EXPERIMENTS
ON THE
ACTION OF CERTAIN DIURETICS
(CITRATE AND ACETATE OF POTASH, SPIRITUS ÆTHERIS NITROSI,
AND OIL OF JUNIPER)
ON
THE URINE IN HEALTH.

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THE following paper contains an account of some experiment made on myself, with the object of ascertaining the influence of citrate and acetate of potash, of sp. ætheris nitrosi, and of oil of juniper on the water, urea, and solids of the urine in health.

As clinical evidence is in favour of the diuretic power of these medicines in some diseases attended by anasarca, one of the therapeutical questions to be considered is whether the increased secretion occurs from their action on the portion of renal structure which remains anatomically unchanged, and quite *irrespective* of the altered condition of the blood; or

whether it only takes place in *consequence* of the state of the blood due to the renal or other disease present ; in other words, do the medicines chosen for experiment act by themselves on the kidneys, or is that changed condition of the blood and of the whole secreting structure of the kidneys, comprised in the idea of *disease*, necessary in order that diuresis may be produced ?

If these substances were found to act as diuretics in health, the former supposition would receive considerable support.

Each set of experiments was conducted under similar conditions of diet and exercise, and lasted about twenty-eight days, on the middle twelve of which the medicine under examination was taken, the medicine-free days before and after this period affording a standard for comparison. Throughout the observations the urine was examined each morning at half-past eight o'clock, from which time the twenty-four hours was reckoned, and the urea and solids determined, the former by Liebig's process, the latter by evaporation and weighing.

Citrate of Potash.

The experiments forming the basis of Tables I and II, were made during the warm summer weather ; the former contains the results of the analysis of the urine during twelve days, on which no medicine was taken. On July 6th a rather larger quantity of animal food than usual was consumed, which may probably account, in some measure, for the large amount of the solids. Table II contains the analysis of the urine for twelve days, on which citrate of potash was taken in doses varying from a scruple to a dram at intervals, amounting in the twenty-four hours to from 2 to 4 drams.

On comparing the means of the tables a slight increase in the water in No. II is seen.

The urea and solids are actually diminished whilst taking citrate of potash, the former by 5·4, the latter by 4 grammes,

in the twenty-four hours. This reduction in the solids is very considerable, especially when allowance has been made for the carbonate of potash they contain, as the product of the decomposition of the citrate; it is possibly due to interference with digestion as well as to "an aberration, so to speak, from the normal course of metamorphosis and oxidation, which may impede the formation and elimination of urea."¹

Whilst taking the citrate, the urine was usually strongly alkaline, except that passed on rising in the morning, and, very frequently, turbid from the presence of phosphates.

Sp. Ætheris Nitrosi (B. P.).

Tables III, IV, and V contain the series of experiments relating to nitrous ether, which was taken in water, in doses varying from 1 to 3 drams, at intervals, amounting in the twenty-four hours to from 10 to 18 drams.

Table IV gives the analysis of the urine on twelve days during which the medicine was taken.

Tables III and V contain the analyses during three and seven days, respectively before and after the period of its injection.

The experiments in table III are too few in number, and hence, in the following comparison, table V is only immediately referred to, although the result obtained is fully confirmed by a comparison of table IV with table I and with the mean of 47 medicine-free days in table XI.

Comparing, then, tables IV and V, nitrous ether would appear slightly to increase the urinary water, by 72 c.c., but to diminish the urea to the extent of 3·4 grammes and the solids to the amount of 8 grammes in the twenty-four hours. Perhaps this decrease in the urea and solids is due to the alcohol contained in the *Sp. Ætheris Nitrosi*, since

¹ Parkes, 'On Urine,' p. 163.

the experiments of Böcker and Hammond¹ show that the urea is considerably lessened by the ingestion of from 7 to 12 drams of alcohol in the twenty-four hours.

Whilst taking Sp. *Ætheris Nitrosi* the urine was clear, acid, and free from albumen.

Acetate of Potash.

Tables V, VI, and VII contain the results of the experiments on acetate of potash.

Table VI gives the state of the urine on twelve days on which the acetate was taken, in doses varying from 20 to 40 grains, every few hours, amounting to from $2\frac{1}{2}$ to $3\frac{1}{2}$ drams in the twenty-four hours.

The salt was taken dissolved in water.

The mean excretion of water, whilst the acetate was taken, exceeds that of the seven previous medicine free days, whilst it falls below that of the six succeeding days, the excess amounting to 150 c.c., the diminution to 100 c.c. It should be observed, however, that the weather during the last six medicine free days was decidedly colder than it had hitherto been. Comparing the three tables, the urea and solids are seen to be considerably reduced, the former by from 2 to 4.4 grammes, the latter by from .7 to 6.7 grammes in the twenty-four hours. The causes of this reduction would probably be the same as in the case of citrate of potash.

These results agree generally with those of Parkes² and of Böcker,³ except that in these experiments the solids were lessened in a far greater degree, even falling below the mean of those on the medicine-free days, notwithstanding the carbonate of potash they contained, and for which allowance must be made. This is, however, only a difference in degree; but W. Moss⁴ finds, as the result of his experiments, that

¹ Quoted by Parkes, *op. cit.*, p. 72.

² Parkes, *op. cit.*, p. 168.

³ Quoted by Parkes, *op. cit.*, p. 162.

⁴ 'American Journal of Medical Science,' April, 1861.

the water, urea and solids are increased by acetate of potash. Ranke¹ found the water considerably increased in one case.

Whilst taking the acetate, the urine was usually alkaline, and frequently turbid from the presence of phosphates.

Oleum Juniperi.

Tables VIII, IX, and X contain this series of experiments.

Table VIII gives the analysis of the urine during twelve days on which the English oil of juniper was taken. From 5 to 10 drops of the essence were put on sugar and taken every few hours, the total amount in the twenty-four hours being from 30 to 40 minims, a quantity representing from 25 to 33 drams of the spiritus juniperi of the British Pharmacopœia.

On comparing the three tables it is seen that the water, whilst the oil of juniper was taken, was equal to that on the nine previous medicine free days, but fell below that on the ten succeeding days, to the amount of 160 c.c.

The urea was increased by from '6 to 1·5 grammes, and the solids by from 2 to 4·3 grammes.

Whilst the oil of juniper was taken, the urine was clear, acid, and free from albumen; it acquired a strongly aromatic odour, occasionally faintly recalling the smell of violets. The evaporated residue had also a strong and peculiar odour. No strangury or irritation of the urinary passages was experienced.

Table XI gives the mean results of the previous tables arranged together, and also the mean per twenty-four hours and the mean per one hour of the forty-seven medicine-free days occurring during the experiments. The results are stated in cubic centimeters and ounces, and in grammes and grains.

The following conclusions may be drawn from these observations :—that in health—

¹ Quoted by Parkes, op. cit., p. 162.

1. Citrate and acetate of potash only slightly increase the quantity of water excreted by the kidneys.

2. They distinctly lessen the amount both of urea and of solids excreted.

3. Spiritus ætheris nitrosi slightly increases the amount of urinary water.

4. It decidedly reduces the quantity both of the urea and solids.

5. Oil of Juniper slightly reduces the amount of water excreted.

6. It appreciably increases both the urea and solids.

It would thus appear that, of these four medicines, citrate and acetate of potash and nitrous ether actually *reduce* the urinary solids, whilst they slightly increase the water, and that oil of juniper *increases* the solids whilst it slightly lessens the water.

It is evident that these experiments, performed on one individual, will not establish generally such conclusions, but they at least show that the action of these medicines, with the exception of oil of juniper, as diuretics in *health*, is very uncertain.

TABLE I.—*No Medicine taken.*

Date.	Water, c. c.	Urea, grm.	Solids, grm.	Sp. gr.
June 28—29.....	1795	36·77	54·80	1·016
„ 29—30.....	1300	33·28	55·54	1·023
„ 30—July 1	1385	34·34	53·84	1·020
July 1—2	1305	32·62	54·32	1·022
„ 2—3	925	32·19	52·35	1·029
„ 3—4	960	31·20	51·45	1·027
„ 4—5	1210	32·18	54·07	1·023
„ 5—6	1325	33·12	56·57	1·021
„ 6—7	1505	39·73	73·79	1·024
„ 7—8	1125	34·65	58·49	1·024
„ 8—9	955	32·28	54·89	1·029
„ 9—10	1390	34·19	58·17	1·023
Mean per 24 hours	1265	33·88	56·52	1·023
Mean per hour ...	52·7	1·408	2·355	...

TABLE II.—*Citrate of Potash.*

Date.	Water, c. c.	Urea, gram.	Solids, gram.	Sp. gr.	Citrate of Potash per 24 hours, gram.	Remarks.
July 11—12	1470	28.22	51.62	1.018	16	Urine alkaline, turbid from phosphates.
„ 12—13	1320	28.24	52.35	1.022	11.5	„
„ 13—14	1260	28.72	53.55	1.021	6	Occasionally acid and turbid.
„ 14—15	1455	31.28	57.91	1.019	9.5	Urine alkaline and turbid.
„ 15—16	1450	32.68	55.80	1.019	10.3	Alkaline or neutral, turbid.
„ 16—17	1140	28.51	49.35	1.020	8	„
„ 17—18	...	...	...	...	5	Urine not collected.
„ 18—19	1140	28.84	51.97	1.020	8.5	Alkaline, sometimes faintly acid.
„ 19—20	1335	26.79	51.25	1.018	10	„
„ 20—21	1620	28.51	54.19	1.019	9.5	„
„ 21—22	1565	30.05	56.35	1.019	10.5	„
„ 22—23	1235	25.14	48.92	1.021	9.5	„
„ 23—24	...	...	...	...	10	} Urine not collected.
„ 24—25	...	...	...	...	5.5	
„ 25—26	1020	24.02	46.19	1.023	12	Alkaline, turbid.
Mean per 24 hours.	1334	28.41	52.45	1.020	Total Quantity, 137.6 gram. =2124 grains.	
Mean per hour	55.58	1.183	2.185	...		

TABLE III.—*No Medicine taken.*

Date.	Water, c. c.	Urea, gm.	Solids, gm.	Sp. gr.
Sept. 8— 9	1430	25·74	47·2	1·017
„ 10—11	1135	31·04	50·75	1·023
„ 12—13	1440	28·51	46·32	1·017
Mean per 24 hours	1335	28·43	48·09	1·019

Nitrous ether taken for 12 days during this interval (see IV).

TABLE IV.—*Nitrous Ether.*

Date.	Water, c. c.	Urea, grm.	Solids, grm.	Sp. gr.	Nitrous ether per 24 hours. c. c.	Remarks.
Sept. 13—14	1505	26·70	48·25	1·018	21·3	Urine clear, acid.
„ 14—15	1265	29·30	49·52	1·021	37·2	„
„ 15—16	1455	31·24	51·20	1·020	46·1	„
„ 16—17	1520	28·60	50·07	1·018	53·2	„
„ 17—18	1612	30·16	50·72	1·016	49·7	„
„ 18—19	1725	33·46	55·42	1·018	49·7	„
„ 19—20	2040	31·74	52·60	1·013	46·1	„
„ 20—21	1665	28·30	50·20	1·017	42·6	„
„ 21—22	1580	30·50	50·80	1·016	49·7	„
„ 22—23	1590	27·98	48·20	1·015	46·1	„
„ 23—24	1250	26·60	46·60	1·019	42·6	„
„ 24—25	1225	28·50	47·30	1·020	35·5	„
Mean per 24 hours.	1536	29·42	50·07	1·017	Total Quantity, 600 c.c. = 18 oz. 2½ drams.	
Mean per hour	64	1·225	2·086	...		

TABLE V.—*No Medicine taken.*

Date.	Water, c. c.	Urea, gram.	Solids, gram.	Sp. gr.
Sept. 25—26	960	30·24	53·76	1·026
„ 26—27	1660	35·80	62·30	1·018
„ 27—28	1620	33·03	59·60	1·019
„ 28—29	1825	34·85	58·90	1·016
„ 29—30	1790	31·50	54·63	1·016
„ 30—Oct. 1	1085	30·16	57·22	1·027
Oct. 1—2	1310	34·32	59·74	1·022
Mean per 24 hours	1464	32·84	58·02	1·020
Mean per hour ...	61·008	1·368	2·417	...

TABLE VI.—*Acetate of Potash.*

Date.	Water, c. c.	Urea, gram.	Solids, gram.	Sp. gr.	Acetate of Potash in 24 hours. gram.	Remarks.
Oct. 2—3 ...	1775	36·74	65·94	1·021	13·33	At midday alkaline and turbid.
„ 3—4 ...	1670	34·23	60·17	1·020	13·33	Alkaline and turbid
„ 4—5 ...	1560	29·79	53·65	1·019	8·66	„
„ 5—6 ...	1515	28·50	49·47	1·018	10	„
„ 6—7 ...	1805	30·14	58·13	1·017	11·33	Neutral or alkaline.
„ 7—8 ...	1700	30·17	61·39	1·020	11·33	„
„ 8—9 ...	1590	29·41	56·14	1·019	10·66	„
„ 9—10 ...	1600	29·12	58·04	1·020	11·33	Occasionally acid.
„ 10—11...	1375	29·15	50·29	1·020	10·66	Alkaline.
„ 11—12...	1465	28·42	53·00	1·020	8	„
„ 12—13...	1640	31·65	62·01	1·020	10·66	„
„ 13—14...	1705	31·71	60·37	1·019	11·33	„
Mean per 24 hours.	1616	30·75	57·38	1·019	Total Quantity, 130·66 gram. =1960 grains.	
Mean per hour	67·36	1·281	2·39	...		

TABLE VII.—*No Medicine taken.*

Date.	Water, c. c.	Urea, grm.	Solids, grm.	Sp. gr.
Oct. 14—15	1630	32·76	57·60	1·018 ¹
„ 15—16	1745	36·64	67·41	1·021
„ 16—17	1640	38·37	68·34	1·020
„ 17—18	1595	34·29	62·66	1·020
„ 18—19	2025	36·65	66·23	1·018
„ 19—20	1655	31·94	61·87	1·020
Mean per 24 hours	1715	35·109	64·018	1·019
Mean per 1 hour	71·45	1·462	2·667	...

¹ The last dose of Acetate of Potash was taken at 7.15 a.m. on October 14th. At 10 a.m. the urine was faintly alkaline and turbid; at 1.15 p.m. it was neutral and turbid—six hours after the last dose; at 5.30 p.m. it was slightly acid—ten hours after the last dose; at 11.30 p.m. it was strongly acid and clear.

Whilst the Acetate of Potash was taken the urine was usually alkaline and turbid from the presence of phosphates. It caused a more frequent desire for micturition than the citrate, as if the urine were more irritating to the bladder, although, weight for weight, more Carbonate of Potash is yielded by Citrate than Acetate of Potash.

TABLE VIII.—*No Medicine taken (before Ol. Juniperi).*

Date.	Water, c. c.	Urea, grm.	Solids, grm.	Sp. gr.
Oct. 27—28	1665	31·47	56·32	1·018
„ 31—Nov. 1...	1145	26·9	48·97	1·021
Nov. 1—2	1415	31·13	57·63	1·020
„ 2—3	1275	30·34	58·45	1·023
„ 3—4	1230	30·13	57·78	1·024
„ 4—5	1575	29·76	56·00	1·019
„ 8—9	1210	23·11	46·15	1·020
„ 10—11	1265	28·40	56·23	1·023
„ 11—12	1275	28·30	55·94	1·023
Mean per 24 hours	1339	28·83	54·83	1·021
Mean per 1 hour	55·8	1·20	2·28	...

TABLE IX.—*Oil of Juniper.*

Date.	Water, c. c.	Urea, gm.	Solids, gm.	Sp. gr.	Ol. Juniperi per 24 hours. M.	Remarks.
Nov. 12—13	1030	26·37	50·27	1·025	7	Violaceous odour a short time after first dose.
„ 13—14	1210	30·00	58·70	1·023	30	Urine acid.
„ 14—15	1395	29·15	59·32	1·022	40	„
„ 15—16	1635	28·28	57·95	1·019	47	Odour of urine strongly aromatic
„ 16—17	1315	27·00	60·65	1·025	37	„
„ 17—18	1635	30·90	64·49	1·022	32	„
„ 18—19	1600	34·88	68·53	1·022	30	„
„ 19—20	1280	32·76	63·11	1·025	31	„
„ 20—21	1335	32·84	62·23	1·022	30	„
„ 21—22	1370	27·26	55·38	1·021	31	„
„ 22—23	1195	28·00	57·05	1·026	31	„
„ 23—24	1072	26·05	52·43	1·026	32	„
Mean per 24 hours	1339	29·45	59·17	1·023	Total Quantity, 3vi, mxviii.	...
Mean per 1 hour.	55·8	1·22	2·46	...	...	...

TABLE X.—*No Medicine taken (after Ol. Juniperi).*

Date.	Water, c. c.	Urea, gram.	Solids, gram.	Sp. gr.	Remarks.
Nov. 24—25	1265	25.00	51.20	1.022	...
„ 25—26	1555	31.41	62.44	1.021	...
„ 26—27	1800	32.94	63.95	1.019	...
„ 27—28	1180	27.00	53.72	1.025	Mean for 4 days: water 1437; urea 29.09; solids 57.83.
Dec. 8—9	1575	28.35	56.98	1.020	...
„ 9—10	1555	27.52	57.25	1.020	...
„ 10—11	1645	30.43	63.08	1.020	...
„ 11—12	1605	26.48	54.69	1.019	...
„ 12—13	1210	24.92	52.62	1.022	...
„ 13—14	1655	25.32	55.22	1.018	Mean for 6 days: water 1541; urea 27.17; solids 56.64.
Mean per 24 hours	1499	27.93	57.11	1.020	...
Mean per 1 hour	62.4	1.151	2.38	...	...

TABLE XI.

	Mean per 24 hours of 12 days previous to Citrate of Potash.	Mean per 24 hours of 13 days on which Citrate of Potash was taken.	Mean per 24 hours of 3 days previous to Sp. Etheris Nitrosi.	Mean per 24 hours of 13 days on which Sp. Etheris Nitrosi was taken.	Mean per 24 hours of 7 days after Sp. Etheris Nitrosi.	Mean per 24 hours of 13 days on which Acetate of Potash was taken.	Mean per 24 hours of 6 days after Acetate of Potash.	Mean per 24 hours of 9 days previous to Oil of Juniper.	Mean per 24 hours of 13 days on which Oil of Juniper was taken.	Mean per 24 hours of 10 days after Oil of Juniper.	Mean per 24 hours of 47 medicine free days.	Mean per 1 hour of 47 medicine free days.
Water, c.c.	1265	1334	1335	1536	1464	1616	1715	1389	1389	1489	1421	59.19
" ounces...	44.5	47	44.5	54.2	51.6	57	60.5	47.1	47.1	52.9	50.1	2.08
Urea, grammes	33.8	28.41	28.43	29.42	32.84	30.75	35.11	28.83	29.45	27.93	31.30	1.304
" grains ...	522.8	438.4	438.4	453.4	507.4	474.5	542	444.8	453.4	431	483	20.12
Solids, grammes	56.52	52.45	48.09	50.07	58.02	57.38	64.02	54.83	59.17	57.11	56.96	2.373
" grains ...	871.2	809.4	742.1	773	895.3	885.5	988	846	913	881.2	878.9	36.6