was 2·19 per cent.

4. *Period of the day.*

PARKES states that the quantities of the ingredients of the urine are the highest in the afternoon and evening, from the effect of the dinner and the exertion of the day. DRAPER found the quantity of urea to have lessened in the night, but the urinary water was equal in the day and night. KAUPP found that when there was a large excretion in one period there was a small one in the other; and PARKES noticed a certain oscillation extending to two or three days. KAUPP also ascertained that there was a diminution in the excretion of urine, urea, and chloride of sodium during the night. In none of these inquiries were the hours of the day and night defined, neither were the conditions as to the ingesta and the hours of the meals alike.

In stating the results of my own inquiries, I shall arrange them under two heads, viz. with ordinary food, and with fasting or variation from ordinary food.

A. *With ordinary food.*

This part of the inquiry has been investigated by several series of experiments. The amount of urea and urinary water evolved per hour was determined thrice a day throughout nearly the whole year, viz. the average excretion of the whole day, the average of the night, and the quantity secreted in the morning, after the night urine had been voided, and before any fluid or solid food had been taken. The two former embraced lengthened periods, whilst the latter extended to from twenty minutes to one hour only. The object in determining the latter quantity was to ascertain if, at the period of the day when the system was the least influenced by food, there was so uniform a production of urea as to constitute a standard with which to compare the quantities produced

at other periods, and to determine the influence of meteorological phenomena over the daily production of this excretion. At that period, moreover, the only disturbing cause in operation was the slight exertion required whilst dressing. This was called the "basis quantity," and corresponds to a similar inquiry recorded in my paper on the evolution of carbonic acid, published in the Philosophical Transactions, 1859. But beyond these three periods of inquiry there was commonly a fourth, viz. that which intervened between the emission of the basis quantity and midday; and further, an analysis of the urine was made at frequent intervals in the afternoon during the months of January, February, and March 1860.

Another series of inquiries was expressly instituted to determine the hourly emission with the utmost exactitude; and on three days the urine was passed at every hour, and on two other days at every quarter of an hour during the day.

The food was taken at the hours indicated in the earlier part of this paper. I shall now proceed to describe the result of the first series of inquiries.

Relations of Urea.

Plate XXXIII. exhibits the hourly quantities of urea and urinary water at the four periods just mentioned, viz. the whole day, the night, the basis quantity, and the period until midday, on each day of the inquiry throughout the year, and the following Table contains the weekly and monthly averages of the daily quantities.

TABLE X.—Showing the quantity of Urea and Urinary Water excreted per hour, at different periods of the day, on the average of the weeks and months of the year.

Weekly Averages.

Date.	Urea.				Greenwich Means.		Urine.			
	24 hours.	Night.	Basis.	To midday.	Temp.	Barom.	24 hours.	Night.	Basis.	To midday.
1860.	grs.	grs.	grs.	grs.	°	in.	fluid oz.	fluid oz.	fluid oz.	fluid oz.
March 18 to 24.	20·3	17·6	21·36		43·1	29·557	2·2	1·13	1·81	
31.	18·2	14	18·31		45·3	29·378	2·06	1·07	1·79	
April 7.	18·5	13·1			45·7	29·740	1·95	1·14		
14.	20·3	16·5	19·01	25·4	40·7	29·805	2·34	1·4	1·98	5·79
21.	20·6	16·7	22	27	42·3	29·926	2·67	1·24	2·24	6·8
28.	22	17·3	20·14	27·72	41·2	29·855	2·27	1·36	1·93	6·1
May 5.	23·9	20·2	18·4	23·8	50·7	30·090	1·75	1·15	1·15	1·98
12.	23·7	21·2	20·3	27·89	52·2	29·639	1·97	1·33	1·36	3·44
19.	21·5	20·2	19·9	24·81	54·4	29·600	1·83	1·22	1·49	2·55
26.	21·8	18·9	20·7	21·9	59	29·850	2·03	1·53	1·79	2·1
June 2.	25·1	19·5	30·5	27·13	51·3	29·578	2·71	2·2	3·36	6·7
9.	22·2	20	22·7		51·9	29·618	2·44	1·6	2·5	
16.	23·3	19	22·9		53·9	29·533	2·35	1·44	2·37	
23.	20·3	17·1	15·9		56·6	29·647	1·71	1·4	1·87	
30.	22·1	15·5	21		57·1	29·767	1·82	1·3	2·2	
July 7.	21·4		18·5		58·5	30·126	1·97		1·45	
14.	20·6	20·2	17·3		57·4	29·870	2·35		1·79	
21.	20·2	17·8	18		59	29·682	2·05		1·87	
28.	21	18·2	18		55·6	29·685	2·43		1·96	
30.	21·8		23				2·28		2·74	
August 10 & 11.	28·1						2·83			
18.	26·4				57·8	29·477	2·61			
25.	26·1				57·3	29·636	2·07			
September 1.	25·5						2·11			
5.	29						3·28			
October 6 to 13.	20·2		20·9		45·8	29·750	2·33		2·2	
20.	21·8		21·7		50	29·612	2·2		2·2	
27.	23	15·4	20·3		53·2	29·911	2·47	0·99	1·95	
November 17.	23	12·07	17·6		41·7	29·416	2·16		2·28	
24.	23·3	13·7	19·6		39·7	29·659	2·14	0·93	1·98	
December 1.	17	17·2	21·6		41·6	29·474	2·07	1·38	2	
8.	18·2	15	21·9		46	29·152	2·07	1·38	2·11	
15.	20	15·2	17·9		40	29·691	2·18	1·02	1·72	
22.	16·1	13·6	18·3		32·1	29·585	2·1	0·92	1·45	
29.	18·3	17·5	25·97		25·9	29·540	2·01	1·1	2·18	
1861. Jan. 5.	20·7	16·5	21·8		32·4	29·714	2·28	0·92	3·08	
12.	18·5	15·4	21	24·13	26·4	30·085	1·99	0·97	2·09	3·9
19.	19·4	15·6	16·42		30·5	29·936	1·71	1·09	1·02	
26.	19·8	16·7	19·15	21·8	41	30·089	1·98	0·99	1·74	4·35
February 2.	21·6	16·7	22·04	27·15	42·3	30·126	1·85	1·2	2·69	4·5
9.	21·4	17·2	19·7	27·5	42·9	29·593	2·14	1·06	2·22	6·43
16.	21·5	17·6	19·5		37·6	29·697	2·27	1·43	2·06	
23.	20·8	16·65	22·64	29·43	45·9	29·461	2·4	1·43		4·85
March 2.	17·1	16·4	20·4		43·4	29·800	2·35	1·33	2·41	
9.	20·2	16·9	19		43·9	30·241	2·01	1·8	2·02	
16.	19·8	16·03	22·7		40·8	29·811	2·37	1·29	2·76	

TABLE X. (continued.)

Monthly Averages.

	Urea.				Greenwich Means.		Urine.			
	24 hours.	Night.	Basis.	To midday.	Temp.	Barom.	24 hours.	Night.	Basis.	To midday.
	grs.	grs.	grs.	grs.	°	in.	fluid oz.	fluid oz.	fluid oz.	fluid oz.
1860, March.....	19·25	15·8	20·8		44·2	29·467	2·17	1·1	1·83	
April	20·3	15·9	20·38	26·7	42·9	29·796	2·27	1·28	2·03	6·23
May	22·7	20	19·8	24·6	53·8	29·746	1·89	1·41	1·45	2·5
June	22·5	18·2	22·6		54·8	29·613	2·21	1·59	2·46	
July	21	18·7	18·9		57·6	29·845	2·3		1·96	
August ...	26·8				57·7	29·556	2·5			
September	27·2				56	30·023	2·7			
October ...	21·6	15·4	20·9		50	29·791	2·33	·99		
November	23·1	12·9	18·6		40·35	29·537	2·15	·93	2·11	
December	17·6	15·7	21·13		36·3	29·491	2·18	1·16	1·89	
1861, January ...	19·6	16	19·6	23	32·7	29·706	1·99	·99	1·97	4·12
February...	21·3	16·5	20·97	28	41·2	29·959	2·2	1·28	2·32	5·29
March ...	19	16·4	20·7		42·7	29·984	2·24	1·7	2·39	

Both the Plate and the Table prove that the least hourly elimination of urea occurred in the night, and that the "basis quantity" was higher than that of the night. The average of the whole day was greater still, and the highest elimination took place in the morning hours, up to, or a little beyond midday. On the average of the whole yearly returns combined, the difference in the amount eliminated at the different periods of the day is sufficiently great; for if the average excretion of the whole day be accepted as the standard, that of the night was 24, and the "basis quantity" was 6·4 per cent. less, whilst the increase to midday was 17·5 per cent. greater than that standard. The following are the average quantities excreted at these periods:—

	Whole day.	Night.	Basal quantity.	To midday.
	grs.	grs.	grs.	grs.
Urea	21·7	16·5	20·3	25·5

The relative diminution of the excretion in the night is greater than this mode of comparison indicates; for the standard of the day has been lowered by adding the diminished quantity of the night, in order to obtain the average of the whole day. Nothing, however, would be gained by separating the day from the night hours, so as to use the rate of excretion in the former as a standard of comparison with the latter, since no two observers agree as to the hours which constitute the day and the night respectively. The Table also imperfectly exhibits the amount of excretion before midday, since that part of the investigation was not pursued at the period of the year when the largest elimination of urea was proceeding; but the second series of inquiries remedy this defect.

The *monthly averages* in Table X. vary the order above given in but one instance, when the basis quantity was ·2 gr. per hour less than that of the night. There is also an unimportant exception in the *weekly averages*, in reference to the rate of the night excretion, in which the night exceeded the day excretion by ·2 gr. per hour. The former occurred in May, and the latter in December.

There are, however, no fewer than seventeen exceptions in reference to the relative position of the basis quantities and the average of the day. In several instances the excess of the basis quantity was very small, but during the occurrence of the frost in December the basis exceeded the day average, on four out of five weeks, by 4·6, 3·7, 2·1, and 7·6 grs. per hour. In five weekly averages the basal rate fell below the night rate.

Plate XXXIII. shows that, in reference to the relative position of the night rate of excretion, on only thirteen occasions throughout the whole year did it exceed the day rate, and then only to the small extent stated in the following Table:—

TABLE XI.—Showing the exceptional instances in which the night rate exceeded the day rate of excretion of urea, and the amount in excess.

1860.	Grains per hour.		Grains per hour.
April 10.	·4	June 22.	·45
12.	·83	23.	·15
16.	·18	25.	·15
May 11.	3·85	January 25.	1·17
16.	1·3	December 4.	·17
18.	·5	8.	1·74
24.	·6		

The most marked exception occurred on May 11, in which the excess was 20 per cent. of the day rate, and was occasioned by an unusually large supper, which was eaten on that night. The same kind of explanation is also applicable to the exception on April 12; but in several other instances, as on December 4 and 8, the exception was due to an unusually low day rate of excretion of urea and urine. In a future part of this paper I shall consider more fully the influence of food in varying the day and night rate of elimination of urea.

The investigation of the true value of the basis quantities is beset with much difficulty; for whilst on a large average they are less than the day rate and greater than the night rate, there are not fewer than seventy-two exceptions to the former and twenty-four to the latter law; and whilst many of them are insignificant, there are others in which the variation is very considerable. I think it of great physiological importance to determine if these quantities will at all represent the average of the day, or be any fixed standard with which to compare other returns of a varying nature; and with a view to the more complete investigation of this period, I have abstracted and tabulated these exceptions, and have placed by their side the actual quantities of urine emitted on the same and on the previous day. It is very probable that, if any relation exists between the urea in the basis quantity and the total quantity of urine of the day, it will have reference to the day preceding the "basis quantity."

TABLE XII.—Showing the *exceptions* in the "basis quantities" as compared with the day and the night rate of elimination of urea, and the quantity of urine emitted on the same and on the preceding day.

I. Basis quantity in excess of the Day Rate.

Date.	Day.	Urine.		Urea variation.	
		Day before.	Same day.	Same day.	Day before.
1860.		fl. oz.	fl. oz.	grs.	grs.
March 19.	Monday	58	50	5·4	
21.	Wednesday	50	41	·2	1
22.	Thursday.....	41	41	2·2	1·8
26.	Monday	54	63	·45	
27.	Tuesday	63	49	2·65	1
29.	Thursday.....	28	40	5·3	4·7
April 1.	Sunday	50	60	·98	
2.	Monday	60	50	1·1	1·1
3.	.....	...	...	...	1·5
11.	Wednesday	46	61	1·76	1·2
12.	Thursday.....	61	46	·1	
13.	Friday	46	57	2·5	6·3
15.	Sunday	77	42	1·9	
16.	Monday	42	61	11·11	8·6
17.	.....	...	...	...	2·2
18.	Wednesday	64	64	3·7	4
20.	Friday	88	42	4·7	2·6
21.	.....	...	...	...	·5
23.	Monday	54	67	3·7	5·6
24.	Tuesday	67	64	3·9	2·4
May 3.	Thursday.....	25	37	1·3	·3
10.	Thursday.....	48	57	1·5	1·5
12.	.....	...	...	...	4·3
20.	.....	...	...	...	2
21.	Monday	55	60	3·0	·7
31.	Thursday.....				
June 1.	Friday	72	72	9·5	
6.	Wednesday	68	57	2·5	4·4
7.	Thursday.....	58	58	6·14	5
8.	Friday	63	63	6·3	4·3
9.	.....	...	...	...	·9
10.	Sunday	67	65	4·9	8·3
11.	Monday	55	55	6·4	·1
22.	Friday	59	68	·39	
23.	Saturday	57	57	2·1	1·4
26.	.....	...	...	·45	·32
July 16.	Monday	56	51	2·9	
17.	Tuesday	51	54	2·67	3·5
21.	Saturday	47	50	·42	
23.	Monday	52	68	1·8	1·4
26.	.....	...	...	...	·12
29.	.....	...	...	...	·3
30.	Monday	54	55	3·3	
October 9.	Tuesday	65	69	1·6	
15.	Monday	...	61	2·33	
16.	.....	...	...	...	3·2
19.	Friday	41	30	4·7	
20.	.....	...	...	...	5·9
23.	Tuesday	61	50	9·2	5·5
24.	.....	...	...	...	1·1

TABLE XII. (continued.)

Date.	Day.	Urine.		Urea variation.	
		Day before.	Same day.	Same day.	Day before.
1860.		fl. oz.	fl. oz.	grs.	grs.
November 12.	Monday	...	58	10·6	
13.	.....	...	...	...	·6
15.	Thursday.....	36	60	·75	·7
16.	Friday	60	56	·3	2·8
17.	Saturday	56	44	·27	
18.	Sunday	44	41	·29	6·8
20.	Tuesday	49	55	9·2	11·5
22.	.....	...	...	...	·1
27.	.....	...	...	...	1·0
29.	Thursday.....	47	49	4·7	
December 1.	Saturday	35	49	·7	4·6
3.	Monday	45	54	·53	2·6
4.	Tuesday	54	37	·6	·7
9.	Sunday	46	38	·19	1
11.	Tuesday	60	57	·7	
13.	.....	...	...	...	3·4
19.	Wednesday	65	30	2	
20.	Thursday.....	30	75	·45	4·2
23.	Sunday	40	40	4·6	7·8
24.	Monday	40	59	4·2	3·3
31.	Monday	30	70	4·8	
1861. Jan. 3.	.....	...	...	...	1·1
7.	Monday	47	68	1·2	·6
10.	Thursday.....	49	40	8·5	10·2
11.	Friday	40	42	2·1	2·7
25.	.....	...	...	...	3·3
27.	Sunday	44	49	4·6	5·1
29.	Tuesday	70	43	5	
February 4.	Sunday	57	64	1·5	1·5
12.	Monday	67	58	·63	
20.	Tuesday	35	55	4·8	5·3
21.	.....	...	...	...	·7
22.	.....	...	...	...	·2
24.	Sunday	51	44	1·7	
25.	Monday	44	65	8·4	8·6
26.	Tuesday	65	62	2·6	·8
27.	Wednesday	62	40	5·38	2·5
March 3.	Sunday	63	44	1·6	
5.	Tuesday	55	49	1·1	
6.	.....	...	...	...	2·2
10.	Sunday	...	31	·4	
11.	Monday	31	60	2·9	2·0
12.	Tuesday	60	59	4·4	3·2
13.	.....	...	...	...	1·6
14.	Thursday	69	92	6·9	2·2

TABLE XII. (continued.)

II. Basis quantity less than the Night Rate of Urea.

Date.	Day.	Urine.		Urea variation.	
		Day before.	Same day.	Night following.	Night before.
1860.		fl. oz.	fl. oz.	grs.	grs.
March 25.	.....	...	...	...	·47
28.	Wednesday	49	28	3·9	
April 3.	Tuesday	50	45	·11	
12.	Thursday.....	61	46	·73	
May 4.	Friday	37	39	3·5	5·0
5.	Saturday	39	50	4·2	1·7
9.	Wednesday	40	48	5·5	·2
11.	Friday	57	49	7·8	5·5
12.	Saturday	49	44	1·2	
13.	Sunday	44	60	·68	5·5
14.	Monday	60	55	·58	3·3
16.	Wednesday	43	53	4·6	·1
17.	.....	...	...	...	1·5
18.	Friday	25	45	2·2	
22.	.....	...	...	...	3
24.	Thursday.....	36	54	6·1	
June 3.	Sunday	72	54	3·6	2·4
5.	Tuesday	69	35	5·6	1·5
12.	.....	...	...	...	4·0
20.	Wednesday	25	34	3·56	3·0
21.	Thursday.....	34	59	2·5	2·9
22.	.....	...	...	...	·5
July 9.	.....	...	...	...	4·4
28.	Saturday	60	57	·4	
November 23.	Friday	62	50	·5	
December 12.	Wednesday	57	53	·9	
1861. Jan. 25.	Friday	33	51	1·9	
February 3.	Sunday	60	57	4·0	
10.	Sunday	40	44	3·14	
March 2.	Saturday	55	63	9·9	5·0

On comparing the exceptions with the daily excretion of urine, it is seen that they are almost equally numerous when compared with the urine of the same or the previous day; so that it might be inferred that there is no essential connexion with either; but on regarding the total average of the quantity of urine emitted on the day before these exceptional occurrences, it will be observed that the quantity is so high as 67·3 oz., and that the list embraces not fewer than twenty-three occasions on which the quantity exceeded 60 ounces daily. Thus there is a connexion established between unusually large excretion of urinary water and unusually high basis quantity of urea emitted on the following morning, and this corresponds with observations recorded when making the

analyses throughout the year. It should also be noticed, in reference to the amount of urine emitted on the same day, that whilst on the average it was scarcely higher than the average of the year, the list comprehends twenty-one occasions on which the quantity exceeded 60 ounces.

On turning to the exceptions in the relation of the basis quantity of urea with the night urine, it is seen that the defect in the quantity of urine emitted, both on the preceding and on the same day on which the defect in the basal quantity of urea occurred, is quite as marked as is the excess of urine in relation to excess of the basal quantity of urea; for the average was below that of the whole year, and the list comprehends a large proportion of the days of unusually small emission of urine.

Hence it is shown that, although the "basis quantity" of urea is on the whole average greater than the night and less than the day quantities, it has a marked tendency to become in excess whenever the quantity of urine is increased, and to be in defect when the quantity of urine is diminished. After a laborious analysis of the returns, and a careful consideration of the subject, I fear that there is not any period of the day at which a standard excretion of urea may be established for short periods, and that the determination of this basis quantity will aid but little as a measure of the vital actions proceeding in the body.

The *monthly* and *weekly* averages of the rate of excretion of urea before midday, with but one exception, conformed to the rule established by the yearly average. The excess in this quantity over the daily average varied in different weeks from 0 to 8·6 grs. per hour. In the instance which forms the exception, this morning rate was equal to that of the whole day, and was caused by a reduction of the rate on one day from an attack of diarrhœa, which occurred in the morning hours. There were also three exceptions in the weekly averages; but two of these involved only the second place in decimals, and the last was deficient to the extent of 2 grs. per hour. With all these exceptional conditions, there was associated a remarkable diminution in the quantity of urine voided during the morning hours.

The relative position of the excretion of urea in the morning hours, in reference to the other periods now referred to, is thus well established.

I determined the rate of the excretion of urea during the afternoon at intervals of two or three hours in the month of February 1860, and have stated the results in a few cases in Table XVI. There are variations on the different days; but they do not affect the general direction of the curves, so that all agree in showing that there is a large and rapid increase in the elimination of urea in the morning hours, followed by a gradual decline as the afternoon advances. The hour of maximum elimination was commonly from midday to 2 P.M.; but sometimes it was so early as 10 A.M., and so late as 4 P.M. There was frequently seen an attempt at increase in the middle of the afternoon, and this will be further elucidated when we describe the results of the next series of inquiries; but in the instance of February 17 this tendency was so exaggerated as to cause the maximum elimination to occur at that period, a circumstance which was due

to the ingestion of an unusually small quantity of fluid at the breakfast, and to my having taken 18 oz. of strong beef-tea without solid food at $1\frac{3}{4}$ P.M. The first cause lessened the morning excretion, whilst the second increased the emission at the hours indicated; and on both of these grounds, and from my being unwell in the afternoon, the day was exceptional.

I now proceed to describe the results of the observations made at each hour of the day, and at every quarter of an hour during limited periods.

Most observers have found that the emission of urinary water is increased nearly one-third in the second or third hours after a meal; but others, as CHAMBERT, found no increase, and BENEKE met with great diversity in his results.

All persons have, however, noticed an increase in the elimination of urea after a meal; but there is a diversity of statement as to the commencement and the duration of the increase. LEHMANN and others found it to commence during the first hour, and to attain its maximum in the third hour; but VOIT, in his experiments upon dogs, sometimes observed the maximum so late as the seventh, and traces of the increase remained throughout nearly a whole day.

On March 1 and 2, 1861, I made hourly observations from 8 or 9 A.M. until midnight. The only variation from the ordinary food was, that the dinner on March 2 was unusually large, and black pudding and coffee were taken so late as $10\frac{1}{2}$ P.M. The following Table contains the results of the inquiries (Plate XXXIV. fig. 1).

TABLE XIII.—Showing the Hourly Excretion of Urea and Urinary Water, and the periods of Meals.

1861.	A.M.				P.M.												
	Breakfast.				Dinner.				Tea.				Supper.				
	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	Night.
	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.
Urea, Mar. 1...	...	23	17·7	20·3	29·7	23	15·4	16·8	13·8	20·4	22·8	22·7	25	16·7	19·1	20·6	15·68
Urea, Mar. 2...	10·6	20·6	31·4	25·8	28	26	24·3	17·8	...	20·7	17·6	25	28·4	29·2	23·9	20·2	19·5
	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.
Water, Mar. 1	...	4·5	3·94	3·2	9	5·12	1·8	1·6	1·28	1·97	1·55	2	2·76	1·82	1·6	1·47	1
Water, Mar. 2	1·03	2·05	7·5	4·1	11·1	5·05	3·35	1·75	...	1·45	1·15	1·95	2·6	2·87	2·23	1·33	1·44

On December 17 and 18, 1860, I determined the rate of excretion at each quarter of an hour, from $9\frac{1}{4}$ A.M. to 1.45 P.M. on the former, and from 1 P.M. to $3\frac{1}{2}$ P.M. on the latter day. I did not venture to pass urine so frequently as each quarter of an hour throughout the whole day without intermission, on account of the influence which I believe it to have of increasing the secretion of urine and of causing an unusual state of excitement at the neck of the bladder. Breakfast was taken on the first day from 9.20 to 9.37 A.M., and dinner commenced at 1.52 P.M.; whilst on the second day coffee, with bread and butter, was taken from 1.20 to 1.30 P.M. The following Table exhibits the results of these inquiries.

TABLE XIV.—Showing the Hourly Rate of Elimination of Urea and Urinary Water at each quarter of an hour.

1860.	A.M.							P.M.													
	10½	10¾	11	11¼	11½	11¾	12	12¼	12½	12¾	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½
December 17.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.							
Urea	29·6	24·8	27·1	26·6	27·8	35·2	33·6	36	40	54·6	26	24	24	25							
	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.							
Water.....	7·7	7·37	8.34	8·2	9·6	12·8	11·6	12	9·9	13·5	6·5	4·6	6	4·6							
December 18.												grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.
Urea	...	...	...	...	...	...	...	...	...	...	...	23·7	22	25·1	20·8	20·5	24·2	22·8	23·2	28·8	25
												fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.
Water.....	...	...	...	...	...	...	...	...	...	...	...	4·4	3·8	4·5	4·2	3·12	3·37	3	3	3·8	5·4

The changes described in Tables XIII. and XIV. are also delineated on Plate XXXIV. figs. 1 & 2.

The hourly inquiries show that there was a rapid increase of from 10 grs. to 30 grs. per hour in the elimination of urea during the morning hours, followed by a diminution to 15 or 17 grs. per hour at the middle hours of the day. There was a second elevation to 25 and 29 grs. per hour in the afternoon with its maximum at 9 or 10 P.M.; and after that period the final fall occurred, which reduced the rate to the lowest amount of the twenty-four hours. The former was the greater and the more enduring elevation. The smallest emission during the day occurred after the early dinner hour, and the second elevation followed the tea meal. On March 2, when the greatest evening elevation occurred, there was an unusually large ingestion of food, viz. 40¾ oz. of solid food (including 9 oz. of meat and bacon), and 68 oz. of fluid, and there was a sense of oppression or of excess in the evening. On comparison of these observations with those made at longer intervals, there appears some disagreement, since the latter (Table XVI.) did not usually show any very distinct evening increase; but it may be stated in explanation, that the longer interval between the inquiries prevented the discovery of the full fall after midday, and by taking the average of a part of the morning increase with a part of the subsequent fall, and again an average of a part of the fall with a part of the subsequent increase, the effect of both seemed to be nearly lost.

The more frequent inquiry at each quarter of an hour, shows yet more clearly the rapid changes which occur during the morning hours. Table XIV. shows that a maximum rate of nearly 55 grs. of urea per hour occurred in 3¼ hours after the breakfast, and was followed by a decline to less than half that amount in the following quarter of an hour. The second part of this inquiry shows the comparatively low and uniform ate of emission after the midday hours, and also the commencement of the evening elevation.

Hence it is proved that when meals are taken at the hours adopted by the mass of tne people, there is a rapid and maximum excretion of urea in the hours following the breakfast, with a subsidence at about the early dinner hour. There is no increase immediately following the dinner, but after the tea meal and in the early evening hours there is a second increase, which is finally lost in the night hours.

Relations of Urinary Water.

Table XVI. shows that the relations of urinary water to period of the day are very similar to those now described in reference to urea. The average rate at all hours combined was 2·21 fluid ounces, whilst that of the night was reduced to 1·19, and the basis quantity to 2·05, but the quantity evolved to midday was increased to 4·41 fluid ounces. The decrease in the night and at the hour of the basis quantity, as compared to the whole day rate, was 46 and 7·2 per cent., and the increase at midday was 100 per cent.

The night rate varied in the different months from ·93 to 1·59 fluid ounce per hour; but its position in reference to the rates at the other periods of the day was uniformly maintained in every month, and also in every week, during the year, except on two occasions (May and June), when it was equal to the basis quantity. Plate XXXIII. shows that in only six instances throughout the year did the night rate equal or exceed the whole day rate; and the increase was only to the following amount:—

May 20.	May 31.	June 21.	December 6.	December 30.	February 23.
·1 fl. oz.	·43 fl. oz.	·43 fl. oz.	·26 fl. oz.	·07 fl. oz.	·18 fl. oz.

There were, however, seventeen instances, as is shown in the following Table, in which the relative positions of the night and basis rate were reversed, and the former exceeded the latter.

TABLE XV.—Showing the exceptional instances in which the night rate of elimination of urinary water exceeded the "basis quantity," and the amount of increase. The seven instances marked with an * correspond with the exceptional instances in reference to urea in Table XII.

1860.		Fluid ounce.			Fluid ounce.
April	14	·9	June	3*	·34
	21	·24		21*	1·31
	25	·72		23	·1
May	5*	·61	December	16	·12
	9*	·47	February	2	·1
	12*	·75		21	·49
	20	·83		23	·47
	24*	·68	May	2*	·41
	31	·13			

If we omit reference to the variation on June 21, the exceptions are not important; and as they form so small a proportion of the whole, they do not invalidate the general law. Hence it is established that the night rate of the emission of urinary water is less than the whole day rate, and than the "basis quantity."

The "*basis quantity*" exceeded the whole day rate in two months, viz. June and March, to the extent of ·25 and ·12 fluid ounces; and in the various weeks the exceptions to the rule were so numerous as 41 per cent. of the whole, and varied from 0 to ·8 fluid ounce. There were sixty-two exceptions in the various days of the year, varying from

an increase of 0 to 2·45 fluid ounces over the whole day rate of the same day. Of these, forty-seven were the days on which the basis quantity of urea also exceeded the whole day rate, as is observed in Table XII. Many of the exceptions were quite insigni ficant, so that in ten instances the excess only involved the second place of decimals; but in ten others it exceeded 1 oz. per hour. The large number of instances in which the basis quantity, both of urea and urinary water, was excessive, proves the relationship which exists between them, and their mutual dependence upon a common cause; but in 34 per cent. of the days on which the basis quantity of urea was exceptional, there was no exception in the rate of excretion of urinary water at the same period. Hence the estimate already given of the value of the basis determination of urea is nearly equally applicable to the excretion of urinary water. Both vary greatly, and chiefly in relation to the amount of urinary water evolved on the preceding day.

The relative position of the rate of urinary excretion before midday was unbroken in every month and week of the year. On three days in the year the rate was less than the whole day rate by the second place in decimals only. There were two exceptions only in reference to the basis quantity, viz. a defect of ·15 and ·57 fluid ounce in May and June. The rate of excretion varied greatly, and on one occasion exceeded an average of 13 fluid ounces per hour.

Table XVI. exhibits the variations of the hourly rate in the excretion of urine during the hours of the afternoon. All the figures show that there was a progressive increase in the quantity through the morning hours, and until two to six o'clock in the evening, and afterwards a progressive decrease until the night period. There were, however, variations in the quantity which are deserving of notice.

TABLE XVI.—Showing the Hourly Rate of Excretion of Urine at various periods of the day, in fluid ounces.

1860.	A.M.				P.M.												
Hours.	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	Night.
	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.		fl. oz.	fl. oz.	fl. oz.	fl. oz.
February 14.	·6	...	...	4·1	...	...	...	6·17	...	6·25	...	...	...	1·85	1·2	...	·97
15.	·9	1·36	...	6·16	...	...	...	...	...	...	1·85	...	...	...	1·68	...	·88
16.	1·3	...	...	3	12·6	...	...	...	...	3·08	...	...	...	...	...	2·48	1·09
17.	2·48	...	...	2·72	...	...	2·66	...	...	...	2·55	...	...	...	1·71	...	1·01
18.	1·8	...	...	4·3	...	...	6·23	...	...	...	1·75	...	...	...	1·62	...	1·14
23.	1·1	8	...	7·73	...	...	5	...	1·75	...	1·33	...	...	...	...	3·3	·88
24.	1·36	1·3	...	1·24	...	5·1	...	...	3·84	...	...	...	...	...	1·91	...	1·24
25.	1·12	...	6·4	3·9	...	...	...	2·47	...	...	...	...	...	...	1·6	...	·86
27.	2·5	5·76	10·4	11·4	8·4	...	...	...	2·4	...	...	2·01	...	...	...	3·05	1·33

The circumstances especially worthy of note in connexion with this Table are the variations in the maximum rate, the different hours in the middle part of the day when it occurred, the great diversity of elimination in successive hours, and the large rate of excretion at midnight on three occasions, compared with the preceding night rate on the same day, or with hours immediately preceding on other days. February 17 was an exceptional day, since I was not well, and beef-tea only was taken at dinner. On the

occasions on which the midnight rate was great, fluid food was taken between 10 and 11 o'clock, the two former with wine, at evening parties, and the latter with coffee only.

On referring to the hourly excretion of urine, as shown in Table XIII. (Plate XXXIV.), we find that the rate increased after the breakfast until 1 A.M., when a maximum of eleven times the basis quantity was emitted. It then fell, and remained low until 8 P.M., when it rose to a second maximum at 9 or 10 o'clock, and thenceforward fell to the night rate. The morning maximum was nearly four times as great as the evening one. The morning emission did not increase in equal proportions during each hour until the maximum was attained, but, after slowly rising, it suddenly ascended to the maximum in one hour, and as suddenly fell at the next hour. I had frequently noticed this occurrence throughout the year; and it was usually found in about four hours after the breakfast meal. On March 2, 1861, there were two maxima in the morning, separated by a decrease at 12 o'clock, the former being at the rate of 7·5, and the latter of 11·1 fluid ounces per hour.

There was a general correspondence between the rate of emission of urea and urine, but not such a one that the proportionate rate of the two remained the same at each hour, as is shown in the following Table.

TABLE XVII.—Showing the number of grains of Urea in each fluid ounce of urine at each hour of the day, on the average of two days.

A.M.				P.M.											Night.
Breakfast.				Dinner.				Tea.				Supper.			
9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
grs. 10	grs. 6	grs. 4·3	grs. 6·3	grs. 2·88	grs. 4·8	grs. 7·8	grs. 10·3	grs. 10·8	grs. 12	grs. 15	grs. 11·7	grs. 10	grs. 10·0	grs. 11·3	grs. 14·2

There was, therefore, the smallest amount of urea in each ounce of urine at the periods when the largest excretion of urine occurred, and *vice versâ*. The contrast between the quantity of urea eliminated per hour, and the quantity contained in each ounce of urine at the various hours of the day, is delineated in Plate XXXIV. fig. 1, and proves that the proportion is the least in the morning hours, advances with the afternoon, and attains its maximum in the night hours. Table XIV. shows that, during the investigation made at every quarter of an hour, the quantity of urine increased from 7·7 fluid ounces per hour at $10\frac{1}{2}$ A.M. to 13·5 fluid ounces per hour at $12\frac{3}{4}$ P.M., and was the greatest at the two periods when the rate of excretion of urea was the greatest, viz. $12\frac{3}{4}$, when 54·6 grs. of urea and 13·5 fluid ounces of water were excreted per hour. There was an increase of urine with the increase of urea per hour, but it was not proportionate to the quantity of urea. In the afternoon the rate slowly fell from 4·4 to 3 fluid ounces per hour at $2\frac{3}{4}$ and 3 P.M., and then rose to 5·4 ounces at the termination of the inquiry.

B. *With variations in the ordinary dietary.*

Fasting.—Mosler, Becher, Böcker, Falck, and Ferber found that when water was administered during fasting for short periods, the evolution of urea and urinary water was considerably increased, but afterwards the former fell below the normal amount. The increase in the elimination of water occurred in the second or third hour, and the increase in the quantity of urinary water was greater than the increase in the quantity of water supplied.

In October 1860 I fasted during 29½ hours from supper-time, and took 30 ounces of water only at about the ordinary meal hours, viz. 8½ A.M., 12½, 5½, and 9 P.M., and determined the hourly excretion of urea and urinary water during the day. The results are given in the following Table, and delineated in Plate XXXIV. fig. 3.

Table XVIII.—Showing the Hourly Rate of Elimination of Urea and Urinary Water during fasting, but with water.

	A.M.					P.M.						
	Water.				Water.						Water.	Water.
	8	9	10	11	12	1	2	3	4	5	8¾	2½
	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.
Urea ...	7·79	20·48	34·5	20·8	17·85	18·72	15·6	14	13·5	5·3	21·6	7·49
	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.
Urine ...	·812	3·2	11·5	6·94	7·44	5·2	10·4	2·93	2·5	1·36	2·57	1·39

The progression in the rate of elimination of urea and water was precisely the same as when ordinary food was taken, and the only evident variation was the rapidity with which the increase and decrease was effected. After the last meal, the night rate of emission of urea was less than 8 grs. per hour; but after taking ten ounces of water it rapidly increased to 34·5 grs. per hour, and subsequently rose after every administration of water, and fell before the period arrived for the subsequent supply. The lowest rate of the day occurred at 5 P.M.; and the two highest followed the breakfast and the tea hours. It is singular to notice that there was very little increase following the administration of water at the dinner-hour; and in this respect also it corresponds with the amount evolved after an ordinary dinner.

The urinary water was also largely increased after every dose of water, so that the maximum rate was fourteen times greater than the basis quantity; and a decrease always preceded the following supply. Hence the simple administration of water at different periods of the day causes a series of defined curves of increase and decrease of the urinary secretion and of urea. The average hourly rate of elimination of urea from 8½ A.M. until 2½ A.M. without any food having been taken was 15·1 grs.

Water only.—On various occasions I drank water or other fluids in the morning, and abstained from food until midday, with a view to determine their influence at the period of the day when the urinary secretion is the most abundant.

The following Table and Plate XXXIV. fig. 6 contains the results of drinking ten

ounces of water at $8\frac{3}{4}$, $9\frac{3}{4}$, and 11 A.M., the effect being determined every quarter of an hour until midday.

TABLE XIX.—Showing the effect of drinking Water alone, upon the Urea and Urinary Water.

	A.M.													P.M.
	Water.					Water.				Water.				
	$8\frac{3}{4}$	9	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	10	$\frac{1}{4}$	$\frac{1}{2}$	11	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	12	3
	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.
Urea ...	20·7	15·28	30·7	35·14	27·65	28·2	35·22	30·86	24·8	26	29·5	32	29	23
	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.
Urine ...	2·8	1·24	2·86	9·6	21·6	16·6	21·4	22·2	14·6	11·6	15	19·4	17·6	4·13

There was an increase in the quantity of urea and urine evolved throughout the whole inquiry; and after each dose of water there was a progressive increase to the maximum rate in half or three-quarters of an hour, and then a decrease until the next supply of water. The maximum rate after the first and second dose was upwards of 35 grs., and after the third dose it was 32 grs. per hour.

The urinary water increased from the basal rate of 2·8 oz. per hour to the rate of 21·6 oz. per hour in one hour; and although it fell at the period of observation following the second dose of water, it was renewed, and increased to the maximum rate of 22·2 oz. in half an hour after the second dose. It again fell, and subsequently rose after the third dose of water, but the rate was not then so high as at the previous maximum periods. The period of maximum emission of water was a quarter of an hour later than that of urea, except after the third dose, when both coincided. The maximum emission was eight times the basis quantity.

Various fluids only.—Numerous other experiments were made of a similar character but with different fluids, and the examinations were made hourly. These are collected in the following Table.

TABLE XX.—Showing the Hourly Rate of Excretion of Urea and Urinary Water before midday under the influence of various fluids, but (with two exceptions) without food.

Urea.

1860.	January.							February.	
	23.	24.	25.	26.	28.	30.	27.	20.	22.
Hour.	Water 8 oz., at 9 A.M.	Water 8 oz., bread 3 oz., at 9 A.M.	Coffee (½ oz.), 8 oz., at 8½ A.M.	Tea (100 grs.), 8 oz., at 9 A.M.	Black dose 2 oz., water 6 oz., at 8½ A.M.	Water 8 oz., at 9 A.M.	Water 8 oz., at 8½	Water 8 oz., at 8½, 9½, 10½ A.M.	Gluten bread 2 oz., water 8 oz., at 9, 10, 11 A.M.
	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.
8½	.....	.....	12·2	.....	12·4	.....	.....	21	
9	17·66	14·7	25·3	15·2	19·8	13	11·7	.....	18·5
9½	.....	.....	.....	.....	.....	.....	15·8	28·64	
10	30·5	17·6	19·3	24·6	21·8	22·7	.....	.....	19·5
10½	.....	.....	.....	.....	.....	.....	23·7	28·1	
11	24·9	26·6	19·2	24·24	23·7	20·16	.....	.....	25·4
11½	.....	.....	.....	.....	.....	.....	.....	28·8	
12	24	30	15·3	17	15·8	20·4	18·7	28	36·9
	Urinary Water.								
	fluid oz.	fluid oz.	fluid oz.	fluid oz.	fluid oz.	fluid oz.	fluid oz.	fluid oz.	fluid oz.
8½	.....	.....	·76	.....	·9	.....	.....	2·5	
9	2	1·4	·3	·8	1·6	3·1	·9	.....	1·7
9½	.....	.....	.....	.....	.....	.....	1·9	12·25	
10	9·25	2	2·35	3·5	2·35	5·2	.....	.....	1·9
10½	.....	.....	.....	.....	.....	.....	5·4	21·5	
11	8·3	6·65	1·8	3·6	2·7	11·2	.....	.....	3·1
11½	.....	.....	.....	.....	.....	.....	.....	16·5	
12	8·5	10·13	1·65	2·25	1·8	8·5	3·26	7	12·6
	Maximum increase per cent. over the basis quantity.								
Urea	76	104	58	59	75	65	102	35	100
Water	341	621	200	350	200	260	500	760	640

The maximum emission of urea in these several experiments varied from 22·7 to 36·9 grs. per hour; but no just comparison can be made, unless we accept the basis quantity as the standard in each experiment. If this be accepted, we find a striking difference in the effects of the several substances.

The greatest increase always occurred when water was the fluid employed. In these experiments with water the increase in the rate of elimination of urea exceeded 100 per cent., whilst in two others with water it was 65 and 76 per cent., and in one was so low as 35 per cent. The effect of tea and coffee was precisely the same, and but little more than half that of water, whilst with black dose there was still an increase of 75 per cent. The addition of a little common bread and of gluten bread did not lessen the effect of the water, but it deferred the period of maximum elimination to the end of the inquiry; and in this respect these experiments stand alone. The largest elimination of urea followed the use of the gluten bread. The maximum effect of coffee is stated in

the Table to be almost immediate; and hence it is possible that it might be due to some unexplained agency, and the subsequent emission should be regarded as the maximum.

The effect upon the urinary water was not precisely parallel to that upon urea; but in the instances in which water caused the largest emission of urea it also caused the largest emission of urinary water. The greatest increase, viz. 760 per cent., occurred in an experiment with water; but in that experiment the basis quantity was unusually high, and the increase in the rate of elimination of urea was proportionately small. The least increase occurred with coffee and black dose; and tea caused a greater increase of urinary water than coffee, although they eliminated urea at precisely the same rate.

All these experiments agree with the foregoing in demonstrating the great activity of the urinary function in the morning hours.

On several occasions I drank $1\frac{1}{2}$ oz. of alcohol with $4\frac{1}{2}$ oz. of water between 8 and 9 A.M., and deferred the breakfast for two hours. The effect in different experiments was to cause within $1\frac{1}{2}$ hour the following increase in the elimination of urea and urinary water.

TABLE XXI.—Showing the early effect of Alcohol and Water without food over the rate of emission of Urea and Urinary Water.

	1860.	May 14.	May 16.	May 19.	May 21.	May 24.
Urea, grs.	Basis	16·3	20·1	21	24·7	17·2
	Maximum	33	27·7	33·6	31·9	24·5
Water, fl. oz.	Basis	1·58	1·57	1·06	2·6	1·15
	Maximum	5·47	9·27	6·92	17	7·3
Increase per cent.						
Urea, grs.		102	38	108	30	43
Urinary water, oz.		246	554	553	553	534

The increase in the rate of elimination of urea varied much, but in two-fifths it was more than equal to a much larger quantity of water taken alone. In one instance, in which the increase was small, the absolute quantity and the basis quantity were both high, whilst in another experiment the absolute quantity was low.

The uniform effect upon the rate of elimination of water is most striking; for, if we except the first experiment, the increase was almost uniformly 550 per cent. This is too remarkable and too often repeated to be merely a coincidence, and it is probable that it may represent the true effect of alcohol when taken in the morning and alone, as above indicated.

Bread and fluids.—Another series of experiments demonstrate the effect of a diet of only bread and water and tea and coffee over the hourly elimination of urea and urinary water. They were made on consecutive days in February 1860, and comprehend one day on bread and water, one on bread and tea, one on bread and coffee, and a fourth

day in which bread and water only were taken until 3 P.M., and then a suitable supply of food. The urine was not emitted at any prescribed hours, but at short intervals. The following Table contains the results of these inquiries.

TABLE XXII.—Showing the Hourly Rate of Excretion of Urea and Urinary Water, with a diet of bread, water, tea or coffee on three days, and additional food on the fourth (Plate XXXIV. fig. 5).

1860.	February 6.		February 7.		February 8.		February 9.	
	Bread 8 oz., water 12 oz., at 8½, 12½, 4½, and 7½, and 2 oz. of bread at midnight.		Bread 8 oz., water 12 oz., tea (black) 75 grs., at 8½, 12½, 3½, 7½ P.M., and 2 oz. of bread at 11.		Bread 8 oz., water 12 oz., coffee ½ oz., at 8½, 12¾, 4½, 8¼.		Bread 8 oz., water 12 oz., at 8¾, 12¾; dinner at 3; tea at 6; coffee 8¼; supper 11.	
Hour.	Urea.	Urine.	Urea.	Urine.	Urea.	Urine.	Urea.	Urine.
	grs.	oz.	grs.	oz.	grs.	oz.	grs.	oz.
8 to 9	14·5	1·51	10·3	·7	13·5	1	13·6	·92
9 to 10	27·9	4·35	17	1·33	22·4	1·87	17·9	1·24
10 to 11			20·5	1·3	19·8	1·65	25·2	2
11 to 12			21·3	2	25·4	3·37	19·8	1·8
3.30	29·3	6·82	24·6	3·0	22·3	3·3	23·7	3·47
4.30			.....	.....				
6 to 7	.....	.....	21·6	2·25	20·4	3	26·4	1·6
8	17·3	1·97	.....	.....				
10½ to 11	15·6	1·37	19·3	1·51	25·2	2	29·6	4
12								
Night.	14·2	1·03	19·7	1·46	13·59	·98	15·6	1

I attended to my ordinary duties during this inquiry. There was a marked sense of want experienced, and particularly on the first day; but the two following circumstances were the most intolerable, viz. the sensation of cold following the drinking of the cold water, and the absence of sufficient saliva to enable me to masticate the bread without taking water with every mouthful. The first was partially relieved by taking a small quantity of bread at night, the second by drinking warm water; but as the quantity of water was insufficient to enable me to well masticate the bread, I found no relief for the third. The experiment was relinquished on the fourth day, from the sense of depression and the want of courage in looking to the prospective periods of the inquiry; and after its relinquishment I ate heartily and with enjoyment.

On the three first days the hourly progression in the rate of elimination of urea and urine was precisely the same as that which occurs with ordinary food; but the maximum was perhaps depressed a little, on account of the small quantity of fluid which was taken at the breakfast. The maximum hourly increase of urea was 14·8 grs., 14·3 grs., and 11·9 grs. in their order; and when compared with the basis quantity, the increase per cent. was 100, 141, and 88 in their order. The first day succeeded to the Sunday, when there was commonly a small excess of food, and the progress through the day was so regular that the rate of excretion during the night was the same as it had been in the early morning. On the days with tea and coffee added to the dietary, the maximum amount

of urea was not so high as it had been on the previous day, but the excretion was very large relatively at midnight on both days. On the fourth day, before additional food was given, the maximum was equal to that on the preceding day, and occurred so early as 11 A.M.; but after the additional food the elimination of urea again increased, and the maximum of the whole day occurred between 7 and 12 P.M. On this day the maximum increase with the bread and water was 10·1 grs. per hour, or 75 per cent. of the basis quantity; but after the additional food and late in the evening it rose to 16 grs. per hour and 117 per cent. of the basis quantity.

It is to be remarked that, after three days insufficient dietary and the addition of abundant food in the afternoon of the fourth day, the rate of elimination on the following night was scarcely, if at all, increased—a circumstance due doubtless to the fixation of the nitrogen.

The rate of the elimination of urine on the first day followed the usual course in health, and attained a maximum of 6·82 oz. per hour. On the second and third day the rate sensibly declined, and on the day with coffee it was relatively high in the evening. On the fourth day, before additional food had been taken, the rate was the least which had occurred, and was so low at midday as 1·8 oz. per hour.

Hence this series of experiments showed that a full dietary of bread and water, or tea or coffee, does not vary the hourly progression of the urinary secretion from that which is found with mixed food, but it fails to yield comfort to the system, and also that with 48 oz. of fluid per day the rate of urinary secretion fell considerably below that which ordinarily occurs. When water is given with bread alone it should be of the temperature of the body.

5. *Cycle of the Week.*

There are no experiments on record in reference to this subject. Sunday was a day of strong contrast with other days of the week; for I took almost perfect rest on that day, and also ate a little additional solid food, as follows:—

1860. March.	April.	May.	June.	July.	1861. February.	March.
oz.	oz.	oz.	oz.	oz.	oz.	oz.
2·0	6·3	·3	·1	2·7	2·6	1·5

The comparison of the urinary excretion on Sunday and on week days may be made in two ways. As compared with the average returns of all the days of the year, the excretion of urea was on Sundays 533·4 grs. against 519 grs. on all days combined; but as many influential causes of variation occurred during each week which did not occur on Sundays, a more just comparison may be made with the average of those days on which no known cause of variation occurred. I have collected all the unexceptional days, and have taken the average of them in each month, as is shown in the following Table:—

TABLE XXIII.—Showing the average excretion of Urea on 191 selected days in the year.

	Average all days.	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.
1860.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.
March	462	580·7	462	455	460	404	375	384
April	489	521	467	458	463	...	493	509
May	546·5	589·4	562	534	528	505	473	558
June	541	555·4	487	543	539	527	467	405
July	505	547·7	496	499	505	494	479	497
August	646	628						
September ...	665	739·3						
October	518	621	534	546	533	492	471	592
November ...	455	485	444	415	421	457	513	418
December ...	451·6	471	476	454	432	456	412	444
1861.								
January	475	475	488	433	479	519	510	475
February ...	515·2	492	525	468	470	515	515	499
March	471·9	471·8	473	437	467	560	441	497

Thus the average daily emission of urea on all these selected days combined was 475·5 grs., giving an increase on the Sundays of 57·9 grs. daily. The increase chiefly occurred before January 1861; and during the winter months of 1861 there was but little variation on Sundays and other days. The causes of exceptional conditions were very few in January, February, and March 1861; and nearly all the days in those months have been included in the selection.

The largest daily emissions of urea which occurred during the year fell relatively more frequently on Sundays than on the whole year, to the following extent:—

Daily excretion, 700 to 800 grs.	600 to 700 grs.	500 to 600 grs.
3·4 per cent.	13·1 per cent.	Equal.

I have sought to ascertain if this periodical day of increase, or the causes which occasioned it, were influential in any defined order in the other days of the week; and the following Table shows that there is a progressive decline in the rate of emission of urea as the week advances to the Saturday, on the average of the 191 selected days and the Sundays just referred to.

Table XXIII., and Plate XXXII. fig. 7, show the average amount of urea excreted on each day in the week, and on the average of the year; the daily excretion was as follows to the end of December 1860:—

	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.
Urea, grs. ...	574	491	488	485	476	460	475

The loss from the Monday to the Saturday was 31 grs., and it was greater proportionately on the Thursday and Friday than on the earlier days in the week. There was an increase on the Saturday; and, in explanation, I may state that Friday is my last Hospital day, when I take only coffee and bread and butter for lunch, and dine at a later hour, and on Saturday I have commonly more rest than on other working days.

Hence during a week of regular labour and food, the daily rate of excretion of urea diminishes as the week advances.

I have also found that, on the average, the weight of the body increases greatly on the Sunday, and progressively lessens throughout the week, with greater or less uniformity, when a tolerably uniform amount of exertion is made; but with the ordinary variations of exertion the weight is the least on the Saturday, and the greatest on the Sunday and Monday mornings. The body was weighed naked on retiring to rest, and also on rising, directly after having passed urine, and before defæcation. The hour of weighing was not fixed, but varied at night from 11 on Sundays to 12 or 1 o'clock on other days, and from 8 to $9\frac{1}{2}$ in the morning; and therefore there would be cause for a slight variation in the results. The scales were good ones, of ordinary construction; and I did not attempt to weigh nearer than to half an ounce. The average of the weights at night and on the following morning were entered as the weight for that day.

The following Table XXIV., and Plate XXXIV. fig. 4, represent the weight on each day from February 4 to March 3, 1861.

TABLE XXIV.—Showing the Weight of the Body naked, and after emission of Urine, on each day of the week, diminished by 13 stones (182 lbs.).

1861.	February 4 to 10.	February 10 to 17.	February 17 to 24.	February 24 to Mar. 3.
	lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
Sunday	.....	9 14	9 3	11 $1\frac{3}{4}$
Monday	9 $6\frac{1}{2}$	7 10	9 2	9 13
Tuesday	9 $7\frac{1}{4}$	8 $7\frac{1}{2}$	10 $7\frac{1}{4}$	9 9
Wednesday.....	9 2	7 $12\frac{1}{2}$	9 $12\frac{1}{2}$	11 2
Thursday	8 $2\frac{1}{4}$	8 $6\frac{3}{4}$	8 $2\frac{1}{2}$	10 $4\frac{1}{4}$
Friday.....	8 8	8 $8\frac{1}{4}$	8 14	
Saturday.....	8 8	7 8	8 $14\frac{1}{4}$	9 15

On the average of this period the weight on the Sunday was 1 lb. 12 oz. greater than on the Saturday.

There was considerable variation in the progression from day to day in the different weeks; but there was much uniformity in the general fact of a decrease in weight towards the end of the week, and the increase at the beginning of the week was without exception. During the first week I made considerable physical exertion daily, but in the others the amount varied; and the average weight of the body increased weekly, as follows: 8 lbs. 4 oz., 9 lbs. $3\frac{1}{4}$ oz., and 10 lbs. 5 oz. + 13 stones. The difference in the average weights on the two first and the two last days of the week was 1 lb. $5\frac{3}{4}$ oz. in favour of the former; but that in the extremes of single observations was 2 lbs. $3\frac{1}{4}$ oz.

There was not a very marked variation in the fluid and solid ingesta during the week, except so far as related to the Sunday; but the following Table offers some points of interest.

TABLE XXV.—Showing the Weight, in ounces avoirdupois, of the Fluid and Solid Ingesta on the various days of the week in March, May, June, and July 1860.

Week. 1860.	Sunday.		Monday.		Tuesday.		Wednesday.		Thursday.		Friday.		Saturday.	
	Solids.	Fluids.	Solids.	Fluids.	Solids.	Fluids.	Solids.	Fluids.	Solids.	Fluids.	Solids.	Fluids.	Solids.	Fluids.
	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
Feb. to 25.	55¼	61	41¾	50	37½	52½	44	51	42½	53½		54	44½	53
March 1.	44½	50	40½	44½	44	50½	42	55¼	38¼	54	39½	56½	36	49½
8.	41½	48	45½	48	39	42	40¼	51½						
15.							40½	57	41	49½	38¾	51		
22.	44¾	50	39½	58	41½	57½	41	65¼	39		27	54	44¼	39
29.	52	53	36½	61	38¾	47	34¾	57	28	45¾	37	43		
Average ...	45¾	50¼	40½	52¾	40¾	49¼	39¾	57¼	36½	49¾	35½	51	40	44¼
May 6.					35½	58½	35	57¼	36½	58	37	49½	36½	55
13.	35¾	49	32	58	37	48½	39½	51½	31¾	59½	41	49½	37	63
20.	39¾	46	35½		41	50			32¼	41½	42½	46	36	
27.	37¾	49					40	56	37¼	54½	41¾	46		
Average ...	37¾	48	33¾		37¾	52¼	38¼	55	34¾	53¼	40½	47¾	36½	59
June 2.											33½	57	30¼	54
9.	35¾	52½	34¾		29¾	68½	38	58½	39	71	36¼	51	43½	65½
16.	37	55¾	40½	68	28½	51½	35½	59½	34¼	49½	37¼	53		
23.							29¾	68½	40¾	53	37	57	35	61
30.	35½	53½			37	44								
Average ...	36	53¾	37¾		31¾	54½	34¼	62	38	57¾	36	56	36¼	60
July 8.							38	59	39½	57½	40	58	38	51½
15.	40¾	69	29¼	59	42¼	63	39½	52¾	33¼	52½	30	60	39	57
22.	42	65	34¾	52	37	53	38¼	58½	34	56	41½	53½	30½	57
Average ...	41¼	67	33	30½	39½	58	38½	56½	35½	55¼	37	57	35¾	55
October 28.					38¼	38½	31¾	59½	37¼					
Total average...	41¾	54	37¼	55¼	37½	51¾	37¾	57¼	36½	53½	37¼	52¼	37½	55

The total average of these observations shows that, with the exception of the increase on the Sunday, there was singular uniformity in the weight of the solid ingesta taken on the various days of the week, there being only one day on which the quantity was below 37 oz. When, however, the fluid and solid ingesta are added together, there is more variation, and the two lowest amounts occurred on my two Hospital days, when there was a lunch of coffee and bread and butter, instead of an early dinner, and dinner was eaten at a later hour, and then there was an increase on the following day. The combined quantities of the fluid and solid ingesta on the different days were as follows, in ounces:—

Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.
95¾	92½	89¼	95	90	89½	92½

6. *Cycle of the Year.*

There are not any recorded observations upon the influence of season over the urinary excretion except those of VOGEL, who found that the urinary water was increased in the cold season.

It is not possible to isolate the effects of season from other influences, as, for example,

by adopting a standard dietary for the whole period, for then the effect of season upon the requirement for food could not be determined; and hence the only practicable inquiry was to allow such food as the system required, and ascertain the absolute amount of urinary excretion during the whole period.

The year 1860 was remarkable for the coldness of its summer, and for the long-continued frost during the winter, so that scarcely any opportunities were afforded of determining the effect of great heat over the elimination of the urinary secretion. The general effect of season was, however, well established by the results which were obtained, and it was shown that the urinary products increased in quantity as the summer advanced, and decreased in the winter season.

Urea.

Table III. shows that on the monthly averages the daily quantity of urea progressively increased from 462 grs. in March, through 489, 546, 541, and 505, to the maximum of 646 and 665 grs. per day in August and September, and thenceforward fell through 518, 455, 451·6, 475, and 515 to 417 grs. in the last month of the inquiry. The progression in the rate of increase was well sustained through the spring and summer months, whilst the fall was rapid in autumn; and the rate continued much below the average of the year throughout the winter. The months of distinct increase were April, May, June, and July; the maximum months were August and September; the month of decrease was October, and the stationary minimum months were all those at the end of autumn and during the winter. [The monthly averages in 1861 and 1862 differed somewhat from the above in actual quantities, but followed almost precisely the same course. Those recorded in September were much lower than those of the corresponding month of 1860, because I was not then staying at the sea-side.]

Thus the year may be conveniently divided into two seasons, one extending from May to October inclusive, and the other from November to April inclusive,—the former being the season of heat and of maximum production of urea, and the latter of cold and the minimum production of urea. The average elimination of urea in the former period was 570·1 grs., and in the latter 480·5 grs. daily [in 1861 and 1862 the quantities were 530 grs. and 460 grs.], a difference so marked as to show a natural division of the year into the two seasons. In this arrangement the month of April would be that of a change towards increase, and October that towards decrease.

The increase from the daily rate of elimination in March to the maximum quantity was 36 per cent. of the former, and the decrease from the maximum to the rate in the following March was 29 per cent. of the maximum, whilst the extreme difference beween the minimum and maximum quantities on the monthly average was 46·1 per cent. of the former.

Urinary water.

The rate of excretion of urinary water followed the course just described in reference to urea, viz. increasing with the summer and decreasing in the winter, but with less

uniformity than was found in reference to the urea. The quantity eliminated in March 1860 was 51·16 oz. daily, and this progressed through 54·42, 45·53, 53·03, 55·3, and 60·1 to the maximum of 64·6 oz. daily in September, and then fell through 56, 51·7, 50·17 to 47·87 in January, and rose to 52·9 and 53·8 in February and March 1861. The progression was thus broken by the diminished rate in May and January, and the increase began so early as February; but the maximum quantities were found at the period of maximum elimination of urea. On dividing the year into two parts, as above indicated, when speaking of urea, we find that the elimination of urinary water was 55·7 oz. daily in the warm, and 51·9 oz. daily in the cold season. The excess of the maximum over the minimum monthly rate was 40·2 per cent. of the latter. [In 1861 and 1862 the maximum quantity of 57 oz. occurred in the month of September, and in the months of June, July, and August the quantities were less than those recorded in 1860. On the division of the year into two parts the quantity was precisely equal in each, viz. 49·3 fluid ounces.]

Causes of Seasonal variation.

Temperature.—KAUPP, in numerous experiments made at various temperatures, found that the quantity of urinary water, urea, chloride of sodium, and, indeed, both solids and liquids diminished as the temperature increased, and he attributed the diminution of the solid excretions to the lessening of the urinary water. LEHMANN found that moderate cold increased, but great cold decreased the urinary excretion.

I have not made any experiments with artificial temperatures, or for short periods, or with any regulated or standard dietary to be used under varying conditions, but have ascertained the effect of seasonal variations of temperature with the ordinary variations of food. I was not able to determine the amount of food taken in August and September; but, being then at the sea-side, it is more than probable that it was increased. Hence it is highly probable that the observations hitherto recorded and those now to be mentioned have not been made under parallel conditions; and the results may be due to different causes, although associated with temperature.

It is also necessary to bear in mind that the mean external temperature very imperfectly represents the true temperature in which we live during the greater part of the twenty-four hours, and particularly in the winter, and also that other causes exert influences which may correspond with or be opposed to those of temperature. Hence the inquiry is a most difficult one.

The general influence of temperature is evident from the foregoing statement; for the lines of temperature and urea were parallel throughout the year. The average temperatures of the two periods of the year were 55° and 44°, corresponding with 570 grs. and 480 grs. of urea daily, which gives the very uniform proportion of 10·36 grs. and 10·9 grs. of urea to each degree of temperature on the average of the two opposite seasons. Moreover, the month (May) of marked increase in the urea (56·5 grs.) was that of marked increase of temperature (10°·9); whilst that (November) of marked decrease (63 grs.) was also that of great decrease of temperature (9°·65). As the pro-

duction of urea is due to many causes, we may not expect to find precise uniformity in its relations to temperature; and hence we find that, after the temperature had attained its maximum, the urea continued to increase for a short period; but when the proportionate amount of urea to temperature is tested in the two highest and two lowest months respectively, it is found to be almost absolutely the same, viz. 11·5 grs. and 11·8 grs. to each degree.

The foregoing refers to the production of urea, since it comprehends lengthened periods; and the influence of temperature is very clear; but on considering the influence of that agent during short intervals, as in sudden changes of temperature, the acts of production and elimination are mixed together and cannot be easily separated. Hence the effect of the changes of temperature seems to vary at different periods; and this occurs, doubtless, because in some instances the urea is retained longer than in others. I have sought to ascertain the effect of sudden changes, and have found great diversity; but commonly the influence was felt on the urinary water on the first, and on the urea on the second day. The following are instances of rapid changes of temperature associated with the effect upon the urinary secretion (Plate XXXII. fig. 6):—

TABLE XXVI.

1860, November	15.	16.	17.	18.	19.	20.	21.	22.	23.	
Temperature...	45°·8	42°·6	48°·3	36°·6	37°·8	41°·1	41°·7	43°·5	37°·6	
Urea (same day)	grs. 457	grs. 478	grs. 433	grs. 485	grs. 413	grs. 428	grs. 446	grs. 489	grs. 548	403
Urea (next day)	478	433	485	413	428	446	489	548	403	

If the temperature and urea on the same day be compared, it will be found that the action of temperature is inverse, and in that sense the various parts would correspond both in the ascending and the descending series, except at the point at which the change in the direction of the lines occurred, as on November 20, when an increase of 3°·3 of temperature would be accompanied by an increase of 15 grs. of urea and thus break the rule; but if the effect of the temperature be sought for on the day following the variation, the action will be found to be direct and to correspond in every part, as is shown in the Table by the lowest line, in which the quantities of urea have been placed a day earlier than they actually occurred.

The following illustration shows a deviation from the rule, in consequence of a very large emission of urine on the day of a frost, compensating the greatly diminished quantity of the preceding day. The urea varied with the temperature of the previous day. The urine increased as the temperature fell; but when the temperature became stationary, it offered the compensating alternations before referred to.

TABLE XXVII.

1860, Dec. 16 to 21.	Frost.									
Temperature...	38°·4	35°·4	30°·5	30°·1	29°	30°·6	31°	26°	22°·4	Ill.
Urea	grs. 526	grs. 498	grs. 473	grs. 401	grs. 464	grs. 365	grs. 443	grs. 528	grs. 506	grs. 298
Urine.....	oz. 44·7	oz. 65	oz. 65	oz. 31	oz. 75	oz. 30	oz. 41	oz. 40·7	oz. 59	oz. 46

In December and January there were various occasions on which frost and thaw rapidly alternated; and the resulting effect upon the urea was one of confusion, as is seen in the following Table:—

TABLE XXVIII.

1861, Feb. 12 to 16.	Frost.			Thaw.				
Temperature ...	37°	31°·9	30°·2	36°·1	36°·2	44°·5	47°·2	
Urea (grs.) ...	526	584	489	517	481	528	488	
Urine (oz.) ...	44	67	49	55	39	61	64	31

Increase in the urea evolved occurred with increase of urine, and the latter alternated in quantity from the varying influences then existing. At the same time constipation of the bowels occurred, and the system became disordered.

Dec. 30.—With a rapid thaw and an increase of 12°·4 of temperature the urea increased 28·9 grs. on the following day. The urine was so low as 30·3 oz., but rose on the following days to 70·8 oz. and 64 oz.

Jan. 11.—With thaw and increase of 6°·1 of temperature the urea remained stationary and high, but fell on the following days with frost and falling temperature. The quantity of urine was very low, and yet fell from 42·5 oz. to 37·6 oz. on the same day to 26·6 oz. on the following day, and then rose to 54 oz. with decreasing temperature.

On April 24, with 7°·8 increase of temperature, the urea rose greatly on the same and on the following day. The excretion of urine was very high, and it increased to 76·7 oz. on the same, and fell to 45·7 oz. on the following day.

On July 11, with 5°·6 increase of temperature, the urea was lessened on the same and on the following days until the fourth day, when it rose 92 grs. with increasing temperature.

Whilst in a majority of instances the influence of temperature acts on the day following any important change, it sometimes acts on the same day, and sometimes the effect is contrary to the law. The urine is commonly increased with a sudden fall and decreased with a sudden rise of temperature on the same day, and the opposite condition occurs on the following day.

There are great oscillations, due to the necessity of maintaining a certain equilibrium in the fluids of the body; and these are set in motion by any act which materially varies the emission of fluid, and they continue in a degree and mask the influence of agents which in their absence could be traced in the elimination of the urinary products.

Atmospheric pressure.—The relation of the production and elimination of urea with the barometric elevation is a direct one, so that both rise and fall together. Table III. shows this relation in reference to the monthly averages; so that the month of the highest elimination of urea was that of the greatest atmospheric pressure, and that of the least elimination was that of the least pressure. There is also an unbroken parallelism in the lines as they increase from March to May, decrease in June, increase in September, decrease in October, November, and December, and increase in January and February; but there is a want of correspondence in July and August. When the year is divided into the two seasons already mentioned, the relations of the barometric elevation, temperature, urea, and urine are as follows:—

	Barometer. inches.	Temperature. °	Urea. grs.	Urine. oz.
Summer	29·762	55	570	55·7
Winter.....	29·658	44	480	51·9

The barometric relation is not so evident as it would have been had there not been the exceptional conditions in July and August; but it is sufficient to show that it corresponds with all the other subjects which we have discussed, and that in summer we had high atmospheric pressure and temperature, and great elimination of urea and urinary water, with the contrary conditions during the winter.

The relation of sudden changes of the barometric pressure to the elimination of urea is well seen in the following sequence of days (Plate XXXII. fig. 8):—

TABLE XXIX.

December ...	11.	12.	13.	14.	15.	16.	17.	18.	19.
	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.	inches.
Barometer	29·528	29·880	29·981	30·120	30·113	29·811	29·513	29·414	29·289
	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.
Urea	420·3	445·2	530·3	561	554·3	526·5	498·5	473·1	401

The two lines run parallel throughout the whole series. The temperature was nearly stationary until the 17th, when it fell, and the diminution in the excretion of urea became greater.

When the lines of temperature and barometric pressure run parallel, their influence over the elimination of urea is increased; but when they are opposed, their influence is lessened. This is shown in the instance on January 2, when, with great diminution of temperature, there was but slight diminution of urea on the same day, and an actual increase on the following day; for the barometer rose from 29·228 inches on the day before to 29·918 inches on the same day, and to 30·143 inches on the following day.

An instance of the relation of high barometric indication and elimination of urea is given in the following sequence:—

TABLE XXX.

	April 24.	April 25.	April 26.	April 27.	April 28.	April 29.	April 30.	May 1.	May 2.
Barometer (in.)	29·619	29·812	30·026	30·120	30·160	30·204	30·273	30·125	29·951
Urea (grs.)	483·5	535·2	611	565·6	511·9	713·7	684·6	545·7	528·4
Urine (oz.)	64	76	47	41	29	42	64	35	25

The quantity of urea evolved on the 26th and the 29th was somewhat unduly increased by food.

Hence, on summing up the results now obtained, I venture to state that the action, both of temperature and atmospheric pressure, is direct, and that the urea varies as they vary; but the results are oftentimes conflicting. The following are some of the causes of variation from the rule:—

1. When the temperature increases and the pressure decreases, and *vice versâ*.

2. When the same cause acts for a lengthened period, the specific effects will be found only in the early days, since the necessity which exists for the maintenance of an equilibrium in the statics of the body induces oscillations, as the two influences are respectively powerful. Hence high atmospheric pressure will at first cause increased elimination of urinary water; but at length a point is reached below which the fluids of the body cannot be reduced consistently with health, and the quantity of urine falls, as is seen in the last Table.

3. Whenever, and from whatever cause, there is an increased elimination of urine, there will usually be an increase in the urea, notwithstanding the influence of adverse atmospheric influences.

4. The effects of meteorological and other influences are frequently carried on to the following day; so that in such a case there will be a modified influence acting on both days, and the distinction will be less perceptible; but sudden increase of pressure commonly caused an immediate increase in the quantity of urine evolved.

5. The actual temperature in which we live is not that of the external atmosphere, and cannot be rigidly determined.

With sudden increase of temperature and a low barometer, there is a sense of faintness and fullness, and the elimination of fluid and urea is retarded; whilst with increased atmospheric pressure and decreased temperature, the bulk of the body is lessened with the increased emission of fluids, and there is according to the degree a sense of lightness or of oppression.

[*Contrast of the daily inquiries during two consecutive years, viz. from March* 1860 *to March* 1862. (Plate XXXVI.)

The long interval which has elapsed since the preparation of this paper has permitted me to continue the daily inquiries through another year, and has afforded me the singular advantage of being able to compare the daily quantities through the several seasons of two successive years, and I have been permitted to add the figures to the Tables (p. 759 *et seq.*), and to represent the oppositions and agreements in the quantities recorded in Plate XXXVI. I now append a short Summary of the points in which the latter year has agreed or contrasted with the former.

Conditions of the inquiry.—During the last year the health has been as uniformly maintained as before; but there has been somewhat less of bodily exertion, and the weight of the body has increased about ten pounds. The daily inquiries have been made with

somewhat fewer intermissions; and there have been fewer experiments, which might interfere somewhat with the regular nutrition of the system. The summer holiday was again taken, and a month was again spent at the sea-side. The only important condition of contrast refers to the frequency of the analyses of urea; for, whilst in the former year there were always three, and often more analyses daily, with a view to determine the excretion at the different periods of the day, in the latter there was but one daily. Hence in the past year it has not been possible to restrict the day to uniform hours, viz. from 8 A.M. as before, since, without knowing the rate of excretion proceeding in the night, no correct addition or subtraction of quantities could be made for defect or excess of time. The twenty-four hours has therefore terminated at periods from 8 to 9½ A.M., but commonly it ended at about 8½ A.M.; and the addition and subtraction has been made by the average rate of emission of the twenty-four hours. The former was doubtless the more correct method; but the latter, by not reducing the day to a uniform hour, has not introduced any material error. It must also be recorded that, as there are errors of inquiry connected with LIEBIG's analysis for urea (as indeed with all other inquiries), they have been varied by the reduction of the number of daily analyses. I am not able to state whether this has rendered the total computation of the daily excretion more or less correct, since it is not known in what direction the errors in the analyses lie, or whether the direction is the same with different inquirers; but, considering that it lies in the appreciation of the exact degree of colour in the test solution, and knowing the degree of care which I have taken, I am inclined to believe that the tendency in my hands would be to lessen the quantity as the experiments were fewer.

Meteorological conditions.—The former year was remarkable for its cold summer and the long-continued frost of winter, whilst the latter, without being a hot year, was warmer in both summer and winter. Each year comprehends a part of two cold seasons, and the summer season, since it begins at the middle of March. The average temperature of the latter year was 2°·2 higher than that of the former. With the exception of May and September, February and March, the monthly temperature was higher; and the difference in May was only a defect 0°·4. The increase of temperature was particularly found in June, July, August, and October, in which the average monthly increase was 4°·4, 3°·1, 5°·6, and 4°·3 respectively. The highest mean daily temperature was 9°·8 higher, and the lowest mean daily temperature was 6°·8 higher, in the latter than in the former year on the days of inquiry. The pressure of the atmosphere was also somewhat higher in the latter than the former year, the excess being ·033 inch. The monthly averages on the days of inquiry were higher, except in July, September, October, February, and March; and the increase was particularly found in April, May, August, and December, in the last of which it was ·450 inch. The most marked months of defect were September and March. As we have shown that the opposition in the movements of these two elements of season have an important influence, it may be remarked that the two years corresponded in April and July, but differed in

September and January, with opposition in the former year, and in July and March in the latter year.

Elimination of Urea.—The total yearly average was less in the latter than in the former year; but the general course throughout the months of the year was the same. The average daily elimination, however, was greater in March (both), July, and August, but particularly in August, whilst the month of the greatest defect was September. In reference to this difference, it must be remarked that the months of greatest divergence were those of difference in the opposition of temperature and atmospheric pressure, and also that the conditions recorded in the month of September were very different in the two years. It has been remarked that in both years August and part of September were spent at Scarborough, and that there was doubtless some increase of nitrogenous food and exertion; and in reference to food, the increase was certainly greater in the latter than in the former year, and may account for the excess of urea in August. In reference to the divergence in September, it is to be remarked that in the former year only six days were included, and those were spent at Scarborough; whilst in the latter year twelve days were referred to, and all of them were spent in London; and hence with difference of conditions there were differences of results. The highest daily elimination of urea occurred in the latter and the least in the former year.

Elimination of Urinary Water.—The quantity of urinary water evolved was less in the latter than in the former year, and the difference occurred in every month of the year except March and May, but chiefly in the summer season. The greatest defect was 10 ounces daily in August. The defect in the winter half of the year was not considerable.

Weight of Body.—The foregoing differences render it very desirable to ascertain in what degree the weight of the body had increased with the diminution of excretion of fluid, and to compare the weight in the two years. The latter information cannot be given, since the inquiries in reference to weight were commenced only at the end of the preceding year; but the former may be abundantly supplied. The general expression is that the weight increased rapidly and greatly from April to October, with a decrease in May and November, and a second increase to the end of the year. The increase was about 10 lbs. from February to October; and thenceforward the monthly average varied in both directions within limits of 12 ounces. Hence, with the conditions of the year, the habits during the year, and the lessened elimination of fluid by the kidneys, there was a marked increase in the weight of the body.

It may be added as a general expression, that whilst the special conditions of each year caused and permitted variations in the vital and physical actions of the body, there was such a general influence exerted that the course of the changes remained the same.]

7. *Relation of Urea to exertion.*

The effect of exertion has, until very recently, been determined only in an indefinite

manner and during short periods. DRAPER, SPECK, and J. LEHMANN found no increase in the urea, whilst C. J. LEHMANN, HAMMOND, BENEKE, and BEIGEL found a variable increase not exceeding 25 per cent. When much sweating occurred, as it commonly did with severe exertion, it was assumed that urea had been lost by the perspiration, in accordance with the results obtained by FUNKE and MEISSNER. The excretion of urinary water varied in the different experiments. VOIT has, I believe, recently ascertained that with prolonged exertion a dog did not emit any materially increased quantity of urea—a result which will now be shown to correspond with my own preceding and contemporaneous experiments.

The relation of urea to exertion was determined by the second series of inquiries, viz. those made on four prisoners from March 1 to March 26, 1860.

The treadwheel is a revolving drum, with steps placed at distances of 8 inches upon the outside of the cylinder; and the prisoners are required to turn the wheel downwards by stepping upwards. The rapidity of revolution is regulated partly by the weight of the prisoners, and partly by a governor, and therefore is not absolutely uniform. The prisoners grasp a crossbar, and partly hang by it, and the body is held behind its centre of gravity. They were engaged in this labour in alternate quarters of an hour, the intervening periods being occupied in perfect rest in the sitting posture. The duration of this mingled labour and rest was from 7.15 to 8.25 A.M., 10.10 A.M. to 1.50 P.M., and 3.10 to 5.20 P.M.; so that the total period of actual labour daily was $3\frac{1}{2}$ hours. The total ascent per hour of continuous labour was 2160 feet, and per day 1·432 mile. The average weight of each man at the end of the inquiry was 105·125 lbs., 108·125 lbs., 120·5 lbs., and 122·625 lbs. avoirdupois, and of the whole 113·75 lbs.; and therefore the number of tons which they lifted 1 foot per day was as follows, upon the data used by Professor HAUGHTON:—

TABLE XXXI.

No. of prisoner	858.	948.	1040.	1041.	Average of all.
Weight in lbs.	105·125	108·125	120·5	122·625	113·75
Tons, 1 foot daily	354·81	356·76	406·56	413·89	383·9

Hence the average labour of each man was represented by lifting 384 tons through 1 foot per day, and this was exacted on alternate days only, on Tuesday, Thursday, and Saturday, whilst Sunday was a day of almost unbroken rest. There were during the inquiry ten days of treadwheel labour, ten of very light labour, and four of perfect rest. Their daily dietary was as follows:—

20 oz. of excellent brown bread, one pint of cocoa, one pint of oatmeal gruel, 6 oz. of cooked meat without bone ($4\frac{1}{2}$ oz. lean and $1\frac{1}{2}$ oz. fat), 8 oz. of boiled potatoes, about 1 oz. of salt, 10 oz. of water at midday, at 2 P.M. with dinner, and at 4 P.M. No. 1040 had $6\frac{2}{3}$ oz. of bread daily. All the food was eaten, and the quantity of salt was regulated to three-quarters of an ounce daily on March 7. Thus the average solid food was 34 oz. (plus $6\frac{2}{3}$ oz. bread for 1040, and the ingredients in the gruel and cocoa in all the

cases), and fluid 70 oz. daily. They were well inured to prison discipline and dietary; and all gained weight during the inquiry, except 1041, who lost a few ounces. They were in fair health, and willingly lent themselves to the inquiry. Their age, height, and occupation were as follows:—

TABLE XXXII.

No. of prisoner ...	858.	948.	1040.	1041.
Age	31	32	43	22
Height	5 ft. $2\frac{1}{4}$ inches.	5 ft. $2\frac{5}{8}$ inches.	5 ft. $5\frac{1}{8}$ inches.	5 ft. 7 inches.
Occupation ...	Plasterer.	Grocer.	Butcher.	Labourer.

Hence their average age, height, and weight were 32 years, 5 ft. $4\frac{1}{4}$ inches, and 113·75 lbs.

The object of the inquiry was to ascertain the weight of urea, chloride of sodium, urinary water and fæces, and to determine by final analysis the amount of nitrogen and ash in the food and in the urinary and fæcal excretions. There were also some variations in the food supplied during the inquiry. Thus, no salt was allowed from the dinner on March 10 to the dinner on March 14, except that added to the gruel; $3\frac{1}{2}$ oz. of extra fat were given daily from March 14 to the end of March 17; half an ounce of tea was given daily with the water from midday on March 18 to the end of March 24; $1\frac{1}{2}$ oz. of coffee was given daily from 1 P.M. on March 22 to the end of March 23; and lastly, 2 oz. of alcohol were given daily from the afternoon of March 24 to the end of March 26,—the duration of these latter inquiries being three days each.

The urine was collected from March 2 to March 17, from $6\frac{1}{4}$ to $7\frac{1}{4}$ A.M. whilst the prisoners were preparing for their duties and were more or less exposed to the open air; and this was regarded as the basis quantity, or that excreted in the absence of food and labour. On the treadwheel days a further quantity was collected from 7.15 to 8.25 A.M., during the treadwheel labour and before fluid or solid food had been taken. After these periods the whole of the urine was collected until $5\frac{1}{2}$ P.M., when the prisoners were locked up for the night; and lastly, the urine passed from $5\frac{1}{2}$ P.M. until $6\frac{1}{4}$ A.M. was collected. On Sundays (and also on weekdays after March 17) there were but two collections, viz. at $6\frac{1}{4}$ A.M. and $5\frac{1}{2}$ P.M. The urine of each man was collected separately, and care taken that not the smallest quantity was lost; and whilst the fæces of each man were weighed separately, the whole was passed into one vessel, and a fair sample submitted to final analysis.

Urea.

The following Table contains the basal quantities of urea passed from $7\frac{1}{4}$ to 8.25 A.M. on each morning (except Sundays) from March 2 to 17, when that part of the inquiry terminated. It will be recollected that the quantity of salt allowed was reduced to three-quarters of an ounce on March 7, and that no salt was given (except that contained in the gruel) from March 10 at dinner time to March 14 at dinner time.

TABLE XXXIII.—Showing the basal quantities of Urea of each of four Prisoners on days of very light and of Treadwheel Labour.

1860.	No. 858.		No. 948.		No. 1040.		No. 1041.	
	Basal.	Treadwheel.	Basal.	Treadwheel.	Basal.	Treadwheel.	Basal.	Treadwheel.
March 3.	11·07	10·27	10·1	12·7	13·8	14·7	17·7	15·9
4.								
5.	10·78	.....	16	.....	16	.....	17·4	
6.	11·6	10·83	18·3	17·2	12	16·3	24	14·8
7.	21·34	.....	14·6	.....	16·2	.....		
8.	12·6	13	14	14·3	13·6	16·3	14·8	12·2
9.	11·9	.....	12·1	.....	17	.....	24·2	
10.	15·0	10·5	15·1	13·0	19·5	14·3		
11.								
12.	23·8	.....	12·6	.....	15	.....	22·5	
13.	.....	.....	13·6	11·5	16	15·4	16·1	14·8
14.	7·3	.....	9·1	.....	14	.....	25·8	
15.	16·8	14·4	12·8	11·3	16·5	23·3	26·3	13·1
16.	25	.....	11·6	.....	20·8	.....	41·3	
17.	6·24	13·03	16·5	14·6	16·5	24	34	18

The Table shows that the quantities of urea evolved by No. 1041 were notably larger than those of the other prisoners. On the average of the three others the quantity evolved per hour during the treadwheel labour was ·2 gr. less than that evolved at rest, viz. 14·4 grs. and 14·6 grs. per hour, but when the returns of No. 1041 are added, the defect with the treadwheel labour is no less than 2·4 grs. per hour. There was some diversity in the returns of each of the three cases; so that in one the quantity of urea was the same under both conditions, in another it was 2·5 grs. in excess with rest, and in the third there was 1·9 gr. in excess with labour. The numbers of times in which any excess was found with labour over rest in the three cases were 28, 33, and 71 per cent. in the order above given. The greatest excess with labour was 7·5 grs., and the greatest defect with labour was 5·3 grs. per hour, and both occurred in the same person. In one-third of all these exceptions the excess was less than 1 gr. per hour. Hence it is shown that violent exertion has no definite influence over the *excretion* of urea in the absence of food.

The following Table contains the results of the daily average of urea, chloride of sodium, and water, in each of the cases during the whole period of inquiry, distinguishing the days of treadwheel labour from those of comparative rest, and indicating the periods when certain additional foods were administered (Plate XXXV.).

TABLE XXXIV.—Showing the Daily Rate of Emission of Urea, Chloride of Sodium, and Urinary Water by four Prisoners, with and without Treadwheel Labour (Plate XXXV.).

1860.	Prisoner No. 858.						No. 948.						No. 1040.						No. 1041.							
	Light work and Sundays.			Treadwheel.			Light work and Sundays.			Treadwheel.			Light work and Sundays.			Treadwheel.			Light work and Sundays.			Treadwheel.				
	Urea.	Ch. Sod.	Urine.	Urea.	Ch. Sod.	Urine.	Urea.	Ch. Sod.	Urine.	Urea.	Ch. Sod.	Urine.	Urea.	Ch. Sod.	Urine.	Urea.	Ch. Sod.	Urine.	Urea.	Ch. Sod.	Urine.	Urea.	Ch. Sod.	Urine.		
	grs.	grs.	fl. oz.	grs.	grs.	fl. oz.	grs.	grs.	fl. oz.	grs.	grs.	fl. oz.	grs.	grs.	fl. oz.	grs.	grs.	fl. oz.	grs.	grs.	fl. oz.	grs.	grs.	fl. oz.		
March 2.	572	594	85·1	...	...	...	...	...	76·2	...	...	...	579	437	71·5	...	...	...	641	329	78·3	...	...	...	March 2.	
3.	...	...	...	591	664	...	...	...	...	547	411	70·1	...	...	...	659*	491	67·4	...	...	...	546	261	51·9	3.	
4.	555	699	80·5	...	...	70·6	516	438	81·5	...	...	...	597	594	61·4	...	...	...	568	374	66·5	...	...	...	4.	Salt 1 oz. daily.
5.	447	591	67·6	...	...	...	525	415	66·9	...	...	...	511	566	64·3	...	...	...	483	529	61	...	...	...	5.	
6.	...	...	...	520	556	...	...	...	...	551	373	85·3	...	...	...	511	415	58	...	...	...	604	544	74·1	6.	
7.	488	533	71·8	...	...	83·4	510	318	65·9	...	...	...	620	456	63·4	...	...	...	523	547	64·3	...	...	...	7.	
8.	...	...	...	570	773	...	...	...	...	546	428	78·5	...	...	...	570*	652	61·3	...	...	...	548	545	68·7	8.	
9.	471	526	72·7	...	...	81·4	712	363	68·9	...	...	...	616	622	66	...	...	...	513	571	59·9	...	...	...	9.	Salt ¾ oz. daily.
10.	...	...	...	501	418	81·8	...	...	...	566*	355	67·5	...	...	...	554*	468	84·7	...	...	...	553	577	80·7	10.	
11.	441	163	76·4	...	...	...	485	149	77	...	...	...	666	110	74·5	...	...	...	476	242	88·5	...	...	...	11.	
12.	528	169	80·4	...	...	...	482	182	69·2	...	...	...	574	193	79·5	...	...	...	577	219	86·5	...	...	...	12.	No salt.
13.	...	...	...	544	84	69·2	...	...	...	512	200	84·1	...	...	...	616	223	71·2	...	...	...	510*	203	76·4	13.	
14.	514	288	48	...	...	...	470	178	51·1	...	...	...	498	202	38·3	...	...	...	570	155	54·8	...	...	...	14.	Salt ¾ oz. daily.
15.	...	...	...	414*	265	47	...	...	...	548	246	68·9	...	...	...	579	382	58·3	...	...	...	487*	141	49·2	15.	
16.	582	273	84·8	...	...	...	492	251	63·9	...	...	...	550	534	65·4	...	...	...	575	514	59·2	...	...	...	16.	Fat 3½ oz. extra.
17.	...	...	...	493	525	62·9	...	...	...	489*	410	88·1	...	...	...	577	536	63·5	...	...	...	567*	514	61·4	17.	Fat ended.
18.	396	562	61·8	...	...	...	405	393	82·5	...	...	...	486	595	64·8	...	...	...	606	757	84·2	...	...	...	18.	
19.	400	542	65·5	...	...	...	462	462	70	...	...	...	454	595	62	...	...	...	451	530	49·1	...	...	...	19.	Tea ½ oz. daily.
20.	...	...	...	544	615	81	...	...	...	498	476	75·5	...	...	...	541	592	70·5	...	...	...	451*	405	52	20.	Tea ended.
21.	430	552	68·2	...	...	...	469	483	58	...	...	...	531	724	73·2	...	...	...	524	583	68·2	...	...	...	21.	Coffee 1 oz. daily.
22.	...	...	...	533	552	74·0	...	...	...	567	348	83	...	...	...	...	...	69·6	...	...	...	...	...	69·5	22.	Coffee 1½ oz. daily.
23.	527	492	74·5	...	...	...	527	320	66·5	...	...	...	473	473	60·7	...	...	...	509	415	62·8	...	...	...	23.	Coffee ended.
24.	...	...	...	439*	316	58·5	...	...	...	461*	238	41·7	...	...	...	443*	495	59	...	...	...	523	482	53·5	24.	
25.	456	380	52·7	...	...	...	475	237	44	...	...	...	418	382	49	...	...	...	436	286	41·5	...	...	...	25.	Alcohol 2 oz. daily.
26.	574	410	52·5	...	...	...	472	226	47·2	...	...	...	545	424	50·5	...	...	...	543	347	46·2	...	...	...	26.	Alcohol 1½ oz. daily.

The average of all the observations gives the following results. On Sundays the elimination was to the extent of 494 grs., on days of comparative rest 512 grs., and on treadwheel days 528 grs. The increase on the days of treadwheel labour over that of merely routine labour was 16 grs. per day. The prisoner No. 1041, to whose exceptional returns I have before alluded, had no average increase with treadwheel labour, but, on the contrary, there was an average decrease of 51 grs., and the increase was carried on to the following day. The three other cases exhibited an increase of 37 grs., 59 grs., and 21 grs. daily, or an average of the three of 42 grs. daily with labour.

None of the cases were without an exception in the relative influence of treadwheel and mere routine labour; but one had two, another had three, and two had four exceptional days on which there was no increase on the treadwheel days. These instances are marked in the Table with an asterisk. When there was no increase on the treadwheel days, there was an increase on the following day of rest; and this irregularity alternated several times in succession.

The cause of these exceptions is not clear; but I am fully convinced that it is not due to any error, nor to any change in the dietary or the habits of the men. There were, however, two noticeable meteorological conditions at the periods when the marked variations occurred. Thus, from March 6 to March 11 the temperature fell from 40° to 30°·9, when the exceptions in No. 1040 occurred, and rose considerably on the day on which the exceptions ended, and at the same period the barometer rose very greatly, and remained at above 30 inches until the day before the exceptions terminated. These would exert a mutually opposing influence. The contrary conditions occurred on the exceptional days in case No. 1041; for the temperature rose from 30°·9 to 46°·5 from March 11 to March 20, when the exceptions ended; and the barometer having fallen to 29·570 inches on the day when the exceptions began, reached 30·012 inches on the day on which they terminated. There is thus at least a singular coincidence in the existence of these disturbing causes and a succession of exceptional results; and on each occasion the usual effect of the treadwheel labour over the *elimination* of urea was retarded one day.

The largest increase from the treadwheel labour was 144 grains, and the largest decrease was 100 grs. of urea per day.

The following Table contains the percentage results of this inquiry.

TABLE XXXV.

	The whole period.	To March 17, before extra food was given.
	per cent.	per cent.
Average increase from treadwheel over routine labour, in all cases combined	3	3·4
Average increase from treadwheel in the three most regular cases...	7·4	4·7
Average increase from treadwheel over Sundays (all combined) ...	6·4	
Average increase from treadwheel over Sundays, three most regular cases	10	
Average increase in the cases Nos. 948, 858, and 1040	7, 11, and 3·7	7·9, 3, 2
Average increase on days of routine labour over the treadwheel days, exceptional case No. 1041	10	
Average increase on treadwheel days, No. 1041	.....	1·5
Maximum increase from treadwheel over routine labour	26	20
Maximum decrease from treadwheel over routine labour	19	19

In order to ascertain how far the addition of alcohol, tea, and coffee may have modified these results, I have in the last column of the preceding Table separated the average returns before those substances were administered. The exceptional case, No. 1041, was regular up to that period, and on the whole average yielded a small increase on treadwheel days ; but the general results in the other cases were varied only so far as that the effect of the treadwheel was less on the short than on the long average.

The average amount of urea excreted daily to each pound weight of the body is as follows; and for comparison I have added the proportion in myself.

TABLE XXXVI.

No. of prisoner.....	858.	948.	1040.	1041.	Average of the whole.	Myself.
Urea, grs. to each lb.....	4·61	4·74	4·58	4·39	4·58	2·73

The foregoing facts prove that, whilst there is no average increase in the *elimination* of urea during the period of actual treadwheel labour without food, there is a small increase in the production on the whole day when ordinary food is taken; but on some occasions this increase is not eliminated on the day of labour, but on the following one of rest. The proportion of urea to the weight of the body on the whole period of labour and rest combined, is 59 per cent. greater than is observed in myself with much greater weight, less food, and less labour.

RUDOLPH found that during fasting there was an increase in the solids in the urine emitted, on the increasing weights of the men; but BENEKE and others have shown that, whilst there may be this general relation, there is much diversity in the results. Moreover, since in one person the bones, and in another the fat, may be relatively heavier than the muscle in a third, and since in relation to body weight the amount of food and the activity of the vital functions vary much, it is impossible that there should be any strict relation. In the case of these prisoners there was but little fat, and the bones were not unusually large, and the muscular system was over worked and under fed. They did not lose weight during this inquiry; but they had been long imprisoned, and the weight with which the final weighing was compared was not that on their entrance into the prison, but the reduced one at the period of this inquiry. It is probable that the knowledge of the relation of urea to body weight is of very little value.

Urinary Water.

The excretion of urinary water was greater on treadwheel days than on days of comparative rest. On the whole cases combined the daily quantity was 69·6 oz. on the former and 64·6 oz. on the latter days, or an increase of nearly 8 per cent. on the days of severe labour. The relative amounts evolved during the first ten days, before any variation of the food occurred, were 74·7 and 67·7 oz., giving an increase with labour of 10·4 per cent.

The rule thus established was not maintained without variation; but on every short

average, and in all the cases, it was observed. The following Table contains the average quantities of urinary water emitted in each of the cases from March 2 to March 10, with the treadwheel and with light labour.

TABLE XXXVII.

No. of prisoner	858.		948.		1040.		1041.		Total average.	
1860.	Light work.	Tread-wheel.	Light work.	Tread-wheel.	Light work.	Tread-wheel.	Light work.	Tread-wheel.	Light work.	Tread-wheel.
	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz.	fl. oz .	fl. oz.
Urine ...	73·15	79·4	70·8	82·87	63·8	67·9	62·9	68·9	67·7	74·7

Chloride of Sodium.

The elimination of chloride of sodium was commonly less on treadwheel than on the other days, but the difference was not very considerable. On the average of all the observations during the first ten days, the quantity of chloride of sodium evolved daily was 509 grs. with treadwheel, and 520 grs. with light labour. After that period the chloride of sodium was temporarily withheld; but upon the average of all the observations throughout the inquiry, the amount of that salt emitted was slightly less on treadwheel than on other days, the actual quantities being 432 grs. and 437 grs. There was much variation in the results both on the same and on different prisoners.

Fæces.

The analyses of the fæces were made by Mr. MANNING, from March 2 to March 16 inclusive, including two Sundays, six treadwheel, and six light-labour days. There was no instance in this part of the inquiry of the evacuation being of a purged character. Nos. 858 and 1040 had only one day without an evacuation, and No. 948 had an evacuation daily; but No. 1041 in but one instance had more than one evacuation every second day. The analysis on each day was made from the evacuation of that day; and therefore on every alternate day there was no fæcal analysis in the case of No. 1041. In determining the amount of the nitrogen emitted by the fæces daily, I have been compelled to admit a small error by dividing the quantity of fæces evacuated by No. 1041, on each occasion, equally between that and the preceding day, and to adopt a similar plan on the two exceptional occasions just mentioned in reference to the other prisoners. This prevents the accurate determination of the amount of nitrogen evolved by No. 1041 on any particular day, as, for example, on the treadwheel days, and so far lessens the characteristic results of each day, on the average of the whole cases. I have also referred the fæces to the *preceding* day, as they are clearly connected with the food of that day.

The following Table gives the total daily weight of the fresh fæces, with the total day emissions of nitrogen, and the amount of water, nitrogen, and ash in each ounce of the fresh fæces.

TABLE XXXVIII.—Showing the amount of Nitrogen and Mineral Matter evolved daily in the Fæces of four Prisoners, and placed under the preceding day.

	Fæces.				Total fæces, average.	Total nitrogen.	In 1 oz. of fresh fæces.	
	No. 858.	No. 948.	No. 1040.	No. 1041.			Water.	Nitrogen.
March.	oz.	oz.	oz.	oz.	oz.	grs.	per cent.	grs.
1.	9·75	4·25	6	2·5	5·62			
2.	7	11·9	6	14·75	9·91	39·7	73·8	4·363
Wheel 3.	5·5	4·25	10·75	9·08	7·4	35·87	72·6	4·848
Sunday 4.	17	12	24·9	9·08	15·74	69·25	73·2	4·4
5.	19	5·66	12·5	6·4	10·89	49	77·6	4·5
Wheel 6.	4·15	6·5	17	6·4	8·51	42·2	73·7	4·96
7.	7·75	5·15	9·25	13·3	8·86	43·23	73	4·88
Wheel 8.	11·41	4	12	13·3	10·1	45·75	72·8	4·52
9.	8·12	7·75	2·4	·87	4·8	21·22	74·3	4·42
Wheel 10.	8·12	1·75	2·4	·87	3·78			
Sunday 11.	9·75	12	10·4	11·5	10·91	50·59	73	4·637
12.	4·75	4·25	8·5	5·45	5·71	27·17	71·8	4·76
Wheel 13.	8·66	11·34	9·5	5·45	8·74	42·86	72	4·904
14.	8·5	10·25	10·5	7·9	9·28	41·46	74·1	4·468
Wheel 15.	9·5	5·75	9·25	7·9	8·1	36	73·3	4·45

The weight of fæces evolved per day was on the whole average 8·55 oz., and in the different cases 9·26, 7·1, 10·1, and 7·64 in their order; but it varied on different days from 24·9 oz. with daily evacuations, and 26·59 oz. with evacuations on alternate days to 1·75 oz. The uniform weight of solid food taken daily was 38 oz., and consequently the weight of the fæces on the average was 22½ per cent. of that of solid food.

The largest emission of fæces was on the Sunday, when it was 44·3, 70, and 74 per cent. higher than the average of all the days in the three first-mentioned cases.

There was a smaller evacuation on the wheel days than on the average of all days, in two of the cases to the extent of 14·8 and 21·1 per cent.; but in the third case both averages were the same. The average diminution, as compared with the quantities evacuated on Sundays, was 41, 53·3, and 42·6 per cent. The least evacuation occurred on the Saturday, which was also a treadwheel day; and in the three cases the diminution below the whole average was 26·1, 57·6, and 34·6 per cent.; but it was less than that of the Sunday by no less than 48, 75, and 62 per cent.

The amount of water contained in the fæces was very uniform, viz. 73·5 per cent. on the average, and varied only from 71·8 to 77·6 per cent. on different days. It was not above the average on Sundays, and it was a little below the average on the treadwheel days. The quantity of nitrogen in each ounce of fæces varied from 4·36 to 4·9 grs., and on the average it was 4·646 grs. The total quantity contained in the daily evacuation of fæces was an average amount of 41·8 grs. There was a considerable increase on the Sunday, and a marked decrease on Saturday, and it was below the average on the treadwheel days,—the actual amount on the three days being 59·9, 35·8, and 40·53 grs., or an increase of 43·3 per cent., and a decrease of 14·3 and 3 per cent.

Hence on Sundays there was a diminution in the amount of urea evolved from March 2 to the 16th, of 13 grs. and 18 grs. in the first two cases, but there was increase

in the nitrogen evolved in the fæces by the three cases, which when reckoned as urea amounted to 17·33 grs. There was no decrease in the quantity of urea on Sundays at this period by the third case, but, on the contrary, there was an increase of 52 grs. above the average of all days. The loss of nitrogen in the urine was thus found in the fæces. The case which was allowed $6\frac{2}{3}$ oz. of extra bread per day had the largest amount of fæces on the average, and the largest increase of fæces on Sundays. The total average excretion of fæces was 73 per cent. greater than in myself, with an equal amount of food and much more exertion.

The foregoing investigation has elicited the following facts.

1. The prisoners emitted much more urea and fæces than occurs in health under ordinary circumstances.

2. On Sundays the amount of urea was commonly lessened, but the nitrogen in the fæces was increased in the same proportion. The whole weight of fæces was increased.

3. With treadwheel labour there was a small increase in the amount of urea and of urine evolved, whilst there was a small decrease in the evolution of chloride of sodium by the urine, the weight of the fæces, and the nitrogen contained in the fæces. On Saturdays, with treadwheel labour the diminution in the fæces and the contained nitrogen was considerable.

4. With increase in the allowance of bread there was a considerable increase in the weight of the fæces, and particularly with rest.

[The following are the results of the experiments which were made upon four prisoners in Wakefield Prison in June 1861, and to which reference has been made at pp. 749–751. I have arranged them in the order observed in reference to the experiments at Coldbath Fields Prison; and, for further convenience of comparison, the pages at which the latter have been recorded in this paper are annexed to each subject of inquiry. The details of the results are given at length in Table XXXIX.

TABLE XXXIX.—The following Table contains the daily quantities of

Two

Date.	Daily Ingesta. Bread. No. 182.	Bread. No. 184.	Bread. Average.	Chloride of sodium, besides that in the bread. No. 182.	Chloride of sodium, besides that in the bread. No. 184.	Chloride of sodium, besides that in the bread. Average.	Water (not in food). No. 182.	Water (not in food). No. 184.	Water (not in food). Average.	Fæces. Quantity. No. 182.	Fæces. Quantity. No. 184.	Fæces. Nitrogen. Per cent., both.	Fæces. Nitrogen. Total daily quantity.
	grs.	grs.	grs.	grs.	grs.	grs.	fl. oz.	fl. oz.	fl. oz.	oz.	oz.	grs.	grs.
1861.													
June 28	10,913	10,898	10,906	194	49	121·5	18	10½	14¼	6·88	9·66	...	...
„ 29	10,849	10,338	10,594	191½	75½	108·5	16	17	16½	4·33	7·19	...	...
„ 30, Sunday	10,791	11,192	10,992	201½	45½	123·5	15	17	16	5·6	10·85	·789	28·5
July 1	10,908	10,748	10,828	187½	87½	137·5	4	10	7	7·53	11·41	·71	29·43
„ 2	10,988	10,727	10,858	190	86	138	29	31	30	5·55	5·35	1·03	24·51
„ 3	12,612	10,500	11,556	192½	92	142·2	10	5	7⅓	4·83	9·64	·88	27·59
„ 4	9,652	10,145	9,899	178	102½	140·2	9	3½	5¼	7·09	10·28	·77	29·27
„ 5	10,430	10,446	10,438	224	115	169·5	8	7½	7⅝	5·55	5·06	1·08	25·1
„ 6	11,275	10,095	10,685	202	143½	172·7	17½	8	12¾	6·21	10·82	·79	29·45
„ 7, Sunday	10,854	10,343	10,599	190½	42½	166·5	9½	11	10¼	5·66	5·9	·98	24·77
„ 8	10,206	9,187	9,697	192	39	116	5	9	7	4·83	10·1	·93	30·48
„ 9	9,830	11,331	10,581	231	41½	136·2	15	7	11	5·09	4·53	1·16	24·42
„ 10	9,893	11,256	10,575	217	40	128·5	11½	9½	11½	5·53	5·78	1·14	28·23

Two Cocoa-

Date.	Daily Ingesta. Bread. No. 7.	Bread. No. 39.	Bread. Average.	Chloride of sodium, besides that in the bread. No. 7.	Chloride of sodium, besides that in the bread. No. 39.	Chloride of sodium, besides that in the bread. Average.	Water (not in food). No. 7.	Water (not in food). No. 39.	Water (not in food). Average.	Fæces. Quantity. No. 7.	Fæces. Quantity. No. 39.	Fæces. Nitrogen. Per cent., both.	Fæces. Nitrogen. Total daily quantity.
	grs.	grs.	grs.	grs.	grs.	grs.	fl. oz.	fl. oz.	fl. oz.	oz.	oz.	grs.	grs.
1861.													
June 28	12,988	12,848	12,918	86½	38½	62·5	31½	60	45¾	9·04	8·48	...	...
„ 29	14,543	14,664	14,604	88	39½	63·7	40	61	50½	15·51	5·96	...	...
„ 30	11,528	14,305	12,917	78½	None	...	14	16	15	6·63	5·88	1·03	26·41
July 1	13,607	13,475	13,541	69	37½	53·2	40	17½	28¾	2·03	10·33	1·24	34·16
„ 2	13,127	12,407	12,767	73	37	55	40	29	34½	10·11	8·52	1·15	46·26
„ 3	13,629	13,758	13,694	88½	42	65·2	29	40	34½	8	13	1·10	50·71
„ 4	13,314	13,412	13,363	105	40½	72·7	40	40	40	5·35	9·23	1·04	34·66
„ 5	12,829	14,588	13,709	86	41	63·5	40	40	40	4·32	7·94	0·97	26·01
„ 6	12,260	14,050	13,155	93	50	71·5	40	29	34½	10·94	8·64	1·35	57·8
„ 7	13,254	13,340	13,297	82	25½	58·7	30½	14	22¼	1·72	14·4	1·00	35·28
„ 8	12,613	12,687	12,650	85	54	74·5	33	40	36½	10·7	5·28	1·31	45·81
„ 9	12,943	13,753	13,348	88	76½	82·2	50	40	45	6·74	12·84	1·05	45·03
„ 10	13,232	13,010	13,121	80	66	73	40	29	34½	10·48	10·45	1·05	48·1

the Ingesta and Egesta in Two Tailors and Two Cocoa-Matting Weavers.

TAILORS.

Daily Egesta.									Weight of body, in lbs. and oz. avoirdupois.			Urea to 1 lb. of body-weight.
Urine. Quantity.			Urea.		Nitrogen, daily.		Chloride of sodium.					
No. 182.	No. 184.	Average.	Per fl. oz. of urine.	Total daily.	Urine.	Total in urine and fæces.	In each fl. oz. of urine.	Total daily in urine.	No. 182.	No. 184.	Average.	
fl. oz.	fl. oz.	fl. oz.	grs.	grs.	grs.	grs.	grs.	grs.	lbs. oz.	lbs. oz.	lbs.	grs.
									124 13	117 $9\frac{1}{4}$	121·35	
44·4	56·6	50·5	14·4	707	330·4	.....	3·0	151·5	125 $2\frac{3}{4}$	117 8	121·35	5·82
59·17	39·04	49·1	14·76	725	338·8	.....	3·6	176·7	125 2	118	121·28	5·91
35·4	43·45	39·45	14·7	580	271	299·5	3	118·3	125 $11\frac{1}{2}$	118 $11\frac{1}{4}$	122·21	4·74
40·0	50·67	45·38	12·30	569	265·8	295·23	2·7	122·4	125 $10\frac{3}{4}$	118 $5\frac{3}{4}$	122	4·66
31·7	43·3	37·5	13·36	501	234·1	258·61	3	112·5	125 $8\frac{1}{2}$	119	122·26	4·09
32·4	38·5	35·45	13·71	456	213	240·59	2·7	95·7	125 $13\frac{3}{4}$	118 $13\frac{3}{4}$	122·36	3·72
34·9	41	37·95	14·44	547	255·6	284·87	3·6	136·6	126 $3\frac{1}{4}$	118 $10\frac{3}{4}$	122·43	4·46
35·7	40	37·85	15·64	592	278·5	303·6	3·6	135·0	126 $2\frac{1}{2}$	119 7	122·8	4·82
49	47·5	48·25	13·83	668	312·1	341·55	2·7	130·27	125 $15\frac{1}{2}$	118 $9\frac{1}{4}$	122·27	5·46
33·3	42·5	37·9	14·4	546	255·5	280·27	4	151·6	126 $4\frac{1}{2}$	119 $3\frac{1}{2}$	122·75	4·44
38·4	39	38·7	17·04	660	307·4	337·88	4	154·8	126	119 $1\frac{1}{4}$	122·53	5·38
33·8	41·5	37·65	18·8	708	376·6	401·02	4	150·6	125 $11\frac{1}{2}$	118 9	122·14	5·79
39·3	40	39·65	16·4	650	303·7	331·93	4	158·6	125 $13\frac{1}{2}$	119 $5\frac{1}{4}$	122·6	5·3

MATTING WEAVERS.

Daily Egesta.									Weight of body, in lbs. and oz. avoirdupois.			Urea to 1 lb. of body-weight.
Urine. Quantity.			Urea.		Nitrogen, daily.		Chloride of sodium.					
No. 7.	No. 39.	Average.	Per fl. oz. of urine.	Total daily.	Urine.	Total in urine and fæces.	In each fl. oz. of urine.	Total daily in urine.	No. 7.	No. 39.	Average.	
fl. oz.	fl. oz.	fl. oz.	grs.	grs.	grs.	grs.	grs.	grs.	lbs. oz.	lbs. oz.	lbs.	grs.
									146 $8\frac{1}{2}$	147 $3\frac{1}{2}$	146·87	
36·8	62·3	49·55	13·74	671	313·4	.....	2·4	118·9	146 10	146 $6\frac{1}{4}$	146·51	4·55
42·7	61·15	51·92	13·8	717	335	.....	2·7	140·1	146 $3\frac{1}{4}$	146 $4\frac{3}{4}$	146·25	4·9
41·06	48·9	44·98	15·36	691	322·9	349·31	2·4	107·9	147 $6\frac{1}{2}$	146 11	147·1	4·7
53·8	40	46·9	14·76	692	323·3	357·46	3·3	154·7	147 $9\frac{3}{4}$	146 11	147·15	4·7
53·9	35·7	45·8	13·89	637	297·3	343·56	3·9	178·6	146 $10\frac{1}{2}$	146 $13\frac{1}{4}$	146·75	4·34
29·4	42·9	46·15	15·42	558	262·6	313·31	3·6	166·1	147 $0\frac{1}{4}$	146 $11\frac{3}{4}$	146·9	3·62
45·5	45	45·25	15·9	710	331·8	366·46	3·6	162·9	147 $5\frac{1}{2}$	146 14	147·11	4·83
55	44	49·5	15·45	765	357·3	383·31	3·3	163·3	147 2	146 $0\frac{3}{4}$	146·58	5·21
74	40·5	57·25	13·53	775	362·1	519·9	2·7	154·5	146 4	146 10	146·43	5·29
48·5	37·5	43	15·87	683	319·1	354·38	2·7	116·1	148 $3\frac{1}{2}$	147 $12\frac{1}{4}$	147·98	4·61
49	44	46·5	15·2	707	330·3	376·11	3·6	167·4	146 $14\frac{1}{4}$	147 12	147·32	4·8
46	46	46	16	736	343·9	388·93	3·6	165·6	144 $15\frac{1}{2}$	147 $11\frac{1}{4}$	146·34	5·02
42	46·5	44·25	17·84	790	369·1	417·2	3·6	159·3	144 $9\frac{1}{4}$	147 $2\frac{1}{4}$	146·36	5·39

Urea (p. 809).

The analysis for urea was made by LIEBIG'S method in the manner already described in reference to the experiments at Coldbath Fields.

The total average daily quantity of urea evolved was 655·65 grs., of which 608·4 grs. were emitted by the Tailors, and 702·9 grs. by the Weavers. The maximum and minimum amounts were 790 grs. and 456 grs.,—the former in the Weavers, and the latter in the Tailors. In the Weavers the quantity exceeded 700 grains on seven of thirteen days, whilst it occurred only three times during that period in the Tailors; and in only one instance during the inquiry was it below 500 grs. daily.

The quantity of urea to each pound of body-weight (p. 810) was 4·812 grs. in the Tailors, and 4·675 grs. in the Weavers; but it varied in the former from 3·72 grs. to 5·82 grs., and in the latter from 3·62 grs. to 5·39 grs. on different days. The quantity of urea eliminated was always lessened on the Sunday (pp. 809, 812). The diminution in the Tailors from the Saturday to the Sunday was 145 grs. and 122 grs., and in the Weavers 26 grs. and 92 grs., yielding an average diminution of 96·25 grs.

The quantity of urea in each ounce of urine was on the average 14·9 grs. in the Tailors, and 15·25 grs. in the Weavers, giving a total average of 15·075 grs. The maximum and minimum quantities were 18·8 grs. and 12·3 grs. in the Tailors, and 17·84 grs. and 13·53 grs. in the Weavers.

Weight of Body (p. 810).

The average weight of three of the prisoners during the inquiry was greater than that recorded on the day preceding the commencement of the inquiry; but there was a loss of weight of the fourth. The average gain of the Tailors was $15\frac{1}{2}$ oz. and $17\frac{3}{4}$ oz., and of one of the Weavers $3\frac{1}{4}$ oz., but the other Weaver lost $3\frac{3}{4}$ oz. The greatest gain in the different cases was 1 lb. $13\frac{1}{4}$ oz. and 1 lb. $7\frac{1}{2}$ oz. in the Tailors, and $8\frac{3}{4}$ oz. and 1 lb. 11 oz. in the Weavers; and the greatest loss was $1\frac{1}{4}$ oz. in one Tailor, and 1 lb. $2\frac{1}{4}$ oz. and $4\frac{1}{2}$ oz. in the Weavers. There was not any unvarying progression in the weight during the week; but in every case there was an increase from the Saturday to the Sunday, and the amount was as follows: $11\frac{1}{4}$ oz. and $10\frac{1}{4}$ oz., $9\frac{1}{2}$ oz. and 5 oz. in the Tailors; $6\frac{1}{4}$ oz. and $18\frac{1}{4}$ oz., $19\frac{1}{4}$ oz. and $31\frac{1}{2}$ oz. in the Weavers, or an average increase on the Sunday of 13·62 oz.

Urine (p. 810).

1. *Quantity.*—The largest quantity of urine evolved in one day was 25,321 grs. (56·6 oz.) and 26,624 grs. (59·17 oz.) in the Tailors, 27,791 grs. (62·3 oz.) and 32,924 grs. (74 oz.) in the Weavers. The average daily quantity was 41·2 oz. in the Tailors, and 47·51 oz. in the Weavers, giving a total daily average of 44·35 oz. There was a large increase on the Saturday, and a marked decrease on the Sunday, as the following quantities prove.

TABLE XL.—Showing the average quantity of Urine evolved on Friday, Saturday, and Sunday.

	Friday.	Saturday.	Sunday.
	oz.	oz.	oz.
Two Tailors	.....	49·1	39·45
	37·85	48·25	37·9
Two Weavers.....	.....	51·92	44·98
	49·5	57·25	43

The average decrease from the Saturday to the Sunday was 10·29 oz.

2. *Specific Gravity.*—The specific gravity of the urine varied from 1016 to 1027·5, but there was singular uniformity in the general results. In the Tailors it was 1023·7 and 1025, and in the Weavers 1024·37 and 1024·6, giving a total average of 1024·35 in the Tailors and 1024·45 in the Weavers.

Chloride of Sodium (p. 811).

The average quantity of chloride of sodium evolved was 3·37 grs. per oz. in the Tailors, and 3·18 grs. per oz. in the Weavers, giving a daily emission of 138·8 grs. in the former, and 148·5 grs. in the latter.

Fæces (p. 811).

The general character of the fæces was homogeneous and moderately cohesive; but on a few occasions there was variety in the consistence. In the 52 observations, 32 exhibited fæces formed but soon subsiding, 7 well-formed, 1 scybalous, 2 soft, and 9 of mixed characters; and no one prisoner offered any very marked difference in those conditions. The trace of the bran of the bread was easily seen in the fæces. The average daily evacuation was 6·98 oz. in the Tailors, and 8·52 oz. in the Weavers, giving a total daily average of 7·75 oz. There were somewhat considerable daily variations; so that the maximum and minimum quantities were in the Tailors 11·41 oz. and 4·32 oz., and in the Weavers 14·42 oz. and 1·72 oz.; but in no instance was there the omission of a daily evacuation.

The quantity of nitrogen per cent. found by Mr. MANNING by the volumetric method, varied from ·71 gr. to 1·16 gr. in the Tailors, and from ·97 gr. to 1·35 gr. in the Weavers; but the total average in the two classes was ·93 gr. in the Tailors and 1·12 gr. in the Weavers, giving 1·025 gr. on the whole.

The total daily elimination of nitrogen by the fæces were found to be 27·43 grs. in the Tailors, and 40·93 grs. in the Weavers. The variation in the amount of fæces on Sunday from that of other days was not uniform in quantity, since it was less on Sunday than on week days in the Weavers, and was equal in the Tailors.

Such is a summary statement of the results obtained in the inquiry on two classes of prisoners, one of which followed a sedentary and non-laborious occupation, whilst the

other really performed hard labour; and it will be observed that there were many differences in the results obtained from them. Both classes had a similar and substantial dietary, but there were certain personal differences. Thus, the weavers of cocoa-matting in the wide loom, when compared with the Tailors, were older, taller, heavier, and broader. They ate more bread, milk, and water. They lost weight, whilst the Tailors gained weight. They emitted more urine, urea, chloride of sodium, and fæces with their contained nitrogen. They exhibited much less diminution in the amount of urea evolved on the Sunday, and a little less urea to body-weight.

It is not possible to compare the results of this inquiry very closely with those already described in reference to Coldbath Fields, since the conditions in each set of experiments were not identical. At Coldbath Fields the quantity of bread and water was rigidly fixed, whilst at Wakefield there were daily variations according to the desires of the prisoners. The quantity of bread eaten was greater at Wakefield than at Coldbath Fields, and would so far increase the amount of urea *produced*, whilst the variable quantity of water taken from day to day would at the same gaol vary the *elimination* of that product. Yet these causes of variation have only a certain value; and upon the whole it will be seen that there is a very close correspondence between the excretions of the Weavers at Wakefield and those who worked the treadwheel at Coldbath Fields.

The weight of the men at Wakefield was greater than that of the prisoners at Coldbath Fields; the quantity of urine and of fluid drank was less, and that of urea was greater; but the proportion of urea to body-weight was very nearly the same at the two prisons. In both there was more urea evolved on days of hard labour, and less on Sunday. There was less chloride of sodium evolved, as there was less supplied in the food. The weight of the fæces and the contained nitrogen was the same at both places.]

8. *Certain relations of Urea to Food.*

All observers have found that the amount of urea varied with the food taken, and was the greatest with that food which yielded the most nitrogen—as, for example, albumen and gelatine. This has been well established by LEHMANN, BIDDER and SCHMIDT, and LAWES and GILBERT, and many others of the best repute; and there was usually a correspondence between the increase in the nitrogen supplied and excreted, if the body-weight remained the same.

I have in former parts of this paper referred to the influence which food exerts upon the excretion of urea, and particularly in the effect of absence of food over the hourly rate of excretion, and the effect of increased food on Sundays. I propose now to show the effect of food taken at a late hour, and of unusual kind and quantity, as occurred on various occasions at dinner and evening parties during the year, and then to refer to a few special experiments on foods.

Instances of excess of Urea after Dinner and Evening Parties, when no excess in food or wine, in the ordinary acceptation of the term, was committed.

Dinner.—Feb. 25. The urea increased from 453·4 grs. on the preceding day, and an average of 438·8 grs. on the three preceding days, to 594·3 and 582 grs. on the same and the succeeding day; also to an average of 648 grs. on the two following days, and 517·2 grs. on the fourth day, and afterwards it fell to 488 and 483 grs. The quantity of urea emitted on the first night was 60 per cent. greater than on the preceding night.

Supper.—Feb. 9. There was no increase in the urea emitted during the night, but on the following day the increase was 144 grs.

Supper.—Feb. 16. The urea increased from 470·6 grs. on the previous day to 539·6, 543·7, 534·4, and 522·1 grs. on succeeding days, and fell to 397 grs. on the fourth day. There was an increase on the first night, and the basis quantity on the following morning was increased 49 per cent.

Dinner, a bottle of Moselle.—March 8. There was an increase of 125 grs. of urea during the night, and a maximum increase of 230 grs. on the following day.

Dinner, pint of mixed wine.—March 23. There was no increase in the quantity of urea until the second day.

Supper.—April 12. There was an increase during the night and on the two following days to the extent of 100 grs. on each day.

Supper.—April 19. After merely taking cream and wine there was an increase during the night, and the basis quantity on the following morning was increased 33 per cent.

Soirée.—April 21. There was an increase of 54 grs. during the night, and the basis quantity was elevated.

Supper.—April 26. There was an increase during the night of 76 grs. of urea, and it continued through the next day.

Supper, meat and ale.—May 11. There was an increase of 42 grs. of urea on the day following. The supper was followed by a sensation of excess.

Supper.—Nov. 22. The urea increased from 490 grs. to 548 grs., and fell on the administration of medicine.

Supper.—Dec. 12. The increase in the urea during the night was 7 grs. per hour, and on the following three days it was 100, 130, and 134 grs.

Dinner.—Dec. 30. The urea was increased 63 per cent. during the night, and on the next day the increase was 92 grs.

Dinner.—Jan. 31. After taking three or four glasses of strong wine and dining heartily I was ill, and vomited very acid matter. There was an increase of 3·4 grs. of urea during the day, but on the next day the quantity was lessened.

[Examples of a similar kind are recorded in the Tables, p. 759 *et seq.*, on March 27, April 15, May 18 and 20, June 12, November 18 and 30, 1861, and February 1, 1862.]

Hence in every instance, and at all periods of the year, when food of an unusual kind and in unusual quantity was taken and retained, an increase in the elimination of urea immediately followed, and continued during periods varying from one to four days. In reference to the influence of wine, I have remarked that on the occasion on which the wine was not good, and any stomach derangement followed, there was a much larger emission of urea than occurred with a greater quantity of wine of fine quality.

[Milk supper was also followed by an increased elimination of urea on May 18, July 11 and 21, September 23; and the same result followed the eating of crab and cow-heel on May 13 and December 1, but the effect was not uniform.]

The influence of some special kinds of food.

As many of the experiments in reference to the action of foods did not extend beyond a part of a day, they cannot show any influence over the daily excretion of urea, and I shall not here refer to them.

On the occasion on which I lived on bread with water, tea, and coffee during three days, the total amount of urea, the quantities of urea and urinary water, were as follows:—

TABLE XLI.

34 oz. bread, 48 oz. water.		34 oz. bread, 48 oz. water, 350 grs. tea.		34 oz. bread, 48 oz. water, 2 oz. coffee.	
Urea.	Urine.	Urea.	Urine.	Urea.	Urine.
grs. 442	fl. oz. 67·85	grs. 467·28	fl. oz. 41·55	grs. 493·16	fl. oz. 52·04

The amounts evolved on the preceding day were 550 grs. of urea and 57·73 oz. of urine; but as that was Sunday, there would have been, with ordinary food, a considerable decrease on the Monday, and hence we lack a good basis for comparison. There can be no doubt, however, that there was a considerable diminution of urea on the day on which bread and water alone were taken; but there was a progressive increase on the two following days, when tea and coffee were administered. On the following day, when bread and water only were taken until $2\frac{1}{2}$ P.M., and then plenty of additional food, the urea increased to 507·2 grs.

The diminution in the excretion of urine with the tea was in part the result of the large elimination on the preceding day. The quantity evolved with the coffee was normal.

The appetite was lessened under the influence of coffee, and there was an odour of coffee in the urine.

If we accept HAUGHTON'S analysis of bread, and consider that 1 oz. of fine bread is equivalent to 12·25 grs. of urea, we find that on the first day there were 25 grs. of urea eliminated by the urine more than could have been contained in the bread.

On the occasion when extra foods were given to the prisoners, the following were the average results obtained:—

TABLE XLII.

3½ oz. extra fat.		½ oz. tea.		1½ oz. coffee.		2 oz. alcohol.	
Urea.	Urine.	Urea.	Urine.	Urea.	Urine.	Urea.	Urine.
grs. 529	fl. oz. 69·17	grs. 474	fl. oz. 68·37	grs. 515	fl. oz. 69	grs. 489	fl. oz. 49·96

The urea and urine, on the average of the four preceding days, were 525 grs. and 70·3 oz.; but the quantity of urea had fallen from the commencement of the inquiry.

Hence the extra fat produced no average change in the excretion of urea and urine; but in No. 858 both were diminished, and in No. 1041 the urea was increased.

BÖCKER and BISCHOFF have shown that, in the ordinary conditions of the system, an increase in the quantity of fat supplied does not vary the amount of urea evolved.

The urea was greatly lessened under the influence of the tea, but that occurred chiefly on the first and second day; for, whilst it fell to 442 grs. on the second day, it rose to 508 grs. on the third, which was a treadwheel day. There is not, however, an unexceptionable basis of comparison, since it is very probable that the average of the three preceding days was unduly increased by two of the three having been treadwheel days; and hence it is probable that the diminution in the excretion of urea under the influence of tea is less than is now represented. The average excretion of urine was unchanged.

The urea rose under the action of the coffee 42 grs. daily, and nearly reached the point from whence it fell before the tea had been administered. The quantity of urine remained unchanged.

Professor LEHMANN found that theine increased the elimination of urea; but BÖCKER and HAMMOND state the contrary to be the action of tea, whilst at the same time they affirm that the urinary water is unaffected. The urinary water was observed by LEHMANN, BÖCKER, and HAMMOND to be increased, and the urea to be decreased, in various degrees by the action of coffee.

The alcohol caused a further diminution in the amount of urea to the extent of 26 grs. per day; but it yet remained 14 grs. per day higher than the point to which it first fell with the tea. In each of three regular cases the alcohol prevented the increased elimination which usually occurred from them on the treadwheel days, and rendered the amount on that day 43 grs. less than it had been with rest on the preceding day; but the urea rose on the third day from 466 grs. with the treadwheel labour, and 446 on the Sunday, to 557 grs. on the Monday.

The amount of urine was reduced nearly 20 oz. per day on the average of the whole of the prisoners, and in each of them.

The barometer fell so low as 28·904 in. on the first day of the administration of the alcohol, and would therefore tend to lessen the elimination of urea.

BÖCKER and HAMMOND found that the addition of moderate quantities of alcohol to the ordinary diet lessened the excretion both of urea and urinary water.

Tea, coffee, and alcohol, but particularly the latter, had, in my experiments, the power

of retarding the elimination of urea for one or two days; but on the third day this power ceased. The same was observed of other changes of diet, as, for example, the omission of salt and the addition of fat,—the former causing a diminution of 26 grs. from the amount on the treadwheel day (when only 10 grs. had been added by the treadwheel day), and the latter a loss of 6 grs., although it was a treadwheel day. The increase with the salt, fat, and coffee occurred on the second day; but with tea and alcohol it was deferred until the third day, and even then the normal quantity of urine was not restored with the alcohol.

There was no disturbance of the health during these investigations, except that No. 1040 was once purged with the coffee; and with the alcohol all complained of being lazy at their work and thirsty, and they noticed that they passed less urine and slept more profoundly.

Chloride of Sodium.

Abstinence from the use of chloride of sodium was found by WUNDT to diminish the quantity of urinary water, and to lessen the amount of chloride of sodium excreted with it progressively through a period of five days.

The rate of excretion of chloride of sodium, when three-quarters of an ounce was allowed daily besides that which was contained in the bread and gruel, was, on the average of all the cases, 506 grs. daily. When only that was allowed which was contained in the bread and gruel, the daily emission was reduced to 184 grs. On renewing the full quantity, and adding $3\frac{1}{2}$ oz. of extra fat, the rate increased to 419 grs. daily, which was a less quantity than that which was recorded when the supply of salt had long been unlimited. The quantity was increased 123 grs. daily under the use of tea, and then fell 48 grs. daily with coffee; and a further loss of 142 grs. daily occurred with the alcohol.

The average elimination under these different conditions was as follows:—

TABLE XLIII.

	Unlimited supply.	$\frac{3}{4}$ oz. less supplied.	Full supply, extra fat.	Full supply, tea.	Full supply, coffee.	Full supply, alcohol.
	grs. daily.	grs. daily.	grs. daily.	grs. daily.	grs. daily.	grs. daily.
Chloride of Sodium ...	506	184	419	542	494	352

The very large supply and elimination of chloride of sodium in prisoners is remarkable, the elimination under ordinary conditions being nearly equal to that of urea. The diminution in the excretion, when the supply had been lessened by three-quarters of an ounce, was almost identical with the diminution of the supply. Thus the loss was 322 grs., and the diminution in the supply was 328 grs. As the lessened elimination during the experiment with extra fat immediately followed the last experiment, it may perhaps be doubted whether some portion of the salt supplied had not been retained, to meet the deficiency previously existing; but the increase with tea and coffee, and par-

ticularly with the former, cannot admit of doubt. The very large diminution in the excretion of chloride of sodium under the action of alcohol corresponds with the lessened excretion of urinary water, so that the former fell 27·5 and the latter 28·7 per cent. The diminution was much greater than that of urea, which was only 5 per cent. on the average of the three days.

9. *Relation of the Excretion of Urea to headache, deranged stomach, and a sense of general malaise.*

I was not subject to any serious illness during the year, but on various occasions, for a day or two at a time, I had derangement of the stomach accompanied by headache, and much nervous irritability and depression. The observations which were then made show that this condition was commonly accompanied by lessened excretion of urea and urine, and the relief of it with increased excretion; but the smaller amount of urea was not necessarily much below the average. I have tabulated the observations in the following manner for convenience of analysis:—

TABLE XLIV.

Date.	State of health.	Urine.	Urea.	Urea. Sequence of days.		
				Previous.	Actual.	Succeeding.
June 4.	Headache; stomach derangement.	Much (69·8 oz.)	Lost 20 grs.; more next day...	517	**497**	596
Oct. 18 & 19.	Headache; took aperients...	Less	Less (190 grs.); increased afterwards.	546	**462**	**350**
December 25.	Headache, severe; aperients.	Less (46 oz.)	Much less (208 grs.)	528, 506	**298**	
January 6.	Headache, little	Less (38 oz.), followed by increase (47 and 68 oz.).	Less (51·5 grs.)	503	**451**	
February 25.	Headache	Much (65 oz.)	Less on two following days...	561, 477	**483**	418, 360
July 19.	Headache	Little (47 oz.); increased ...	Low; increased 35 grs. when relieved.	.....	**464**	500
December 9.	Headache; aperients	Less, and then more	Very low; increased afterwards.	380	398	455
February 21.	Food disagreed; fish	Very much (87 oz.)	Increased three days 87·7 grs.	474	**543**	552, 561
Mar. 14 & 15.	The same; chawl	Greatly increased (92·6 oz.)..	Much less (163·2 grs.)	574	**460**	**411**, 455
March 6.	Very tired and oppressed ...		Lessened 71 grs.	523	**456**	527
January 17.	Tired; heavy; full; with the thaw.		Increased 56 grs.	495	**552**	444
Feb. 25, 1860.	Full (Sunday)		Increased 77 grs.	502	**580**	471
May 10.	Oppressed		High; fell next day 141 grs., and increased following day.	.....	**595**	452, 595
October 23.	Oppressed; full	50 oz.	Fell 79 grs.; increased next day.	540	**461**	521
May 2.	Irritable; depressed	Very low (25 oz.); had been purged.	Very high, as preceding days, and fell to normal quantity.	713, 684	**545**	528

It is very likely that all the conditions above mentioned were not identical; but they show that in all the attacks of illness which I had the elimination of urea was disturbed. Commonly the elimination of urea was temporarily lessened, and had been above the average amount. The effect upon the urine was not uniform; but the very largely increased elimination of urine, with lessened elimination of urea, in the two instances in which food disagreed were very striking. In every instance of headache the relief was attended by a return to the usual rate of elimination of urea. There was not, on those

occasions, any material change in the quantity of food taken; for aperients and emetics were had recourse to, and relief was soon obtained.

[The years 1861 and 1862, Table I. p. 759 *et seq.*, offer numerous records in which the quantity of urea eliminated was temporarily lessened under the influence of oppressive weather or of internal conditions, causing headache and general malaise. Such are May 14 and 21, and 28 to 31; June 14; July 2 to 5 and 20; October 8; November 3 and 4, 6 and 8; December 6 to 10, 1861; and January 26, 1862.]

The effect of purging over the elimination of urea was commonly inconsiderable; but in one instance there was a great diminution of both urea and urine.

10. *Relation of Urea and Carbonic Acid.*

Scarcely any observations have hitherto been made in reference to the relation of urea and carbonic acid; but BECHER (HENLE'S 'Zeits.' 1855) observed a general relation existing between these two excretions, and particularly in their relation to food, but the two did not move in parallel lines. My inquiries into the evolution of carbonic acid and urea enable me to show some of their relations, as follows:—

1. In both alike the period of production is not identical with that of elimination. Tea and coffee cause a larger elimination of carbon than they supply; and in a paper published in the 'Philosophical Magazine' for December 1859, I showed it to be probable that the immediate action of all food is elimination, whilst the act of production is more remote. Hence carbonic acid may accumulate to a certain point, and be discharged on the application of an efficient cause. So, in like manner, water alone largely eliminates urea; and therefore urea must have accumulated, unless we admit it to be possible that it promotes the production of urea by increasing metamorphosis of tissue.

2. Water has a relation to the elimination of urea analogous to that of air in the elimination of carbonic acid, and an increase of both will equally cause an increase in the elimination.

3. The progression in the rate of hourly excretion of both substances after food is very similar, in so far that the largest excretion follows the breakfast and the tea meals, and the least follows the early dinner; but the proportionate excretion of urea in the middle hours of the day is less than that of carbonic acid. In both the lowest rate occurs in the night.

4. I cannot contrast the effect of season upon these excretions with certainty, since the experiments in reference to carbonic acid were limited to the excretion in the absence of food and exertion, whilst those on urea extended over the whole day, and comprised the whole influence of food and exertion. Hence these are, perhaps, not parallel conditions. Season lessens the production of carbonic acid before breakfast as the summer advances, and the greatest emission occurs in the spring and winter; but the production of urea with ordinary food and exertion increases with the summer, and is the least in the cold season.

5. Temperature, as it increases, lessens the production of carbonic acid, and lessens

it in an increasing ratio; and in like manner the action of barometric elevation was inverse; but in reference to urea with food and exertion both relations are direct, and the urea increases as they increase. The effect upon the elimination of carbonic acid was immediate, but upon the excretion of urea it was not usually evident until the following day.

6. Both excretions are influenced by excess of food, as has been shown by the "basis quantities;" but the influence upon urea was much greater than that upon carbonic acid.

7. Exertion influences the excretion of carbonic acid much more than urea.

8. Hence the relation of urea and carbonic acid is one of a general character only.

11. *The Relation of Urea to Nutrition.*

This is associated with both the ingestion and the egestion of nitrogen.

The Ingestion of Nitrogen.—The ruling theory in reference to the ingestion of nitrogen is, that the elements of food are absolutely divisible into two classes, and that the nitrogenous are expended in repairing nitrogenous tissues, and the hydrocarbons in supplying heat. But I proved in my former paper on carbonic acid *, on the one hand, that starch and fat, apart from nitrogen, do not increase the emission of carbonic acid (the accepted evidence of the activity of the heat-forming function), and, on the other, that nitrogenous foods do increase the emission of that substance, and are thereby respiratory and heat-forming excitants. It had also been shown by several eminent chemists, that the fattening properties of fodder are in proportion, not to the carbon, but to the nitrogen which it contains; and thence I infer, in accordance with my experiments, that, in the experiments on animals, the fat was due in some way to the nitrogen. It is therefore, I think, impossible to defend this theoretical division of foods, and nitrogen should probably be regarded both as an element of tissue and an excitant of vital actions.

The Excretion of Nitrogen.—The views in reference to the excretion of nitrogen are three:—

1. That of Liebig and his pupils, as Bischoff and Voit—that the excretion of urea is in proportion to the metamorphosis of tissue, and is as the bulk of the tissue, the nitrogenous fluids contained in the tissue, and the oxygen supplied, or, in other words, as the wants of the tissues, the supply of nitrogenous food, and the activity of the vital processes. They affirm that in every condition in which the elimination of urea is increased there is increased vital action; and the following Table, derived from my own experiments, shows that even the ingestion of fluid on a day of entire abstinence from food causes temporary increase of pulsation.

* Philosophical Transactions, 1859.

TABLE XLV.—Showing the effect of Water drunk during fasting over pulsation and respiration.

Water.				Water.					Water.		Water.	
Hour.	9.	10.	11.	12.	2.	3.	4.	5.	6.	7½.	10.	10½.
Pulsation ...	67	64	64	69	72	64	60	64	71	70	73	72
Respiration...	14	...	...	12½	13	...	...	13	...	13½	13½	

I believe that this statement is true.

2. That of BIDDER and SCHMIDT, FRERICHS, and LEHMANN—that the excretion of urea results chiefly from excess of food, and represents "luxus consumption," and has no *necessary* relation to tissue action or tissue metamorphosis. This is based upon the fact that with excess of food, and with certain kinds of food, as gelatine, there is an almost immediate increase in the elimination of nitrogen; and this is abundantly supported by the experiments of LAWES and GILBERT, and by those recorded in this paper.

3. That of LUDWIG and FUHRER—that urea is due neither to the immediate changes from food nor to changes from tissue, but to the destruction of blood-cells. This view is, I think, of little value, since it simply indicates, in a general manner, that the urea is due to activity of the vital functions.

The first view is in accord with LIEBIG'S theory of the use of nitrogen, and refers essentially to the *formation* of urea; whilst the second view, regarding the close connexion of excess of food with urea, refers chiefly, or at least in great part, to the *elimination*, and only by theoretical reasoning to the *production* of urea; and as the acts of production and elimination are not identical in nature or time, the two sets of views probably do not refer to parallel actions, and may both so far be true.

It appears to me that there is much truth in both of these views, and that the difference is very much more one of terms than of things, as I will now endeavour to show.

An idea which leads to divergence of opinion in reference to the first view is that connected with tissue-change, representing the tissue as something solid, and quite apart from the circulating mass. But a muscle, besides its tissue framework, and perhaps its fat, consists of fluids which are in the closest relation to the circulating fluid, for there is a perpetual interchange proceeding between them; and in reference to nutrition, the fluids in a tissue (and therefore nearly the whole of the soft tissues) are truly parts of the circulating fluid.

Another idea, having a similar tendency and connected with the second view, is that which limits the changes proceeding in the blood from food, as if they were apart in space, and different in kind from the changes which proceed in the tissues; but the perpetual circulation of the blood through every part of the body, which is completed every few minutes, makes this a distinction almost without a difference, for at every circulation of the blood it receives from and distributes to every tissue.

If, therefore, we consider the tissue-fluids as a part of the circulating medium, and the products of food as perpetually circulating amongst the tissues, we take away the distinctive peculiarities of these two views.

All experiments have shown (and none more clearly than those of BISCHOFF and VOIT) that there is the closest correspondence between the amount of nitrogen which has entered the blood from food and that excreted as urea in flesh-feeding animals, and that the former might in these animals really measure the latter. In man and other animals there is a small elimination of nitrogen by other sources, as certain organic compounds passing off by the skin and lungs, by the uric acid, creatine, and hippuric acid, by which the urea in the urine does not fully represent the nitrogen contained in the food which has entered the blood; but, on the whole, as it does not probably exceed 5 grs. of nitrogen in man, or its equivalent of about 11 grs. of urea, we need not consider it in the following observations. The prison experiments recorded in this paper, when compared with those on myself, explain the cause of some discrepancies in the results heretofore obtained. In prisoners the urea was lessened on Sundays, when, with no change of food, there was no exertion, and thereby there was relatively an increase of food; whilst in myself there was great increase in the urea, with no exertion and a small increase of food. Two explanations offer themselves:—1st. I am over-fed, so that the full bulk of my tissues is at all times maintained, and therefore I most readily show the effects of increase; but they are rather under-fed, and their tissues have not therefore their full bulk, and hence they appropriate increased food, and do not show the full effects of increase. 2nd. In the absence of the powerful stimulus of violent exertion, the assimilation of food was lessened in the prisoners, and a less proportion of the food was admitted into the blood. Urea is a measure of exertion only so far as it measures food, if the nitrogen of the food be sufficient to maintain the vital actions; but if the tissues lose weight, the excess of nitrogen thus evolved will be added to the urea. If during muscular action there be waste of nitrogen in the muscle, there will be also appropriation of nitrogen by the same muscle, and the equilibrium will be maintained. If the appropriation proceed *pari passu* with the waste, there will be as much nitrogen consumed from the food as is excreted by the tissue, and the final quantity of urea will be always unchanged; and if the waste should exceed the appropriation during exertion, and appropriation exceed waste in the intervals of rest and at night in the same proportion, the balance will be maintained, and the amount of urea eliminated in the whole twenty-four hours will be unchanged. Hence, with sufficient food, there cannot be any increased elimination of nitrogen from exertion, unless the tissue weight be lessened, and the urea will, *de facto*, represent the nitrogen taken into the blood with the food. On the other hand, if the bulk of the muscles increase with sufficient food, there will be a loss in the excretion of nitrogen, because there has been an appropriation of it.

Hence the evident relation of urea must be with food, although it may be derived partly from tissue and partly from food; and the precise correspondence in quantity will be regulated by the relation of appropriation to excretion of nitrogen in the tissues. As the urea is derived from various sources, it is impossible that it can measure either tissue-waste or food separately.

The true measure of exertion, and therefore, by inference, of tissue-waste also, is the evolution of carbonic acid, which, as I showed in my former paper, is increased immediately, and in a definite and almost proportionate degree by every degree of exertion, whilst no such relation can be traced between exertion and urea.

Hence I venture to submit—

1. That nitrogen is essential to vital transformation as well as to the constitution of certain tissues, and that all in excess of the latter quantity is after a short period cast out of the system.

2. That when the bulk of the tissue is maintained, urea represents nearly all the nitrogen which has entered the blood from the food; when the bulk of the tissue is increased, the urea represents the nitrogen in the food minus the nitrogen gained by the tissues; and when the bulk is lessened, the urea represents the nitrogen supplied by the food plus the nitrogen lost by the tissues; and as in a well-balanced adult system the tissues maintain a standard bulk with some uniformity, the first is the representative condition of urea.

3. That commonly the urea varies as the food.

4. That whilst it is probable that all vital transformations take place in connexion with tissues, it does not follow that vital changes (including the production of urea) do necessarily imply interchange of tissue-elements (solids).

5. The period and amount of elimination of urea is dependent upon the existence of water within the body in excess of that necessary to maintain the due bulk of the tissues and the blood. The urea may therefore accumulate, or, on the other hand, it may be rapidly eliminated. The bulk of the body regulates the *emission*, but the supply of food and the activity of the vital actions regulate the *production* of urea.

6. The effect of temperature and atmospheric pressure is probably that of food absolutely or the relation of food to the vital actions in the *production* of urea, whilst it is that of the statics of the body in relation to the *elimination* of urinary water and urea.

7. That daily variations are not necessary evidences of variations in the formation of urea. They are lost on a long average by a compensating power, which controls the emission of fluids.

Résumé.

The following is a *résumé* of the principal facts which are contained in the preceding communication:—

1. The inquiry was intended to show the changes normally proceeding in a healthy and abundantly fed system, under the ordinary and varying conditions under which men live in the course of the year, and also the effect of treadwheel [and other] labour upon prisoners who are well fed, but have no surplus nutritive material in them.

2. The inquiry upon myself was continued during [two years and two months, and embraced 635 days, and more than 1400 analyses for urea.]

3. The average daily evolution of urea was 519 grs. [on the average of two years 500 grs.], and the proportion to each lb. of body-weight was 2·73 grs. The extremes were 298 and [876] grs. daily, and 1·56 to [4·38] grs. per lb. of body-weight.

The quantity of between 400 and 500 grs. daily was found in 46 per cent., and between 400 and 600 grs. daily in 85 per cent. of the whole.

The weekly averages varied from 428 to 715 grs. daily, and the monthly from 451 to 665 grs. daily.

The average daily excretion of urinary water was 53·1 fl. oz. [on the average of two years 51·2 fl. oz.], or ·28 fl. oz. to each lb. of body-weight. The extremes were 23·5 and 92·67 fl. oz. daily, or ·123 to ·487 fl. oz. to each lb. of body-weight.

The quantities of between 40 and 60 fl. oz. were found in 52·7 per cent. of the observations, but those between 40 and 50, 50 and 60, and 60 and 70 oz. were found respectively in 26·2, 26·5, and 22·4 per cent.

Large quantities were always followed, or immediately preceded, by small ones. Daily alternations in quantity were observed. Waves of increase and decrease, or *vice versâ*, were common; and sometimes there was a progressive increase or decrease, or the quantity remained very high for some days. The daily variations were very great.

4. The relation in the quantity of urea and urinary water varied much; but with increasing decades of ounces of urine there was increasing quantity of urea. The average quantity of urea in 55 oz. of urine passed daily was 9·4 grs. to each ounce; but with 25 oz. it was double that amount per ounce, whilst with an equal quantity in the direction of increase, viz. from 55 to 85 oz. per day, the decrease in the urea per ounce was only 25 per cent. Hence, from a medium standard, the quantity of urea in an ounce of urine decreases much less with increase of urine than it increases with decrease of urine.

5. The average amount of urea per hour, in the twenty-four hours, was 21·7 grs., whilst that of the night was only 16·5 grs., and the basis quantity was 20·3 grs.; but that passed to midday was 25·5 grs. The average of the whole day being the standard, the decrease at night was 24 per cent., and of the "basis quantity" 6·4 per cent., whilst the increase to midday was $17\frac{1}{2}$ per cent.

The greatest number of exceptions occurred with the "basis quantities;" so that, the higher the "basis quantity" on the whole average, the greater was the amount of urine evolved on the preceding day.

The "basis quantity" cannot be used as a measure of the total quantity of urea on the same day.

There were two maxima of elimination of urea and urine, at 1 P.M. and 9 P.M., after breakfast and tea, (the former being the highest,) and an intervening low period from 2 to 5 o'clock after dinner.

In the examination at each quarter of an hour, the maximum emission of 54·6 grs. of urea and 13·5 oz. of urine occurred at $12\frac{3}{4}$ P.M., three and a quarter hours after breakfast. There was a gradual ascent to, and descent from, the maximum; but during the hour of maximum elimination the increase was proportionately greater, and in one instance was at the rate of 21 oz. per hour.

6. The relations of urinary water to period of the day are similar to those of urea. The average rate of the whole day was 2·21 fl. oz., of the night 1·19 fl. oz., the "basis quantity" 2·65 oz., and to midday 4·41. The decrease of the night and the basis quantity from that of the whole day was 46 and 7·2 per cent., and the increase to midday 100 per cent.

The lines representing the quantity of urea eliminated per hour during the day, and those in each fluid ounce of urine are opposed, and the most so in the morning, but they meet during the night.

7. When, during a fast from food, water is taken at the usual meal-hours during the day, it causes an elimination of urea and urinary water, precisely as if food had been taken, both in degree and progression. There were two maxima after the breakfast- and tea-hours, but no increase after the dinner-hour. The maximum was 34·5 grs. of urea, and 11½ oz. of urine in one hour and a half after having drunk the water at the breakfast period; and the minimum was 5·3 grs. of urea, and 1·36 oz. of urine at 5 P.M., before the tea hour.

With water taken at 8¾, 9¾, and 11 A.M., without any food, and the urine passed every quarter of an hour, there was a maximum elimination of urea in three-quarters of an hour after the first and third, and in half an hour after the second dose. The maximum elimination of urine occurred in one hour after the first, and in three-quarters of an hour after the second and third doses. The three maxima were, urea 35·14, 35·22, and 32 grs.; urine 21·6, 21·2, and 19·4 fl. oz. per hour.

When 8 oz. of water were taken alone at about 9 A.M., the maximum elimination was in one or one and a half hour; but when 3 oz. of bread, or 2 oz. of gluten bread were added, it did not occur in less than three hours. When tea or coffee were added, it occurred in one and two hours, and in two hours after taking black dose.

The maximum increase of urea within three hours from water was from 65 to 104 per cent., but from tea and coffee it was 59 and 58 per cent. The increase in the urine varied from 260 to 640 per cent. with water, 200 per cent. with black dose, and 200 and 350 per cent. with coffee and tea, the "basis quantity" being the standard.

8. 6 oz. of alcohol and water (1½ to 4½ oz.) caused within two hours an increase of urea from 38 to 108 per cent., and of urine from 246 to 554 per cent. The increase of the two was not parallel.

9. With a diet of 34 oz. of bread and 48 oz. of water alone, and then with 300 grs. of tea, and again with 2 oz. of coffee added, the hourly progression was the same as with ordinary food, except that with tea and coffee the maximum elimination was reduced, and the quantity evolved late at night was largely increased; in other words, the elimination of urea was deferred some hours. The maxima of urea were 29·3 grs., 24·6 grs., and 25·4 grs., with water, tea, and coffee, in their order. The total quantity of urea evolved was 442, 467, and 493 grs. daily, in the same order.

10. The largest average elimination of urea occurred on Sunday, with some increase of food and rest, in myself, in whom there is commonly an excess of nutritive material; but the least elimination was then found in the prisoners without change of food and with rest, in whom there is, with a good dietary, a tendency to defect of food; and then also an increased quantity of nitrogen was found in the fæces. In myself the excess of urea was 14·4 grs. when compared with all the days of the year, and 67·9 grs. when compared with 191 days on which there was no known cause of variation. The daily excretion on Sundays of between 700 and 800 grs. was 3·4, and between 600 and 700 grs. 13·1 per cent. more frequent than on all days combined. The elimination of urea decreased

daily to the end of the week, with regular work, from 574 grs. on Sunday, to 460 grs. on Friday; but this varied with the amount of labour and the dependent conditions.

11. The weight of the body after the emission of urine was the greatest on the Sunday, including the Sunday night, and increased from the Saturday from 1 lb. 6 oz. to 2 lb. 3 oz. It decreased progressively during a week of regular labour, but increased on any day with rest.

12. The solid ingesta, on the average of four months, was between $36\frac{1}{2}$ and $37\frac{1}{2}$ oz. on each week day, but on Sunday it was $41\frac{3}{4}$ oz. The total solid and fluid ingesta were $95\frac{3}{4}$ oz. on Sunday, and from $89\frac{1}{4}$ oz. to 95 oz. on the week days.

13. The quantity of urea eliminated increased in the summer; and, on the average, from May to October inclusive it was 570·1 grs., and from October to April inclusive 480·5 grs. daily. The increase from March to the maximum in August and September was 36 per cent. of the former; and the succeeding decrease to March was 29 per cent. of the maximum. The difference between the maximum and minimum was 46·1 per cent. of the latter.

14. The elimination of urinary water followed the same course, and was 55·7 fl. oz. in the warm, and 51·9 fl. oz. in the cold half of the year. The excess of the maximum over the minimum quantity was 40·2 per cent. of the latter.

15. The elimination of urea increased with increase of temperature and barometric elevation, but it occurred usually on the second day. When the direction of the two influences was different, they neutralized each other. The proportions of urea to one degree of temperature, in the two seasons of the year, were nearly identical, viz. 10·36 grs. in the hot, and 10·9 grs. in the cold season. The months of marked increase and decrease of temperature were those of marked increase and decrease in the elimination of urea. The proportions of urea to one degree of temperature in the two highest and the two lowest months were the same, viz. 11·5 and 11·8 grs.

The elimination of urine increased with sudden cold, and decreased with sudden warmth on the same day, and then oscillated to maintain the necessary equilibrium of the fluids in the body.

16. [There are variations in the quantities according to the conditions of each year; but the seasonal-conditions progression remains the same. It is now important to ascertain the influence of the several conditions attending a temporary summer residence at the sea-side, in reference to the increase of urea which then occurs.]

17. With the labour of the treadwheel there was no increase in the elimination of urea in one hour and ten minutes before breakfast, but an average decrease of 2·4 grs. per hour. There was an increase on the whole day over the day of routine labour of 16 grs., and over the Sundays of 34 grs. per day. The increase of the former was 3 per cent. The prisoners lifted from 354·81 to 413·89 tons through 1 foot per day, with treadwheel labour. The increase occurred on the treadwheel day alone, except in a few instances, when, with meteorological disturbances, it was deferred to the second day in two cases; and then by the necessary alternations the largest excretion occurred on the days of rest, viz. on the alternate days.

18. The rate of excretion of urea to each lb. of body-weight varied only from 4·39 to 4·74 grs., and was 59 per cent. greater than in myself.

19. [The labour of cocoa-matting weaving, as compared with that of tailors, caused the weavers to consume more bread, milk, and water; to lose weight; to emit more urine, urea, chloride of sodium, and fæces, and consequently more nitrogen; to exhibit much less diminution in the amount of urea evolved on the Sunday, and a little less urea to body-weight.]

20. The elimination of urea was always increased after additional and unusual food, as at dinner and evening parties; and the increase sometimes continued for some days.

The addition of extra fat to the dietary of the prisoners did not vary the amount of urea or urine. Tea, coffee, and alcohol largely decreased the urea on the first and second day, but not on the third day. Tea and coffee did not vary the amount of urine; but alcohol lessened it nearly 20 oz. per day.

21. Chloride of sodium was largely eliminated under the influence of tea, and as largely retained under that of alcohol; and in the latter it corresponded with the reduction of the urine, viz. 27·5 and 28·7 per cent. When $\frac{3}{4}$ oz. of salt was withdrawn from the dietary, there was that precise amount deficient in the urine.

22. With headache and stomach-derangement there was commonly lessened excretion of urea, followed by increased excretion on recovery.

23. Urea and carbonic acid accumulate in the system; and the period of production is not that of elimination. Food first causes increased elimination of the stored-up excretion, and then supplies material to be transformed.

The hourly rate of excretion of both is very similar with food; but there is no increase of urea after early dinner. The effect of season, temperature, and pressure of the atmosphere is reversed if the *total daily emission* of urea may be compared with the *basal quantities* of carbonic acid.

24. The direct relation of urea is with food, and, under certain conditions, varies precisely as the food if the tissue-weight remains unchanged; but when the latter varies, the relation of urea to food will vary in the same proportion.

25. Exertion cannot cause increase of urea over the corresponding quantities of nitrogen contained in the food, unless the muscular bulk be lessened. Commonly the reparation and the waste proceed *pari passu*, or the reparation is in excess during the periods of rest, and restores the equilibrium on a long average. When there is deficient muscle-bulk, increase of food does not induce a corresponding increase in the urea, but a part is retained by the muscle.

The following are the points to which I desire more particularly to direct attention:—

1. That every question connected with urea is one of great complexity.

2. That observations made at different hours of the day, and in different seasons of the year, cannot be truthfully compared.

3. That no inquiry less than that involved in the collection of the whole urine evolved in the day can determine the total daily elimination of urea.

4. That, as elimination and formation of urea are different acts, but incapable of separation, the influence of agents exerted over the production of urea must be examined on many successive days.

5. As urea is a mixed product from food and tissue, it cannot in any case (even in prolonged fasting) be taken as an absolute indication relative to the one or the other.

6. As the relations of urea are chiefly with food, and, other things being equal, urea, with the nitrogen in the fæces, will measure the amount of nitrogen contained in the food, its chief value in health and under ordinary conditions is in indicating the amount of food which has entered the blood as distinct from that which has passed through the bowel. In fasting, it will measure nearly the whole of the loss of nitrogen sustained by the tissues, minus an unknown amount which the tissues have received from the albuminous elements of the blood.

7. The relation of urea to weight of body is indefinite and intermediate, since the relation is true only so far as weight of body may represent the consumption of nitrogenous foods.

8. It is probable that the determination of the amount of urea eliminated under the ordinary conditions of life, is much less valuable than is at present supposed.

9. The relation of period of the day to the elimination of urea is that of fluids to the solids in food, and the necessity for fluid in the body, and is one of *elimination* chiefly, whilst the relation of season of the year and its coexistent circumstances is with the solids in food and the *production* of urea.

10. The appetite for food, and the amount of nitrogen contained in the food, chiefly affect the *production* of urea, whilst the statics of the body, and their relation to atmospheric pressure and to temperature, by regulating the quantity of fluid to be retained and emitted, affect the *elimination* of urea. Certain fluids, and perhaps solids, have the power of retarding the elimination of urea, by causing a retention or accumulation of fluids in the body.

11. The alternations in the quantity of urine emitted on succeeding days are due chiefly to atmospheric influences, acting with, or in opposition to, the statics of the body.

12. The excretion of urea is not affected by purging, except so far as the supply of food may be varied, and fluid be emitted by the kidneys in less quantity than is usual.

13. The relation of urea to such disordered states of the system as are found in derangements of the stomach and in headache is probably less than that of fluid retained; for relief is found rather with the emission of fluid by the bowel or by the kidneys, than with any remarkable and sudden increase in the elimination of urea.

14. The production of carbonic acid is the best measure which we have of the activity of the vital functions attending muscular exertion.

15. The variations in the amount of urine excreted at different seasons of the year are different from what (and not so great as) has been stated, when the amount of fluid drunk is not limited, and the inquiries extend over a lengthened period.

16. It is now most desirable that inquiries should be directed to determine the relative amount of nitrogen in the food which enters the blood to that which remains in

the bowel. It is probable that this would elucidate many states of disease, and explain some of the anomalies which still exist as to the relation of urea to food.

Explanation of the Plates.

PLATE XXXII.

Figs. 1 & 2. Examples of alternations and waves in the daily elimination of urinary water.

Figs. 3 & 4. The daily quantity of urea, and the amount of urea in each fluid ounce of urine with increasing decades of ounces of urine.

Fig. 5. Monthly averages, during two years, of the daily elimination of urea and urinary water, with the atmospheric temperature and pressure.

Fig. 6. Relations of atmospheric temperature to the elimination of urea on the same day and the succeeding day.

Fig. 7. Amount of urea excreted on each day of the week.

PLATE XXXIII.

Daily observations, throughout the year, on the excretion of urea at four periods of the day, compared with the mean daily temperature at Greenwich.

PLATE XXXIV.

Fig. 1. Hourly elimination of urea and urinary water, and the quantity of urea in each ounce of urine.

Fig. 2. Hourly elimination of urea and urinary water at each quarter of an hour.

Fig. 3. Hourly elimination of urea and urinary water, and the rate of pulsation during a day of fasting, except from water, which was drunk at four periods of the day.

Fig. 4. Daily weight which, with a constant of 13 stones, represented the weight of the naked body.

Fig. 5. Hourly elimination of urea and urinary water under the influence of water, tea, coffee, and bread only.

Fig. 6. The effect of drinking water before breakfast upon the quantity of urea and urinary water eliminated at each quarter of an hour.

Fig. 7. Relation of atmospheric pressure to the elimination of urea on the same day.

PLATE XXXV.

Urea evolved by four prisoners on days of treadwheel, light labour, and Sundays, compared with the mean daily temperature at Greenwich, with ordinary and special diets.

PLATE XXXVI.

Contrast of the daily quantities during two years in the elimination of urea and urinary water, and the atmospheric temperature and pressure at Greenwich, with the daily weight of the body during one year.

Fig. 5.

Monthly Averages.

Daily elimination of Urea & Urinary Water with Temp: & Barometric Pressure.

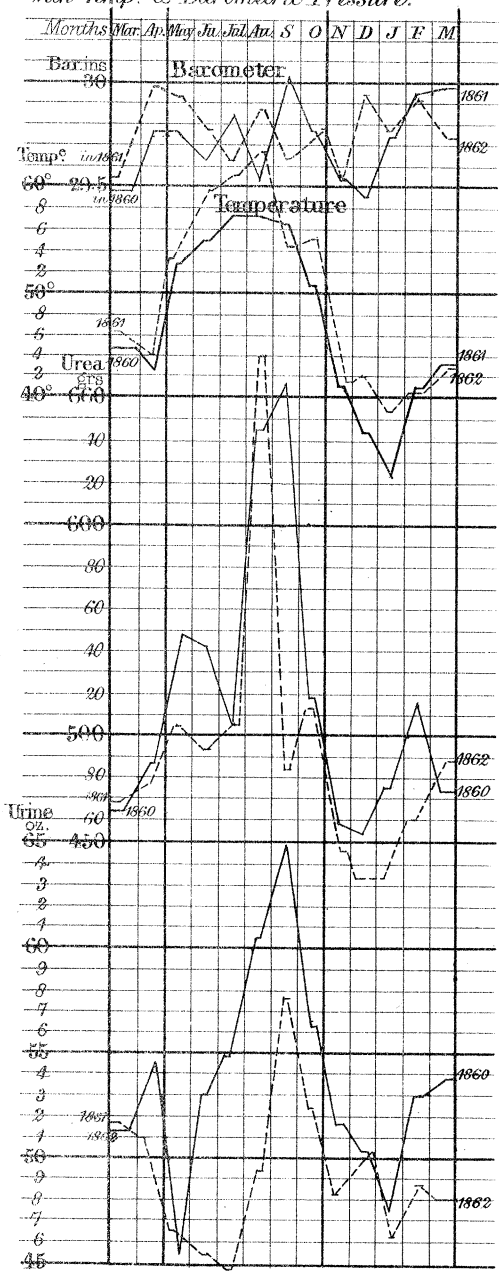


Fig. 2.

Urine oz. on succeeding days. Waves.

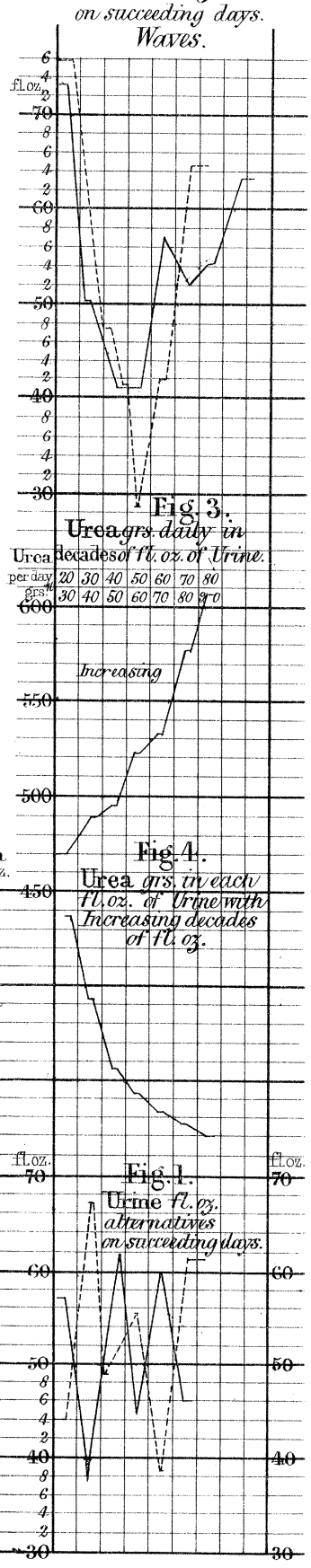


Fig. 3.

Urea *grs. daily in decades of fl. oz. of Urine.*

Urea per day grs.	20	30	40	50	60	70	80
	30	40	50	60	70	80	90

Increasing

Fig. 4.

Urea *grs. in each fl. oz. of Urine with Increasing decades of fl. oz.*

Fig. 1.

Urine *fl. oz. alternatives on succeeding days.*

Fig. 6.

Relation of Temperature to Urea.

on the same day.....

on the succeeding day - - - -

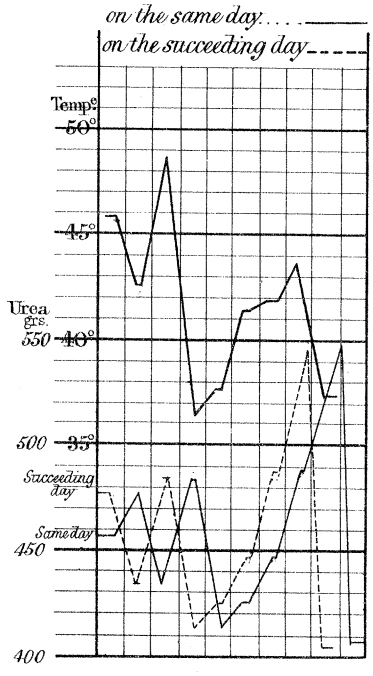
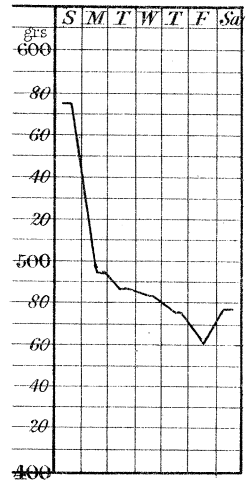


Fig. 7.

Amount of Urea excreted on each day of the week on an average of 9 months.



Daily obse

1860 March April May

Tempe
60°
50°
40°

Mean Temperature
Greenwich

Urea (grains) per hour

Urea grs.
30 30
20
10

To Mid day
Average of whole day
Night

Average of whole day
night

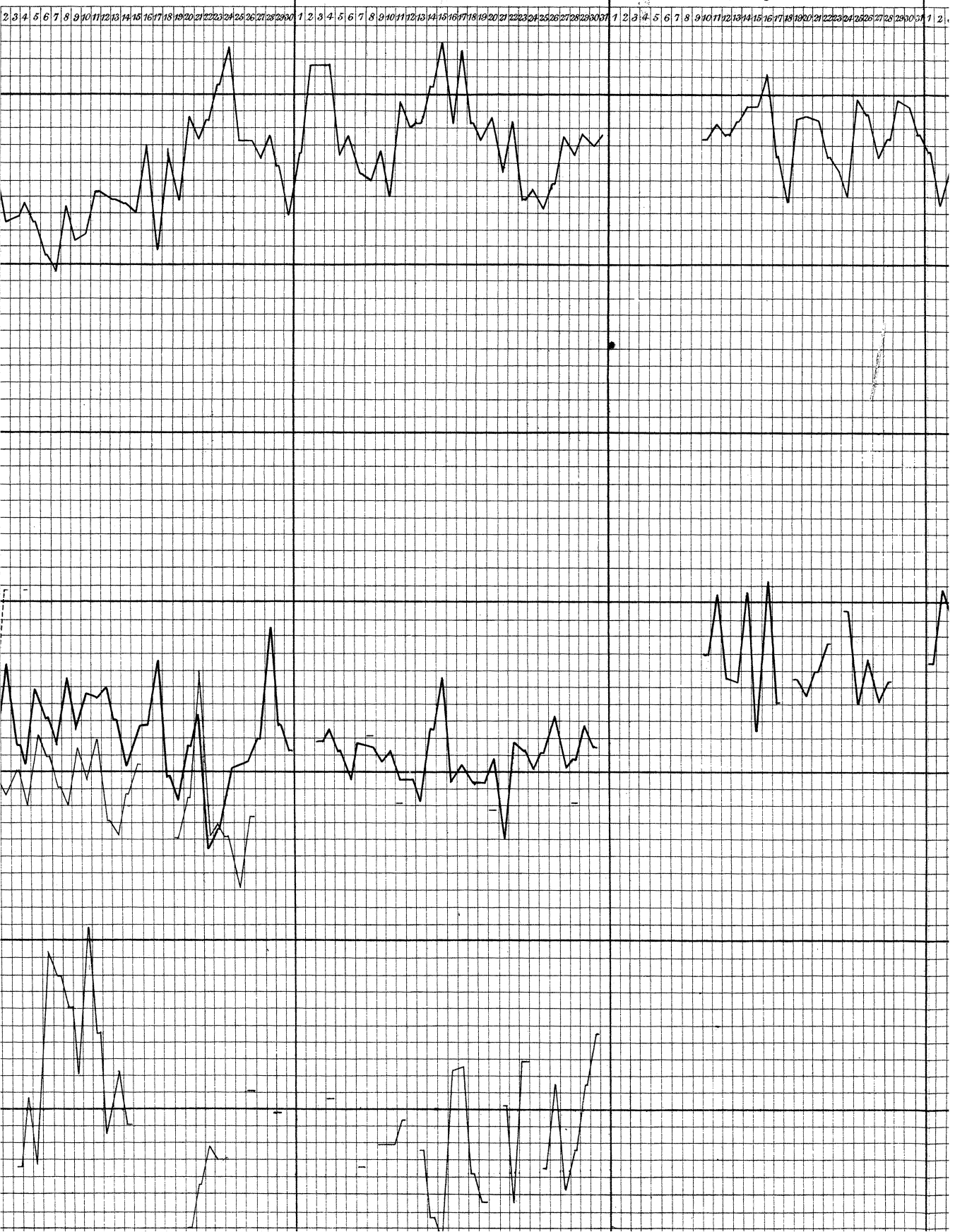
Urea Basis
30 grs.

Basis Quantity
20

DR E. SMITH'S

ly observations on the excretion of Urea at four periods__ on the whole day__ the night

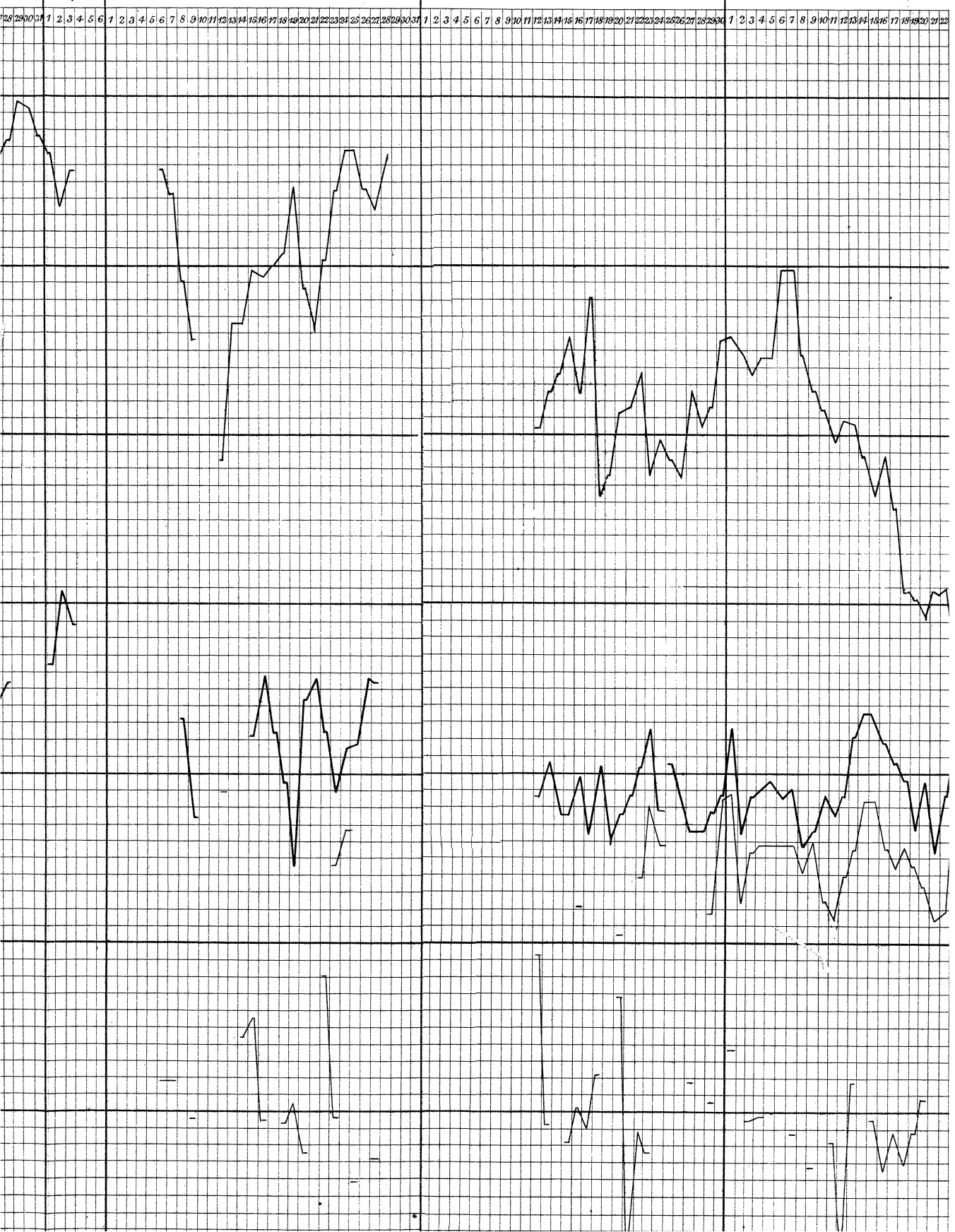
June *July* *August* *S*



ITH'S PAPER ON UREA.

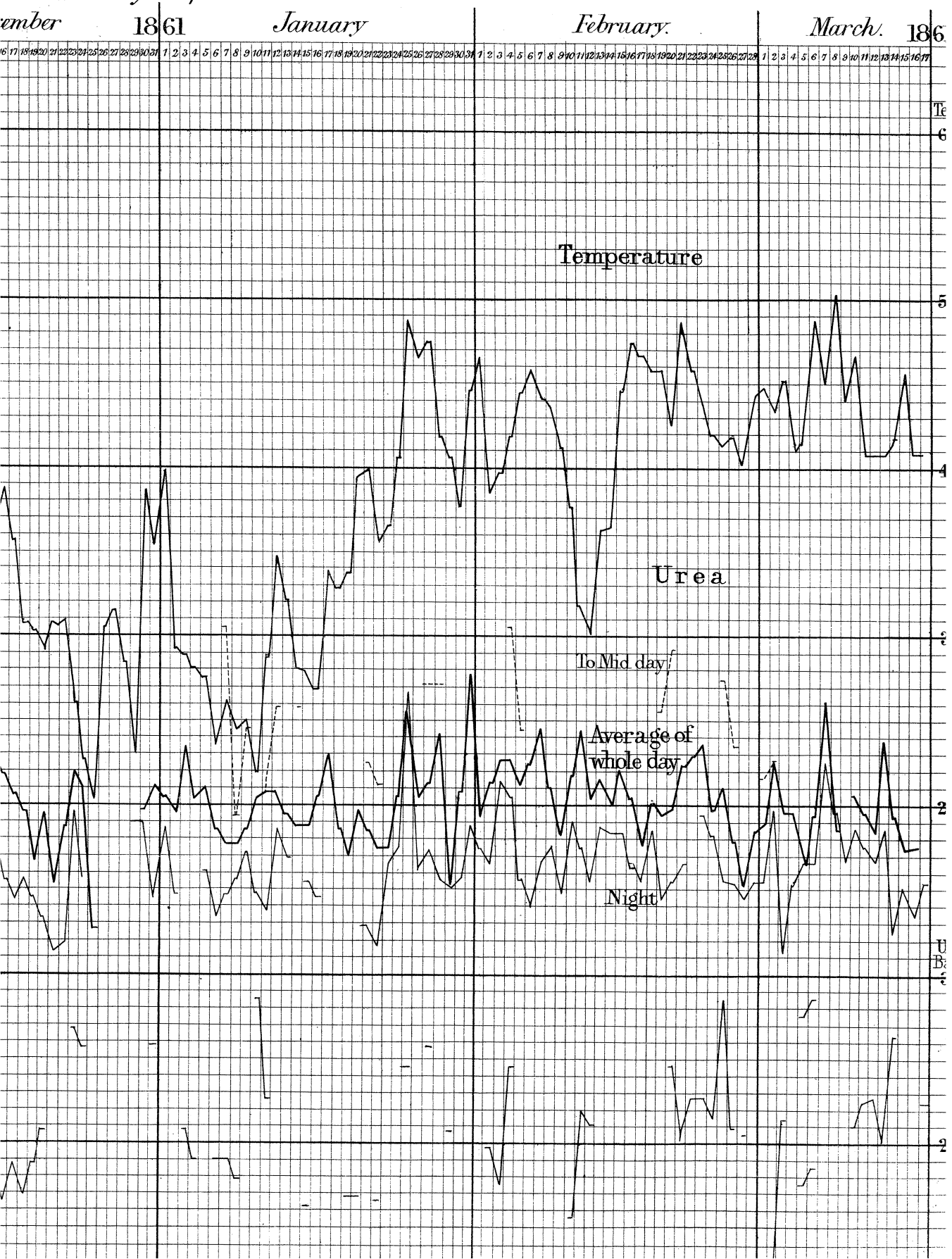
e night before breakfast (basis quantities) & before midday compared with the Mea

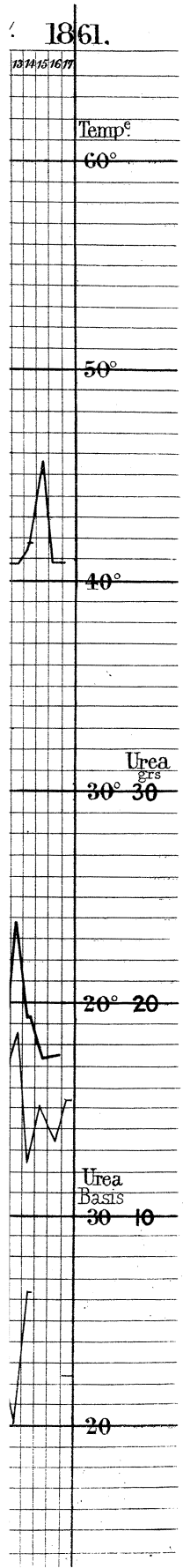
Sept.r October November December

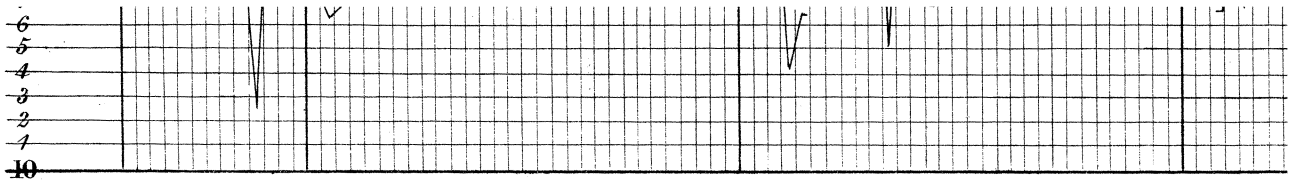


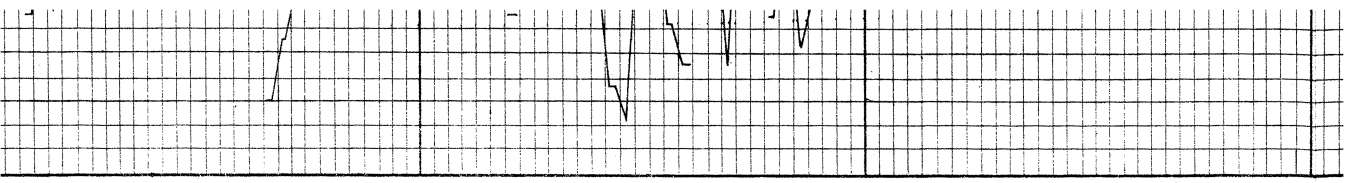
e Mean daily Temp.e at Greenwich.

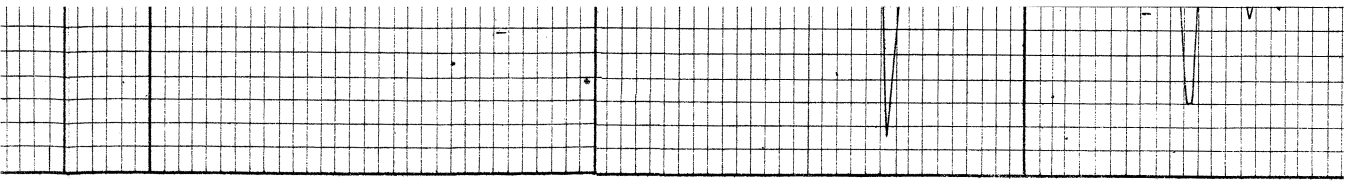
ember 1861 January February. March. 186

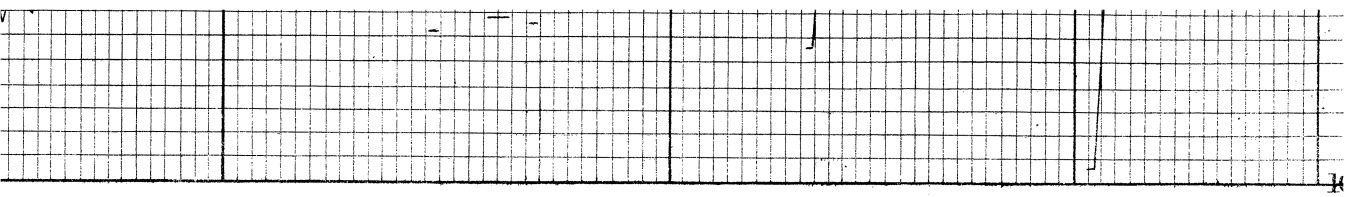



1861.
13 14 15 16 17
Temp.e
60°
50°
40°
Urea
grs
30° 30
20° 20
Urea
Basis
30 10
20


6
5
4
3
2
1
10







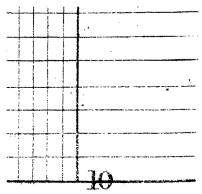

10

Fig. 1.

Hourly elimination of Urea & Urinary Water on Mar 1 & 2, 1860, with the proportion of Urea in each oz. of Urine.

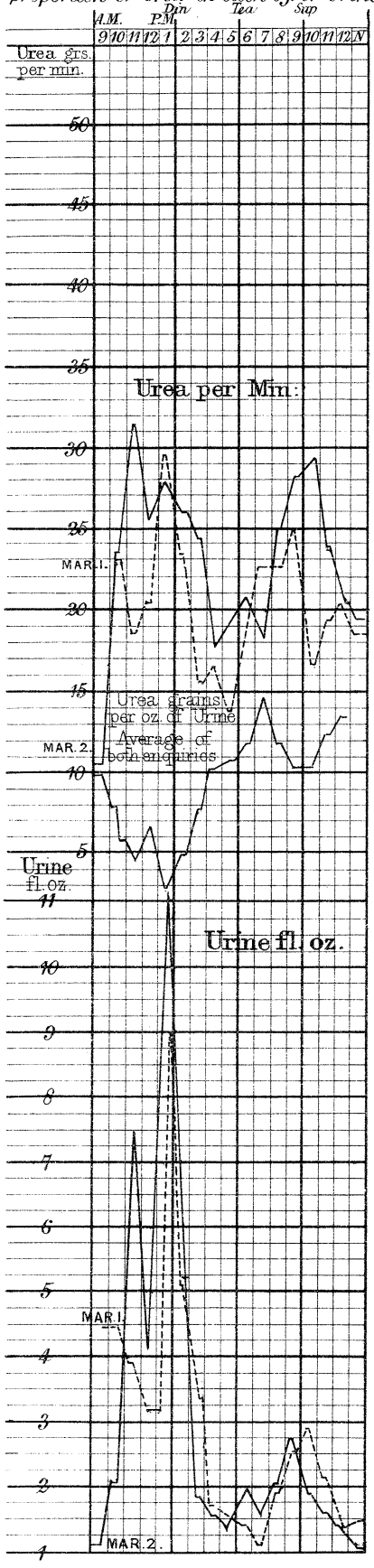
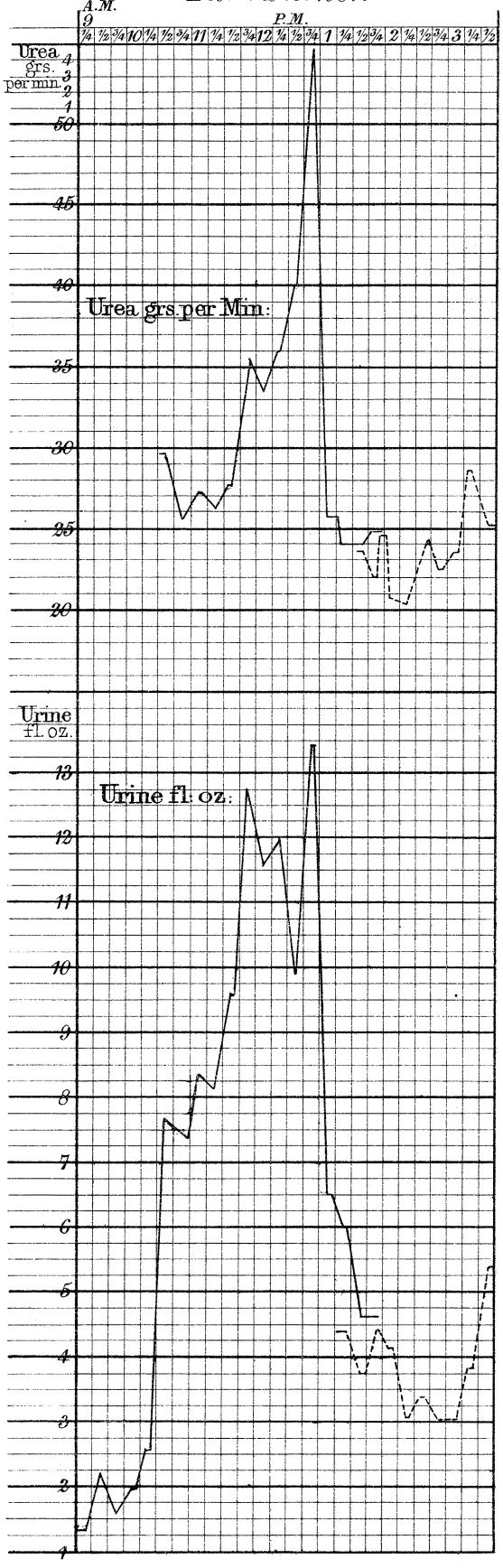


Fig. 2.

Hourly elimination of Urea & Urinary Water at each ¼ of an hour. Dec.r 17 & 18. 1861.



Fig

Hourly eliminatio Water with the rate Fasting except fron

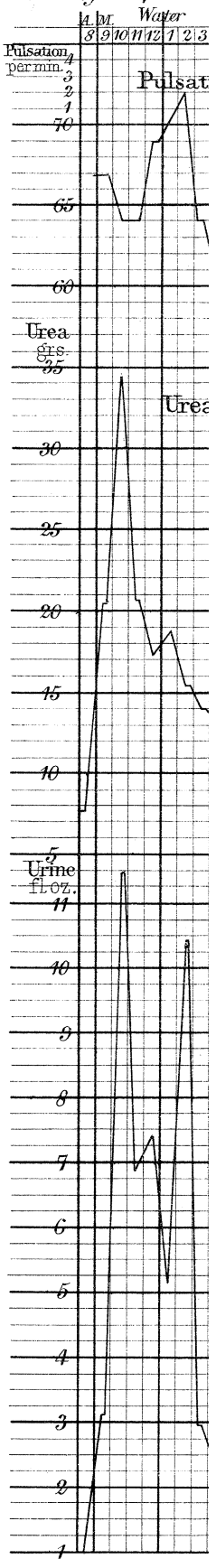


Fig. 3.

lination of Urea & Urinary
the rate of pulsation when
cept from Water.

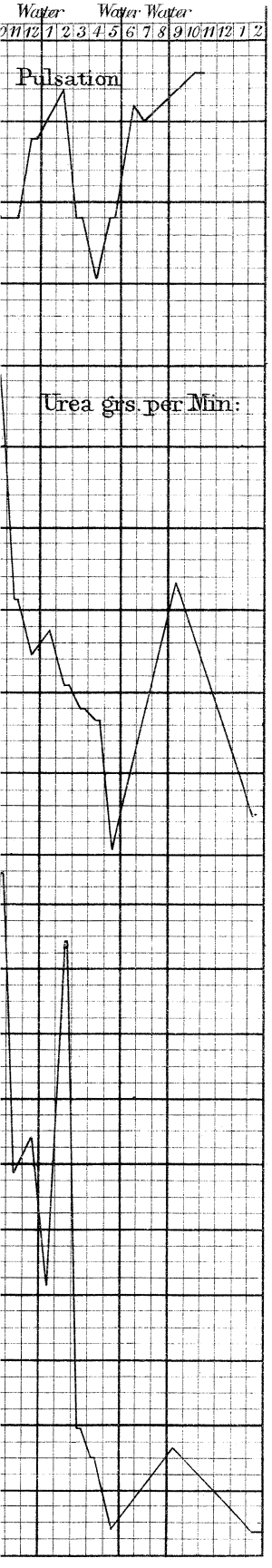


Fig. 4.

The daily weight of the body taken Naked & after the Emission of Urine on retiring to bed & rising, Subtracting a constant weight of 13 Stones or 182 lbs.

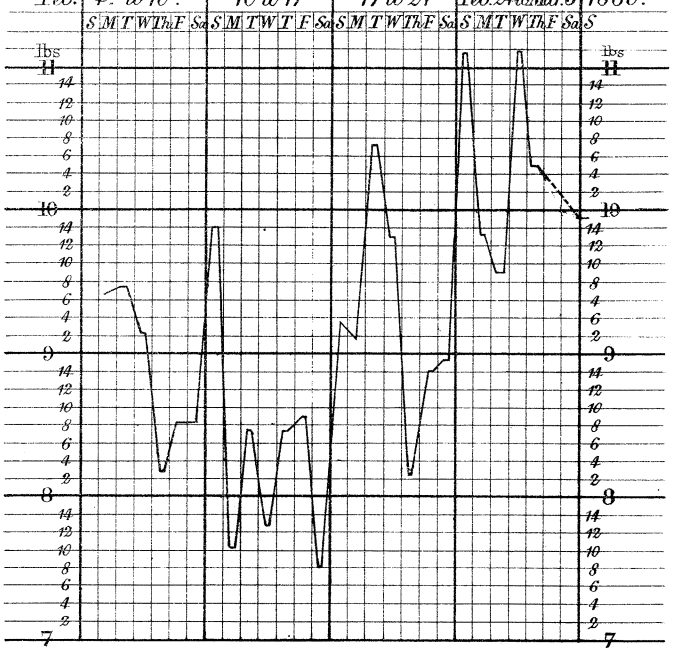


Fig. 5.

Hourly elimination of Urea & Urinary Water under the influence of Water, Tea & Coffee with Bread.

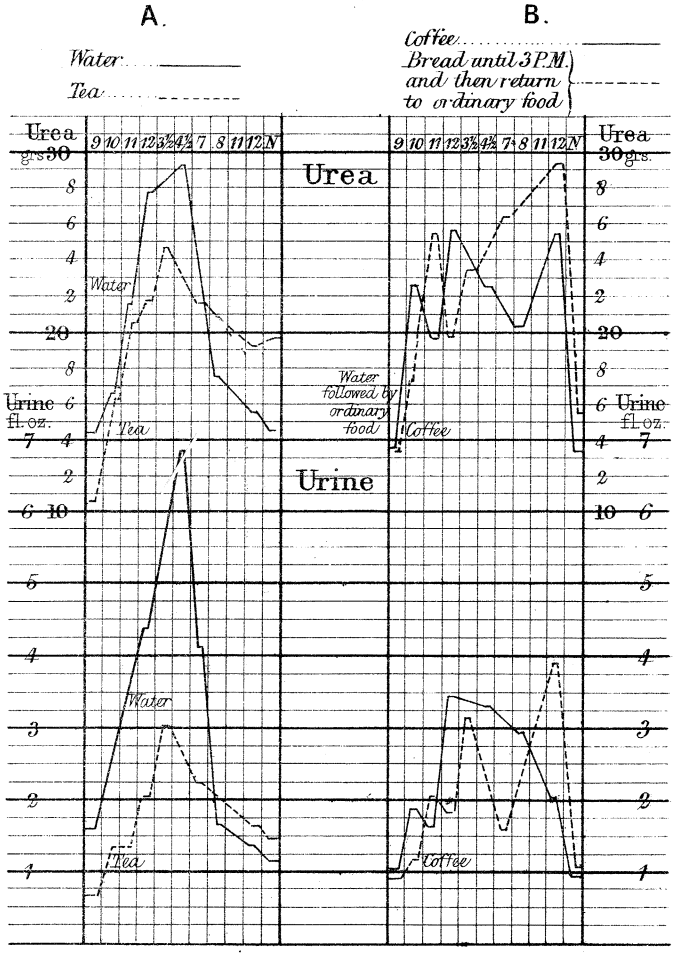


Fig. 6.

Shewing the effect of dri water over the excretion of Ur

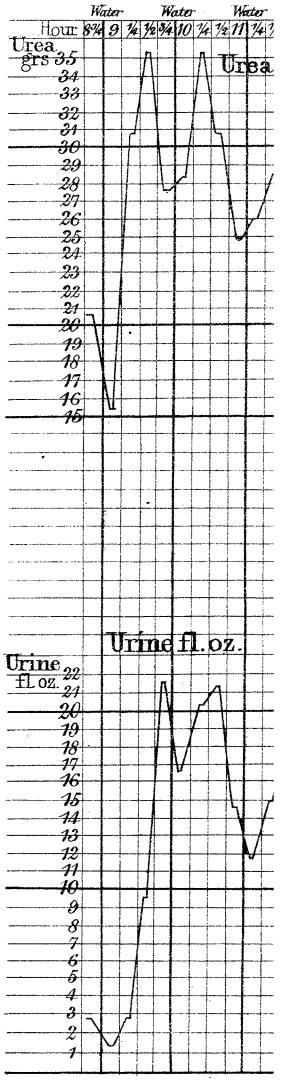
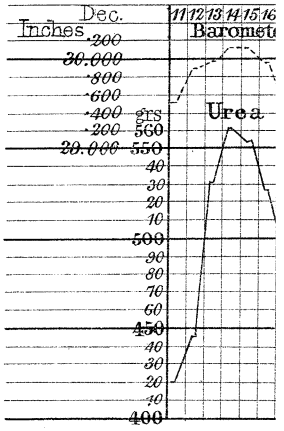


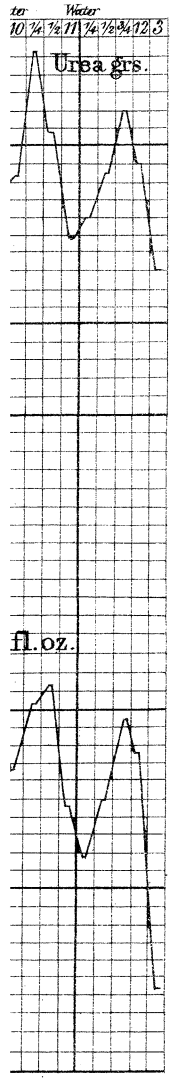
Fig. 7.

Relation of Atmosphe Pressure and Urea.



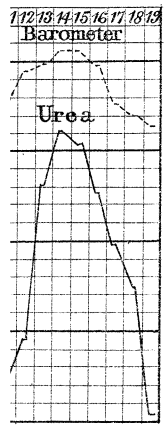
. 6.

ect of drinking
etion of Urea & Urine.



. 7.

ltmospheric
Urea.



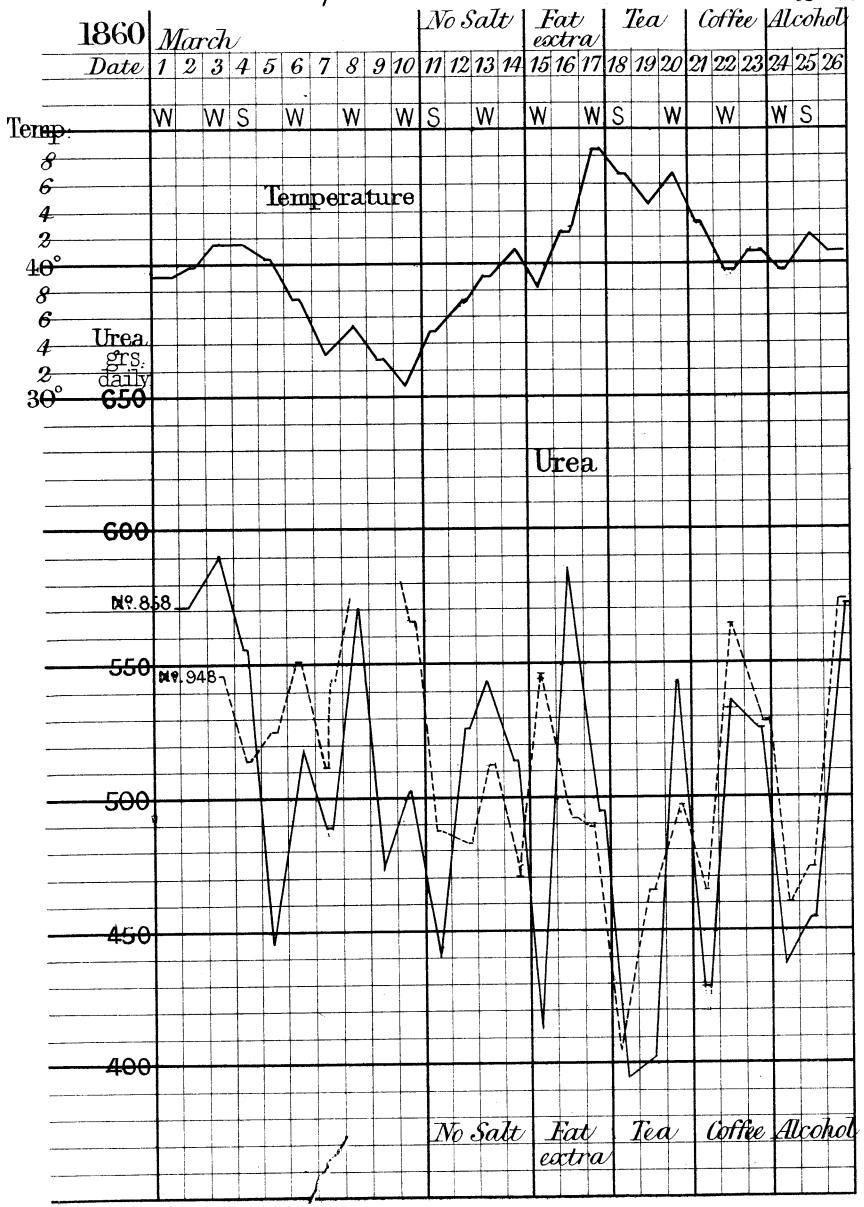
J. Basire lith.

W. signifies Tread Wheel day.
S. " Sundays.

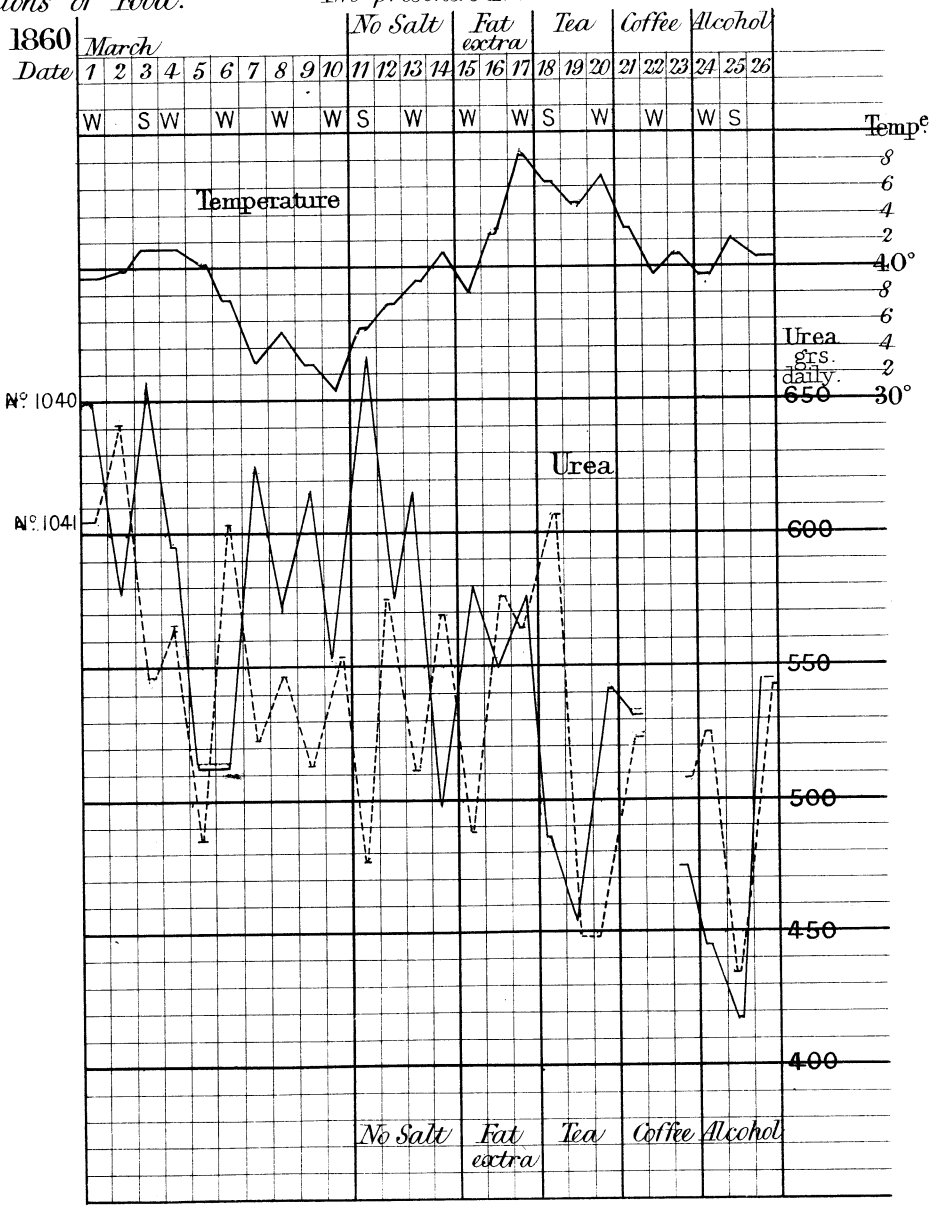
Dr E. SMITH'S PAPER ON UREA.

Urea evolved daily by four prisoners on days of Tread Wheel labour, light labour & Sundays, compared with the Mean daily Temp. at Greenwich, & with Variations of Food.

Two prisoners Nos 858 & 948.



Two prisoners Nos 1040 & 1041.

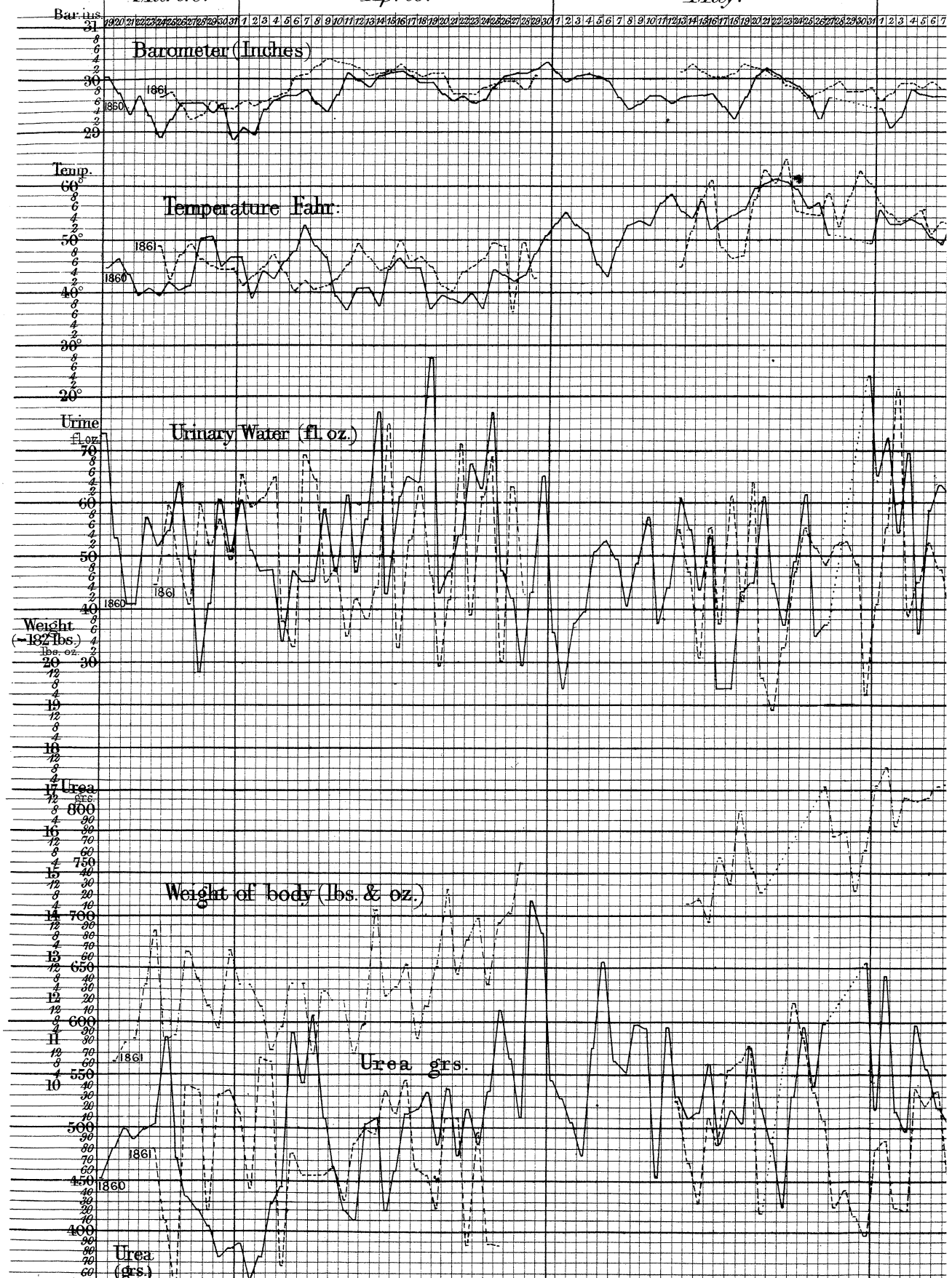


_____ *indicates* 1860–1.

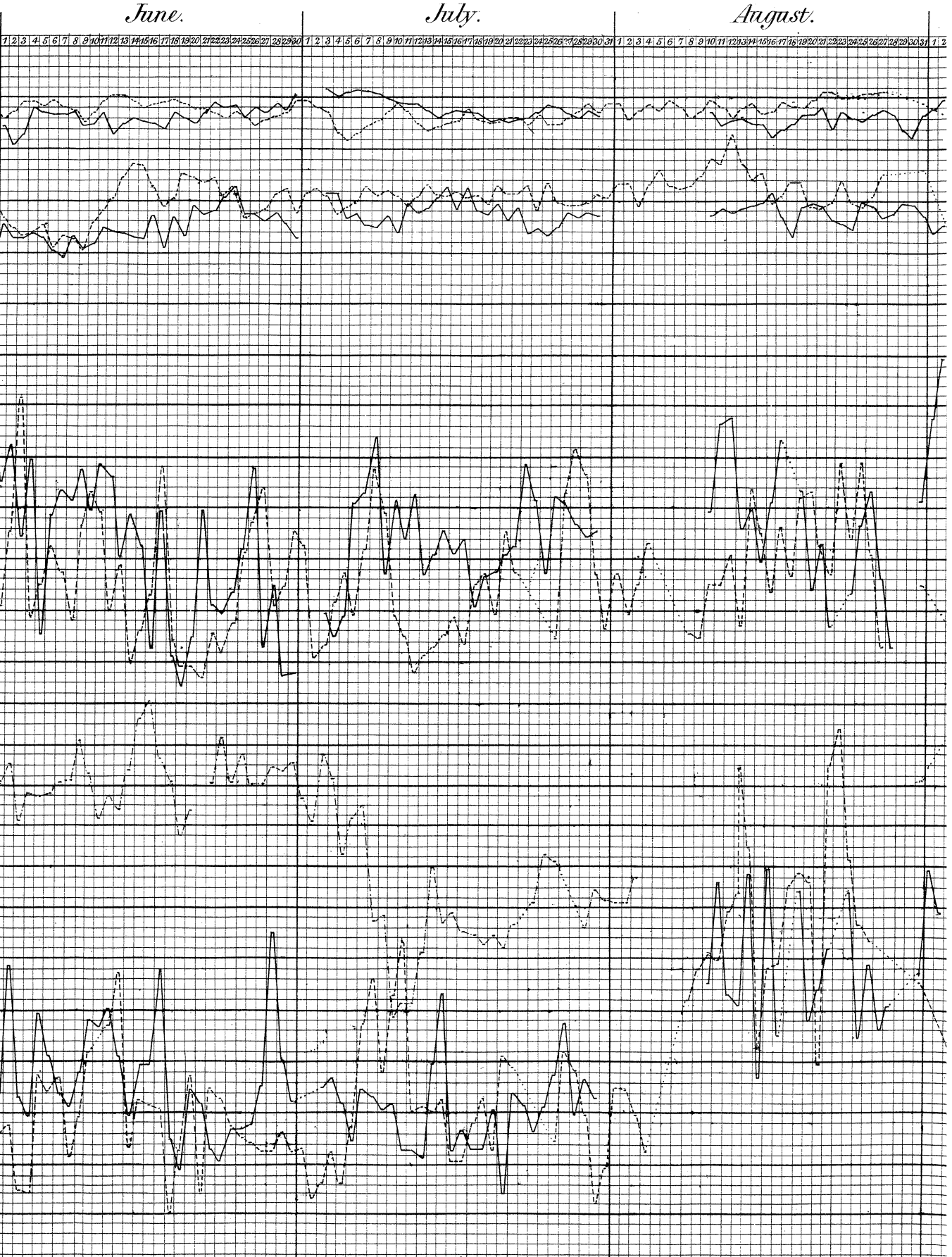
- - - - - - - - - - - - 1861–2.

Contrast

March. *April.* *May.*

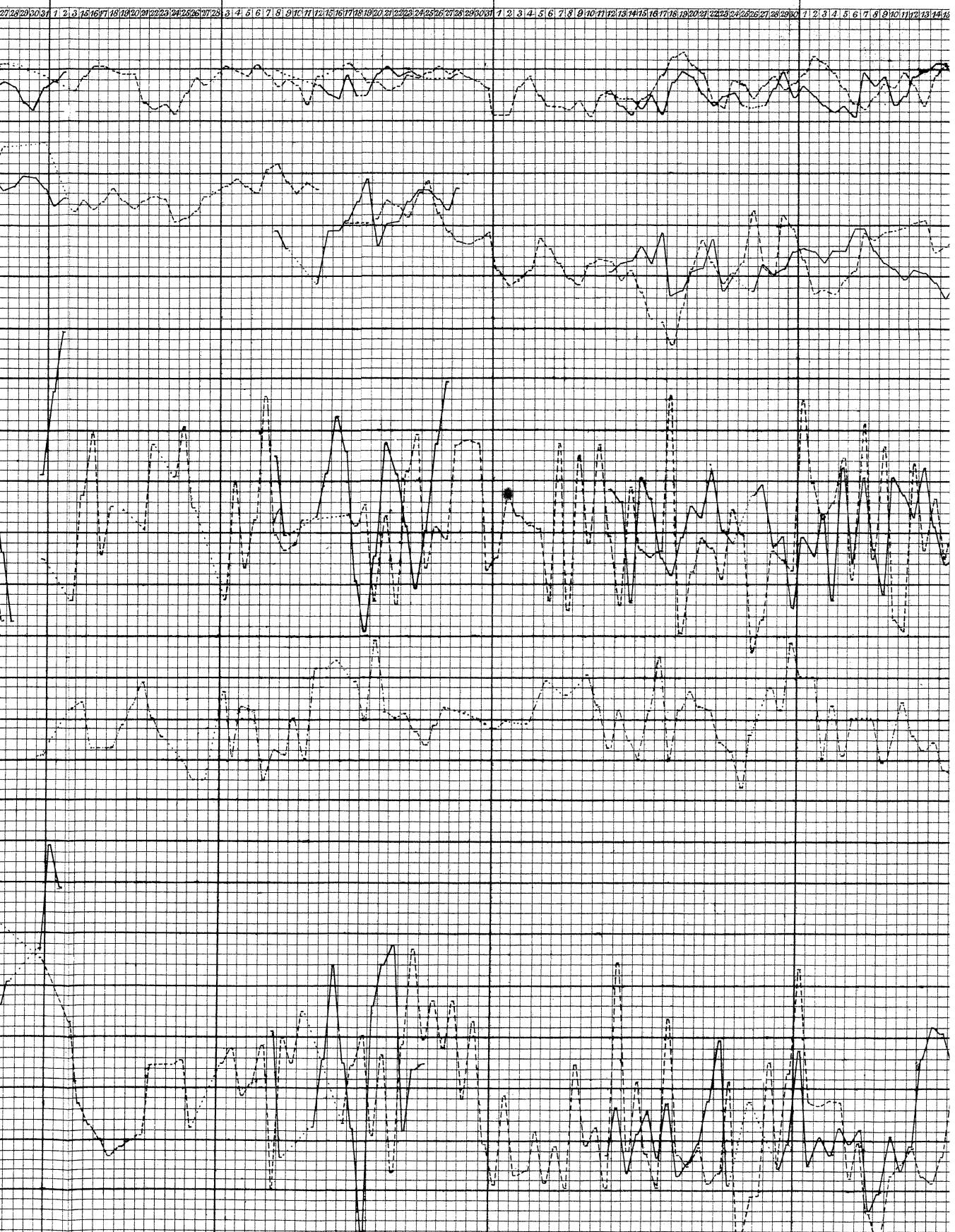


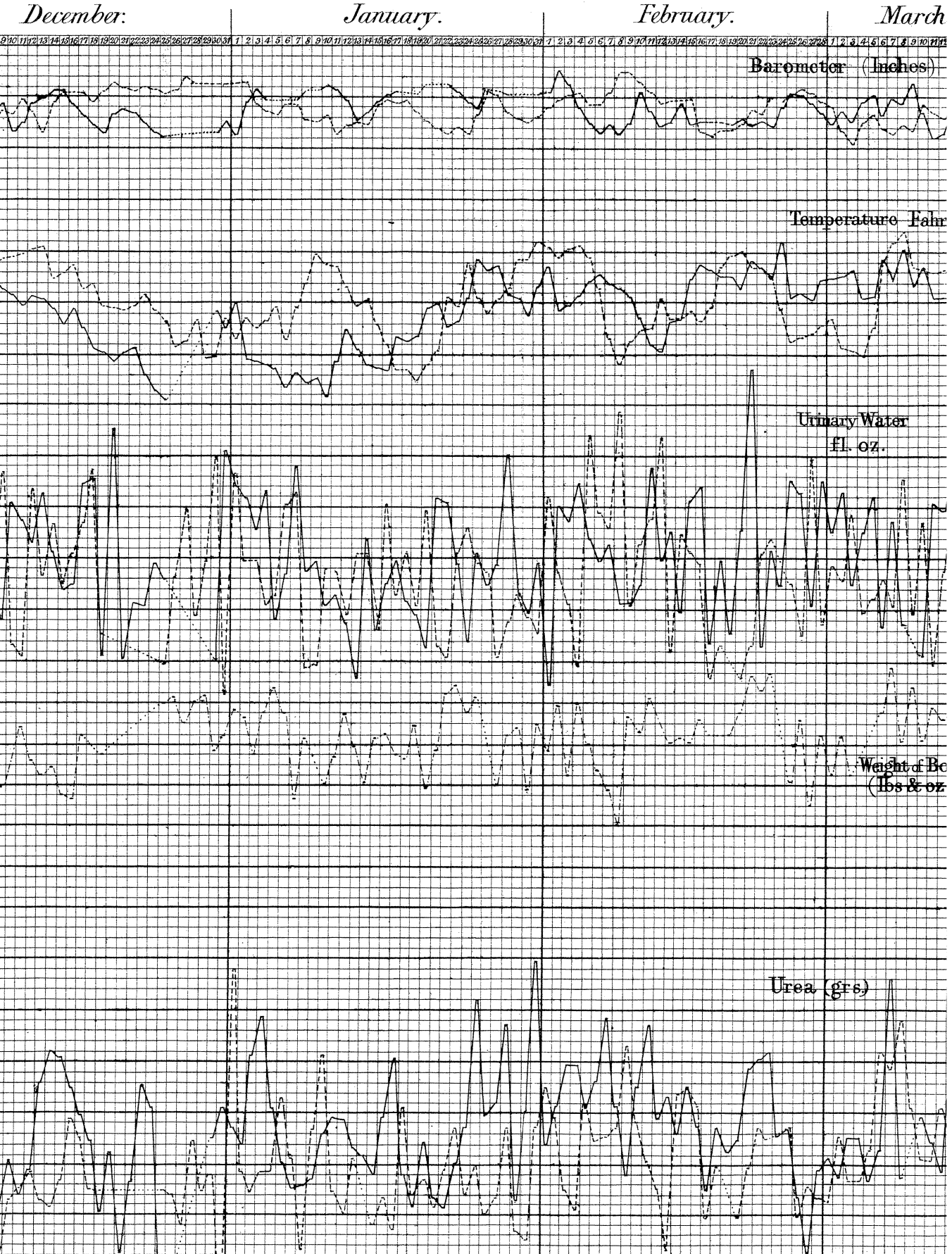
ntrast of daily quantities in the years 1860–1 and 1861–2 in Barometric hei



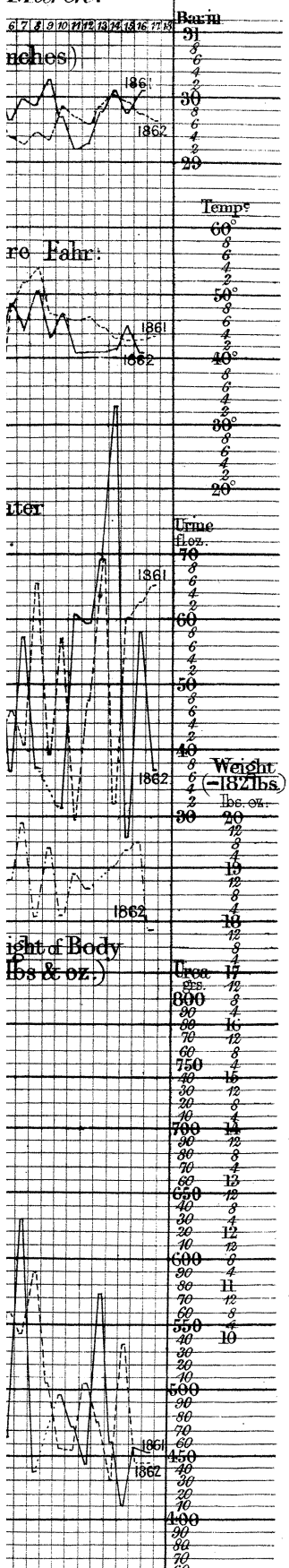
ric height & Temperature at Greenwich, & Urinary Water, weight of body & Urea in the

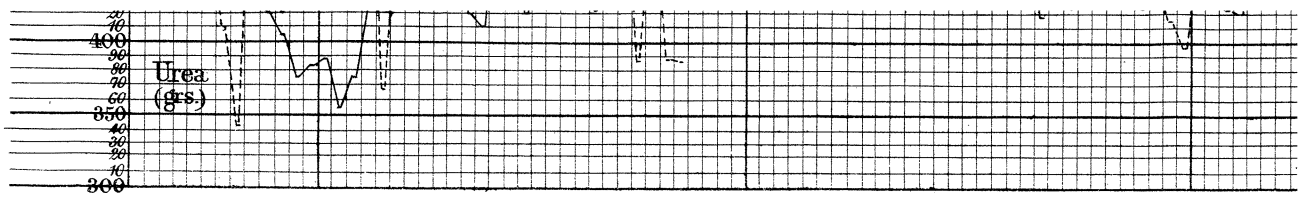
September. *October.* *November.* *Dece*

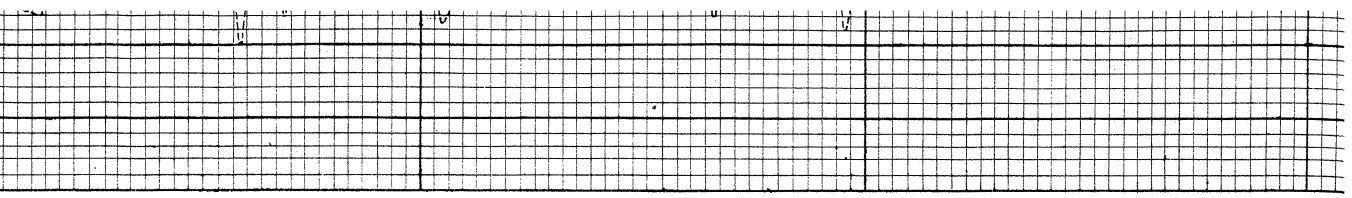


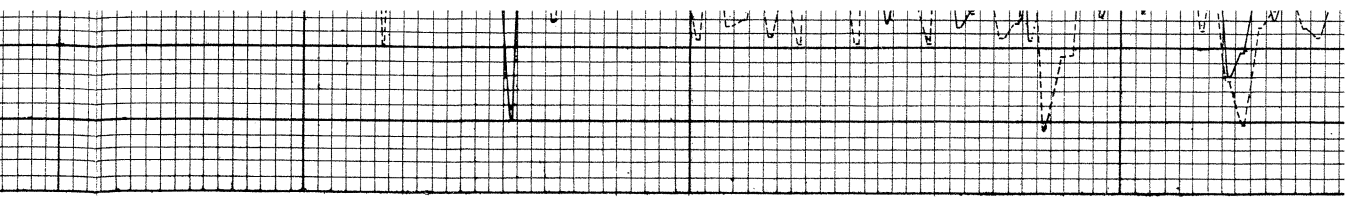

December.
January.
February.
March
Barometer (Inches)
Temperature Fahr
Urinary Water
fl. oz.
Weight of Bo
(lbs & oz
Urea (grs.)

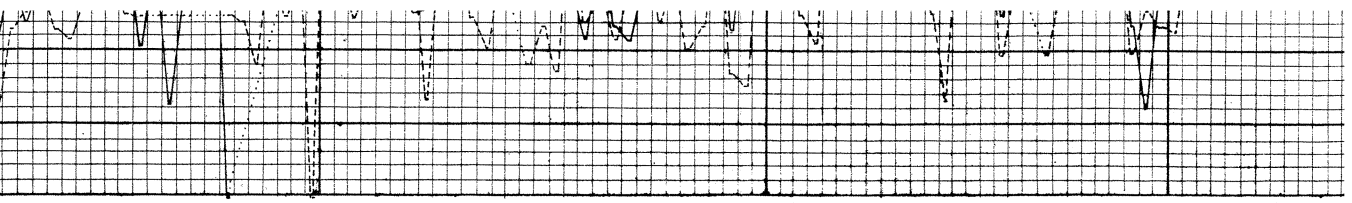
March.

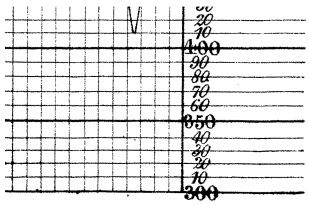

Barm
Temps
Urine
fl.oz.
Weight
(=182lbs.)
lbs. oz.
Urea
grs.
1861
1862


Urea
(grs.)
400
350
300









J. Basire, litho.

DR E. SMITH'S PAPER ON UREA.

Daily observations on the excretion of Urea at four periods — on the whole day — the night — before breakfast (basis quantities) & before midday compared with the Mean daily Temp^e at Greenwich.

Phil. Trans. MDCCCLXI. Plate XXXIII.

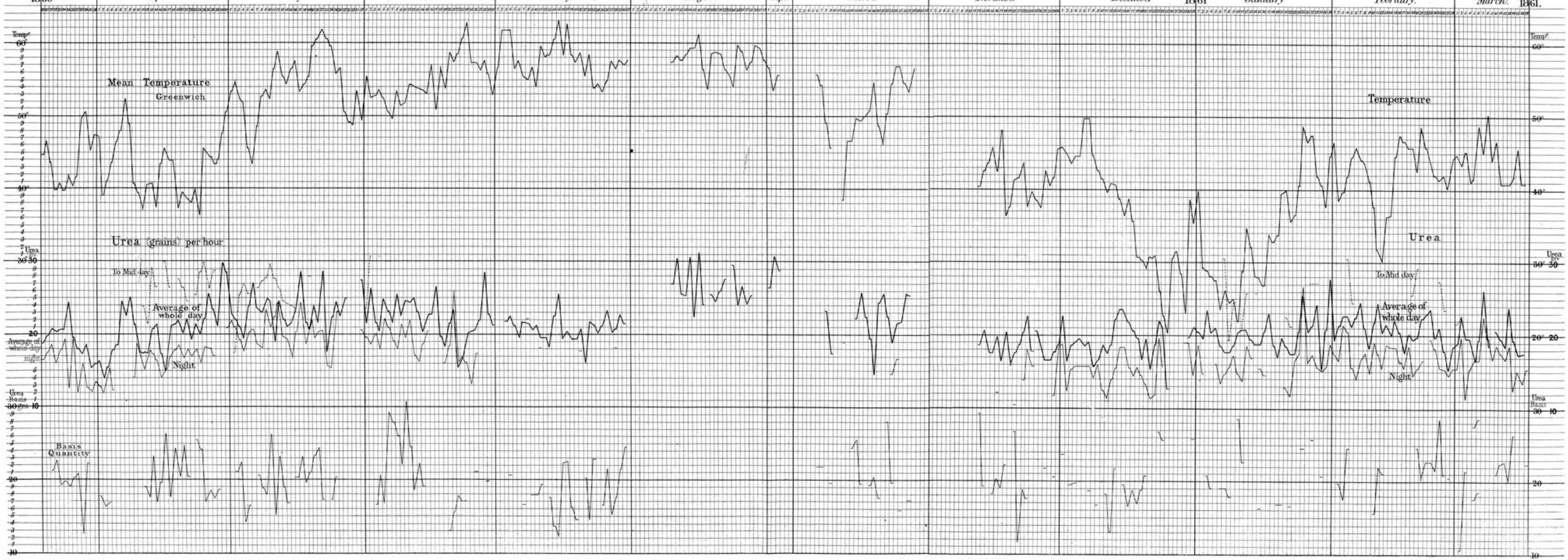


Fig. 1.

Hourly elimination of Urea & Urinary Water on Mar 1 & 2, 1860, with the proportion of Urea in each oz. of Urine.

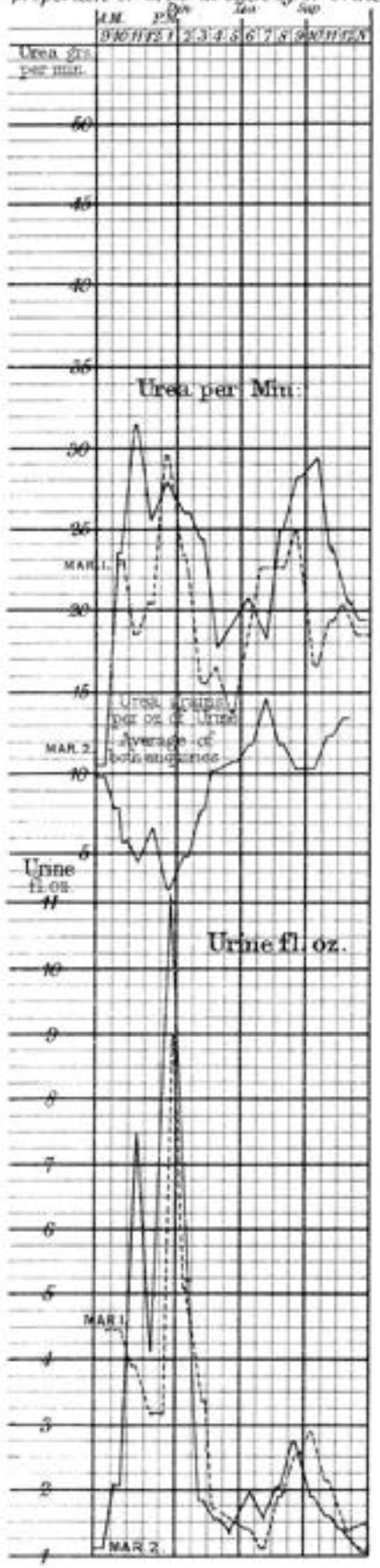


Fig. 2.

Hourly elimination of Urea & Urinary Water at each ¼ of an hour. Dec^r 17 & 18. 1861.

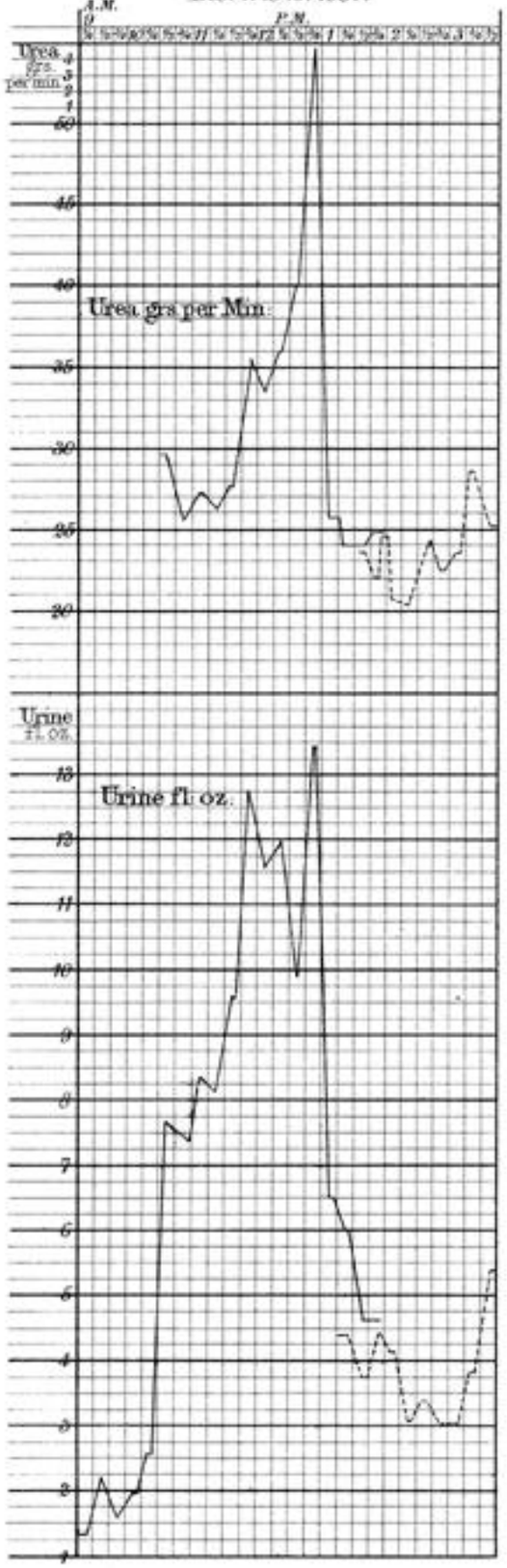


Fig. 3.

Hourly elimination of Urea & Urinary Water with the rate of pulsation when Fasting except from Water.

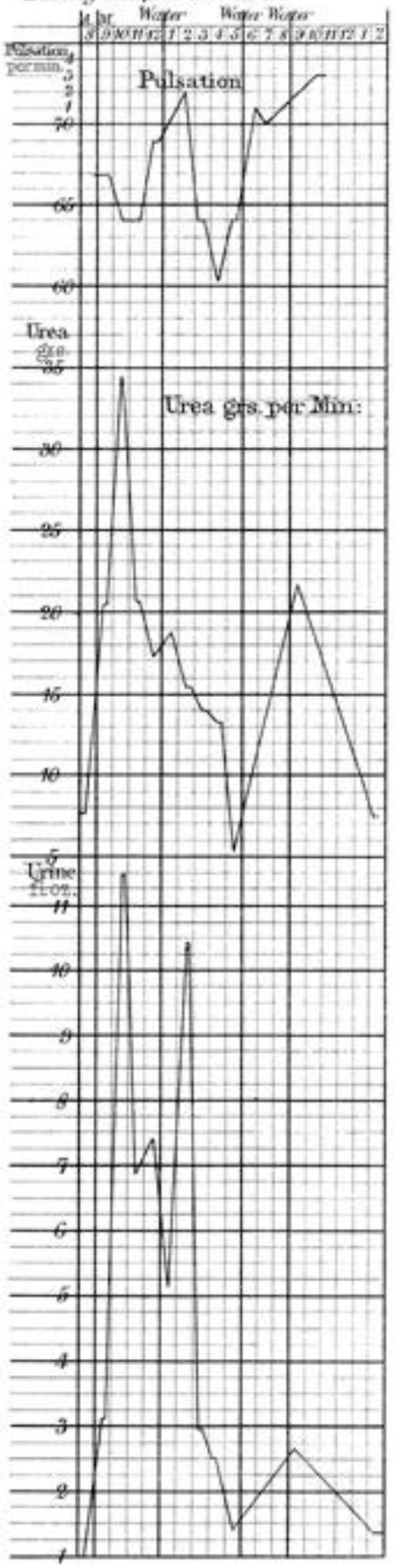


Fig. 4.

The daily weight of the body taken Naked & after the Emission of Urine on returning to bed & rising. Subtracting a constant weight of 13 Stones or 182 lbs. 1860

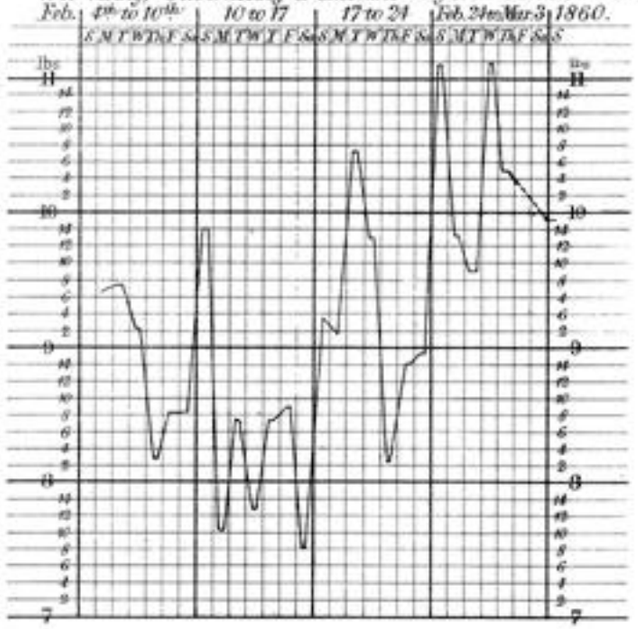


Fig. 5.

Hourly elimination of Urea & Urinary Water under the influence of Water, Tea & Coffee with Bread.

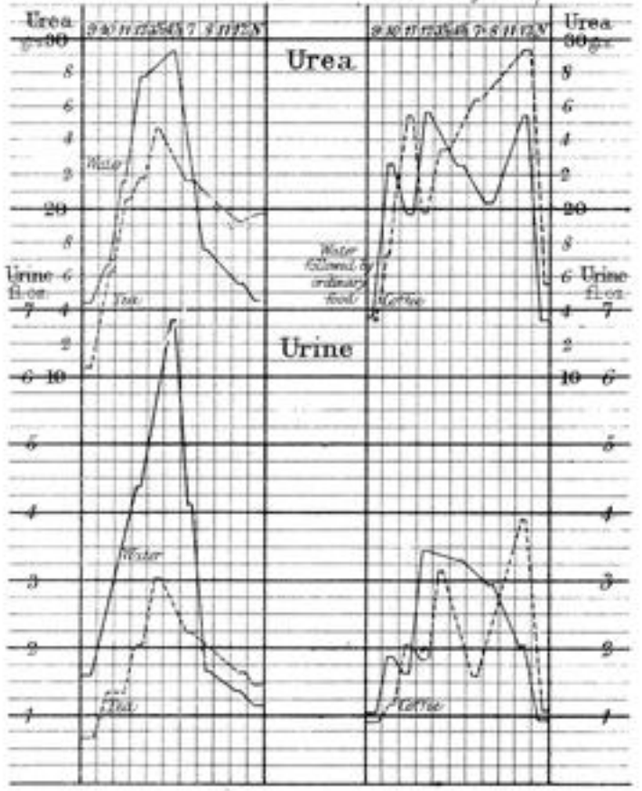


Fig. 6.

Shewing the effect of drinking water over the excretion of Urea & Urine.

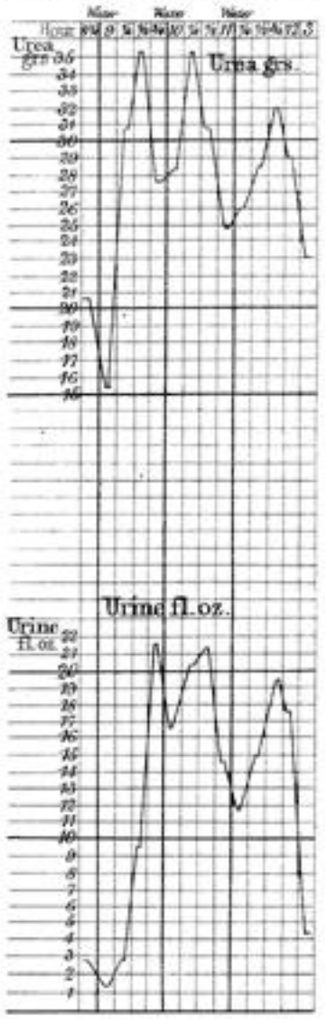
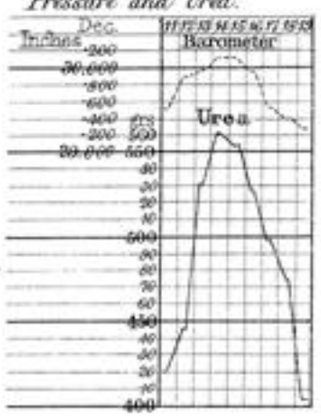


Fig. 7.

Relation of Atmospheric Pressure and Urea.



J. Basire lith.

Dr E. SMITH'S PAPER ON UREA, &c.

_____ indicates 1860–1.
- - - - - - indicates 1861–2.

Contrast of daily quantities in the years 1860–1 and 1861–2 in Barometric height & Temperature at Greenwich, & Urinary Water, weight of body & Urea in the Author.

March. April. May. June. July. August. September. October. November. December. January. February. March.

Barometer (Inches)

Temperature Fahr.

Urinary Water (fl. oz.)

Weight of body (lbs & oz.)

Urea grs.

Barometer (Inches)

Temperature Fahr.

Urinary Water fl. oz.

Weight of Body (lbs & oz.)

Urea (grs.)

J. Basire lithe.