

On metabolism in phthisis / by Francis W. Goodbody, Noel D. Bardswell and J.E. Chapman.

Contributors

Chapman, J. E.
Bardswell, Noel D. 1871-
Goodbody, Francis W.
Royal College of Physicians of Edinburgh

Publication/Creation

London : Royal Medical and Chirurgical Society, 1902.

Persistent URL

<https://wellcomecollection.org/works/h72vv7yx>

Provider

Royal College of Physicians Edinburgh

License and attribution

This material has been provided by This material has been provided by the Royal College of Physicians of Edinburgh. The original may be consulted at the Royal College of Physicians of Edinburgh. where the originals may be consulted.

Conditions of use: it is possible this item is protected by copyright and/or related rights. You are free to use this item in any way that is permitted by the copyright and related rights legislation that applies to your use. For other uses you need to obtain permission from the rights-holder(s).



Wellcome Collection
183 Euston Road
London NW1 2BE UK
T +44 (0)20 7611 8722
E library@wellcomecollection.org
<https://wellcomecollection.org>



ON METABOLISM IN PHTHISIS

BY

FRANCIS W. GOODBODY, M.D., M.R.C.P.

ASSISTANT PROFESSOR, PATHOLOGICAL CHEMISTRY, UNIVERSITY COLLEGE,
LONDON

NOEL D. BARDSWELL, M.D., M.R.C.P.

PHYSICIAN, SANATORIUM, BANCHORY

AND

J. E. CHAPMAN, L.R.C.P.

CLINICAL PATHOLOGIST TO THE SANATORIUM, BANCHORY

(FROM THE CHEMICAL PATHOLOGICAL DEPARTMENT,
UNIVERSITY COLLEGE, LONDON)

[*From Volume 84 of the 'Medico-Chirurgical Transactions'*]

BIBLIOTH
COLL. REG.
MED. EDIN.

LONDON

PUBLISHED BY THE ROYAL MEDICAL AND CHIRURGICAL SOCIETY
AND SOLD BY H. K. LEWIS, 136, GOWER STREET, W.C.

1902

R37982

ON METABOLISM IN PHTHISIS

BY

FRANCIS W. GOODBODY, M.D., M.R.C.P.

ASSISTANT PROFESSOR, PATHOLOGICAL CHEMISTRY, UNIVERSITY COLLEGE,
LONDON

NOEL D. BARDSWELL, M.D., M.R.C.P.

PHYSICIAN, SANATORIUM, BANCHORY

AND

J. E. CHAPMAN, L.R.C.P.

CLINICAL PATHOLOGIST TO THE SANATORIUM, BANCHORY

(FROM THE CHEMICAL PATHOLOGICAL DEPARTMENT,
UNIVERSITY COLLEGE, LONDON)

Received June 5th—Read June 11th, 1901

THE method of combating tubercular disease, and more especially pulmonary tuberculosis, by over-feeding, has attracted considerable notice of late years; and the opinions of various observers as to its efficacy differ vastly. It occurred to us that it would be interesting, from the scientific as well as from the clinical standpoint, to carry out some research as to the effect of over-feeding on the metabolism of patients suffering from pulmonary tuberculosis. It appeared to us that the best

manner of obtaining definite results would be to take cases of varying severity, and after having determined the metabolism on the diet on which they were ordinarily placed in hospital, to gradually increase the diet in various ways in order to ascertain what was the maximum diet which they could take with advantage, and without causing too great a strain on the organism from a clinical point of view. It seemed to us that one of the most important points to be determined was what number of calories was the most suitable, as this is the easiest method of determining the diet suitable for any given case. The most satisfactory method of obtaining the number of calories per kilo. body-weight suitable for a patient, appeared to be to take his highest known weight, and to calculate the number of calories that he would require in health. From this, it is comparatively easy to make out the sufficient number of calories, so as to ensure that the system of over-feeding—but not necessarily forced feeding—is being carried out. Physiologically it seemed rational to conclude that the system of forced feeding carried out at Nordrach and elsewhere was faulty, as the patients are forced to eat very large quantities of food, quite independently of their subjective symptoms (anorexia, dyspepsia, etc.). We failed to see what benefit the patient could obtain by this system of "cramming," as the strain on the organism must be very excessive; and, as far as the disease was concerned, equally good results could be obtained by studying the individual cases more particularly. There seemed to be no object in compelling a patient suffering from the dyspeptic symptoms so often present in pulmonary tuberculosis to consume, roughly, eighty calories per kilo. body-weight, if the same result could be obtained with a diet containing about sixty calories per kilo. body-weight.

Owing to the kindness of the Committee of the Brompton Hospital we were enabled to carry out this research, to whom—and to Dr. Kingston Fowler for kindly placing a ward at our disposal and for selecting cases for us—we

desire to express our cordial thanks. We are also indebted to Dr. Price, the Assistant Resident Medical Officer, for the trouble he took in superintending the work at the hospital. We also desire to take this opportunity of expressing our cordial thanks to Professor Vaughan Harley for much kind assistance and advice during the progress of this research, which was carried out in his laboratory.

Although for some years there has been a considerable amount of discussion, in both England and Germany, as to whether over-feeding in pulmonary tuberculosis is well founded in a physiological sense, very little work appears to have been undertaken with a view to determining the metabolic condition; and the Russian observers have carried out by far the greater number of researches.

Griezdiev (1) studied the effect of drinking large quantities of hot and cold water in febrile diseases (including phthisis), and states that the nitrogen metabolism was improved qualitatively, and also that the nitrogen was excreted in a more oxidised form.

Kurlov (2), in some experiments regarding the effect of forced feeding by De Bove's method, observes that the metabolism and assimilation of nitrogen was improved, that there was a rapid gain in weight, that the temperature was lowered, and that diarrhoea was relieved. In addition, the general condition improved, as perspiration, cough, and expectoration diminished, and more sleep was obtained. The same observer also states that the forced feeding sometimes changed an excessive excretion of nitrogen into a normal one, or even that a retention of nitrogen followed.

Swavastyanov (3), in studying the effect of food on pulmonary phthisis, found that an increased quantity of nitrogen in the food made very little difference in the amount retained in the body, but that it sometimes converted an excessive waste into a retention of this substance.

Blumenfeld (4) found that the assimilation of fats in this disease was within the normal limits, thus placing on a firm basis the clinical observation that fats are well borne in this disease.

Levin (5), in some observations which he made as to the metabolism in pulmonary phthisis, found that elimination of nitrogen was very low, especially in bad cases, and that the excretion of phosphoric acid was also below the normal quantity, and that this was especially marked in severe cases.

After these preliminary remarks, we now come to consider our own researches into the influence of over-feeding in pulmonary tuberculosis.

Method of Investigation.—During the week previous to the period of the investigation the patients were kept on their ordinary diets, each article of food being separately weighed before it was brought to them, anything that was left over being again weighed. This was done in order to obtain an idea of the quantity of food taken by each patient under normal conditions. Having thus obtained some data, a diet was made out for each patient for the following week, and, on the morning of the fourth day, four drachms of powdered charcoal were given at 8 a.m. The urine was collected in twenty-four hour periods up to 8 a.m. on the eighth day, when four more drachms of charcoal were given. The fæces were collected from the appearance of the first charcoal until the second charcoal appeared.

Then a fresh diet, which had been previously determined upon, was given during the next week, the time and manner of collection remaining the same. A similar plan was followed during the two succeeding weeks, and then the experiment had to be stopped, as some of the patients were leaving the hospital, and we had not sufficient time to spare to make it worth while commencing a second series.

Owing to the difficulty which was experienced in persuading the patient to eat all the diet provided, the

figures given in the tables represent the absolute quantity of the diet constituents taken, the amount ordered being only occasionally eaten. In Periods B, C, and D a weighed quantity of figs and grapes was given, as some of the patients suffered considerably from constipation, and, as will be noticed later, in some of the cases it was necessary to give enemata. (It was decided to take this means of evacuating the large intestine, as it appears to cause as little interference with metabolism as the administration of drugs.)

The total nitrogen was estimated by Kjeldahl's method, no further oxidising agent being employed in the case of the urine, while sodium pyrophosphate was added for the purpose of estimating the oxidation of the fæces.

The quantity of urea was estimated by the sodium hypobromite method.

The method of Gowland Hopkins was used for estimation of the uric acid, ammonia being added to hasten the conversion of this substance into ammonium biurate.

Schlösing's apparatus was employed for the estimation of the quantity of ammonia.

The amount of phosphoric acid was estimated by the uranium nitrate method, and that of the chlorides by precipitating with silver nitrate, and then titrating with potassium sulphocyanide.

The quantity of sulphates in the urine was estimated by Baumann's method—that is, precipitated with barium chloride, and weighing the barium sulphate thus obtained.

The estimation of the quantity of fats in the fæces was made by extraction of the previously acidified dried fæces with ether in Soxhlett's apparatus, the ether extract being dried at 100° C., and weighed after cooling over sulphuric acid.

Two analyses were made in each case, and the average taken, except in the analysis of the sulphates.

In the following description the successive periods are lettered A, B, C, D.

Approximate Diets.—The following can be taken as

the types of diets employed during the different periods, but it should be mentioned that though these were the diets ordered, the patients very rarely took their full quantity of food, so that the quantities actually consumed varied considerably. In consequence of the patients not being able always to eat their full quotient of food, allowance was made for this in calculating the daily diets, and the corrected quantities appear in the metabolism tables.

In Cases 1, 4, 5, and 6, the ordinary diet in use at Brompton Hospital was given in Period A, and this consisted of—

Milk	3 pints.	Bread	8 oz.
Meat	3 oz.	Sugar	1 „
Bacon	1 „	Potatoes and cabbage	4 „
Butter	1 „	Rice pudding	5 „

In addition, during the Period B, the following was given :

Egg	1	Potatoes	2 oz.
Butter	1 oz.	Figs	4 „
Grapes	4 „		

In Period C the diet was altered, so that the patients received :

Milk	4 pints.	Potatoes	2 oz.
Meat	4 oz.	Cabbage	4 „
Bacon	1½ „	Rice pudding	5 „
Eggs	2	Somatose	3 „
Butter	2 oz.	Grapes	4 „
Bread	8 „	Figs	4 „
Sugar	1½ „		

In Period D the diets varied considerably; but the largest given—that of Case 1—was as follows :

Milk	5 pints.	Rice pudding	5 oz.
Chicken	4 oz.	Potatoes	2 „
Bacon	2 „	Cabbage	4 „
Eggs	2	Grapes	4 „
Butter	2½ oz.	Figs	4 „
Bread	11 „	Somatose	3 „
Sugar	3 „	Lactose	1 „

During Periods A and B Cases Nos. 2 and 3 were on the diet that is given in the open-air wards at Brompton Hospital, which consists of—

Milk	3 pints.	Bread	7 oz.
Meat	7 oz.	Sugar	1 „
Egg	1	Potatoes	3 „
Bacon	2 oz.	Cabbage	3 „
Butter	4 „	Rice pudding	3 „

In Period C the diet was altered, so that the following was given :

Milk	4 pints.	Sugar	2 oz.
Meat	7 oz.	Potatoes	4 „
Egg	1	Cabbage	4 „
Bacon	1½ oz.	Rice pudding	5 „
Butter	2 „	Grapes	4 „
Bread	6 „		

The following diet was given during Period D :

Milk	4 pints.	Sugar	3 oz.
Meat	7 oz.	Potatoes	4 „
Egg	1	Cabbage	4 „
Bacon	1 oz.	Grapes	4 „
Butter	1 „	Rice pudding	5 „
Bread	6 „		

CASE 1. *Pulmonary Tuberculosis ; Acute Infiltration.*

Clinical History.—Age 22, footman. This case was an early one, being only of six months' duration. He was admitted to the special open-air wards on July 18th, 1900, and the following return as to his condition was made at that time :

Left Lung : extensive infiltration in the upper lobe with commencing caseation, and fairly extensive infiltration of the lower lobe.

Right Lung : infiltration of apex of lower lobe and probably early disease of apex of upper lobe.

At the commencement of the research his general condition had improved, the sputum being small in amount, but containing numerous bacilli. The night sweats were very much less marked than when admitted, and the

pyrexia tended to diminish, but oscillated between 99° F. and 100·5° F. The appetite and digestion were good, and the digestive apparatus was in excellent condition, in spite of a tendency to constipation.

He was at least ten kilos. below his highest known weight, but had gained 1·5 kilos. since his admission to the hospital. There was no obvious anæmia, but some dyspnœa. Cough was troublesome, and sleep good. No albumen or sugar was present in the urine.

TABLE 1.—*The various Diets and number of Calories given in Case 1, together with the Percentage of Nitrogen and Fats absorbed, etc.*

Period.	A.	B.	C.	D.
Proteids	116·13	137·50	232·50	271·13
Fats	123·28	136·96	183·93	231·22
Carbohydrates . . .	296·71	296·32	321·37	392·17
Total calories . . .	2897·74	3105·96	4126·75	5026·43
Calories per kilo. . .	56·93	59·73	76·28	89·44
Fluids	2029	2204	2810	3444
Nitrogen in urine . .	16·64	14·53	20·82	23·88
Urea „	30·70	28·35	35·56	40·62
Nitrogen in fæces . .	1·62	0·56	2·11	4·36
Fat „	7·94	2·53	3·88	7·85
Nitrogen absorbed, per cent.	91·25	97·45	94·20	89·95
Fat „ „	93·82	98·15	97·90	96·41
Weight at end of period .	50·76	52·34	54·36	55·16

Period A.—During this week the patient was kept on the same diet on which he had been since admission, and on which he had decidedly improved. This consisted of a normal quantity of proteids (116·13 grammes), a slightly increased amount of fats (123·28 grammes), and a somewhat small amount of carbohydrates (296·71 grammes). The total number of calories contained in this diet was 2897·74, and was high, considering the fact that the patient was kept in bed. The number of calories per kilo. body-weight was 56·93.

Owing to the fact that a considerable quantity of nourishment was taken in the form of milk, the daily

quantity of fluid was high, being 2029 c.c., and the fluctuations seen in the tables were due to the fact that it was necessary to give more water on some days than on others.

On this diet a daily average of 18.58 grammes of nitrogen was ingested, and since the total quantity of this substance found in the urine was 16.64 grammes, and in the fæces 1.62 grammes, it will be seen that only 0.32 gramme were retained in the body, so that the patient was practically on nitrogen equilibrium.

The average daily excretion of urine was 1653 c.c., and this can be considered the normal amount in health.

The average specific gravity was 1016.

TABLE 2.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 1 on Diet A.*

Date.	Nitrogen.		Urea.		Uric acid.		Ammonia.
8—9	. 16.26	...	34.02	...	0.81	...	0.30
9—10	. 13.09	...	21.19	...	0.55	...	0.16
10—11	. 19.34	...	34.97	...	1.00	...	0.43
11—12	. 17.85	...	32.62	...	1.00	...	0.29
Average	. 16.64	...	30.70	...	0.84	...	0.30

The average daily elimination of nitrogen in the urine was 16.64 grammes, and was distributed amongst the nitrogenous substances, so that 86.12 per cent. was excreted in the form of urea, 1.68 per cent. in the form of uric acid, and 1.48 in the form of ammonia. From this it will be seen that 11.21 per cent. was excreted as nitrogen rest¹ a quantity which is well within the normal limits.

The absolute excretion of the nitrogen-containing substances in the urine was, taking the average of the twenty-four days, 30.70 grammes urea, 0.84 gramme

¹ It has been shown by v. Noorden ('Path. d. Stoffwechsels,' p. 62) that 84 to 87 per cent. of the nitrogen is in the form of urea, 2 to 5 per cent. in the form of ammonia, 1 to 3 per cent. in the form of uric acid, and 7 to 10 per cent. in the form of nitrogen rest, or in the form of extractions, such as xanthines, hypo-xanthine, creatin, hippuric acid, and colouring matters.

uric acid, and 0.30 gramme ammonia. All these quantities are within the normal amounts except that of uric acid, which is rather high, considering the quantity of fluid taken.

TABLE 3.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 1 on Diet A.*

Date.	Phosphoric acid.	Chlorides.	Sulphates.					Ratio.
			Total.	Alkaline.	Aromatic.			
8—9	2.63	4.62	3.20	2.92	0.28	11.1:1		
9—10	1.58	4.63	2.66	2.50	0.16	14.4:1		
10—11	3.33	7.84	3.58	3.30	0.20	16.9:1		
11—12	2.27	6.02	3.21	3.00	0.21	14.3:1		
Average	2.45	5.78	3.16	2.95	0.21	14.0:1		

On turning now to consider the inorganic constituents of the urine, it will be seen that the excretion of phosphoric acid was about the normal—except on the second day, when the quantity eliminated was small,—and that the daily average was 2.45 grammes. The average elimination per diem of chlorides was 5.78 grammes, this being apparently due to the considerable increase found on the third and fourth days, and is about that found in normal individuals.

The quantity of sulphates excreted in the urine showed a daily average of 3.16 grammes, and was about the normal quantity, thus showing that there was an active proteid metabolism going on in the body. The quantity of alkaline sulphates contained in this amount was 2.95 grammes, so that 0.21 gramme were excreted in the form of aromatic sulphates, this latter figure being about the quantity which has been found by one of us (G—), in conjunction with Professor Vaughan Harley (6), to be the amount normally excreted. The ratio of the alkaline to the aromatic sulphates was 14:1, showing that there was no increased intestinal putrefaction occurring during this period.

TABLE 4.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 1 on Diet A.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
8—9	520	80·91	3·27	16·11
9—10	102	93·09	0·23	1·14
10—11	410	89·01	1·49	7·26
11—12	410	89·01	1·49	7·26
Average	361	87·26	1·62	7·94

The average daily elimination of nitrogen in the fæces was high, being 1·62 grammes, and this was due to the fact that it was necessary to administer enemata on two occasions, owing to the constipation becoming much more marked. On referring to the complete metabolism Tables (see Appendix), it will be seen that the quantity of this substance eliminated in the fæces belonging to the first day was very large, and, although the amount passed on the second day was very low, this was followed by a high excretion on the third and fourth days. As the second enema given brought away the fæces belonging to these two days, it has been considered advisable to divide the quantity by two, so as to obtain the approximate absorption for these days. The remarks about the action of the enemata increasing the quantity of nitrogen in the fæces apply also to the fats, and the average daily elimination of this substance was high, being 7·94 grammes. The quantity passed on the first day (16·11 grammes) was extremely large, and accounts, in a great measure, for this high average.

TABLE 5.—*The Daily Diet and Percentage of Nitrogen and Fats absorbed in Case 1 on Diet A.*

Date.	Nitrogen in diet.	Fats in diet.	Nitrogen absorbed per cent.	Fats absorbed per cent.
8—9	18·59	123·55	82·41	86·99
9—10	18·90	123·66	98·78	99·08
10—11	18·43	123·48	91·91	94·12
11—12	18·40	122·44	91·91	94·07
Average	18·58	123·28	91·25	93·82

The average quantity of nitrogen absorbed per diem was considerably below the normal, being only 91.25 per cent., this being accounted for by the large quantity eliminated in the fæces.¹ The average quantity of fats absorbed per diem was 93.82 per cent., a quantity considerably below the normal amount—in direct opposition to what was found,—as will be noticed later, in the other periods.

His weight remained almost stationary during this period, and on the last day was 50.76 kilos., the average for the four days on which analyses were made being 50.90 kilos.

Clinically, the patient did very well on this diet, and took his food very well. There was no apparent bad symptom, except that he suffered considerably, as already mentioned, from constipation, for the relief of which it was necessary to employ enemata.

Period B.—During this week it was decided to keep the patient on practically the same diet as the above, but as beef (which was substituted for the mutton given in period A) contains a greater quantity of proteid and fat, the amount of these two latter substances taken shows a slight increase. In addition to the grapes and figs already mentioned, 280 c.c. of hot water was ordered to be taken every morning, to combat the constipation. These measures resulted in a slight increase of appetite, and consequently the various constituents of the diet were as follows:—proteids, 137.50 grammes; fats, 136.96 grammes; and carbohydrates, 296.32 grammes. The total number of calories contained in this diet was 3105.96, as compared with 2897.74 in period A; and the average number of calories per kilo. body-weight increased to 59.73, notwithstanding the fact that there was a considerable increase in weight during this period.

Although 280 c.c. of water was ordered in addition to the quantity of milk to be taken each day, the increase in

¹ The views as to there being an absorption and re-excretion of nitrogen in the intestines have not been taken into account in this connection.

the quantity of fluids was only trifling, as the patient did not take so much water at other times; and the average quantity drunk daily was 2204 c.c., as compared with 2029 c.c. in the previous period.

The average daily quantity of nitrogen taken in the diet during this week was 22.00 grammes; and since 14.53 grammes of this substance was passed in the urine, and 0.56 gramme in the fæces, it will be seen that 5.91 grammes were retained in the body—a very different condition to that of period A, when the patient was on nitrogen equilibrium.

Notwithstanding the increased quantity of fluids taken, the average daily excretion of urine diminished to 1493 c.c., as compared with 1653 c.c. in the previous week—a decrease which cannot be accounted for by the fact that there was an increase in the night sweats, or any sensible perspiration at any other time. The average specific gravity declined during this period from 1016 to 1015.

TABLE 6.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 1 on Diet B.*

Date.	Nitrogen.		Urea.	Uric acid.		Ammonia.
15—16	15.23	...	27.66	...	0.66	0.23
16—17	17.75	...	35.82	...	0.71	0.34
17—18	12.45	...	—	...	0.65	0.19
18—19	12.69	...	23.05	...	0.55	0.30
Average	14.53	...	28.84	...	0.64	0.27

As was indicated by the lowered specific gravity, the average daily excretion of total nitrogen in the urine diminished, despite the increased quantity given in the food, and was 14.53 grammes as compared with 16.64 grammes in period A. This quantity of nitrogen was distributed amongst the nitrogen-containing substances in the urine as follows:—87.92 per cent. was excreted in the form of urea,¹ 1.49 per cent. in that of uric acid, and 1.51 per

¹ Owing to neglect in repeating the estimation on the third day of the analytical period, the result obtained on this day being too high had to be

cent. in that of ammonia; the proportion excreted as nitrogen rest being 9.08 per cent. This latter percentage is still within the normal limits, and compares with 11.21 per cent. in the previous period.

As has already been mentioned, only three days' analyses of the quantity of urea are available; but the average excretion per diem was 28.84 grammes, as compared with 30.70 grammes during the previous week. The average daily excretion of uric acid also showed a diminution, from 0.84 gramme to 0.64 gramme; and that of ammonia a slight decrease, from 0.30 gramme to 0.27 gramme.

TABLE 7.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 1 on Diet B.*

Date.	Phosphoric acid.	Chlorides.	Sulphates.				Ratio.
			Total.	Alkaline.	Aromatic.		
15—16 .	2.45 ...	4.90 ...	2.69 ...	2.53 ...	0.16 ...		15.8:1
16—17 .	2.26 ...	3.05 ...	1.99 ...	1.75 ...	0.24 ...		7.3:1
17—18 .	2.12 ...	6.13 ...	2.82 ...	2.62 ...	0.20 ...		13.1:1
18—19 .	1.90 ...	5.94 ...	2.89 ...	2.69 ...	0.20 ...		13.5:1
Average	2.18 ...	5.01 ...	2.60 ...	2.40 ...	0.20 ...		12.0:1

Having discussed the excretion of the nitrogenous constituents of the urine, we now turn to the inorganic substances, and it will be noticed that the average daily elimination of phosphoric acid diminished from 2.45 to 2.18 grammes. The chlorides also shared in the generally lessened excretion noticed in the other substances analysed for; and the daily average elimination was 5.01 grammes, as compared with 5.75 grammes in the previous period.

The average excretion of the total sulphates in the urine per diem showed a decided diminution, being only 2.60 grammes, as compared with 3.16 grammes in period A; and the decline in the quantity of the alkaline sulphates was proportionately greater than that of the aromatic sulphates, and consequently the figures given above are the average of only three days.

phates, the former diminishing from 2.95 grammes to 2.40 grammes, while the latter only decreased from 0.21 grammes to 0.20 grammes. Consequently, the ratio between these two substances was 12:1, as compared with 14:1 in the previous week.

Decrease of phosphates, chlorides, and sulphates, together with the nitrogen, is no doubt due to the building up of tissue proteids in the patient.

TABLE 8.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 1 on Diet B.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
15—16 . .	103	78.87	0.72	3.27
16—17 . .	103	78.87	0.72	3.27
17—18 . .	72	92.88	0.17	0.75
18—19 . .	48	59.96	0.63	2.83
Average . .	82	77.65	0.56	2.53

On turning to the consideration of the fæces, it will be noticed, on referring to the table given above, that there was a marked diminution in the quantity of nitrogen excreted, the daily average amount during this week being only 0.56 gramme, as compared with 1.62 grammes in period A. The explanation of this great difference is to be found in the fact that there was no necessity to administer enemata during this week, and, consequently, there was no excessive excitation of the intestinal walls. For the same reason the average excretion of fats per diem decreased from 7.94 grammes to 2.53 grammes.

TABLE 9.—*The Daily Diet and Percentage of Nitrogen and Fats absorbed in Case 1 on Diet B.*

Date.	Nitrogen in diet.	Fats in diet.	Nitrogen absorbed per cent.	Fats absorbed per cent.
15—16 . .	21.84	136.89	96.70	97.61
16—17 . .	21.69	136.82	96.68	97.61
17—18 . .	22.31	137.10	99.24	99.45
18—19 . .	22.16	137.03	97.16	97.93
Average	22.00	136.96	97.45	98.15

Corresponding to the diminution in the quantity of nitrogen found in the fæces (noted above), and due also to the fact that the quantity of proteids given in the diet was increased, there was a marked rise in the average amount of nitrogen absorbed—97·45 per cent., as compared with 91·25 per cent. in the previous period. This was a very good rate of absorption, especially when it is remembered that the patient was taking a considerable quantity of fat. The average rate of absorption of fats also increased decidedly, and reached the normal limits, being 98·15 per cent., as against 93·82 per cent. in period A.

The condition of the patient clinically was very favourable, as he took his food better, and constipation was absent, there being also a decided gain in weight.

Period C.—Since in the first period it had been necessary to administer enemata, it had been considered advisable, as already mentioned, to obtain practically another normal period in this case; and, in this period, it was decided to test the effect of a marked increase in the quantity of food given. The diet was so arranged that the given increase was made in the proteids and in the fats, as we were anxious to keep the quantity of carbohydrates as near the previous amount as was practicable. The most convenient way to obtain this end was to increase the quantity of milk, as we did not wish to use a very excessive quantity of concentrated foods. The concentrated food employed in these experiments was somatose, and, both on the grounds of expense and for the future practical value of our results, it was not advisable to make too great use of it.

The quantity of proteids was accordingly increased by almost 60 per cent, to 232·50 grammes, and 72 grammes of somatose were given per diem in order to effect part of this large increase. The fats were also increased in nearly the same proportion, as 183·93 grammes were given on an average, while the quantity of carbohydrates increased from 296·32 grammes to 321·37 grammes. The total number of calories was thus increased by, roughly, 25 per cent., as 4126·75 were contained in this diet, as compared with

3105·96 in period B. Despite a further marked rise in weight, the average number of calories per kilo. body-weight was increased to 76·28—a very large number when it is remembered that the patient was at rest in bed.

The daily quantity of fluids taken was increased to 2810 c.c., partly owing to the increased amount of milk given, and partly due to the fact that the patient desired a larger quantity of water.

The amount of nitrogen contained in the proteids given during this period averaged 37·20 grammes; and the average amount of this substance recovered from the urine was 20·82 grammes, and from the fæces 2·11 grammes. Therefore 14·27 grammes were retained in the body. Though this is absolutely a large increase over the quantity (5·91 grammes) retained on an average during period B, it will be seen later that the increase is proportionately small, and at a great expenditure of food, when the greatly increased quantity of nitrogen given in the diet is taken into consideration.

The daily average excretion of urine was 1957 c.c., and although this is a marked increase over the quantity found in the last period, still the increase is not so marked as would be expected from the extra quantity of fluid taken. The increase in the quantity of urine not keeping pace with that of the fluids was noticed in all the cases, even when (as in this case) there was no increase, or even diminution, in the amount of night sweat. The average specific gravity remained practically the same, being 1014.

TABLE 10.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 1 on Diet C.*

Date.	Nitrogen.		Urea.		Uric acid.		Ammonia.
22—23 .	18·98	...	30·59	...	0·60	...	0·16
23—24 .	23·58	...	42·11	...	0·84	...	0·23
24—25 .	18·26	...	33·69	...	0·51	...	0·14
25—26 .	22·34	...	35·85	...	0·88	...	0·30
Average .	20·82	...	35·56	...	0·71	...	0·21

The amount of total nitrogen excreted in the urine averaged 20.82 grammes per diem, and showed a marked increase over that of period B, when it was only 14.53 grammes. The total nitrogen was distributed so that 79.88 per cent. was excreted as urea (a marked decrease from the 87.92 per cent. excreted in this form in period B), while 1.12 per cent. was excreted as uric acid, and 0.81 per cent. as ammonia, the percentage of these two latter substances also showing a decrease. The amount excreted as nitrogen rest increased very markedly, being 18.19 per cent., and appears to suggest a greatly diminished power of elaboration by the liver.

The average daily excretion of urea rose from 28.84 grammes in period B, to 35.56 grammes in this period; and that of uric acid from 0.64 grammes to 0.71; while that of ammonia decreased from 0.27 grammes to 0.21 grammes.

TABLE 11.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 1 on Diet C.*

Date.	Sulphuric acid.	Chlorides.	Total.	Sulphates.			Ratio.
				Alkaline.	Aromatic.		
22—23	2.34	6.80	4.75	4.52	0.23		19.9:1
23—24	3.11	13.44	3.96	3.45	0.51		6.8:1
24—25	2.95	8.11	2.90	2.68	0.22		12.2:1
25—26	3.26	7.41	2.89	2.64	0.25		10.5:1
Average.	2.92	8.94	3.62	3.32	0.30		12.4:1

On turning to the consideration of the inorganic substances in the urine, it will be noticed that the average excretion of phosphoric acid per diem showed a marked increase over that of the previous period, as, in this case, the average was 2.92 grammes, as compared with 2.18 grammes. The average daily excretion of the chlorides was 8.94 grammes, showing a very marked increase over that in the previous period, when it was 5.01 grammes. This marked rise in the quantity of the chlorides on increasing the quantity of the food is to be noticed in several of the cases; but, as will be seen later, it is not always main-

tained, and is difficult to explain, especially when, as in this case, the most marked increase occurs on the second day of analysis—that is, on the fifth day of the increased diet.

There was a very marked rise in the average daily excretion of total sulphates (3.62 grammes), pointing to an increase in proteid metabolism; and, of this quantity, the alkaline sulphates are represented by 3.32 grammes; therefore, the average amount of the aromatic sulphates excreted was 0.30 grammes—a quantity rather above the normal, and indicating the onset of the increased intestinal putrefaction, which became so marked in the next period. Despite the increase in the quantity of these substances, the ratio of the alkaline to the aromatic remained practically the same as in period B, being 12.4 : 1.

TABLE 12.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 1 on Diet C.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
22—23 .	186	67.57	3.43	5.07
23—24 .	164	81.23	1.75	2.59
24—25 .	137	69.26	2.34	4.94
25—26 .	58	60.05	1.32	2.93
Average .	136	69.50	2.11	3.88

Although in this period there was no disturbing factor, such as the administration of enemata, the average quantity of nitrogen excreted per diem in the fæces was very markedly increased, being 2.11 grammes, as compared with 0.56 grammes in period B. As this figure is, roughly, double the normal amount passed in the fæces, it appears to indicate that the intestinal tract was not able to deal properly with so large a quantity of proteid food. On the other hand, the results obtained in the analysis of the fats in the fæces show that the average daily excretion was 3.88 grammes—that is to say, well within the normal limits. Therefore, the intestinal tract still retained its power of dealing with the fat constituents of the food, al-

though the proteid constituents were not being properly utilised.

TABLE 13.—*The Daily Diet and percentage of Nitrogen and Fats absorbed in Case 1 on Diet C.*

Date.	Nitrogen in diet.	Fats in diet.	Nitrogen absorbed per cent.	Fats absorbed per cent.
22—23	37·21	186·80	90·78	97·29
23—24	37·21	186·80	95·83	98·61
24—25	37·37	186·87	93·74	97·36
25—26	37·07	175·23	96·44	98·33
Average	37·21	183·93	94·20	97·90

Despite the great increase in the amount of proteids given in the diet, the quantity of nitrogen absorbed only averaged 94·20 per cent. per diem, this also showing that the intestinal tract was being over-taxed by the excessive quantity given. The average absorption of the fats was 97·90 per cent.—nearly the same as in the previous week. This latter percentage confirms the well-known clinical fact, that patients suffering from pulmonary phthisis are able to deal satisfactorily with a diet containing large quantities of fats.

On the last day of this period, the patient's weight was 54·36 kilos.—an increase of 2·02 kilos. over that of the corresponding day of period B, and an increase of 3·60 kilos. over that of period A; while the average weight of the four days on which he was on analysis was 54·1 kilos., as compared with 52·0 kilos. and 50·9 kilos. respectively of the former periods.

The clinical report of this period was that the patient had difficulty in finishing the required quantity of food, and that he complained of unpleasant subjective symptoms after meals, such as fulness, heaviness, etc.

Period D.—During this week it was decided to make a general increase in the various constituents of the diet, and, so as to avoid too excessive a bulk, it was necessary to fall back on some concentrated foods. For this reason the

72 grammes of somatose given each day during period C were continued, and also the quantity of sugar was increased. In addition 28 grammes of lactose were given, to assist in attaining the increased quantity of carbohydrates. A larger quantity of milk was also given. The average amount of proteids consumed under these circumstances was 271.13 grammes, an increase over that of period C of 38.63 grammes; while the fats increased from 183.93 grammes to 231.22 grammes—that is to say, to $2\frac{1}{2}$ times the usual quantity. The average quantity of carbohydrates taken per diem rose from 321.37 grammes to 392.17 grammes, some of this increase being effected, as above mentioned, by means of sugar and lactose, in order to avoid intestinal irritation from the excessive bulk. The total number of calories contained in this enormous diet was naturally very large, amounting to 5026.43, as against 4126.75 in period C, and was, approximately, 2000 more than in the first two periods. Although there was a further decided increase in weight, the average number of calories per kilo. body-weight rose to the very high value of 89.44. Owing to a further increase in the quantity of milk taken per diem, the average quantity of fluids was 3444 c.c.

The amount of nitrogen contained in the average quantity of proteids given was 43.38 grammes, and since the total amount of nitrogen found in the urine was 23.88 grammes, and in the fæces 4.35 grammes, it follows that 15.65 grammes were retained in the body—a very slight increase over period C, when it is remembered that more than 6 grammes extra of nitrogen were given in the food, representing no less than 37.50 grammes of proteids.

The average quantity of urine passed per diem rose further, to 2288 c.c., but still was decidedly beneath the quantity of fluids taken, and the disparity tended to become more and more marked the greater the increase in the quantity of fluids. This difference between the quantity of fluid taken and the quantity excreted as urine may be explained by the kidneys ceasing to become stimulated by the increased quantity of the nitrogenous constituents of

the urine, and this appears to be borne out by the fact that the specific gravity diminished to 1012.

TABLE 14.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 1 on Diet D.*

Date.	Nitrogen.		Urea.	Uric acid,		Ammonia.
29—30	. 23·33	...	36·95	...	0·87	0·30
30—31	. 24·24	...	43·35	...	0·83	0·31
31—1	. 22·46	...	38·44	...	0·73	0·20
1—2	. 25·38	...	43·72	...	0·84	0·68
Average	. 23·88	...	40·62	...	0·82	0·39

The average excretion of total nitrogen in the urine rose to 23·88 grammes, a proportionately greater increase than that of the previous period, when the respective increase in the quantity given in the food is taken into consideration. The average proportion of total nitrogen excreted as urea was 79·33 per cent., practically the same as in period C, both being considerably below the normal. The proportion excreted in the form of uric acid remained almost the same (1·44 per cent.), while that in the form of ammonia was almost double the previous quantity, being 1·45 per cent., as compared with 0·81 per cent. in period C. The quantity excreted as nitrogen rest remained about the same (18·08 per cent.), and points to the lessened power of elaboration and oxydation noticed in the last period. As indicated in the account of the percentage of nitrogen in the forms of urea and uric acid, both these substances showed a proportionate increase to that of the total nitrogen in the urine, the average daily quantity of the former being 40·64 grammes, and of the latter 0·82 grammes. The average daily excretion of ammonia, however, showed a marked increase, being 0·39 grammes as compared with 0·21 grammes in the previous period, thus indicating a diminished alkalinity of the blood.

TABLE 15.—*The Daily Excretion of Inorganic Substances in the Urine in Case 1 on Diet D.*

Date.	Phosphoric acid.	Chlorides.	Sulphates.				Ratio.
			Total.	Alkaline.	Aromatic.		
29—30	2.08	9.27	3.90	3.39	0.51		6.6:1
30—31	2.03	7.87	4.52	4.02	0.50		8:1
31—1	3.67	4.75	4.08	3.63	0.45		8.1:1
1—2	3.64	11.71	4.59	4.09	0.50		8.1:1
Average	2.86	8.15	4.27	3.78	0.49		7.7:1

Having above shortly discussed the behaviour of the nitrogenous constituents of the urine during this very large diet, it is now necessary to turn to the inorganic constituents of the urine, and we find that the average daily excretion of phosphoric acid was very much the same as in period C, being 2.86 grammes, the further increase in the diet not having the effect noticed in comparing periods B and C. The same result is to be seen in the average excretion of the chlorides in this substance. However, the decrease was more marked since, in this period, the average daily excretion was 8.15 grammes, as compared with 8.94 grammes in the previous week; there being, therefore, an absolute diminution in the quantity found. The average excretion of total sulphates in the urine per diem showed a further rise to 4.27 grammes, indicating a continued activity in proteid metabolism. But, as 0.49 grammes of this amount represented aromatic sulphates, as compared with 3.78 grammes of the alkaline sulphates, it will be seen that the tendency to increased putrefaction noticed in the last period had greatly increased, and that the intestinal tract was thus confessing its inability to deal properly with the enormous quantity of food provided. This is easily seen on comparing the ratio of the alkaline to the aromatic sulphates (7.7 : 1) with that of the previous period (12.4 : 1).

TABLE 16.—*The Daily Excretion of Nitrogen and Fat in the Faeces in Case 1 on Diet D.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
29—30	200	64·25	3·79	6·67
30—31	235	66·97	4·11	7·24
31—1	303	67·35	5·24	9·89
1—2	252	67·70	4·31	7·59
Average	248	66·02	4·36	7·85

On turning to the consideration of the faeces, the first point to be noted is the enormous increase in the quantity of nitrogen excreted in this manner, the daily average rising to no less than 4·36 grammes as compared with 2·11 grammes in period C. This great increase was entirely due to the diminished absorptive power of the intestines, as no purgatives or enemata were given to hasten peristalsis; and in all probability explains the increased putrefaction in the intestines, indicated in a striking manner by the analysis of the aromatic sulphates. If the increase in the quantities of fats given in the food be taken into consideration, the larger average daily excretion (7·85 grammes) is not surprising, and indicates that the intestinal tract is capable of dealing satisfactorily with large quantities of this substance, even though the amount of putrefaction going on there be very considerable.

TABLE 17.—*The Daily Diet and percentage of Nitrogen and Fat absorbed in Case 1 on Diet D.*

Date.	Nitrogen in diet.	Fats in diet.	Nitrogen absorbed per cent.	Fats absorbed per cent.
29—30	43·65	232·86	91·32	97·14
30—31	43·21	238·49	90·49	96·96
31—1	43·65	232·86	87·99	95·75
1—2	43·02	221·08	89·98	96·57
Average	43·38	231·32	89·95	96·41

The quantity of nitrogen contained in the faeces indicated that the absorption of this substance was diminished;

but the daily average found (89.95 per cent.) was much below that to be expected, considering the very large quantities of proteids given in the diet, and shows to what a large extent this substance was wasted. The average absorption of fats showed a further slight diminution, being 96.41 per cent., as compared with 97.90 per cent. in period C; but this amount is only slightly below the normal limits.

On the last day of this period the patient's weight was 55.16 kilos.—that is, an increase of 1.80 kilos. over the corresponding day of the previous period. The average weight of the four days on which analysis was carried out was 56.1 kilos., a gain of 2.0 kilos. over that of period A.

The clinical report of this week was that the patient was by no means so well, that pain and feelings of distension after food had markedly increased, and that other dyspeptic symptoms were more marked; his appetite had failed completely, and he said that he felt utterly unable to continue on the same diet.

Summary.—This patient was confined to bed throughout the time that we are concerned with, and while he was under observation, was considerably below his normal weight, though he was steadily improving in his general condition. During period B the diet was maintained at a slightly higher level than in period A, but was still practically a normal diet for a phthisical patient undergoing open-air treatment, and has been taken as a basis for comparison, as period A was not suitable for this purpose on account of the administration of enemata. Taking these two periods, therefore, as a starting-point, the diet was increased until (during period D) double as much proteid was given, nearly twice as much fat, and a considerable increase in the quantity of carbohydrates; the total number of calories being increased from 3105.96 to 5026.43.

The following table shows the extra quantity of nitrogen retained in the body on increasing the amount of nitrogen in the food.

TABLE 18.—*The Increased Quantity of Nitrogen retained in the body on increasing the amount given in the diet in Case 1.*

Period.		Increase of nitrogen ingested over previous diet, in grammes.		Increase or decrease of nitrogen excreted over previous periods, in grammes. ¹		Increased amount of nitrogen retained, in grammes.
A	...	—	...	—	...	+ 0·32
B	...	+ 3·42	...	— 3·17	...	+ 6·59
C	...	+ 15·07	...	+ 6·84	...	+ 9·23
D	...	+ 6·18	...	+ 5·27	...	+ 0·91

It will be seen from the above that on the diet in period B, the retention of nitrogen was very satisfactory, while the quantity excreted was at its minimum. On the diet in period C, there was certainly a greatly increased retention of nitrogen in the body; but the extra quantity excreted amounted to nearly half the increased quantity of this substance ingested, and it was causing an over-strain on the intestinal tract, as has already been pointed out in discussing this period. Almost the whole of the extra nitrogen ingested in period D was immediately excreted, as there was only an extra 0·94 grammes retained in the body, although the increase in the quantity of food was no less than 6·21 grammes; and thus an excessive strain was thrown on the organism without attaining any appreciable result.

From these considerations, it appears that the diet given in period B was probably the maximum which could be advantageously made use of by the patient. This consisted of a slight excess of proteids (137·50 grammes), a moderately increased quantity of fats (136·96 grammes), and a somewhat small amount of carbohydrates (296·32 grammes), and would have been a very generous diet even if the patient had been up to weight, healthy, and at work.

¹ That found in both the urine and fæces.

TABLE 19.—*The proportion of the total Nitrogen in the Urine excreted as Urea, Uric Acid, and Ammonia in Case 1.*

Period.	Total nitrogen in urine.	Nitrogen as urea.	Nitrogen as uric acid.	Nitrogen as ammonia.	Nitrogen as nitrogen rest.
A ...	16.64 ...	85.71 ...	1.66 ...	1.42 ...	11.21 ...
B ...	14.53 ...	87.92 ...	1.49 ...	1.51 ...	9.07 ...
C ...	20.82 ...	79.89 ...	1.12 ...	0.81 ...	18.18 ...
D ...	23.88 ...	79.33 ...	1.14 ...	1.32 ...	18.21 ...

The averages of the Periods are here given.

From the foregoing table, it will be seen that the greatest percentage of nitrogen in the urine was excreted in the most oxydised form (urea) in the second Period (B), while in Periods C and A the quantity passed in this form diminished below the normal. Conversely, the quantity excreted as nitrogen rest doubled during Periods C and D, in comparison with that found in Period B. Thus, a very valuable indication is afforded as to when the strain on the organism of the body is becoming excessive.

The marked increase in the average quantity of ammonia excreted per diem in Period D is of interest, as it shows a sudden tendency in the organism to break down under over-strain.

The steady increase in the average quantity of sulphates excreted during periods C and D shows that the proteid metabolism was proceeding vigorously, but the marked rise in the average quantity of the aromatic sulphates also indicates that this metabolism was not proceeding at a sufficient rate to deal with the large quantity supplied, and that, consequently, the amount of intestinal putrefaction was increasing. This is also indicated by the diminution in the ratio between the alkaline and the aromatic sulphates, owing to the increase in the latter.

The marked rise in the average quantity of nitrogen excreted in the two latter periods—especially in period D—indicates the danger and uselessness of cramming

these patients to too great an excess. This is further brought out by the decline in the percentage absorbed, since, from the satisfactory figure (97·45 per cent.) in Period B, the percentage absorbed diminished to 89·95 in Period D. As has been already mentioned, no notice has been taken of the results in Period A in these considerations, owing to the administration of enemata.

The excretion of fats, although large, in Period D did not show such great variations as that of the nitrogen, and the lowest percentage obtained (that of Period D, 96·41) was still within the normal limits, so that these substances are of great value in the diet in this disease.

On turning to the consideration of the weight it will be seen that there was a gain in each period. The increase (1·58 kilos.) in period B was very satisfactory, and although the gain was more marked in Periods C and D, still, as has been before pointed out, the increase was obtained at too great a cost.

Clinically the state of the patient was most satisfactory during Periods A and B; but on increasing the diet in Periods C and D, the subjective symptoms—as already mentioned—increased to such an extent that it would have been impossible for him to have continued on either of these diets.

During the four weeks that the patient was under observation his pyrexia steadily diminished, and the condition of his lungs improved markedly, so that this method of treatment showed clinically that it was of advantage to the patient.

CASE 2.—*Pulmonary Tuberculosis—Moderately early stage, with considerable degree of arrest.*

Clinical History.—Age thirteen, schoolboy, admitted May 16th, 1900. This case was also an early one, being only of five months' duration. On admission he only weighed 31·05 kilos., and had a slight amount of fever. There was early infiltration of the left apex, with some

softening, and his sputum, which was small in amount (1 drachm) contained numerous tubercle bacilli.

On the commencement of the metabolism experiments three months later he was considerably improved in every respect, his general health being completely restored. He had been free from fever for several weeks, and had no cough or expectoration. His weight was 33·60 kilos. (without his clothes), so that he had gained 2·55 kilos. since admission. His physical signs now suggested the presence of a small dry cavity at the left apex. His appetite and digestion were excellent, and he was in the grounds all day taking a considerable amount of walking exercise.

TABLE 20.—*The various Diets and number of Calories given in Case 2, together with the percentage of Nitrogen and Fats absorbed, etc.*

	Period.			
	A	B	C	D
Proteids	147·88 ...	145·19 ...	160·38 ...	156·81
Fats	212·48 ...	192·46 ...	179·83 ...	166·11
Carbo-hydrates	222·25 ...	217·04 ...	271·45 ...	314·44
Total calories	3567·82 ...	3352·37 ...	3442·92 ...	3476·95
Calories per kilo.	105·87 ...	97·17 ...	104·15 ...	102·92
Fluids	1854 ...	2043 ...	2586 ...	2698
Nitrogen in urine	13·21 ...	14·66 ...	16·47 ...	14·22
Urea	24·15 ...	26·99 ...	27·35 ...	22·42
Nitrogen in fæces	0·96 ...	0·89 ...	1·00 ...	1·07
Fat „	3·20 ...	2·45 ...	1·83 ...	2·62
Nitrogen absorbed per cent.	95·88 ...	96·29 ...	96·11 ...	95·76
Fat „ „	98·52 ...	98·93 ...	99·14 ...	98·43
Weight at end of period	34·09 ...	34·76 ...	35·10 ...	35·33

Period A.—During this period the patient was kept on the ordinary diet in use in the open-air wards at Brompton Hospital, and the daily average quantity of food taken by him was:—147·88 grammes of proteid, 212·48 grammes of fat, and 222·25 grammes of carbohydrates. It will be seen from the above that this diet contained a large quantity of fats, but the patient took it well, except on

the second day of analysis, when only 202·15 grammes of this substance were consumed. On the last day of analysis he only took 199·94 grammes of carbohydrates, as he did not finish the allotted quantity of bread. The total number of calories contained in this diet was 3567·82, and the average number of calories per kilo. body-weight during the analytical period was 105·87.

Though this is naturally a very large number of calories, it must be remembered that the patient was a growing boy, and was taking a good deal of exercise; and, as a rule, it did not cause him any discomfort. The quantity of fluids taken daily averaged 1854 c.c., principally due to the quantity of milk ordered.

The average quantity of nitrogen contained in the diet was 23·66 grammes and the total quantity found was 13·21 grammes in the urine, and 0·96 grammes in the faeces, so that 9·94 grammes were retained in the body.

The average quantity of urine excreted *per diem* was 1353 c.c., a quantity rather above the normal, considering the patient's age. But in this connection it must be remembered that he was taking a considerable quantity of fluid. The average specific gravity was 1015.¹

TABLE 21.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 2 on Diet II.*

Date.	Nitrogen.		Urea.		Uric acid.		Ammonia.
8—9	15·48	...	28·91	...	0·37	...	0·33
9—10	8·64	...	14·69	...	0·20	...	0·30
10—11	12·43	...	23·44	...	0·39	...	0·22
11—12	16·28	...	29·56	...	0·60	...	0·28
Average	13·21	...	24·15	...	0·39	...	0·28

The average daily excretion of total nitrogen during the four days of analysis was 13·21 grammes, and this quantity was distributed amongst the nitrogen-containing

¹ Unfortunately the sp. gr. was not taken on the first day of analysis, so that the average only of the later days is given.

substances in the urine in the following manner :—84·04 per cent. was excreted in the form of urea, 0·94 per cent. in that of uric acid, and 1·80 per cent. in that of ammonia, so that 13·22 per cent. was excreted in the form of nitrogen rest.

The average daily excretion of urea was 24·15 grammes, that of uric acid 0·39 grammes, and that of ammonia 0·28 grammes, the quantity of the last-named constituent being rather above the normal.

TABLE 22.—*The Daily Excretion of Inorganic Substances in the Urine in Case 2 on Diet A.*

Date.	Phosphoric acid.	Chlorides.	Sulphates.				Ratio.
			Total.	Alkaline.	Aromatic.		
8—9	2·48	9·73	3·02	2·89	0·13		23 : 1
9—10	1·63	2·75	1·82	1·74	0·08		21·7 : 1
10—11	2·27	3·56	2·37	2·27	0·10		22·7 : 1
11—12	2·48	6·27	3·05	2·92	0·13		22·3 : 1
Average.	2·22	5·59	2·57	2·46	0·11		22·4 : 1

As regards the inorganic constituents of the urine, the average excretion of phosphoric acid was 2·22 grammes per diem and the elimination of this substance remained fairly constant, except on the second day of analysis, when only 1·63 grammes were passed. The excretion of the chlorides varied markedly, being 9·73 grammes on the first day of analysis and only 2·75 grammes on the following day. The average of the four days was, however, 5·59 grammes.

The average daily excretion of total sulphates in the urine was 2·57 grammes, so that proteid metabolism was not very active. Of this quantity 2·46 grammes represented the alkaline sulphates, so that the quantity of the aromatic sulphates excreted (0·11 grammes) was very low, and therefore the ratio of the alkaline to the aromatic sulphates was high, being 22·4 : 1.

TABLE 23.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 2 on Diet A.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
8—9 .	150	... 78·03	... 1·31	... 4·36
9—10 .	116	... 82·46	... 0·81	... 1·89
10—11 .	81	... 76·77	... 0·75	... 3·36
11—12 .	122	... 80·30	... 0·96	... 3·17
Average .	117	... 79·39	... 0·96	... 3·20

On turning to the consideration of the fæces, it will be seen that the average quantity of nitrogen excreted in the fæces per diem was 0·96 grammes, a quantity much above the normal, and the same remark applies to the fats, which averaged 3·20 grammes.

TABLE 24.—*The Daily Diet and percentage of Nitrogen and Fats absorbed in Case 2 on Diet A.*

Date.	Nitrogen in diet.	Fats in diet.	Nitrogen absorbed per cent.	Fats absorbed per cent.
8—9 .	24·14	... 215·59	... 94·57	... 97·98
9—10 .	23·10	... 202·15	... 96·49	... 99·07
10—11 .	23·16	... 215·84	... 96·76	... 98·44
11—12 .	22·24	... 216·33	... 95·68	... 98·58
Average	23·66	... 212·48	... 95·88	... 98·52

The daily average absorption of nitrogen was satisfactory, being 95·88 per cent., and a similar remark applies to the fats, as, on an average, 98·52 per cent. was absorbed.

The patient's weight on the last day of this period was 34·09 kilos., and the average weight for the four days of analysis 33·7 kilos.

Clinically the patient felt well, his appetite was good, and altogether he felt that he had been making progress during the week.

Period B.—It was intended to keep the patient on the same diet during this week, but, owing to one of the temporary diminutions in appetite, which is so common

in this disease, he did not take his food quite so well, especially on the last day. Therefore the average daily quantity taken was diminished, particularly in the case of the fats. The average quantity of proteids consumed was 145.19 grammes, of fats 192.46 grammes, and of carbohydrates 217.04 grammes. Principally owing to the lessened quantity of fats taken, the average total number of calories fell from 3567.82 to 3352.37. The number of calories per kilo. body-weight diminished from 105.87 to 97.17, but some of this decline was due to the increase in weight. Owing to the patient taking a larger quantity of water, the average of fluids consumed per diem rose to 2043 c.c.

The quantity of nitrogen contained in the diet averaged 23.23 grammes per diem, and since 14.66 grammes were found in the urine, and 0.89 gramme in the fæces, 7.68 grammes were retained in the body—that is, rather less than the quantity retained in the previous period (9.49 grammes).

Notwithstanding the increase in the average quantity of fluid taken per diem, the daily quantity of urine passed averaged only 1225 c.c., there being thus an average diminution of 128 c.c. per diem, as compared with that in period A. There was no change in the average specific gravity, which remained 1015.

TABLE 25.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 2 on Diet B.*

Date.	Nitrogen.		Urea.		Uric acid.		Ammonia.
15—16	16.12	...	28.18	...	0.39	...	—
16—17	12.65	...	24.19	...	0.36	...	0.24
17—18	13.62	...	26.32	...	0.56	...	0.29
18—19	16.23	...	29.25	...	0.56	...	0.20
Average	14.66	...	26.99	...	0.47	...	0.24

The average daily excretion of nitrogen in the urine increased from 13.21 grammes in period A to 14.66 grammes during this week, and this quantity was distributed amongst the nitrogen-containing constituents

of the urine as follows :—86·28 per cent. was excreted in the form of urea, that is to say, a slightly increased percentage over that of the previous period. There was also a slightly increased amount excreted in the form of uric acid, the quantity in this period amounting to 1·07 per cent.; but the quantity excreted in the form of ammonia diminished to 1·44 per cent. The average quantity excreted in the form of nitrogen rest was 11·21 per cent., and was therefore slightly below that of period A, when 13·22 per cent. was excreted.

The average daily quantity of urea excreted was 26·99 grammes, and that of uric acid 0·47 gramme, both of these substances showing a slight increase over period A. The quantity of ammonia excreted averaged 0·24 gramme *per diem*—a slight decrease as compared with that in the previous period.

TABLE 26.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 2 on Diet B.*

Date.	Phosphoric acid.	Chlorides.	Total.	Sulphates.		Ratio.
				Alkaline.	Aromatic.	
15—16	2·71	5·29	2·81	2·68	0·13	22·2:1
16—17	2·20	4·95	2·67	2·60	0·07	37·1:1
17—18	2·36	3·29	2·51	2·39	0·12	19·9:1
18—19	2·70	3·39	2·38	2·25	0·13	17·3:1
Average	2·49	4·23	2·59	2·48	0·11	22·5:1

On turning to the consideration of the inorganic substances in the urine, it is to be noticed that there was a slight rise in the average excretion of phosphoric acid, as 2·49 grammes were passed as compared with 2·22 grammes in period A. There was a considerable fall in the average daily excretion of chlorides, 4·23 grammes being eliminated as compared with 5·59 grammes in the previous period, this decrease being much more than could be accounted for by the slight diminution in the diet. There was practically no change in the average excretion of total sulphates in the urine (2·59 grammes) as compared with period A, and of this amount 2·48

grammes were passed in the form of alkaline sulphates, so that the excretion of aromatic sulphates still remained at the previous low level (0.11 gramme). From this it is seen that the ratio of the alkaline to the aromatic sulphates was 22.5 : 1, that is, the same as in the previous period.

TABLE 27.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 2 on Diet B.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
15—16 .	108	77.20	1.04	2.68
16—17 .	128	80.00	1.07	2.86
17—18 .	83	78.18	0.76	2.04
18—19 .	89	81.77	0.78	1.81
Average .	102	79.29	0.89	2.45

On turning to the consideration of the fæces, it will be seen that the quantity of nitrogen excreted in this manner was practically the same as in period A, since 0.89 gramme were passed on an average *per diem* during this week, and this notwithstanding the fact that there was a slight diminution in the quantity of nitrogen given in the food. The average daily excretion of fats in the fæces also showed a slight diminution, from 3.20 grammes to 2.45 grammes, and this quantity is, if anything, rather below that found in normal individuals, who are taking an ordinary amount of fat in the diet, and is, therefore, very small in comparison with the large quantity of fats ingested.

TABLE 28.—*The Daily Diet and Percentage of Nitrogen and Fats absorbed in Case 2 on Diet B.*

Date.	Nitrogen in diet.	Fats in diet.	Nitrogen absorbed per cent.	Fats absorbed per cent.
15—16 .	24.76	203.18	95.79	98.68
16—17 .	23.57	219.57	95.42	96.61
17—18 .	22.67	240.53	96.65	99.45
18—19 .	21.92	173.79	96.89	98.96
Average .	23.23	192.46	96.29	98.93

Notwithstanding the slight decrease in the quantity of proteid given in the food, there was a slight rise in the rate of absorption of nitrogen, as 96·29 per cent. was absorbed on an average each day. The average quantity of fats absorbed increased very slightly, and reached the high rate of 98·93 per cent. There was therefore a very excellent utilisation of these constituents of the diet, and the slight diminution in the quantities given in the food was, if anything, of benefit.

The weight on the last day of this period was 34·76 kilos.—a gain of 0·67 kilo. over the corresponding day of period A, while the average on the four days on which analyses were carried out was 34·5 kilos.—a gain of 0·8 kilo. over the corresponding period.

Clinically the patient felt extremely well, and though the average quantity of food taken was slightly smaller, he did not feel himself that his appetite was not as good as in the previous period.

Period C.—As we have now obtained two practically normal periods—that is to say, normal periods in respect of the diet that the patient had been on during the previous three months—it was decided to increase the quantity of proteids and carbohydrates, while further slightly diminishing the amount of the fats. The patient took his food well, except on the second day of analysis, when the quantity of carbohydrates consumed was low (254·17 grammes). In comparison with the other days the average daily quantity of proteids in the diet was 160·38 grammes—an increase of 15·19 grammes over that given in period B. The quantity of the fats was diminished by 12·63 grammes, so that the average taken *per diem* during this week was 179·83 grammes, while the average amount of the carbohydrates was increased by 54·41 grammes, so that the total quantity taken each day was 271·45 grammes. The total number of calories contained in this diet was 3442·92—a slightly greater number than in period A, as the increase caused by the larger amount of carbohydrates given was partly neutralised by

the diminution in the quantity of fats ingested. The average number of calories per kilo. body-weight was 104.15. Owing to the increased quantity of milk given, the average amount of fluid consumed each day rose to 2586 c.c.

There was an average of 25.66 grammes of nitrogen contained in the daily diet, and 16.47 grammes of this substance were found in the urine, and 1.00 gramme in the fæces, so that 8.19 grammes were retained in the body, this being practically equal to the retention in period B, notwithstanding the fact that 2.43 grammes more nitrogen were given in the food.

The average daily excretion of urine rose considerably, being 1685 c.c. as against 1225 c.c. in period B, and this increase was almost proportional with the increased quantity of fluids given. The average specific gravity decreased to 1012, evidently owing to the larger quantity of water passed, as, on referring to the tables, it is seen that the average amounts of all the substances analysed for showed an increase.

TABLE 29.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 2 on Diet C.*

Date.	Nitrogen.		Urea.		Uric acid.		Ammonia.
22—23 .	17.61	...	26.38	...	0.35	...	0.37
23—24 .	15.66	...	25.39	...	0.47	...	0.20
24—25 .	14.26	...	26.68	...	0.42	...	0.22
25—26 .	18.35	...	30.96	...	0.64	...	0.54
Average	16.47	...	27.35	...	0.47	...	0.33

The average excretion of total nitrogen *per diem* in the urine increased to 16.47 grammes as compared with 14.66 grammes in the previous period. The distribution of the nitrogen amongst the nitrogen-containing constituents of the urine was such that 77.97 per cent. was excreted in the form of urea—a decided decrease on the 86.33 per cent. found in this form in period B; 0.95 per cent. was eliminated in the form of uric acid,

while the amount excreted in the form of ammonia was 1.62 per cent. There was consequently a marked rise in the amount of nitrogen excreted in the form of nitrogen rest, 19.41 per cent. being eliminated in this form as against 11.16 per cent. in the previous period. Taken in conjunction with the diminished percentage excreted in the form of urea, this large quantity suggests that the liver was becoming unable to perform its functions properly.

The average daily quantity of urea excreted rose slightly to 27.35 grammes, that of uric acid remained the same, 0.47 gramme, while there was a slight increase in that of ammonia, 0.33 gramme.

TABLE 30.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 2 on Diet C.*

Date.	Phosphoric acid.	Chlorides.	Total.	Sulphates.		Ratio.
				Alkaline.	Aromatic.	
22—23	2.83	7.44	3.02	2.88	0.14	20.3:1
23—24	2.56	5.37	2.82	2.67	0.15	17.8:1
24—25	2.53	5.29	2.83	2.69	0.14	19.2:1
25—26	2.57	6.24	3.42	3.25	0.17	18.6:1
Average	2.62	6.09	3.02	2.87	0.15	19.1:1

Having considered the behaviour of the nitrogen-containing bodies in the urine, we now turn to the inorganic substances analysed for, and, taking the phosphoric acid first, it will be noticed that there was a further slight rise in this substance (2.62 grammes being the average daily excretion as compared with 2.49 grammes in the previous period). As has been pointed out in discussing period C of Case 1, the average daily excretion of the chlorides showed a considerable increase on increasing the diet, 6.09 grammes being eliminated as compared with 4.23 grammes in period B. The average daily quantity of total sulphates excreted in the urine increased to 3.02 grammes, so that there was an increase in the proteid metabolism, and 2.87

grammes of this amount was excreted in the form of alkaline sulphates, so that the average of the aromatic group *per diem* increased to 0.15 gramme. From this it will be seen that the ratio of the alkaline to the aromatic sulphates diminished slightly, being 19.1 : 1.

TABLE 31.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 2 on Diet C.*

Date.	Quantity.			Water per cent.	Nitrogen.			Fats.
22—23	.	130	...	76.85	...	1.36	...	2.46
23—24	.	128	...	83.81	...	0.93	...	1.69
24—25	.	123	...	81.85	...	1.01	...	1.92
25—26	.	137	...	88.71	...	0.70	...	1.26
Average	.	130	...	82.81	...	1.00	...	1.83

The average daily quantity of nitrogen excreted in the fæces show a slight rise, being 1.00 gramme as compared with 0.89 gramme in the previous period; but this quantity is well within the normal limits. The average quantity of fats excreted *per diem* in the fæces was very low, being only 1.83 grammes, and shows that the intestinal tract was able to deal more satisfactorily with the quantities given in the diet.

TABLE 32.—*The Daily Diet and Percentage of Nitrogen and Fats absorbed in Case 2 on Diet C.*

Date.	Nitrogen in diet.		Fats in diet.		Nitrogen absorbed per cent.		Fats absorbed per cent.	
22—23	.	26.06	...	186.09	...	94.78	...	98.68
23—24	.	25.70	...	169.27	...	96.38	...	99.00
24—25	.	25.89	...	193.83	...	96.09	...	98.96
25—26	.	24.92	...	167.13	...	97.19	...	99.91
Average	.	25.66	...	179.83	...	96.11	...	99.14

There was practically no change in the percentage of nitrogen absorbed, the average daily amount in this period being 96.11 per cent., so that the total quantity of nitrogen absorbed was greater than in period B, as

the quantity given in the food had been increased in this period. 99·14 per cent. of fats were absorbed, this being practically the maximum absorption that has been found in any metabolism experiments that we are acquainted with.

The weight on the last day of this period was 35·10 kilos. Therefore the gain on the corresponding day of period B was very slight, being only 0·36 kilo. The average weight on the four days of analyses was 35·0 kilos., so that there was an increase of 0·5 kilo. over that of the previous week.

Clinically the patient felt extremely well throughout the week, except on the last day, when there was a slight attack of vomiting. This, however, did not at all interfere with his appetite, which remained good, and did not diminish at the commencement of the following period.

Period D.—Notwithstanding the attack of vomiting previously alluded to, it was decided to increase the quantity of carbohydrates in this period, while further diminishing that of the fats. The original intention was to keep the quantity of proteids the same, but unfortunately the patient did not take his proteid food quite so well. However, as the average daily quantity consumed was 156·81 grammes, the diminution was extremely slight, being less than 3 grammes per diem. On the last two days of the analytical period there was a marked decrease in the quantity of the fats taken, so that the daily average only worked out at 166·11 grammes, and a similar state of things occurred in the case of the carbohydrates, the average here being 314·44 grammes. The total number of calories contained in this diet was 3476·95, as the lessened number of calories taken in the form of fats was almost entirely neutralised by the larger number taken in the form of carbohydrates, so that there was practically no difference between the total number of calories in this period as compared with that contained in the diet in period C. Owing to a

slight increase in weight the number of calories per kilo. body-weight diminished very slightly, being 102.92. The average quantity of fluids consumed each day was slightly increased, being 2698 c.c.

The amount of nitrogen contained in the average daily quantity of proteid taken was 25.09 grammes, and since 14.22 grammes of this substance were found in the urine, and 1.07 grammes in the fæces, 9.80 grammes were retained in the body—rather more than that retained in periods B and C, but only slightly in excess of that in period A. The average quantity of urine excreted per diem diminished to 1435 c.c., despite the fact that the quantity of fluids taken was slightly increased during this period, while the specific gravity remained the same, 1012.

TABLE 33.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 2 on Diet D.*

Date.	Nitrogen.		Urea.		Uric acid.		Ammonia.
29—30 .	14.13	...	22.73	...	0.49	...	0.42
30—31 .	11.10	...	16.41	...	0.46	...	0.27
31— 1 .	13.92	...	19.49	..	0.50	...	0.53
1— 2 .	18.63	...	31.05	...	0.64	...	0.62
Average .	14.22	...	22.42	...	0.52	...	0.46

The excretion of total nitrogen in the urine averaged 14.22 grammes per diem—a considerable decrease from the 16.47 grammes found during period C. The amount of nitrogen excreted in the form of urea was only 71.79 per cent., there being thus a considerable further diminution in the amount excreted in this form, as compared with period C, when 77.97 per cent. of nitrogen was eliminated in the form of urea.

The amount eliminated in the form of uric acid was slightly increased (1.23 per cent.), while there was a marked rise in the amount excreted in the form of ammonia, 2.59 per cent. being eliminated in this manner,

as against 1·62 per cent. in the previous period. In this period the amount of nitrogen excreted in the form of nitrogen rest was extremely high, and was nearly one quarter of the total excretion, since 24·41 per cent. was eliminated in this manner. This, taken in conjunction with the low percentage of nitrogen eliminated in the form of urea, and also with the increase in that found in the form of ammonia, is a very strong indication that the elaboration and oxidisation of proteids were being seriously impaired. The average daily excretion of urea diminished to 22·42 grammes, that of uric acid increased slightly to 0·52 gramme. The average daily excretion of ammonia rose from 0·33 gramme to 0·46 gramme, this considerable increase pointing to commencing diminished alkalinity of the blood.

TABLE 34.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 2 on Diet D.*

Date.	Phosphoric acid.	Chlorides.	Total.	Sulphates.		Ratio.
				Alkaline.	Aromatic.	
29—30 .	2·18 ...	3·39 ...	2·42 ...	2·31 ...	0·11 ...	21 : 1
30—31 .	1·73 ...	3·64 ...	2·04 ...	1·95 ...	0·09 ...	21·7 : 1
31— 1 .	1·98 ...	2·78 ...	2·44 ...	2·35 ...	0·09 ...	26·1 : 1
1— 2 .	3·20 ...	7·66 ...	3·13 ...	2·98 ...	0·15 ...	19·1 : 1
Average	2·27 ...	4·37 ...	2·51 ...	2·40 ...	0·11 ...	21·8 : 1

In common with the other inorganic constituents of the urine there was a decided diminution in the quantity of phosphoric acid excreted per diem, 2·27 grammes only being found as compared with 2·62 grammes in the previous period. The decrease in the quantity of chlorides excreted was marked, the daily average being only 4·37 grammes as compared with 6·09 grammes in period C, notwithstanding the fact that the diet remained practically the same.

The average daily excretion of the total sulphates in the urine diminished to 2·51 grammes, that is practically the same as in the first two periods, so that there was a

decrease in the proteid metabolism. 2.40 grammes of this quantity were eliminated in the form of alkaline sulphates, so that the quantity eliminated in the aromatic group fell again to its original amount, that is 0.11 gramme. There was, consequently, a slight increase in the ratio of the alkaline to the aromatic sulphates, which worked out in this period to 21.8 : 1.

TABLE 35.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 2 on Diet D.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
29—30 .	144	79.97	1.32	3.21
30—31 .	140	82.74	1.11	2.80
31— 1 .	98	79.23	0.94	2.26
1— 2 .	114	82.68	0.91	2.20
Average .	124	81.16	1.07	2.62

On turning to the consideration of the fæces it will be seen that the quantity of nitrogen excreted in this manner rose again slightly to 1.07 grammes, as compared with 1.00 gramme in period C, the former figure still being within the normal limits of excretion of this substance. Notwithstanding the fact that there was a further diminution in the quantity of fats ingested, the average daily excretion of this substance increased slightly, being 2.62 grammes as compared with 1.83 grammes in period C.

TABLE 36.—*The Daily Diet and Percentage of Nitrogen and Fats absorbed in Case 2 on Diet D.*

Date.	Nitrogen in diet.	Fats in diet.	Nitrogen absorbed per cent.	Fats absorbed per cent.
29—30 .	25.79	184.66	94.88	98.26
30—31 .	25.48	184.42	95.64	98.48
31— 1 .	24.14	156.01	96.19	98.55
1— 2 .	24.43	139.26	96.32	98.42
Average .	25.09	166.11	95.75	98.43

On account of the slightly lessened quantity of nitrogen taken in the food, and the rather larger amount found in the fæces, the absorption of this substance diminished to 95·75 per cent., and though rather below the normal limits, still remained at a fairly high level. 98·43 per cent. of the fats given in the diet were absorbed, so that the rate of absorption of this substance remained extremely good all through.

On the last day of this period the patient weighed 35·33 kilos., so that the gain since the corresponding day of period C was very small, being only 0·23 kilo. On taking the average of the four days of analysis in this period, there was a gain of 0·4 kilo. over the previous period, the average weight being 34·4 kilos.

From a clinical standpoint the patient was getting on well and his appetite remained good. He did not feel, however, as if he could have continued very much longer on this diet, though unable to give us any satisfactory reason why not, and he did not complain of any symptoms indicative of digestive troubles.

Summary.—At the commencement of the time that this patient was under observation he was still somewhat below his proper weight; his condition in every other respect was satisfactory.

As has already been mentioned, the patient was kept, during the first two periods, on the diet that he had been taking since his admission to the hospital, so as to obtain an idea of his ordinary metabolism during his stay in the hospital. It will be noticed, however, that the usual hospital diet was too much for this patient, as on weighing his food we discovered that on no day did he take the full quantity sent up to him. Having thus obtained an idea of his metabolism, it was decided to try the effect of slightly increasing the quantity of proteids, at the same time making a progressive increase in the amount of carbohydrates, while the quantity of the fats was gradually diminished. On account of the higher caloric value of fat-containing foods the total number of calories was

at the maximum in period A and at the minimum in period B; as in this latter period the quantity of carbohydrates had not been increased sufficiently to make up for the diminution caused by the higher caloric value of the fat-containing foods. In periods C and D the number of calories approximated closely with that of the first period; as in these periods the quantity of carbohydrates was almost sufficient to neutralise the diminished amount of fats given from the caloric standpoint. On account of the increase in weight the number of calories per kilo. body-weight diminished slightly in the later periods, but remained at a very high level all through.

The following table shows the different quantities of nitrogen retained in the body on varying the amounts of the diet.

TABLE 37.—*The Increased or Decreased Quantity of Nitrogen on increasing or decreasing the Amount given in the Diet in Case 2.*

Period.	Increase or decrease in nitrogen ingested over previous period, in grammes.		Increase or decrease in nitrogen excreted over previous period, in grammes. ¹		Increase or decrease in amount of nitrogen retained, in grammes.	
A	...	—	...	—	...	+ 9.49
B	...	- 0.43	...	+ 1.38	...	- 1.81
C	...	+ 2.43	...	+ 1.92	...	+ 0.51
D	...	- 0.57	...	- 2.18	...	+ 1.61

It will be seen from the above that, considering the quantities of proteids given in the foods, the best absorption was obtained in period A. The quantity absorbed in period D was very slightly better, but, as will be seen on referring to the clinical remarks at the end of this period, the patient was unable to continue this diet for long. In period C practically the whole of the extra nitrogen ingested was immediately excreted, while in period B there was an increased excretion as well as a decreased ingestion.

As will be seen later, the increased retention in period

That found in both urine and fæces.

D was accompanied by a very large increase in the quantity of nitrogen excreted as nitrogen rest—that is, nitrogen excreted in a less oxidised form, and therefore the results obtained on this diet were at too great a cost in the efficiency of the organism.

On the whole, the diet in period A appears to be the most satisfactory for this patient, it being a very generous one for a growing boy of his age. To recapitulate, it consisted of 147·8 grammes proteids, 212·48 grammes fats, and 222·25 grammes carbohydrates; and therefore contained a slight excess of proteids, a considerable excess of fats, and a slightly diminished quantity of carbohydrates.

TABLE 38.—*The Proportion of the Total Nitrogen in the Urine excreted as Urea, Uric Acid, and Ammonia in Case 2.*

Period.	Total nitrogen in urine.	Nitrogen as urea.	Nitrogen as uric acid.	Nitrogen as ammonia.	Nitrogen as nitrogen rest.
A ...	13·21	83·04	0·94	1·80	14·22
B ...	14·66	86·33	1·07	1·44	11·16
C ...	16·47	77·97	0·95	1·62	19·41
D ...	14·22	71·79	1·23	2·59	24·41

The averages of the Periods are here given.

The quantity of nitrogen excreted in the most highly oxidised form (urea) is seen from the above to be greatest in Period B, although fairly good in Period A. The effect of increasing the strain on the organism by increasing the diet—especially in carbohydrates—is well shown in Periods C and D, as in addition to the marked diminution in the percentage of nitrogen excreted in the form of urea, there was a marked increase in that excreted as nitrogen rest; the latter rising, in the last Period, to the very high amount of 24·41 per cent., thus showing that the metabolic organs were unable to bear the strain.

The marked increase in the quantity of ammonia excreted per diem in period D, and the large quantity

eliminated (0.46 gramme), also indicated an excessive strain on the organism and showed that there was certainly a tendency to diminishing the alkalinity of the blood.

The excretion of sulphates in the urine indicated that, considering the patient's age, the proteid metabolism was proceeding actively, and the small amounts passed in the aromatic group show that there was no excess of intestinal putrefaction going on in any of the Periods.

The average quantity of nitrogen excreted in the fæces remained within the normal limits throughout. The absorption of this substance was within the lower normal limits all through, although in the last period it was, if anything, slightly below them.

The average excretion of fats was low, especially in Period C, when it only amounted to 1.83 grammes, and, consequently, the absorption was very good all through, the rate obtained (99.14 per cent.) in Period C being extremely high. These absorption rates point out the desirability of including large quantities of fats in the dietary of phthysical patients.

Clinically the patient felt very well throughout the first two Periods, but the attack of vomiting on the last day of Period C appears to have been an indication that the highest point in "cramming" had been reached, and, as already mentioned, he felt at the end of Period D that he could not have continued on the larger diet.

The gain in weight was satisfactory, as, in the four weeks that he was under observation, it amounted, on taking the averages of the Periods, to 1.7 kilos.

The report on the condition of his lesion at the conclusion of the experiment was very satisfactory, as it showed that it was almost completely quiescent.

Case 3.—Tubercular chronic pulmonary infiltration and softening (fairly limited) with considerable arrest.

Clinical history.—Age twenty-one, carman, admitted April 23rd, 1900. Physical state—right lung, infiltra-

tion and softening of apex of upper lobe; left lung, infiltration of both lobes. He had a high degree of fever and much constitutional disturbance, and his weight at this time was 61·65 kilos., his greatest known weight having been 73·35 kilos. (in his clothes).

On August 8th, after three months' treatment, he was much better, and was practically apyrexical.

His physical signs showed a considerable degree of arrest in the progress of the disease, and he had gained 6·08 kilos., so that he was nearly up to his normal weight. He was taking no exercise, his appetite was beginning to fail, and he had recently had a good deal of dyspeptic trouble.

TABLE 39.—*The various Diets and Number of Calories given in Case 3, together with the Percentage of Nitrogen and Fats absorbed, etc.*

Period.	A.	B.	C.	D.
Proteids	144·31 ...	143·00 ...	169·31 ...	167·18
Fats	211·82 ...	183·03 ...	203·42 ...	162·87
Carbohydrates	235·39 ...	211·87 ...	283·28 ...	317·76
Total calories	3526·70 ...	3265·15 ...	3747·13 ...	3482·49
Calories per kilo.	54·01 ...	49·62 ...	34·85 ...	31·21
Fluids	1854 ...	1966 ...	2474 ...	2726
Nitrogen in urine	15·68 ...	17·66 ...	24·37 ...	22·87
Urea	28·34 ...	30·97 ...	43·84 ...	39·87
Nitrogen in fæces	1·11 ...	0·96 ...	1·59 ...	1·90
Fat in fæces	5·60 ...	3·16 ...	7·11 ...	6·74
Nitrogen absorbed per cent.	95·09 ...	95·79 ...	94·06 ...	92·66
Fat absorbed per cent.	97·35 ...	98·28 ...	96·44 ...	95·53
Weight at end of period	65·36 ...	66·26 ...	66·83 ...	67·05

Period A.—As has already been mentioned in the clinical account of this case, the condition of the patient was not very satisfactory at the commencement of this period; and, although he was nominally on the diet given in the open-air wards at Brompton Hospital, the average daily quantity taken during the four days of analysis was—144·31 grammes proteids; 211·82 grammes fat; 235·39 grammes carbohydrates, as he was in the

habit of leaving a considerable quantity of food each day. The average total number of calories contained in the diet consumed was 3526·70, and the number per kilo. body-weight 54·01. The average daily amount of fluids consumed was 1854 c.c.

The average quantity of nitrogen contained in this diet per diem was 23·09 grammes, and 15·68 grammes of this substance were excreted in the urine, and 1·11 grammes in the fæces. Therefore 5·30 grammes were retained in the body.

The average daily excretion of urine was very small, when the quantity of fluids taken is remembered, and was only 1055 c.c., the average specific gravity being rather high, 1021.

TABLE 40.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 3 on Diet A.*

Date.	Nitrogen.		Urea.		Uric acid.		Ammonia.
8—9 .	18·15	...	32·40	...	0·75	...	0·32
9—10 .	15·82	...	28·60	...	0·88	...	0·22
10—11 .	12·24	...	22·88	...	1·28	...	0·13
11—12 .	16·52	...	29·49	...	0·90	...	0·19
Average .	15·68	...	28·34	...	0·95	...	0·22

The excretion of total nitrogen in the urine averaged 15·68 grammes per diem, and, of this amount, 84·56 per cent. was excreted in the form of urea and 2·15 per cent. in that of uric acid, 1·11 per cent. being eliminated in the form of ammonia, so that the quantity excreted in the form of nitrogen rest was 12·19 per cent.

The average quantity of urea excreted per diem was 28·34 grammes, that of uric acid 0·95 gramme, and that of ammonia 0·22 gramme.

TABLE 41.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 3 on Diet A.*

Date.	Phosphoric acid.	Chlorides.	Sulphates.				Ratio.
			Total.	Alkaline.	Aromatic.		
8—9	2.38	6.01	3.36	3.19	0.17		18.7:1
9—10	2.38	5.75	2.94	2.77	0.17		16.3:1
10—11	1.73	3.96	2.37	2.15	0.24		8.9:1
11—12	2.16	6.84	2.78	2.62	0.16		16.3:1
Average	2.16	5.64	2.87	2.68	0.19		14.1:1

On turning to the consideration of the inorganic substances analysed in the urine it will be seen that the average daily excretion of phosphoric acid was 2.16 grammes, that is, an amount slightly below the normal. The excretion of chlorides averaged 5.64 grammes per diem—a normal quantity considering the diet. The quantity of total sulphates excreted in the urine showed a daily average of 2.87 grammes, and, of this quantity, 2.68 grammes were passed in the form of alkaline sulphates, and 0.19 gramme in that of the aromatic group, this latter number being slightly below the normal. The ratio of the alkaline to the aromatic sulphates was 14.1:1.

TABLE 42.—*The Daily Excretion of Nitrogen and Fats in the Faeces in Case 3 on Diet A.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
8—9	120	76.08	1.05	5.60
9—10	219	83.74	1.68	7.95
10—11	110	79.20	0.85	4.43
11—12	110	79.20	0.85	4.43
Average	140	79.67	1.11	5.60

It will be seen from the above table that the daily average excretion of nitrogen in the faeces was within the normal limits, being 1.11 grammes. The excretion of the fats was rather above the normal, but was not

high considering the large quantity taken in the diet, the daily average being 5·60 grammes.

TABLE 43.—*The Daily Diet and Percentage of Nitrogen and Fats absorbed in Case 3 on Diet A.*

Date.	Nitrogen in diet.		Fats in diet.		Nitrogen absorbed per cent.		Fats absorbed per cent.
8—9 .	24·72	...	221·92	...	95·75	...	97·48
9—10 .	20·66	...	206·49	...	91·87	...	96·15
10—11 .	24·24	...	221·71	...	96·49	...	98·02
11—12 .	22·74	...	197·14	...	96·26	...	97·75
Average	23·09	...	211·82	...	95·09	...	97·35

Considering the quantity of nitrogen given in the diet, and that found in the fæces, the rate of absorption (95·09 per cent.) was rather below that which would have been expected from a cursory glance, this amount being rather below the lower normal limits of absorption of this substance. On the other hand, the rate of absorption of the fats was satisfactory, being 97·35 per cent., and was normal considering the large quantity of fats given in the diet.

On the last day of this period the patient weighed 65·36 kilos., and the average weight for the four days during which analysis was carried out was 65·3 kilos., his weight having been stationary for some time.

Clinically the report for this week was that the patient took his food very well, although his appetite was failing and some dyspeptic symptoms were present. In addition, he was complaining of feeling drowsy and heavy.

Period B.—Owing to the condition not having been very satisfactory during the previous week, it was decided to keep him on the same diet. However, his appetite failed still more, and consequently the average daily quantity of food taken rather diminished, especially in the fats and carbohydrates, and the following was the absolute diet taken in this period:—143·00 grammes

fats, 183.03 grammes fats (that is, a decrease of 28.78 grammes), and 211.87 grammes of carbohydrates (a diminution of 23.52 grammes). The average total number of calories contained in this diet was 3265.15—a decrease of 261.24 as compared with that of period A. The average number of calories per kilo. body-weight was 49.62 as compared with 54.01 in the previous period. There was a slight increase in the average quantity of fluid taken per diem, as 1966 c.c. were consumed in this period as against 1854 c.c. in period A.

22.88 grammes of nitrogen were contained in the above diet, and 17.66 grammes of this substance were found in the urine, and 0.96 gramme in the fæces, so that 4.26 grammes were retained in the body—a slight decrease as compared with that found in the previous period, when 5.30 grammes were retained.

On the third day of analysis the quantity of urine excreted was very low, being only 400 c.c., but it was necessary to consider this amount as the total, as, on very careful investigation, we could find no evidence of any of the urine having been lost. On the succeeding day there was a very great increase in the quantity, 1675 c.c. being passed, and there had been very little storing up of solids during the preceding day, as the specific gravity was 1022.

The average excretion of urine for the four days was 1101 c.c., that is, slightly more than in the previous period, but still very low in comparison with the quantity of fluids taken. The average specific gravity was 1022.

TABLE 44.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 3 on Diet B.*

Date.	Nitrogen.		Urea.		Uric acid.		Ammonia.
15—16 .	19.04	...	33.10	...	0.84	...	0.28
16—17 .	16.00	...	30.78	...	0.86	...	0.14
17—18 .	7.64	...	15.08	...	0.85	...	0.24
18—19 .	27.97	...	44.90	...	1.22	...	0.14
Average.	17.66	...	30.97	...	0.94	...	0.20

The average excretion of total nitrogen in the urine per diem was 17·66 grammes, as against 15·68 grammes in period A. It should be mentioned that the quantity of nitrogen found on the third day of analysis was very small—7·64 grammes; but this was counterbalanced by the large quantity passed on the following day, 27·97 grammes, and supports the suggestion already made in considering the large quantity of urine passed on the former day. The distribution of the nitrogen amongst the various nitrogen-containing constituents in the body was as follows:—84·52 per cent. was eliminated in the form of urea, that is, practically, the same as in the former period; 2·01 per cent. was eliminated in the form of uric acid, and 1·24 per cent. in that of ammonia. The quantity of nitrogen excreted as nitrogen rest was 12·20 per cent, that is, practically, the same as in period A. The daily average excretion of urea was 30·97 grammes, the diminution on the third day of analysis being proportionate to the small quantity of nitrogen already mentioned. The excretion of uric acid, however, did not diminish on the third day of analysis in common with the other nitrogenous constituents, and the daily average was 0·94 gramme. The quantity of ammonia excreted on the third day of analysis was, comparatively speaking, larger, being 0·24 gramme, and the average per diem of this substance passed was 0·20 gramme.

TABLE 45.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 3 on Diet B.*

Date.	Phosphoric acid.	Chlorides.	Sulphates.				Ratio.
			Total.	Alkaline.	Aromatic.		
15—16 .	3·08	... 2·35	2·99	2·79	0·20	...	13·1:1
16—17 .	2·07	... 6·32	2·38	2·21	0·17	...	12·1:1
17—18 .	0·88	... 2·56	1·25	1·18	0·07	...	17·1:1
18—19 .	4·19	... 7·37	4·94	4·70	0·24	...	19·6:1
Average .	2·56	... 4·65	2·89	2·72	0·17	...	16·1:1

It will be seen from the above table that there was a rise in the average daily excretion of phosphoric acid, 2.56 grammes being eliminated in this period, as compared with 2.16 grammes in period A; while, on the contrary, the average daily excretion of the chlorides diminished from 5.64 grammes to 4.65 grammes. The quantity of total sulphates excreted in the urine was about the same as in the previous period, the daily average being 2.89 grammes. The alkaline sulphates represented 2.72 grammes of this amount, so that there was a slight diminution in the quantity of aromatic sulphates passed, 0.17 gramme, as compared with 0.19 gramme in period A. The ratio (16.1:1) of the alkaline to the aromatic sulphates consequently showed a slight increase.

TABLE 46.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 3 on Diet B.*

Date.	Quantity.		Water per cent.		Nitrogen.		Fats.
15—16	130	...	80.00	...	1.04	...	3.42
16—17	149	...	79.22	...	1.23	...	4.07
17—18	102	...	81.16	...	0.77	...	2.54
18—19	103	...	81.16	...	0.78	...	2.62
Average	121	...	80.13	...	0.96	...	3.16

On turning to the consideration of the fæces, it will be seen that there was a slight diminution in the average daily quantity of nitrogen excreted in this manner, the quantity being 0.96 gramme as compared with 1.11 gramme in the previous period. While only this trifling diminution in the quantity of nitrogen was found, there was a decided decrease in the quantity of fats excreted, the daily average amount falling from 5.60 grammes to 3.16 grammes.

TABLE 47.—*The Daily Diet and Percentage of Nitrogen and Fats absorbed in Case 3 on Diet B.*

Date.	Nitrogen in diet.	Fats in diet.	Nitrogen absorbed per cent.	Fats absorbed per cent.
15—16 .	20·92	168·55	95·03	97·97
16—17 .	23·59	190·23	94·78	97·85
17—18 .	22·40	183·29	96·51	98·67
18—19 .	24·59	190·01	96·83	98·62
Average .	22·88	183·03	95·79	98·28

Although there was a very slightly diminished quantity of nitrogen given in the food, the amount absorbed rose to 95·79 per cent., consequent on the lessened excretion of this substance in the fæces, so that the patient made use of practically the same amount of nitrogen as in the previous period. Despite the diminution on the quantity of fats given, the absorption rate reached the very satisfactory level of 98·28 per cent., and compares favourably with the 97·35 per cent. found in period A.

On the last day of this period the patient's weight was 66·26 kilos., so that there was a gain of 0·90 kilo. on that of the corresponding day of the previous week, while the average weight of the four days during which analyses were carried out was 65·8 kilos., there being thus only an improvement of 0·5 kilo. on comparing the two analytical periods.

The clinical note at the commencement of this period showed that the patient complained of "indigestion" and headache, and the tongue was slightly furred, and anorexia was increasing. On this account he was ordered into the grounds for the whole day and told to take a little exercise, the result being that both his digestion and appetite improved.

Period C.—As the patient's condition and appetite had been improved by being allowed out during the day, and by being allowed to take a little exercise, it was decided to increase his diet in this period, especially as regards the quantity of carbohydrates. The average quantity of

proteids taken daily was 169·31 grammes, an increase of 26·31 grammes over that given in period B, while the quantity of fats was increased by 20·39 grammes, the total quantity taken daily being 203·42 grammes. The daily quantity of carbohydrates was 283·28 grammes, the considerable addition of 71·41 grammes being made to the daily diet in this constituent. The average total number of calories contained in this diet was 3747·43, an increase of 482·28 over the previous period, and the number of calories per kilo. body-weight was 54·85, so that this latter was approximately the same as in the former diet. Owing to an increased quantity of milk being given daily, the average quantity of fluids consumed increased to 2474 c.c.

The quantity of nitrogen contained in the above diet was 26·77 grammes, and as 24·37 grammes were found in the urine, and 1·59 grammes in the fæces, therefore the patient was practically on nitrogen equilibrium, as only 0·81 gramme were retained in the body.

The average daily excretion of urine increased from 1101 c.c. to 1506 c.c., that is to say, nearly proportional to the increased quantity of fluids given, while the specific gravity remains practically the same, being 1021.

TABLE 48.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 3 on Diet C.*

Date.		Nitrogen.		Urea.		Uric Acid.		Ammonia.
22—23	.	32·39	...	58·59	...	1·03	...	0·37
23—24	.	22·28	...	39·13	...	1·21	...	0·52
24—25	.	22·13	...	40·28	...	0·89	...	0·29
25—26	.	20·67	...	37·37	...	0·76	...	0·40
Average	.	24·37	...	43·84	...	0·97	...	0·39

From the foregoing table it will be seen that there was a marked increase in the average quantity of total nitrogen eliminated in the urine *per diem*, 24·37 grammes being excreted as compared with 17·66 grammes in period B. Of this nitrogen, 83·92 per cent. was eliminated in

the form of urea, a very slight diminution as compared with that of the previous period; 1.36 per cent. was eliminated as uric acid, and 1.39 per cent. as ammonia. From these figures it will be noticed that there was a slight increase in the average daily quantity excreted as nitrogen rest, 13.28 grammes as compared with 12.20 per cent. in period B.

The average daily excretion of urea increased from 30.97 grammes to 43.84 grammes. That of uric acid was practically the same, being 0.97 gramme, while that of ammonia increased markedly, being 0.39 gramme as compared with 0.20 gramme in the previous period, the quantity passed on the second day of analysis, 0.52 gramme, being extremely high.

TABLE 49.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 3 on Diet C.*

Date.	Phosphoric Acid.	Chlorides.	Sulphates.				Ratio.
			Total.	Alkaline.	Aromatic.		
22—23	3.97	7.79	4.43	4.20	0.23		18.2:1
23—24	2.28	6.16	2.24	2.07	0.17		12.3:1
24—25	2.54	5.83	2.36	2.21	0.15		14.7:1
25—26	2.45	6.20	2.88	2.74	0.14		19.6:1
Average	2.81	6.47	2.98	2.81	0.17		16.5:1

On turning to the consideration of the inorganic constituents of the urine, we find that there was a further rise in the average daily elimination of phosphoric acid, the quantity (2.81 grammes) being practically normal, and showing a rise of 0.35 gramme over the previous week. In this week, again, there was a marked increase in the excretion of the chlorides on increasing the diet, the average amount eliminated *per diem* being 6.47 grammes in comparison with 4.65 grammes in period B.

The average excretion of total sulphates in the urine did not show so great an increase as might have been expected from the excretion of total nitrogen in the urine, as only 2.98 grammes were found, this being a slight in-

crease over that of the previous period (2.89 grammes). Of this quantity 2.72 grammes were represented by the alkaline sulphates, so that the average quantity of the aromatic sulphates found (0.17 gramme) remained the same as in period B. Consequently the ratio (16.5 : 1) of the alkaline to the aromatic sulphates showed a further slight increase.

TABLE 50.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 3 on Diet C.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
22—23	259	82.88	1.72	7.54
23—24	246	76.65	2.22	9.77
24—25	141	81.93	0.94	4.33
25—26	214	81.43	1.47	6.79
Average	213	80.70	1.59	7.11

It will be seen from the foregoing table that there was a considerable increase in the average daily quantity of nitrogen excreted in the fæces, 1.59 as against 0.96 gramme, and the quantity found exceeded the normal limits, even when the quantity of proteids ingested is taken into consideration. There was also a noteworthy increase in the daily average quantity of fats (7.11 grammes), being more than double that of the last period, and the results obtained in this period appear to be more comparable, as will be seen later, with normal persons on forced feeding than with patients suffering from pulmonary phthisis.

TABLE 51.—*The Daily Diet and Percentage of Nitrogen and Fats absorbed in Case 3 on Diet C.*

Date.	Nitrogen in diet.	Fats in diet.	Nitrogen absorbed per cent.	Fats absorbed per cent.
22—23	26.53	203.76	93.52	96.29
23—24	26.69	186.58	91.68	94.76
24—25	27.27	220.14	96.55	98.03
25—26	26.58	203.19	94.47	96.66
Average	26.77	203.42	94.06	96.44

As was to be expected from the increased quantity of nitrogen found in the fæces, there was a diminution in the percentage of absorption rate, 94·06 per cent. as compared with 95·79 per cent. in period B; and the absorption of this substance was tending to fall decidedly below normal limits. Although the absorption of fats diminished to 96·44 per cent., as compared with 98·28 per cent. in the previous period, still the rate found during this week cannot be considered below the normal limits.

The gain in weight, on comparing the last day of the previous period with that of this one, was 0·57 kilo., the actual weight of the latter day being 66·83 kilos., practically the same increase as is to be found on comparing the average weights during the four days of analysis in the two periods, the weight being 66·5 kilos., as against 65·8 kilos. in period B; the gain was 0·7 kilo.

Clinically the patient was much brighter, the headache having entirely disappeared, and there was practically no further complaint of "indigestion." His appetite was also much improved.

Period D.—In this period it was decided to continue on the same lines as in the last period of Case 2, that is, to keep the quantity of proteids practically the same, to slightly diminish the fats, and to increase considerably the quantity of carbohydrates. On the last two days of the analytical period, however, this patient took fats and carbohydrates badly, so that the following amounts only were obtained:—The quantity of proteids was practically the same as in the last period, being 167·19 grammes, that of the fats 162·87 grammes—a decrease of 40·55 grammes, while the average increase in the quantity of the carbohydrates was only 34·48 grammes, the total daily quantity taken being 317·76 grammes. The average total number of calories contained in this diet was 3482·49, that is, a decrease of 256·01 as compared with period C, while the number of calories per kilo. body-weight was 51·21. There was, however, an increase in the daily

average quantity of fluids taken from 2474 c.c. to 2726 c.c.

The above diet contained an average of 25.95 grammes of nitrogen, and since 22.87 grammes of this substance were found in the urine and 1.09 grammes in the fæces, there was only a retention of 1.18 grammes in the body, so that this patient, during this period, may be considered to have been almost on nitrogen equilibrium.

The average daily excretion of urine rose considerably in this period, being 1943 c.c., the quantity passed on the last day being extremely large (2640 c.c.). This average increase was proportionately greater than the extra quantity of fluids taken, and this was the only instance in which such an occurrence was noted. The average specific gravity, however, diminished more than could be accounted for by the increased quantity of urine passed, as it was only 1014.

TABLE 52.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 3 on Diet D.*

Date.	Nitrogen.		Urea.		Uric acid.		Ammonia.
29—30	. 24.48	...	45.56	...	0.97	...	0.31
30—31	. 18.65	...	30.78	...	0.98	...	0.47
31— 1	. 20.35	...	35.34	...	0.93	...	0.37
1— 2	. 27.98	...	47.78	...	1.27	...	—
Average	. 22.87	...	39.87	...	1.04	...	0.38

The excretion of total nitrogen in the urine varied considerably, being between 18.65 grammes and 27.91 grammes, and the average of the four days was 22.87 grammes—a slight decrease compared with that found in period C. Of this nitrogen 81.55 per cent. was eliminated in the form of urea—a slight decrease when compared with the 83.92 per cent. absorbed in the previous period, while the amounts excreted in the forms of uric acid and ammonia (1.53 per cent. and 1.54 per cent. respectively) showed a slight increase.

The average daily excretion of urea was 39·87 grammes, that of uric acid increasing from 0·97 gramme to 1·04 grammes, while that of ammonia (the mean of three days' analysis) was practically the same, 0·38 gramme.

TABLE 53.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 3 on Diet D.*

Date.	Phosphoric acid.	Chlorides.	Total.	Sulphates.		Ratio.
				Alkaline.	Aromatic.	
29—30	2·48	6·48	3·33	3·17	0·16	19·8 : 1
30—31	2·62	6·07	3·01	2·81	0·19	15·7 : 1
31— 1	2·66	4·44	3·63	3·44	0·19	17 : 1
1— 2	3·96	13·46	4·43	4·17	0·26	16 : 1
Average	2·91	7·61	3·60	3·40	0·20	17 : 1

In contradistinction to the decrease observed in the nitrogen-containing constituents of the urine, there was a slight increase in the amount of phosphoric acid found, a daily average elimination of 2·91 grammes being observed. There was also a further increase in the average quantity of chlorides excreted, 7·61 grammes being eliminated *per diem* as compared with 6·47 grammes in period C.

The daily average excretion of total sulphates in the urine showed an increase from 2·98 grammes to 3·60 grammes, so that proteid metabolism at this period was much more active than in any of the previous ones. The distribution of the sulphates in the urine was as follows :— 3·40 grammes were excreted in the form of alkaline sulphates, and 0·20 gramme in the aromatic group, so that the ratio of the former to the latter again increased slightly, being 17 : 1, as compared with 16 : 5 in period C.

TABLE 54.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 3 on Diet D.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
29—30 .	238	... 75·04	... 2·43	... 8·68
30—31 .	91	... 84·93	... 0·56	... 2·00
31— 1 .	225	... 79·21	... 1·92	... 6·84
1— 2 .	301	... 78·59	... 2·68	... 9·42
Average .	214	... 79·44	... 1·90	... 6·74

The average daily excretion of nitrogen in the fæces showed a considerable rise, 1·90 grammes being found as against 1·59 grammes in the previous period, and thus there was an increased waste of proteid material. The average daily excretion of fats fell slightly, being 6·74 grammes as compared with 7·11 grammes in period C. But this quantity was still rather above the normal amount, even considering the comparatively speaking large quantity of fats given in the diet.

TABLE 55.—*The Daily Diet and Percentage of Nitrogen and Fats absorbed in Case 3 on Diet D.*

Date.	Nitrogen in diet.	Fats in diet.	Nitrogen absorbed per cent.	Fats absorbed per cent.
29—30 .	26·80	... 185·80	... 90·93	... 95·33
30—31 .	26·49	... 197·16	... 97·89	... 98·98
31— 1 .	25·03	... 139·63	... 92·33	... 95·11
1— 2 .	25·46	... 128·90	... 89·47	... 92·69
Average .	25·95	... 162·87	... 92·66	... 95·53

As was only to be expected from the large quantity of nitrogen found in the fæces, and also from the slightly smaller amount of this substance given in the diet, there was a further decrease in the absorption in this period, since only 92·66 per cent. was absorbed, showing that the quantity of proteids given was considerably in excess of the amount that the intestinal tract could deal with effectively. There was also a further diminution in the

absorption of fats—95·53 per cent. as compared with 96·44 per cent. in the previous period, this being despite a considerable diminution in the quantity of fats ingested.

On the last day of this period the patient weighed 67·05 kilos., so that the gain over the corresponding day of period C was very small, being only 0·22 kilo. However, the increase over the last day of period A was moderately satisfactory, amounting to 1·69 kilos. The average weight of the four days during which analyses were carried out was 68·0 kilos., so that the increase over the corresponding period of the previous week was only 0·2 kilo.

The clinical report for this week was that there was no dyspepsia, that the appetite was good, and that the patient felt very well. He was also taking more exercise.

Summary.—The diet in the first period was the normal one on which the patient had been for some time, and on which he had regained a large part of his lost weight; and he had apparently reached the point when he was unable to continue taking this quantity of food satisfactorily, as in period B, during which we attempted to keep him on the same diet, we found a considerable failure of appetite. However, on ordering him into the grounds and giving him a certain amount of exercise, his appetite and capacity for taking food returned, and he bore the increased diet ordered in period C fairly well; but this was only a temporary effort, as shown in period D, as he was unable to continue on roughly the same quantity of food.

The above considerations appear to show that the limit of "cramming" in this patient had been reached, and, judging from the total amounts of his analyses, he was approaching his normal condition, and probably would have been better from a metabolic standpoint if his diet had been reduced considerably.

The following table shows the differences in the quantities of nitrogen retained in the body on altering the amounts of proteid given.

TABLE 56.—*The Increased or Decreased Quantity of Nitrogen retained in the Body on increasing or decreasing the Amount given in the Diet in Case 3.*

Period.	Increase or decrease in the nitrogen in the food, in grammes.	Increase or decrease in the nitrogen excreted, in grammes. ¹	Increased or decreased amount of nitrogen retained, in grammes.
A . . .	—	—	6·30
B . . .	−0·21	+1·83	−2·04
C . . .	+3·89	+7·34	−3·55
D . . .	−0·82	−1·19	−0·37

It will be seen from the above table that in none of the later periods was there an increased amount of nitrogen retained in the body on altering the quantity of this substance given in the food. In fact, during the periods of C and D, the patient was, as has already been noted, practically on nitrogen equilibrium. Although there was an adverse balance of 2·04 grammes in period B, still the diet in this period appears to have been the most suitable, as over four more grammes of nitrogen were retained in the body *per diem*; and it will be seen later that the rates of absorption of both nitrogen and fats were on the whole more satisfactory in this period.

This diet consisted of 143·00 grammes proteids, 183·03 grammes fat, and 211·87 grammes carbohydrates, the value in calories being 3265·15.

¹ That found in both urine and fæces.

TABLE 57.—*Nitrogen Percentage Table, Case 3. The proportion of the total Nitrogen in the Urine Excreted as Urea, Uric Acid, and Ammonia in Case 3.*

Period.	Total Nitrogen in Urine.	Nitrogen as Urea.	Nitrogen as Uric acid.	Nitrogen as Ammonia.	Nitrogen as Nitrogen Rest.
A. .	15.68	84.56	2.15	1.11	12.19
B. .	17.66	84.52	2.01	1.24	12.20
C. .	24.37	83.92	1.36	1.39	13.28
D. .	22.87	81.15	1.53	1.54	15.78

The averages of the periods are here given.

The quantity of nitrogen excreted in the most highly oxidised form (urea) is seen in the above table to be in periods A and B; although the diminution in the two later periods is only slight, still it indicates that the powers of the organism were being rather too highly taxed, and that one of the earlier diets was the more suitable. The quantity of nitrogen excreted as nitrogen rest was practically the same in periods A and B, and the gradual increase in periods C and D also shows that the maximum point of benefit had been passed. This is also borne out by the increase in the quantity of ammonia, which, it will be remembered, rose from 0.20 gramme in period B to 0.39 gramme and 0.38 gramme in periods C and D respectively.

The average excretion of total sulphates showed a progressive increase, indicating the activity of proteid metabolism; but this increase was not so marked in period C as one would have expected from the quantity of nitrogen found in the urine, the metabolism in period D being more active, although there was a lessened excretion of nitrogen in the urine in this period. The average quantity of aromatic sulphates found was within the normal limits in all four periods, and consequently there was no increase of intestinal putrefaction during the period under observation.

The decided increase in the average quantity of nitrogen excreted in the fæces in period C as compared

with period B is of interest, as it shows that the intestinal tract was unable to deal advantageously with even the slightly increased quantity given in the food in this period; while the further increase in period D, even though the patient of his own accord, slightly diminished the quantity ingested, and required persuasion to eat as much as he did, shows the length of time that the intestines required to recover their full activity after overstrain.

The excretion of the fats indicates the same point, and the very marked increase in period C is to be noted, as it shows the patient was getting on to the border line between the normal and pathological states, as far as metabolism was concerned.

The absorption of nitrogen reached its highest level in period B, notwithstanding the patient having complained most of dyspeptic symptoms in this week, and this was evidently the best diet. The only effect of increasing the quantity of proteids in the diet was to diminish the absorption, so that the total increase in the quantity absorbed was very slight.

The absorption of fat was also much better in period B, and although the quantity taken in the food was reduced in periods C and D, the rates of absorption diminished.

From a clinical standpoint, during the first two periods under observation he was no better as regards his appetite and digestive symptoms, but on getting out of doors and taking a certain amount of exercise, he improved very greatly in these respects.

The condition of his lesions improved considerably during the month.

CASE 4.—*Pulmonary Tuberculosis, Chronic, Progressive.*

Clinical history.—Age 34, furnace-worker, he had been failing for five years with cough and expectoration, and for the last three years had been unfit for continuous work. During the twelve months previous to admission he had become much worse in every respect. For the last two months of this period he had been attending as an out-patient; he had only benefited very slightly, although he had gained 0·9 kilo. during this time. His condition on admission on July 20th, 1900, was as follows:—Right lung, extensive infiltration throughout the whole lung, with probable excavation, not now active, of medium size in the upper lobe. Left lung: probable infiltration of lower lobe.

At the commencement of the period of observation he was markedly emaciated, of poor general physique, and had much dyspnœa on exertion. His cough was very troublesome, and his sputum (which averaged 6 drachms daily) contained numerous tubercle bacilli.

The amount of fever was slight, never rising above 100° F. (rectal); the appetite was capricious and bad, and the digestion very poor. He was also subject to attacks of vomiting and diarrhœa; there was a certain amount of cyanosis, and well-marked clubbing of the fingers.

During the three weeks since admission he had been for the most part in bed, and had gained 1·46 kilos., his weight being 53·89 kilos. (in dressing-gown and slippers), and he was at this time 21·78 kilos. below his highest known weight, which was 75·60 kilos. His condition otherwise had remained much the same.

TABLE 58.—*The Various Diets and Number of Calories given in Case 4, together with the percentage of Nitrogen and Fats absorbed, etc.*

Period.	A.	B.	C.	D.
Proteids . . .	110·26 ...	115·87 ...	...	...
Fats . . .	126·20 ...	161·18 ...	...	...
Carbohydrates . .	222·74 ...	219·33 ...	...	...
Total calories . .	2538·86 ...	2873·29 ...	...	...
Calories per kilo. .	48·98 ...	54·83 ...	...	...
Fluids . . .	1896 ...	2064 ...	...	...
Nitrogen in urine .	10·25 ...	6·57 ...	...	...
Urea „ . .	18·32 ...	11·62 ...	...	...
Nitrogen in fæces .	1·08 ...	1·10 ...	...	...
Fat in fæces . .	3·27 ...	4·56 ...	...	...
Nitrogen absorbed, per cent. . . .	93·95 ...	94·15 ...	...	...
Fat absorbed per cent.	97·43 ...	97·20 ...	...	...
Weight at end of period	54·11 ...	55·01 ...	...	...

Period A.—During the first week under observation he was kept on the diet on which he had been since his admission, and of which he took on an average, 110·26 grammes proteids, 126·20 grammes fats, and 222·74 grammes carbohydrates; so that this diet was very similar to that taken by Case 1 in period A. The total number of calories contained in this diet was 2538·86, and the number per kilo. body-weight 48·98. The average daily quantity of fluids taken was 1896 c.c.

The average daily amount of nitrogen contained in this diet was 17·42 grammes, and 10·25 grammes of this substance were found in the urine, and 8·08 grammes in the fæces, so that 6·09 grammes were retained in the body.

The average daily excretion of urine was 1293 c.c., so that it was rather low in comparison with the quantity of fluid taken. The average specific gravity was 1014.

TABLE 59.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 4 on Diet A.*

Date.		Nitrogen.		Urea.		Uric acid.		Ammonia.
8—9	...	7·61	...	15·23	...	0·24	...	0·14
9—10	...	10·25	...	17·66	...	0·44	...	0·19
10—11	...	9·45	...	16·13	...	0·39	...	0·13
11—12	...	13·67	...	24·26	...	0·66	...	0·21
Average	...	10·25	...	18·32	...	0·43	...	0·17

In this case the quantity of total nitrogen excreted in the urine was low, the average being only 10·25 grammes. The daily quantities of nitrogen found varied from 7·61 grammes to 13·67 grammes, so that this patient showed great irregularity as to the manner in which he utilised the proteids given in the food. The distribution of the nitrogen amongst the various nitrogenous constituents of the urine was as follows:—84·07 per cent. was excreted in the form of urea, 1·37 per cent. in the form of uric acid, 1·36 per cent. in that of ammonia; so that the quantity excreted in the form of nitrogen rest was 13·28 per cent.

The excretion of urea averaged 18·32 grammes per diem, that of uric acid 0·43 gramme per diem, and that of ammonia 0·17 per diem.

TABLE 60.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 4 on Diet A.*

Date.	Phosphoric acid.	Chlorides.	Total.	Sulphates.			Ratio.
				Alkaline.	Aromatic.		
8—9	1·20	2·92	1·33	1·25	0·08		15·9 : 1
9—10	2·12	6·05	2·11	2·20	0·11		17·3 : 1
10—11	1·06	4·50	—	—	—		—
11—12	2·14	6·02	2·62	2·43	0·19		12·8 : 1
Average	1·63	4·87	2·02	1·89	0·13		14·5 : 1

On turning to the inorganic constituents of the urine, it will be noticed that the excretion of phosphoric acid

was very low on the first and third days of this period, while on the second and fourth it was still below normal, though practically double that of the two days first mentioned. The average daily elimination of this substance only amounted to 1.63 grammes. The excretion of the chlorides—except on the first day, when it was low, being only 2.92 grammes—was about that which is found in the other cases, and the daily average elimination of this substance was 4.87 grammes. The excretion of the total sulphates in the urine was also low in this period, the daily average being only 2.02 grammes (the mean of three analyses), so that this further shows a small amount of proteid metabolism going on in the body. Of this quantity 1.89 grammes was excreted in the form of alkaline sulphates; therefore the amount of aromatic sulphates passed per diem (0.13) was low. The ratio of the alkaline to the aromatic sulphates was 14.5 : 1, thus being within the normal limits.

TABLE 61.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 4 on Diet A.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
8—9	160	76.98	1.58	4.79
9—10	54	76.22	0.55	1.67
10—11	118	78.33	1.09	3.33
11—12	117	78.33	1.08	3.30
Average	113	77.47	1.08	3.27

The quantity of nitrogen excreted in the fæces varied considerably, from 0.55 gramme on the second day to 1.58 gramme on the first day of analysis, and the average excretion of this substance per diem was 1.08 gramme, that is to say, about the normal. The average daily excretion of the fats was 3.27 grammes, and the eliminations of these substances show a considerable amount of variation, from 4.79 grammes to 1.67 gramme, the average for the four days being roughly about the normal.

TABLE 62.—*The Daily Diet and Percentage of Nitrogen and Fats absorbed in Case 4 on Diet A.*

Date.	Nitrogen in diet.		Fats in diet.		Nitrogen absorbed per cent.		Fats absorbed per cent.	
8—9	...	18·69	...	128·55	...	91·83	...	96·27
9—10	...	16·69	...	124·09	...	96·76	...	98·65
10—11	...	17·73	...	127·08	...	93·85	...	97·43
11—12	...	16·56	...	125·07	...	93·37	...	97·36
Average	...	17·42	...	126·20	...	93·95	...	97·43

On turning to the consideration of the absorption of the proteids, it will be seen that the average rate (93·95 per cent.) found in the case of nitrogen was decidedly below the normal, while that of the fats, as usually found, was very satisfactory, the average daily excretion being 97·43 per cent.

Throughout the whole of this week the patient's weight remained practically the same, and on the last day the recorded weight was 51·83 kilos. the average for the four days during which he was on analysis being 51·74 kilos.

The clinical report was as follows:—The patient took his food badly, and complained a good deal of “dyspeptic symptoms.”

Period B.—Owing to the unsatisfactory condition of the patient during the previous week, and the great difficulty which was experienced in persuading him to take the required quantity of food, it was decided to make only a slight alteration in the diet during this week, and the average quantity of proteids given per diem was only very slightly increased, being 115·87 grammes. The daily quantity of fats taken on the four days during which analyses were carried out was 161·18 grammes, so that there was an increase of 34·98 grammes given per diem. The average daily quantity of carbohydrates remained practically the same, being 219·33 grammes. The total number of calories contained in this diet was 2873·29, there being an increase of 334·43 over period A, while

the number of calories per kilo. body-weight increased from 48.98 to 54.83. During this week the average daily quantity of fluids taken was 2064 c.c.

The average daily quantity of nitrogen contained in the above diet was 18.54 grammes, and since only the very small quantity of 6.57 grammes of this substance was excreted in the urine, and 1.10 gramme in the fæces, 10.87 grammes were retained in the body, as compared with 6.09 grammes in the previous week.

Notwithstanding the increased quantity of fluids given, the average daily excretion of urine diminished from 1293 c.c. to 1000 c.c., although the patient did not complain of night-sweats, or perspirations during the daytime. The average specific gravity also diminished in this period to 1010, as compared with 1014 in period A.

TABLE 63.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 4 on Diet B.*

Date.		Nitrogen.		Urea.		Uric acid.		Ammonia.
15—16	...	5.12	...	8.51	...	0.19	...	0.13
16—17	...	7.86	...	14.64	...	0.26	...	0.17
17—18	...	7.90	...	14.64	...	0.39	...	0.13
18—19	...	5.40	...	8.69	...	0.19	...	0.20
Average	...	6.57	...	11.62	...	0.26	...	0.16

During this week, the average quantity of total nitrogen excreted in the urine fell markedly, and only reached the low figure of 6.57 grammes, the daily excretion remaining fairly equal throughout the four days. The distribution of this substance was as follows: 81.51 per cent. was eliminated in the form of urea, 1.30 per cent. in that of uric acid, and 2.07 per cent. in that of ammonia, the last-named percentage being a considerable increase over that found in period A, while the percentages of urea and uric acid showed slight diminution. The quantity of nitrogen eliminated in the form of nitrogen rest increased, being 15.13 per cent., as compared with 13.20 per cent. in the previous record.

The average daily excretion of both urea and uric acid diminished considerably, only 11.62 grammes of the former, and 0.26 gramme of the latter being excreted, while that of the ammonia remained practically the same as in period A (0.16 gramme).

TABLE 64.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 4 on Diet B.*

Date.	Phosphoric Acid.	Chlorides.	Sulphates.			Ratio.
			Total.	Alkaline.	Aromatic.	
15—16 ...	0.97 ...	2.19 ...	0.85 ...	0.77 ...	0.08 ...	9.6 : 1
16—17 ...	1.46 ...	3.34 ...	1.37 ...	1.32 ...	0.05 ...	26.4 : 1
17—18 ...	1.32 ...	2.28 ...	1.45 ...	1.33 ...	0.12 ...	11.1 : 1
18—19 ...	0.91 ...	2.39 ...	0.91 ...	0.84 ...	0.07 ...	12 : 1
Average ...	1.17 ...	2.55 ...	1.15 ...	1.07 ...	0.08 ...	13.4 : 1

It will be seen from the above table that the average daily quantity of phosphoric acid excreted was only 1.17 gramme, and on the first and last days of this period the excretion was very small, being less than 1 gramme. There was also a very marked decrease in the average daily excretion of chlorides, this amounting only to 2.55 grammes, being the lowest average that was obtained in this observation. As will be seen from the very low quantity of total sulphates, excreted in the urine (1.15 grammes) the metabolism of proteid material during this period was at a minimum. 1.07 grammes of this total amount was excreted in the form of alkaline sulphates, and the extraordinarily small quantity of 0.08 gramme of aromatic sulphates was found. The relation of the latter to the former still remained about normal, being 13.4 : 1.

TABLE 65.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 4 on Diet B.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
15—16	159	82.12	1.22	5.07
16—17	87	80.21	0.74	3.07
17—18	86	80.21	0.73	3.04
18—19	114	65.29	1.69	7.06
Average	114	75.87	1.10	4.56

On turning to the consideration of the fæces, it will be seen that there was practically no change in the average daily excretion of nitrogen in this manner, between the two periods, as 1.10 grammes were found in this week. The excretion of fats, however, rose, especially on the last day of the analytical period, when 7.06 grammes were found, the daily average being 4.56 grammes.

TABLE 66.—*The Daily Diet and Percentage of Nitrogen and Fats absorbed in Case 4 on Diet B.*

Date.	Nitrogen in diet.	Fats in diet.	Nitrogen absorbed per cent.	Fats absorbed per cent.
15—16	19.12	178.24	93.62	97.16
16—17	17.40	144.95	95.72	97.88
17—18	18.38	162.78	96.03	98.13
18—19	19.25	154.74	91.24	95.63
Average	18.54	161.18	94.15	97.20

The average rate of absorption of nitrogen improved slightly, from 93.95 per cent. to 94.15 per cent. but this latter quantity still remained below the normal amount, despite the increase in the quantity of fats eliminated. The rate of absorption of this substance remained practically the same, being 97.20 per cent., as against 97.43 per cent. in period A, and there was a considerable increase in the quantity of fats given in the food, so the total amount of this constituent was considerably increased.

On comparing the weights of the last days of periods A and B, it will be seen that there was a satisfactory in-

crease, amounting to 0·9 kilo. The average weight of the four days of analysis was 52·4 kilos., and thus there was a gain of 0·7 kilo. in this latter period as compared with that of the previous week.

Clinically, the condition of the patient was not satisfactory, as the dyspeptic symptoms remained about the same, and his appetite was so poor that he could not eat anything like the quantity of food prescribed.

Summary.—As has just been mentioned, this patient either could not or would not take the prescribed diets, and we have been obliged to omit the last two periods on account of his unsatisfactory behaviour, as, despite the careful attention of the nurses, we could not be certain that he was obeying the regulations as to the collection of the urine and fæces.

During period B there was a satisfactory increase in the quantity of nitrogen retained in the body, as it will be seen from the above table that very little extra of this substance was given in the diet, while practically 3 grammes more were retained.

The marked drop in the excretion of total nitrogen which has been already pointed out is impossible to explain, as the surroundings of the patient remained practically the same throughout the fortnight, and there was no cause at all that could be discovered for its diminution, which appears to be rather similar to that found in the metabolism of people who are taking no food at all.

TABLE 67.—*The Proportion of the Total Nitrogen in the Urine excreted as Urea, Uric Acid and Ammonia in Case 4.*

Nitrogen Percentage Table.

Period.	Total nitrogen in urine.	Nitrogen as urea.	Nitrogen as uric acid.	Nitrogen as ammonia.	Nitrogen as nitrogen heat.
A. ...	10·25	84·07	1·37	1·36	13·20
B. ...	6·57	81·51	1·30	2·07	15·13

The averages of the periods are here given.

The percentage of nitrogen excreted in the most highly oxidised form (urea) was fairly satisfactory in this patient, and there was no marked rise in the proportion eliminated in the form of nitrogen rest, which would be expected if the physical condition was altering very much for the worse.

The excretion of the sulphates in the urine shows that the breaking-up of the proteids was very small, especially in period B; while the very small quantity of aromatic sulphates shows that the amount of intestinal putrefaction was diminished considerably below the normal. The average excretion of the nitrogen and the fats remained within the normal limits throughout both periods, but the absorption of nitrogen was always below the normal, though slightly better in period B. The absorption of the fats was also satisfactory during this week, and it will be clear that this was the better of the two diets tried, as there was also the above-mentioned considerable retention of nitrogen. The fact that there was a diminished breaking down of proteids in the body already mentioned, in this period, does not appear to invalidate this conclusion, as the patient was in such a condition that the principal object of treatment at this time was to give him a reserve of proteid in his body to draw upon.

As far as his clinical condition was concerned, the patient remained in much the same state throughout the two weeks that he was under observation.

CASE 5.—*Chronic Pulmonary Tuberculosis, with Recent very Acute Collapse.*

Clinical history.—Age 36, door porter, admitted July 28th, 1900. This patient commenced treatment as an out-patient at the Brompton Hospital in March, 1899, having at that time slight infiltration of the right apex. By July of the same year the physical signs had cleared up, and he ceased attending, and recommenced work. His weight at that time was 64·83 kilos.

He returned again on July 28th, 1900, and was at once admitted. At this time his condition was as follows:—Right lung: extensive infiltration, with softening and excavation of the upper lobe. Left lung: early infiltration of the upper lobe.

At the commencement of the metabolism experiments, his general condition was very bad, his cough was incessant, and often caused vomiting, the sputum was very abundant, averaging 10 oz. daily, and contained very numerous tubercle bacilli. Night sweats were constant and very profuse. He had high remittent fever, dyspnoea was very marked, and he was very anæmic. The appetite was bad, and he suffered from dyspepsia. His weight was 56·39 kilos. (in dressing-gown, etc.), and he had lost 2·03 kilos. since his admission. No albumen or sugar were found in the urine.

TABLE 68.—*The Various Diets and Number of Calories given in Case 5, together with the Percentage of Nitrogen and Fats absorbed, etc.*

Period.	A.	B.	C.	D.
Proteids . . .	114·93	129·87	220·14	251·47
Fats . . .	121·69	127·05	179·91	208·38
Carbohydrates . .	240·13	225·56	264·83	297·26
Total calories . .	2590·26	2654·23	3661·54	4187·73
Calories per kilo. .	44·59	50·27	67·81	77·28
Fluids. . .	1952	2183	2726	3234
Nitrogen in urine .	13·45	12·93	15·18	18·14
Urea „ . .	20·56	22·13	24·52	28·44
Nitrogen in fæces .	1·10	1·16	2·97	2·41
Fat in fæces . .	6·09	2·13	4·41	4·47
Nitrogen absorbed, per cent. . . .	93·36	94·41	91·67	93·93
Fat absorbed per cent. .	95·06	98·33	97·54	97·70
Weight at end of period	55·46	54·90	56·03	56·14

Period A.—During this week he was kept on practically the same diet on which he had been since his admission, and the average quantity of food taken daily consisted of 114·13 grammes proteids, 121·69 grammes

fats, and 240.13 grammes carbohydrates. The average total number of calories contained in this diet was 2590.26, and the number per kilo. body-weight 44.59. The average daily quantity of fluids taken was rather large, 1952 c.c., owing to the fact that, in addition to the milk given, the patient drank a considerable quantity of water.

The quantity of nitrogen contained in this diet averaged 18.39 grammes per diem, and as 13.45 grammes of this substance were found in the urine, and 1.10 gramme in the fæces, therefore 3.84 grammes were retained in the body.

The average daily excretion of urine was low, being 1050 c. c., this small amount being probably due to the combination of the night-sweats and the pyrexia. The average specific gravity was 1022, the urine being thus of the febrile type.

TABLE 69.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 5 on Diet A.*

Date.		Nitrogen.		Urea.		Uric acid.		Ammonia.
8—9	...	15.66	...	27.47	...	1.01	...	0.14
9—10	...	12.93	...	21.88	...	0.85	...	0.19
10—11	...	12.02	...	20.57	...	0.77	...	0.23
11—12	...	13.17	...	22.33	...	0.93	...	
Average	...	13.45	...	23.06	...	0.89	...	0.19

The quantity of total nitrogen excreted per diem in the urine averaged 13.45 grammes, and this amount was distributed in the following manner:—80.05 per cent. was eliminated in the form of urea, 2.21 per cent. in that of uric acid, and 1.17 per cent. in that of ammonia. Consequently the amount excreted as nitrogen rest was large, the daily average being 16.60 per cent. The daily excretion of urea averaged 23.06 grammes, and that of ammonia 0.19 gramme.*

* The estimation of ammonia was lost on the fourth day of analysis, so that this figure is the mean of three analyses.

TABLE 70.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 5 on Diet A.*

Date.	Phosphoric acid.	Chlorides.	Total.	Sulphates.			Ratio.
				Alkaline.	Aromatic.		
8—9 ...	1·41	5·40	2·44	2·17	0·27		8 : 1
9—10 ...	1·76	5·27	2·36	2·13	0·23		9·3 : 1
10—11 ...	1·36	3·10	1·80	1·61	0·19		8·3 : 1
11—12 ...	1·34	4·47	2·06	1·85	0·21		8·8 : 1
Average ...	1·47	4·56	2·17	1·94	0·23		8·6 : 1

It will be seen from the above table that the average excretion of phosphoric acid was rather low, being 1·47 gramme per diem. The excretion of chlorides in the urine averaged 4·56 grammes, and was about that noticed in the first periods of the other cases, this being a large quantity considering the large amount of sputum expectorated.

The quantity of total sulphates excreted in the urine averaged 2·17 grammes per diem, so that there was a moderate breaking down of proteids. Of this amount 1·94 gramme was excreted in the form of alkaline sulphates, and 0·23 in that of the aromatic group. The ratio therefore of the alkaline to the aromatic sulphates was 8·6 : 1, this ratio being rather below the normal, there being a slightly excessive amount of intestinal putrefaction present.

TABLE 71.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 5 on Diet A.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
8—9 ...	185	80·15	1·70	8·38
9—10 ...	196	89·32	0·96	4·77
10—11 ...	159	78·21	1·10	7·97
11—12 ...	59	76·11	0·64	3·22
Average ...	150	80·95	1·10	6·09

On turning to the consideration of the fæces, it will be seen that the average daily excretion of nitrogen in

this manner was 1.10 grammes, that is about the normal. The excretion of the fats, however, was rather high, the daily average being 6.09 grammes, and the excretion of this substance showed a considerable amount of variation, between 8.38 grammes on the first day to 3.22 grammes on the last day of analysis.

TABLE 72.—*The Daily Diet and Percentage of Nitrogen and Fats absorbed in Case 5 on Diet A.*

Date.	Nitrogen in diet.		Fats in diet.		Nitrogen absorbed per cent.		Fats absorbed per cent.	
8—9	...	19.72	...	124.87	...	91.43	...	93.29
9—10	...	19.26	...	124.74	...	95.02	...	96.18
10—11	...	17.16	...	118.86	...	90.68	...	93.29
11—12	...	17.40	...	118.26	...	96.32	...	97.29
Average	...	18.39	...	121.69	...	93.36	...	95.01

It will be seen from the above table that the average rates of absorption of both nitrogen and fats were below the normal in this case, that of the former being 93.36 per cent., and that of the latter 95.01 per cent.

On the last day of this week the patient weighed 53.49 kilos., the average weight for the four days of the analytical period being 53.6 kilos.

As far as his clinical condition was concerned, the patient suffered a good deal from dyspepsia, his condition otherwise remaining about the same.

Period B.—Having now obtained some idea as to the patient's metabolism on the diet on which he had been since admission, it was decided to increase the quantity of food in the following manner:—A slight increase was made in the average daily quantity of proteids, the total given being 129.87 grammes, that is an increase of 15.94 grammes over that given in the previous period; the average daily quantity of fats was very slightly increased, 5.36 grammes being added to the previous amount, so that the total here was 127.05 grammes; while the quantity of the carbohydrates was diminished to 225.56 grammes, a diminution effected principally by the patient

himself, as he found great difficulty in taking food containing much of this constituent. This diet gave 2654·23 total calories, that is practically the same as in period A; but, owing to a decrease in the average weight obtained during the first four days of analysis, the number of calories per kilo. body-weight rose to 50·27. There was a slight increase in the average daily quantity of fluids taken, from 1952 c.c. to 2183 c.c.

20·78 grammes was the amount of nitrogen contained in the proteids in the above diet, and 12·93 grammes of nitrogen were excreted in the urine, and 1·16 grammes in the fæces, so that the amount retained in the body was 6·69 grammes, that is, approximately double that retained in period A.

Notwithstanding the increased quantity of fluids taken, the average daily excretion of urine diminished from 1050 c.c. to 935 c.c., while there was an increase in the average specific gravity from 1022 to 1024.

TABLE 73.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 5 on Diet B.*

Date.		Nitrogen.		Urea.		Uric acid.		Ammonia.
15—16	...	13·78	...	24·02	...	0·93	...	0·24
16—17	...	12·88	...	22·84	...	0·77	...	0·26
17—18	...	13·32	...	24·41	...	0·79	...	0·36
18—19	...	11·73	...	17·25	...	0·57	...	—
Average	...	12·93	...	22·13	...	0·76	...	0·29

The diminution in the average daily quantity of total nitrogen excreted in the urine was very slight, being 12·93 grammes as against 13·45 grammes in the previous week. There was also a slight diminution in the amount of nitrogen eliminated in the form of urea, 79·56 per cent. being found in this period, as compared with 80·02 per cent. in the previous week. The proportion eliminated in the form of uric acid also decreased from 2·21 per cent. to 1·96 per cent.; while the quantity eliminated in the form of ammonia was nearly doubled, an average of 2·04 per

cent. being obtained as compared with 1·17 per cent. in period A. There was practically no difference in the proportion excreted as nitrogen rest, the average in this period being 16·44 per cent. The excretion of urea per diem averaged 22·13 grammes as against 23·04 grammes in the previous week, while the uric acid diminished from 0·89 gramme to 0·76 gramme. There was a considerable increase in the average daily quantity of ammonia excreted, 0·29 gramme being passed per diem as compared with 0·19 gramme in the previous period.*

TABLE 74.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 5 on Diet B.*

Date.	Phosphoric acid.		Chlorides.		Sulphates.							
					Total.	Alkaline.		Aromatic.		Ratio.		
15—16	..	1·78	...	3·65	...	1·99	...	1·74	...	0·25	...	7 : 1
16—17	...	1·60	...	4·14	...	1·92	...	1·74	...	0·18	...	9·6 : 1
17—18	...	1·33	...	4·33	...	2·11	...	1·85	...	0·26	...	7·1 : 1
18—19	...	1·49	...	3·10	...	1·70	...	1·48	...	0·22	...	6·7 : 1
Average	...	1·55	...	3·81	...	1·93	...	1·70	...	0·23	...	7·4 : 1

On turning to the consideration of the inorganic constituents of the urine, it will be seen that there was a very slight difference only in the average daily excretion of phosphoric acid, 1·55 grammes being eliminated in this period as against 1·47 grammes in period A. In common with the other constituents of the urine analysed for, there was a decrease in the quantity of chlorides excreted in the urine, a daily average of 3·81 grammes being found as compared with 4·56 grammes in period A. The excretion of the total sulphates in the urine also showed a diminution, as the daily average fell from 2·17 grammes to 1·93 grammes. Of this amount, 1·70 grammes was eliminated in the form of alkaline sulphates, the quantity of aromatic sulphates remaining the same, 0·23 gramme, this latter quantity being relatively large, although the absolute amount was not above the normal,

* The analysis on the last day of this period was also lost.

and indicated that the amount of intestinal putrefaction going on was considerable. The ratio of the alkaline to the aromatic sulphates diminished in this period from 8.4 : 1 to 7.4 : 1.

TABLE 75.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 5 on Diet B.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
15—16	100	76.13	1.21	2.22
16—17	100	76.13	1.21	2.22
17—18	73	69.63	1.12	2.06
18—19	72	69.63	1.10	2.03
Average	86	72.38	1.16	2.13

The average daily excretion of nitrogen in the fæces remained practically the same in this period, being 1.16 grammes, and was well within the normal limits, considering the fact that the patient was taking a considerable quantity of proteid food. The excretion of the fats in the fæces showed a marked difference from that of period A, since the daily average was only 2.13 grammes, as compared with 6.09 grammes in period A.

TABLE 76.—*The Daily Diet and Percentage of Nitrogen and Fats absorbed in Case 5 on Diet B.*

Date.	Nitrogen in diet.	Fats in diet.	Nitrogen absorbed per cent.	Fats absorbed per cent.
15—16	21.33	130.24	94.33	98.29
16—17	19.51	124.29	93.79	98.21
17—18	20.97	124.50	94.66	98.33
18—19	21.31	129.17	94.84	98.42
Average	20.78	127.05	94.41	98.33

It will be seen from the above table that the average absorption of nitrogen increased slightly, 94.41 per cent. being absorbed, as compared with 93.36 per cent. in the previous period; but the rate of absorption of this substance still remained below the normal. On account of the slightly larger quantity of fats ingested, and the

marked decrease in the quantity excreted in the fæces, there was a considerable rise in the rate of absorption of this substance, the daily average being 98·33 per cent., as against 95·01 per cent. in period A, so that the intestinal tract had recovered from its temporary inability to utilise these constituents in the food.

On the last day of this period, the weight of the patient was 52·93 kilos., so that there was a decrease of 0·44 kilo. as compared with that of the corresponding day of the previous week. Owing to the condition of the patient, it was not possible to weigh him on each day of the analytical period, so that we were obliged to take the mean of the weights on the first and last days of this time, and this was 52·4 kilos., so that there was a loss of 1·2 kilos. in comparison with period A. The principal part of this loss was during the middle of the week, his weight on the first day of the period being 53·04 kilos.

During this period the clinical report was that the patient was very weak, and had to be entirely confined to bed during the greater part of this time. He also suffered a good deal from dyspepsia. However, it is satisfactory to be able to say that the night-sweats were somewhat diminished.

Period C.—Although the condition of the patient had not been at all satisfactory during the previous week, it was decided to make a marked increase in the diet, and, in order to avoid an excessive bulk of food, some of the increase in proteids was obtained by the use of somatose, 72 grammes of this substance being given daily.

The average quantity of proteids given was 220·14 grammes, an increase of 90·27 grammes over the previous period; that of the fats 179·91 grammes, an increase of 52·86 grammes; and that of the carbohydrates 264·83 grammes, an increase of 39·27 grammes. There was consequently a considerable increase in the total number of calories given in the above diet—3661·54, as compared with 2654·23 in period B. Despite the increase in the average weight of this period, the number of calories per

kilo. body-weight was 67·81 kilos., that is an increase of 17·54 per kilo. over the previous week. Owing to the quantity of milk being increased in this period, the average daily amount of fluids consumed was 2726 c.c., as against 2183 c.c. in period B.

The average quantity of nitrogen in the above diet was 35·23 grammes, and 15·08 grammes of this substance were eliminated in the urine, and 2·97 grammes in the faeces, so that 17·08 grammes were retained in the body. Though this quantity was much greater than that retained in the latter period, it will be seen later—after having discussed the case as a whole—that there is really no advantage gained by the large amount of proteids given in the diet, as a great part of the increase was immediately excreted.

Although there was an increased quantity of urine excreted per diem, the quantity found (1138 c.c.) was very small in comparison with the large quantity of fluid taken. The average specific gravity remained about the same, being 1023 ; but this is only the average of three days, as there was no record of it on the second day of analysis.

TABLE 77.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 5 on Diet C.*

Date.		Nitrogen.		Urea.		Uric acid.		Ammonia.
22—23	...	17·25	...	27·60	...	0·78	...	0·31
23—24	...	16·68	...	27·12	...	0·90	...	0·41
24—25	...	13·49	...	25·56	...	0·67	...	0·19
25—26	...	13·30	...	19·80	...	0·88	...	
Average	...	15·18	...	24·52	...	0·81	...	0·31

The average quantity of total nitrogen excreted per diem in the urine was 15·18 grammes, an increase, as compared with the 12·93 grammes excreted in period B. ; but very small in comparison with the great increase in the quantity taken in the food. This appears to show

that the organism was not capable of responding to the stimulus that nitrogenous materials normally exert in the healthy being. The distribution of this nitrogen was as follows:—75·40 per cent. was eliminated in the form of urea, a considerable drop from that noted in the last period, when 79·56 per cent. was passed in this form. The proportion eliminated in the form of uric acid was 1·79 per cent., and that in the form of urea 1·60 per cent. The proportion excreted in the form of nitrogen rest was considerably increased, amounting to 22·21 per cent., so that nearly a quarter of the total nitrogen excreted in the urine was in a form that showed that it had not been made use of for proper metabolic purposes. This also showed that the liver was unable to deal adequately with the large quantity of proteid given in the diet. The average daily excretion of urea was 24·52 grammes, that of uric acid 0·81 gramme, and that of ammonia 0·31 gramme.*

TABLE 78.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 5 on Diet C.*

Date.		Phosphoric acid.		Chlorides.		Sulphates.						
						Total.	Alkaline.		Aromatic.		Ratio.	
22—23	...	1·29	...	6·39	...	2·18	...	1·75	...	0·43	...	4·1 : 1
23—24	...	0·68	...	5·28	...	2·41	...	2·10	...	0·31	...	6·8 : 1
24—25	...	1·64	...	4·18	...	2·16	...	1·90	...	0·26	...	6·1 : 1
25—26	...	1·32	...	5·28	...	2·06	...	1·75	...	0·31	...	5·7 : 1
Average	...	0·94	...	5·26	...	2·21	...	1·88	...	0·33	...	5·7 : 1

There was a marked decrease in the daily average excretion of phosphoric acid, only 0·94 gramme being eliminated, as compared with 1·55 grammes in period B, so that there was only a very slight amount of nucleo-albumen being broken up during this week. The increase in the quantity of chlorides, which has been previously

* The analysis of this last-mentioned substance was again lost on the fourth day.

pointed out as having occurred on increasing the diet, was also noticed in this week; a daily average of 5.26 grammes being eliminated, as compared with 3.84 grammes in period B. The average daily excretion of total sulphates in the urine increased slightly, from 1.93 grammes to 2.21 grammes, the proteid metabolism being thus still very small. Of this amount 1.88 grammes was eliminated in the form of alkaline sulphates, there being an increase in the quantity of aromatic sulphates from 0.23 gramme to 0.33 gramme. It was evident from this that the amount of intestinal putrefaction had still further increased during this week, and this is very clearly seen from the small ratio of the alkaline to the aromatic sulphates found (5.7 : 1).

TABLE 79.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 5 on Diet C.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
22—23	347	81.01	4.48	6.59
23—24	114	77.04	1.78	2.61
24—25	166	91.53	0.95	1.60
25—26	300	77.17	4.65	6.85
Average	232	79.44	2.97	4.41

In the above table it will be seen that there was a very marked increase in the average daily excretion of nitrogen in the fæces, 2.97 grammes being eliminated in this manner, as against 1.16 gramme in period B, so that a large quantity of proteids was being passed through the intestines without being utilised.

The quantity of fats excreted per diem was about normal, being 4.41 grammes, an increase over the small quantity (2.13 grammes) found in period B.

TABLE 80.—*The Daily Diet and Percentage of Nitrogen and Fats absorbed in Case 5 on Diet C.*

Date.		Nitrogen in diet.		Fats in diet.		Nitrogen absorbed per cent.		Fats absorbed per cent.
22—23	...	35.12	...	176.05	...	87.24	...	96.26
23—24	...	33.56	...	174.27	...	94.69	...	98.50
24—25	...	35.28	...	183.33	...	97.31	...	99.13
25—26	...	36.95	...	185.99	...	87.42	...	96.26
Average	...	35.23	...	179.91	...	91.67	...	97.54

Notwithstanding the increased quantity of proteid given in the food, the average rate of absorption of nitrogen was very low, being only 91.67 per cent. as compared with 94.41 per cent. in the previous week. Although the quantity of fats in the diet was slightly increased, the rate of absorption of this substance diminished slightly, being 97.54 per cent., and was still within the normal limits.

The patient's weight on the last day of this period was 54.05 kilos., so that there was a gain of 1.12 kilos. over the corresponding day of period B; and he had more than regained the loss of that week, as there was an increase of 0.56 kilo. on comparing this day with the corresponding day of period A. During this week we were again unable to weigh him more than twice during the four days of analysis. The mean of these two occasions was 54.0 kilos., there being a gain of 1.6 kilos. as compared with the weight in period B.

Clinically, the patient was still very weak, and practically confined to bed during this period. His general condition was, however, slightly improved, although his dyspepsia remained as bad as ever.

Period D.—As from the clinical report of the previous week it was evident that the patient's dyspepsia did not increase, it was decided to still further increase the diet, principally by the addition of milk; 56 grammes of sugar and 28 grammes of lactose were also given. The average daily quantity of proteids given was increased

by 31·33 grammes, the total amount therefore being 251·47 grammes. An addition of 28·47 grammes of fats was made to the previous diet, the total quantity in this week being therefore 208·38 grammes. The average quantity of carbohydrates given was 297·26 grammes, there being thus an increase of 32·43 grammes. The total number of calories contained in this diet was 4187·73, that is an increase of 526·19 over that of period C; and the number per kilo. body-weight increased to 77·26. The average daily quantity of fluids taken was further increased to 3234 c.c., principally due to the larger quantity of milk ordered.

The quantity of nitrogen contained in the above diet was 40·14 grammes, and since 18·14 grammes of this substance was excreted in the urine, and 2·41 grammes in the fæces, 19·69 grammes were retained in the body. Although the quantity retained was absolutely increased, it will be seen that there was only a very slight proportional increase, when the increased quantity of proteids ingested is taken into consideration.

There was a considerable increase in the average daily quantity of urine excreted, 1673 c.c. being eliminated, as compared with 1138 c.c. in period C, this increase being nearly proportional to the increase in the quantity of fluids given. The average amount still remained very small in comparison with the total amount of liquid drunk. There was a decline in the average specific gravity from 1023 to 1014.

TABLE 81.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 5 on Diet D.*

Date.	Nitrogen.		Urea.		Uric acid.		Ammonia.
29—30	...	24·75	...	41·40	...	1·49	0·63
30—31	...	11·53	...	20·15	...	0·68	0·24
31— 1	...	21·46	...	26·72	...	0·99	0·41
1— 2	...	14·80	...	25·07	...	0·92	0·38
Average	...	18·14	...	28·44	...	1·02	0·42

The average excretion of total nitrogen in the urine per diem increased from 15.18 grammes in period C to 18.14 grammes in this week, the quantity being low in comparison with the large quantity of proteids taken in the food. The distribution of this nitrogen was as follows:—79.57 per cent. was eliminated in the form of urea, so that the proportion was slightly better than that found in the previous week; the proportion eliminated in the form of uric acid was 1.09 per cent., and that in the form of ammonia 1.87 per cent. In comparison with the large proportion eliminated in the previous week in the form of nitrogen rest, the 16.66 per cent. found in this period showed an improvement; but the amount excreted in this form was still much above the normal. The average excretion of urea was 28.44 grammes.*

The average daily excretion of uric acid increased from 0.81 gramme to 1.02 grammes, that of ammonia being 0.42 gramme.

TABLE 82.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 5 on Diet D.*

Date.	Phosphoric acid.	Chlorides.	Total.	Sulphates.		Ratio.
				Alkaline.	Aromatic.	
29—30	1.37	9.47	3.99	3.36	0.63	5.3 : 1
30—31	0.79	2.73	1.97	1.73	0.24	7.2 : 1
31—1	1.75	8.32	3.33	2.92	0.41	7.1 : 1
1—2	1.64	6.17	2.31	2.05	0.26	7.9 : 1
Average	1.39	6.67	2.90	2.52	0.38	6.6 : 1

On turning to the consideration of the inorganic constituents of the urine, it will be seen from the above Table that there was a slight increase in the average daily quantity of phosphoric acid eliminated, but the amount found (1.39 grammes), though satisfactory as compared with the 0.94 gramme found in period C, was still much below the normal quantity. There was a

* On the second day of analysis, the amount of this substance was not estimated.

further increase in the quantity of chlorides eliminated in the urine, the daily average being 6.67 grammes as compared with 5.26 grammes in the previous period. The excretion of total sulphates in the urine showed a daily average of 2.90 grammes, as against 2.21 grammes in the previous period, so that proteid metabolism was more active during this week. Of this amount 2.52 grammes were eliminated in the form of alkaline sulphates, while there was a further increase in the quantity eliminated in the form of aromatic sulphates, the large amount found (0.38 gramme) indicating that there was a further increased amount of intestinal putrefaction. The ratio of the alkaline to the aromatic sulphates showed a slight increase, being 6.6 : 1, as compared with 5.7 : 1 in period C.

TABLE 83.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 5 on Diet D.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
29—30	138	76.28	2.16	4.25
30—31	138	76.28	2.16	4.25
31—1	163	75.39	2.64	5.22
1—2	144	71.49	2.71	5.34
Average	146	74.86	2.41	4.77

From the above table it will be seen that the excretion of nitrogen in the fæces still remained very high, although the average quantity found (2.41 grammes) was slightly lower than that in period C, when 2.91 grammes were found. The quantity of fats excreted per diem was very slightly increased, being 4.77 grammes, as compared with 4.41 grammes in period C.

TABLE 84.—*The Daily Diet and Percentage of Nitrogen and Fats absorbed in Case 5 on Diet D.*

Date.		Nitrogen in diet.		Fats in diet.		Nitrogen absorbed per cent.		Fats absorbed per cent.
29—30	...	40·79	...	220·16	...	94·71	...	98·07
30—31	...	39·34	...	207·57	...	94·51	...	97·95
31— 1	...	40·22	...	208·48	...	93·44	...	97·49
1— 2	...	40·22	...	196·90	...	93·24	...	97·29
Average	...	40·14	...	208·38	...	93·93	...	97·70

Although there was a slight increase in the rate of absorption of nitrogen, the quantity found (93·93 per cent.) was still low, but on taking into consideration the extra quantity of nitrogen given in the food, there was a decided increase in the total amount absorbed. There was practically no difference in the rate of absorption of fats in this period, 97·70 per cent. being absorbed as compared with 97·54 per cent. in the previous week.

On the last day of this period the patient's weight was 54·16 kilos., there being a gain of 0·11 kilo. over the corresponding day of period C. On comparing this day with the corresponding day of period A the total increase was only 0·67 kilo., so that in this respect the patient's progress was not satisfactory. On comparing the average weights of the four days during which analyses were carried out in periods C and D, it will be seen that there was an increase in weight of only 0·2 kilo. respectively, the weights being 54·0 kilos. in period C, and 54·2 kilos. in period D.

The clinical report was that the patient was very ill, and though perhaps slightly stronger, could not have continued on the above diet for any length of time, owing to the severe dyspepsia produced.

Summary.—From a clinical point of view this patient's case was hopeless, as he was much below his proper weight, and, in addition, had very high pyrexia, and profound constitutional disturbance.

Throughout the whole month his weight remained

practically stationary, being 53·49 kilos. on the first day, and 54·05 kilos. on the last day of the period under observation. The fluctuations, however, were very large, ranging between 51·91 kilos. and 54·39 kilos. He frequently lost weight during the first part of the period, and regained it during the latter part, or *vice versa*. The weight therefore gave no help in determining the most advantageous diet for him. As far as the diets were concerned, this case was practically a repetition of Case 1, as, commencing with a diet containing a normal quantity of proteids, a slight excess of fats, and a small quantity of carbohydrates, he came to take—in period D—rather more than double the quantity of proteids, 70 per cent. more of fats, and 20 per cent. more carbohydrates. The total number of calories increased progressively from 2590·26 to 4187·73. The following table shows the quantity of nitrogen contained in the body on increasing the amount in the food.

TABLE 85.

Period.	Increased amount of nitrogen in diet, in grammes.	Increased or decreased amount of nitrogen excreted,* in grammes.	Increased amount of nitrogen retained in the body, in grammes.
A	...	...	+ 3·71
B	+ 2·39	— 0·59	+ 2·98
C	+ 14·45	+ 4·03	+ 10·42
D	+ 4·91	+ 2·43	+ 2·48

* Total excretion in both urine and fæces.

It will be seen from the foregoing table that, on the diet in period B, the retention of nitrogen was satisfactory, as more than the extra quantity given in the food was retained, the excretion being at its minimum in this period. The quantity retained in period C was large, but there was also a great increase—amounting to more than 25 per cent.—in the amount excreted, and therefore a considerable amount of useless work was being thrown on the organism; and, as has already been pointed out in discussing the sulphates of this period, there was a

very excessive amount of intestinal putrefaction caused. On increasing the diet in period D, almost 50 per cent. of the added nitrogen was excreted immediately, so that here also the organism was unduly tasked in order to obtain slightly greater absorption.

TABLE 86.—*The Proportion of the Total Nitrogen in the Urine excreted as Urea, Uric Acid, and Ammonia, in Case 5.*

Nitrogen Percentage Table.

Period.	Total nitrogen in urine.	Nitrogen as urea.	Nitrogen as uric acid.	Nitrogen as ammonia.	Nitrogen as nitrogen rest.
A. ...	13.45 ...	80.02 ...	2.21 ...	1.17 ...	16.60
B. ...	12.93 ...	79.56 ...	1.96 ...	2.04 ...	16.44
C. ...	15.18 ...	75.40 ...	1.79 ...	1.60 ...	22.21
D. ...	18.14 ...	79.57 ...	1.90 ...	1.87 ...	16.66

The averages of the periods are here given.

It will be seen from the foregoing table that the quantity of nitrogen excreted in the most highly oxidised form (urea) was low in period A, and that it further diminished in periods B and C, as the quantity of this substance in the diet was increased. In period C it was much below the normal, so that it is evident that the liver was unable to fulfil its functions properly, as was also the case in the two former periods. Notwithstanding the increase in the diet in period B, the percentage excreted in this form rose slightly, being practically the same as in period B. The proportion excreted as nitrogen rest was much above the normal throughout all the periods, and reached its maximum in period C, when roughly 22 per cent. of the total nitrogen excreted in the urine was in this form. It will be noticed that the excretion was at its minimum in period B. It is evident that this large quantity of imperfectly oxidised nitrogen circulating in the blood must produce very prejudicial effects on the body, and may explain the fluctuations in and loss of weight noticed in the various periods.

The average excretion of ammonia increased steadily,

and the large quantity excreted in period D showed that the alkalinity of the blood was diminished.

The average excretion of total sulphates was low throughout all the periods, indicating diminished activity of proteid metabolism; but the principal interest centres in the large quantity of aromatic sulphates, both relatively and absolutely. The great increase in the amount of intestinal putrefaction is very apparent on considering these totals. In this connection it is necessary to lay stress on the fact that the ratio of the alkaline to the aromatic sulphates indicated that the increased amount of intestinal putrefaction was greater than would appear from a consideration of the quantity of the aromatic sulphates alone—especially in the first two periods, as the increase in this latter substance was more relative than absolute, on account of the small quantity of total sulphates excreted.

The quantity of nitrogen in the fæces was about normal in period A, and remained much about the same in period B, and then rose markedly in period C, behaving in a similar manner to that noticed in Case I. However, in period D, the further increase noticed in the last-mentioned case was not apparent, there being a slight diminution, although the quantity still remained high. Though the quantity of fats excreted in period A was high from some unknown cause, still the excretion of this substance did not, in the remaining periods, show any decided variation from the normal, although in period B, the quantity excreted was rather low.

The absorption of nitrogen was very low all through, and was at its best in period B. The absorption in this case differs from that in Case I in the fact that the lowest rate was not obtained in period D, when the diet was largest, but in the previous period. The absorption of fats was best in period B, but remained about normal in the two following periods. We are unable to offer any explanation of the relatively low percentage absorbed in period A.

From the various constituents alluded to above, it would appear that the best diet in this case was that given in period B, which consisted of a slight excess of proteids and fats, and a rather small amount of carbohydrates. Probably, a slight increase in this diet—about halfway between this and that given in period C—would have shown better results.

It was impossible clinically to compare this case period by period at the end of the four weeks under observation. He was certainly better in general health than at the commencement, although the dyspepsia was as bad as ever. The night-sweats were less severe, and he appeared to be stronger. However, an examination of the lung showed a further spread of the disease.

CASE 6.—*Chronic Progressive Tuberculosis with Partial Arrest.*

Clinical history.—Age 49, engineer, admitted July 16th, 1900. The disease was of ten months' duration, during the last six of which he had been living an open-air life, as far as was possible, in his own home in Barnsbury. During this time he had improved considerably, and had gained 3·38 kilos. in weight. On admission, his condition was as follows:—*Right lung*: early extensive infiltration of the upper lobe, and also of the apex of the lower lobe. *Left lung*: infiltration and some softening, followed by partial arrest in the upper lobe, and infiltration of the lower lobe.

At the commencement of the period of metabolism experiments his general condition showed satisfactory improvement, and he was practically apyrexial; his appetite was good, but his digestion somewhat faulty, as he was liable to bad attacks of dyspepsia and obstinate constipation. His weight was 63·46 kilos., and he had gained 3·38 kilos. since admission. He was very considerably below his proper weight, his highest known weight (in his clothes) being 88·2 kilos. He spent the whole day in

the hospital grounds, and took a good deal of walking exercise.

TABLE 87.—*The Various Diets and Number of Calories given in Case 6, together with the Percentage of Nitrogen and Fats absorbed, etc.*

Period	A.	B.	C.	D.
Proteids . . .	109·13 ...	131·38 ...	228·44 ...	161·56
Fats . . .	122·86 ...	190·46 ...	197·72 ...	186·49
Carbohydrates . . .	245·00 ...	249·04 ...	283·16 ...	267·97
Total calories . . .	2594·53 ...	3332·00 ...	3936·35 ...	3495·43
Calories per kilo. . .	41·65 ...	52·23 ...	60·01 ...	52·19
Fluids . . .	1917 ...	2166 ...	2802 ...	2723
Nitrogen in urine . . .	6·79 ...	6·87 ...	10·29 ...	11·12
Urea . . .	11·53 ...	11·93 ...	18·18 ...	18·83
Nitrogen in fæces . . .	2·14 ...	1·60 ...	2·01 ...	1·29
Fat in fæces . . .	8·42 ...	6·72 ...	3·19 ...	4·75
Nitrogen absorbed per cent.	87·40 ...	94·14 ...	94·46 ...	94·50
Fat absorbed per cent..	93·12 ...	69·44 ...	98·51 ...	97·83
Weight at end of period	64·91 ...	66·60 ...	68·51 ...	68·96

Period A.—During this period the diet remained the same as that which he had taken since admission, and consisted of 109·13 grammes proteids, 122·86 grammes fats, and 245·00 grammes carbohydrates. The total number of calories contained in this diet was 2594·53, and the number per kilo. body-weight 41·65, the diet, therefore, being an ample one for a normal individual on ordinary exercise. The daily average quantity of fluids taken was 1917 c.c.

The quantity of nitrogen contained in this diet was 17·46 grammes, and 6·79 grammes were excreted in the urine, and 2·14 grammes in the fæces, this latter high amount being due to the necessity of using enemata. Therefore, 10·53 grammes were retained in the body.

The average daily excretion of urine was very low, considering the quantity of fluids taken, and only amounted to 973 c.c., while the average specific gravity was also low—1010.

TABLE 88.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 6 on Diet A.*

Date.	Nitrogen.		Urea.		Uric acid.		Ammonia.
8—9	...	9.91	...	13.82	...	0.35	0.088
9—10	...	5.30	...	8.74	...	0.13	0.050
10—11	...	6.89	...	12.71	...	0.38	0.092
11—12	...	6.05	...	10.85	...	0.22	0.099
Average	...	6.79	...	11.53	...	0.27	0.082

The quantity of total nitrogen excreted in the urine per diem was extremely low, only averaging 6.79 grammes, and this quantity was distributed in the following manner:—81.40 per cent. was eliminated in the form of urea, 1.33 per cent. in that of uric acid, and 1.03 per cent. in that of ammonia; therefore the proportion eliminated in the form of nitrogen rest was large, being 16.25 per cent. The average daily excretion of urea was very low, as was to be expected from the small quantity of nitrogen eliminated, and only amounted to 11.53 grammes. The average excretion of uric acid was also small, considering the age of the patient, and only amounted to 0.27 gramme per diem, while that of the ammonia was especially low, being only 0.08 gramme.

TABLE 89.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 6 on Diet A.*

Date.	Phosphoric acid.	Chlorides.	Total.	Sulphates.		Ratio.
				Alkaline.	Aromatic.	
8—9	1.04	0.98	1.67	1.53	0.14	10.9 : 1
9—10	0.63	2.47	0.87	0.73	0.11	12 : 1
10—11	1.40	2.19	1.38	1.28	0.10	12.8 : 1
11—12	0.94	3.65	1.09	0.96	0.13	7.4 : 1
Average	1.00	2.32	1.25	1.13	0.13	10.8 : 1

It will be seen from the above table that the quantity of phosphoric acid excreted was extremely low, the daily average being only 1.00 gramme. The excretion of chlorides in the urine was below the normal, only averaging 2.32 grammes per diem. In addition, there

was a small excretion of total sulphates in the urine, the daily average being 1.25 grammes, so that the amount of proteid metabolism going on was very slight. The distribution of the total sulphates was as follows:—1.13 grammes were excreted in the form of alkaline sulphates, while the average quantity of aromatic sulphates eliminated was much below the normal, being only 0.13 gramme. This excretion, though really below the normal, was relatively rather large in comparison with the alkaline sulphates, and the ratio of the latter to the former was consequently low, being 8.6 : 1; but no evidence as to an increased amount of intestinal putrefaction being present can be drawn from the above, on account of the small excretion of this substance.

TABLE 90.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 6 on Diet A.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
8—9	334	82.03	2.46	9.63
9—10	666	94.89	1.39	5.46
10—11	450	95.91	0.75	2.97
11—12	540	82.06	3.97	15.64
Average	498	88.72	2.14	8.42

Since—owing to the constipation—it was necessary to administer enemata during this period, the average daily excretion of nitrogen in the fæces was increased, and amounted to 2.14 grammes per diem. For the same reason, the excretion of the fats was above the normal, the daily average being 8.42 grammes.

TABLE 91.—*The Daily Diet and Percentage of Nitrogen and Fats absorbed in Case 6 on Diet A.*

Date.	Nitrogen in diet.	Fats in diet.	Nitrogen absorbed per cent.	Fats absorbed per cent.
8—9	18.01	123.89	86.34	92.23
9—10	18.17	123.96	92.35	95.59
10—11	17.69	123.75	95.76	97.62
11—12	15.96	119.82	75.13	87.03
Average	17.46	122.86	87.40	93.12

On account of the large quantity of nitrogen excreted in the fæces, the absorption of this substance was very low, being only 87·40 per cent., while that of the fats was also low, being 93·12 per cent.

On the last day of this period, the patient's weight was 62·57 kilos., and the average of the four days on which he was on analysis was 62·3 kilos.

Clinically, the patient did extremely well, except that he was greatly troubled with constipation.

Period B.—Notwithstanding the fact that it had been necessary to administer enemata during the previous week, it was decided to increase the diet; but the one given in this period, although a very generous one, could scarcely be described under the heading of a "cram diet." The average daily quantity of proteids taken was increased to 131·38 grammes; the average quantity of the fats was 190·46 grammes (an increase of 67·60 grammes); and that of the carbohydrates was practically the same as in the previous period. The total number of calories contained in this diet was 3332·00, a considerable increase over the number in the diet in period A, which was 2594·53. Despite the increase in the weight during this period, the number of calories per kilo. body-weight rose from 41·65 to 52·23. The average daily quantity of fluids taken increased from 1917 c.c. to 2166 c.c.

The quantity of nitrogen contained in this diet was 21·02 grammes, and as only 6·87 grammes were excreted in the urine, and 1·60 grammes in the fæces, it follows that 12·55 grammes were retained in the body, that is, proportionately less than in the previous period.

Despite the increase in the daily quantity of fluids, the average quantity of urine passed per diem diminished from 973 c.c. to 795 c.c., while the average specific gravity increased to 1014.

TABLE 92.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 6 on Diet B.*

Date.		Nitrogen.		Urea.		Uric acid.		Ammonia.
15—16	...	8.18	...	13.47	...	0.28	...	0.10
16—17	...	6.63	...	11.80	...	0.26	...	0.10
17—18	...	5.14	...	9.80	...	0.22	...	0.09
18—19	...	7.53	...	12.66	...	0.28	...	—
Average	...	6.87	...	11.93	...	0.26	...	0.10

It will be seen from the foregoing table that there was practically no change in the average daily excretion of total nitrogen in the urine, 6.87 grammes being eliminated as compared with 6.79 grammes in period A, and it still remained extremely low. The proportion of this substance excreted in the form of urea remained practically the same, being 81.83 per cent., that eliminated in the form of uric acid being 1.29 per cent., and that in the form of ammonia, 1.23 per cent. There was a very slight diminution in the proportion excreted as nitrogen rest, the daily average being 15.65 per cent. as compared with 16.25 per cent. in the previous week. The average daily excretion of urea was 11.93 grammes, that of uric acid 0.26 gramme, and that of ammonia 0.10 gramme, so that the excretion of these three substances was below the normal.

TABLE 93.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 6 on Diet B.*

Date.	Phosphoric acid.	Chlorides.	Sulphates.					Ratio.
			Total.	Alkaline.	Aromatic.			
15—16	... 1.31	... 1.38	... 1.27	... 1.18	... 0.09	13.1 : 1		
16—17	... 0.83	... 2.30	... 1.46	... 1.36	... 0.10	13.6 : 1		
17—18	... 0.79	... 3.16	... 0.85	... 0.75	... 0.10	7.5 : 1		
18—19	... 1.14	... 3.70	—	—	—	—		
Average	... 1.02	... 2.64	... 1.20	... 1.10	... 0.10	11 : 1		

On turning to the consideration of the inorganic constituents of the urine, it will be seen that there was also

practically no change in the average quantity of phosphoric acid excreted, as 1.02 grammes were eliminated per diem, the excretion still remaining at its previous low level. There was a slight increase in the excretion of chlorides in the urine, the daily average being 2.64 grammes as against 2.32 grammes in period A. The average daily excretion of total sulphates in the urine remained practically the same, being 1.20 grammes (the average of three days' analyses). 1.10 grammes of this amount was eliminated in the form of alkaline sulphates, so that there was a further slight diminution in the average quantity of aromatic sulphates eliminated, this aromatic group only amounting to 0.10 gramme; the ratio of the alkaline to the aromatic sulphates was therefore 11 : 1.

TABLE 94.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 6 on Diet B.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
15—16	190	77.09	1.57	6.56
16—17	397	84.98	2.14	8.99
17—18	398	84.98	2.15	9.02
18—19	66	76.63	0.55	2.32
Average	265	79.57	1.60	6.72

Although it was necessary to give an enema on one occasion in this period, the average excretion of nitrogen in the fæces diminished to 1.60 grammes per diem, this quantity, however, being still considerably above the normal. There was also a diminution in the average excretion of fats, 6.72 grammes being found, as compared with 8.42 grammes in period A; and although the administration of the enema accounted for a certain proportion of this quantity, still some of this amount was probably due to the increased quantity of fats given in the diet.

TABLE 95.—*The Daily Diet and Percentage of Nitrogen and Fats absorbed in Case 6 on Diet B.*

Date.	Nitrogen in diet.		Fats in diet.		Nitrogen absorbed per cent.	Fats absorbed per cent.
15—16	...	22·30	...	196·04	92·97	96·65
16—17	...	23·03	...	198·16	90·71	95·46
17—18	...	19·22	...	175·99	88·87	94·87
18—19	...	20·52	...	191·66	97·27	98·79
Average	...	21·02	...	190·46	94·94	96·44

It will be seen from the above table that there was a marked increase in the rate of absorption of nitrogen, 94·94 per cent. being absorbed in this period, as compared with 87·40 per cent. in period A. There was also a considerable improvement in the absorption of fats, 96·44 per cent. being absorbed as compared with 93·12 per cent. in the previous week.

The patient's weight on the last day of this period was 64·26 kilos., there being, consequently, a gain of 1·69 kilos. during the week; while, on comparing the average weight of the two four-day periods of analysis, it will be noticed that there was an increase of 1·5 kilos., the weight in this period being 63·8 kilos.

From the clinical standpoint the patient did extremely well, except that he was troubled with constipation. He took his food moderately well, and was not so troubled with dyspeptic symptoms.

Period C.—During this week it was decided to test the effect of a large increase in proteids, together with a very small increase in fats and a moderate one in carbohydrates. In order to effect the increase in proteids 72 grammes of somatose were given each day, and the quantity of milk was increased. The average daily quantity of proteids was increased by 97·06 grammes, the total quantity being 228·44 grammes. The average quantity of fats was increased from 190·46 grammes to 197·72 grammes, and that of the carbohydrates from 249·04 grammes to 283·16 grammes. The total number of

calories amounted to 3936·35, so that there was an increase of 604·35 over the number given in the previous period. Notwithstanding the considerable increase in weight during this period, the average number of calories per kilo. body-weight rose to 60·01. The average daily quantity of fluids taken was 2802 c.c.—a largely increased quantity over that of period B, when 2166 c.c. were taken on an average.

The quantity of nitrogen contained in the above diet was 36·55 grammes, and since 10·29 grammes were excreted in the urine, and 2·10 grammes in the fæces, it follows that the large quantity of 24·25 grammes was retained in the body. The average excretion of urine per diem was 1130 c.c.—a slight increase over that of period B; but if the large increase in the quantity of fluids consumed is taken into account, the increase in quantity is extremely small. There was practically no change in the average specific gravity, which was 1013 as compared with 1014 in the previous week.

TABLE 96.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 6 on Diet C.*

Date.		Nitrogen.		Urea.		Uric acid.		Ammonia.
22—23	...	11·90	...	21·38	...	0·37	...	0·13
23—24	...	13·30	...	21·59	...	0·42	...	0·09
24—25	...	8·56	...	15·25	...	0·34	...	0·08
25—26	...	7·39	...	14·50	...	0·29	...	0·08
Average	...	10·29	...	18·18	...	0·36	...	0·10

There was an increase in the excretion of total nitrogen in the urine, the daily average in this period being 10·29 grammes as compared with 6·8 grammes in the previous week, this being a very small increase when compared with the large extra quantity of nitrogen taken in the diet. The daily fluctuations in the excretion of this substance were very marked, ranging from 7·39 grammes to 13·30 grammes. The distribution of this nitrogen was as follows:—83·58 per cent. was

eliminated in the form of urea, 1.18 per cent. in the form of uric acid, and 70.78 per cent. in that of ammonia. There was a slight further diminution in the proportion excreted as nitrogen rest, the daily average being 14.46 as compared with 15.65 per cent. in period B. The average excretion of urea was 18.18 grammes per diem, that of uric acid 0.36 gramme per diem, and that of ammonia 0.10 gramme per diem.

TABLE 97.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 6 on Diet C.*

Date.	Phosphoric acid.	Chlorides.	Total.	Sulphates.		Ratio.
				Alkaline.	Aromatic.	
22—23 ...	1.60 ...	6.14 ...	2.16 ...	2.00 ...	0.16 ...	12.5 : 1
23—24 ...	1.05 ...	4.43 ...	1.95 ...	1.73 ...	0.22 ...	7.9 : 1
24—25 ...	0.93 ...	3.35 ...	1.45 ...	1.30 ...	0.15 ...	8.7 : 1
25—26 ...	0.84 ...	2.38 ...	1.12 ...	1.05 ...	0.07 ...	15 : 1
Average...	1.11 ...	4.08 ...	1.67 ...	1.52 ...	0.15 ...	10.1 : 1

It will be seen from the foregoing table that the excretion of phosphoric acid still remained extremely low, although the daily average eliminated (1.11 grammes) was slightly above that of the previous week. The excretion of chlorides in the urine showed the usual rise on increasing the diet, and the daily average found (4.08 grammes) was rather less than that noted in the other cases. The quantity of total sulphates excreted in the urine showed an increase, 1.67 grammes being eliminated, on an average, per diem, and of this quantity 1.52 grammes was passed in the form of alkaline sulphates, so that there was a slight increase in the excretion of aromatic sulphates, 0.15 gramme being eliminated as compared with 0.10 gramme in period B. The ratio of the alkaline to the aromatic sulphates remained practically the same, being 10.1 : 1.

TABLE 98.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 6 on Diet C.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
22—23 ...	76 ...	65·81 ...	1·84 ...	1·91
23—24 ...	59 ...	76·58 ...	0·94 ...	1·64
24—25 ...	245 ...	73·19 ...	4·46 ...	7·86
25—26 ...	70 ...	83·87 ...	0·78 ...	1·35
Average ...	113 ...	74·86 ...	2·01 ...	3·19

Although there were no enemata administered in this period, the average excretion of nitrogen in the fæces increased to 2·01 grammes per diem, due apparently to the largely increased nitrogen in-taken. On the other hand, the average excretion of fats diminished by half, being only 3·19 grammes per diem as compared with 6·72 grammes in the previous period.

TABLE 99.—*The Daily Diet and Percentage of Nitrogen and Fats absorbed in Case 6 on Diet C.*

Date.	Nitrogen in diet.	Fats in diet.	Nitrogen absorbed per cent.	Fats absorbed per cent.
22—23 ...	36·60 ...	197·99 ...	94·97 ...	99·03
23—24 ...	36·91 ...	209·63 ...	97·45 ...	99·69
24—25 ...	35·78 ...	197·61 ...	87·53 ...	96·02
25—26 ...	36·91 ...	186·63 ...	97·89 ...	99·28
Average ...	36·55 ...	197·72 ...	94·46 ...	98·51

On account of the largely increased quantity of nitrogen taken in the food the rate of absorption of this substance remained practically the same, being 94·46 per cent., so that, although the percentage absorbed remained practically the same, there was a large increase in the total quantity of nitrogen stored up in the body. On account of the greatly diminished excretion of fats in the fæces the rate absorbed of this substance increased considerably, and 98·51 per cent. was absorbed in this period.

On the last day of this period the patient's weight was 66·17 kilos., there being consequently a gain of 1·8 kilos. over the analytical period of the previous week.

Clinically the patient did well, and was not much troubled with constipation. He complained occasionally that the somatose caused some nausea, but there was no vomiting.

Period D.—During this week it was decided to omit the daily dose of somatose, and to keep the remainder of the diet exactly the same, in order to test the effect of this substance on metabolism. Unfortunately the patient did not take his food quite so well, so that there was a slight general decrease in the average quantity of the various constituents. The quantity of proteids taken per diem was 161·56 grammes, that of the fats 186·49 grammes, and that of the carbohydrates 267·97 grammes.

The total number of calories contained in this diet was 3495·43, being 540·92 less than the number in the diet in period C, and 163·43 more than in period B. The average number of calories per kilo. body-weight was 52·19—practically the same as in period B; but there had been a considerable increase in weight since that time. As on an average a smaller quantity of water per diem was taken, the amount of fluid consumed each day was 2723 c.c. as compared with 2802 c.c. in period C.

The quantity of nitrogen contained in the above diet was 25·85 grammes, and 11·12 grammes of this substance was excreted in the urine, and 1·29 grammes in the fæces; so that 13·44 grammes were retained in the body.

Although the quantity of fluid taken diminished slightly, the average daily excretion of urine increased to 1223 c.c. as compared with 1130 c.c. in the previous week; while there was no change in the specific gravity, which averaged 1013.

TABLE 100.—*The Daily Excretion of Nitrogen and Nitrogenous Substances in the Urine in Case 6 on Diet D.*

Date.		Nitrogen.		Urea.		Uric acid.		Ammonia.
29—30	...	12·74	...	21·45	...	0·68	...	0·09
30—31	...	9·12	...	14·16	...	0·39	...	0·11
31— 1	...	9·84	...	21·36	...	0·35	...	0·13
1— 2	...	12·78	...	20·87	...	0·51	...	0·22
Average	...	11·12	...	18·83	...	0·48	...	0·14

It will be noticed that there was a slight further increase in the excretion of total nitrogen in the urine, an average of 11.12 grammes being eliminated per diem as compared with 10.29 grammes in the previous period. The distribution of this nitrogen was as follows:—75.75 per cent. was eliminated in the form of urea, a considerable diminution from the proportion (83.58 per cent.) found in period C; 1.44 per cent. was eliminated in the form of uric acid, and 1.05 per cent. in that of ammonia. The proportion eliminated as nitrogen rest rose considerably, and 21.76 per cent. was excreted in this form, showing that a considerable quantity of the nitrogen in the body was not being properly broken up. The average daily excretion of urea was 18.83 grammes;* that of uric acid 0.48 gramme, and that of ammonia 0.14 gramme.

TABLE 101.—*The Daily Excretion of the Inorganic Substances in the Urine in Case 6 on Diet D.*

Date.	Phosphoric acid.	Chlorides.	Total.	Sulphates.		Ratio.
				Alkaline.	Aromatic.	
29—30 ...	1.61 ...	4.68 ...	2.28 ...	2.12 ...	0.16 ...	13.3 : 1
30—31 ...	1.62 ...	3.20 ...	1.66 ...	1.55 ...	0.11 ...	14.1 : 1
31— 1 ...	1.44 ...	3.96 ...	1.68 ...	1.58 ...	0.10 ...	15.8 : 1
1— 2 ...	1.56 ...	5.68 ...	2.28 ...	2.13 ...	0.15 ...	14.2 : 1
Average ...	1.61 ...	4.38 ...	1.98 ...	1.85 ...	0.13 ...	14.3 : 1

It will be seen from the above table that the excretion of phosphoric acid remained almost the same, the daily average being only 1.61 grammes, so that throughout the whole experiment the elimination of this substance was very low. There was another slight increase in the elimination of chlorides in the urine. Although the amount of proteids given in the diet was diminished, a daily average of 4.38 grammes was found as against 4.08 grammes in the previous period. The average daily excretion of total sulphates in the urine increased from 1.67 grammes to 1.98 grammes; and of this quantity 1.85 grammes were passed in the form

* The average of three days only being given.

of alkaline sulphates. The average excretion of the aromatic sulphates diminished slightly, and the ratio of the alkaline to the aromatic sulphates increased slightly, being 14·3 : 1.

TABLE 102.—*The Daily Excretion of Nitrogen and Fats in the Fæces in Case 6 on Diet D.*

Date.	Quantity.	Water per cent.	Nitrogen.	Fats.
29—30 ...	77 ...	73·36 ...	0·86 ...	3·22
30—31 ...	201 ...	77·41 ...	1·90 ...	6·86
31— 1 ...	129 ...	77·96 ...	1·19 ...	4·46
1— 2 ...	129 ...	77·96 ...	1·19 ...	4·46
Average ...	134 ...	76·67 ...	1·29 ...	4·75

On turning to the consideration of the fæces, it will be seen that there was a marked decrease in the excretion of nitrogen in this manner, the daily average being only 1·29 grammes as compared with 2·01 grammes in the previous period. On the other hand, there was an increase from 3·17 grammes to 4·75 grammes in the daily average excretion of fats.

TABLE 103.—*The Daily Diet and Percentage of Nitrogen and Fats absorbed in Case 6 on Diet D.*

Date.	Nitrogen in diet.	Fats in diet.	Nitrogen absorbed per cent.	Fats absorbed per cent.
29—30 ...	25·85 ...	186·49 ...	96·67 ...	98·81
30—31 ...	26·01 ...	186·56 ...	92·69 ...	96·22
31— 1 ...	25·70 ...	186·42 ...	95·37 ...	97·68
1— 2 ...	25·85 ...	186·49 ...	95·39 ...	97·61
Average ...	25·85 ...	186·49 ...	94·50 ...	97·83

The average rate of absorption of nitrogen (94·50 per cent.) was practically the same as in period C; but as the quantity of proteids in the diet had been considerably reduced, there was a considerable diminution in the total quantity absorbed. Owing to the lessened ingestion and increased excretion of fats the rate of absorption diminished from 98·51 per cent. to 97·83 per cent., the latter rate being, however, a satisfactory one.

On the last day of this period the patient weighed 66.62 kilos., and consequently had gained 0.45 kilo. since the corresponding day of period C, the total gain, since the last day of period A, having been 4.05 kilos. The average weight of the four days during which analyses were carried out was 66.6 kilos.—an increase of 1.00 kilo. over that of period C, and a total gain of 4.3 kilos. since the commencement of the experiment.

From a clinical standpoint the patient did extremely well, although he had not quite so much appetite for his food.

Summary.—During the four weeks that this patient was under observation he showed considerable improvement and put on a satisfactory amount of weight, although at the conclusion he was still much below his proper weight.

Although there was a considerable increase in the quantity of the diets ordered in the different periods, the principal object of this was to study the effect of largely increased quantities of proteids, and it had been intended to compare this case with Case 4; however, as already stated, we were unable to carry out the analysis throughout the whole month in the latter, and consequently this case stands more or less alone. The object of diminishing the proteids in the diet in period D was to see the effect, if any, that was produced in the period following the in-take of such a large quantity. As will be seen from the account of period D, there was apparently no difference caused.

TABLE 104.—*The Increased or Decreased Quantity of Nitrogen retained in the Body on increasing or decreasing the Amount given in the Diet in Case 6.*

Period.	Increase in quantity of nitrogen in food (in grammes).	Increase or decrease of nitrogen excreted * (in grammes).	Increase or decrease in nitrogen retained (in grammes).
A	..... —	..... —	..... + 10.67
B	..... + 3.56	..... - 0.46	..... + 4.06
C	..... + 15.53	..... + 3.83	..... + 11.70
D	..... - 10.70	..... + 0.11	..... - 10.81

From the above table it will be seen that the quantity

* Total excretion in both urine and fæces.

of nitrogen retained in period B was greater than the extra quantity ingested, this being probably due to the previous stimulation of the intestines by the enemata in period A. The increased retention in period C was very considerable, even though the extra quantity taken per diem was large, and the patient was apparently able to deal satisfactorily with the large amount given. In period D the quantity retained diminished *pari passu* with the decreased in-take, and therefore the digestive tract in this case was not apparently injured by the large quantity of proteids given in period C.

The very low excretion of nitrogen in the urine is noteworthy, but it is impossible to explain why there was such a small proteid metabolism, except on the theory that the patient was replacing degenerated cells by active ones, and that nucleo-albumen was being stored up for the future use of the nuclei.

TABLE 105.—*The Proportion of the Total Nitrogen in the Urine excreted as Urea, Uric Acid, and Ammonia in Case 6.*

Nitrogen Percentage Table.

Period.		Total nitrogen in urine.		Nitrogen as urea.		Nitrogen as uric acid.		Nitrogen as ammonia.		Nitrogen as nitrogen rest.
A	...	6.79	...	81.40	...	1.33	...	1.03	...	16.25
B	...	6.87	...	81.83	...	1.29	...	1.23	...	15.65
C	...	10.29	...	83.58	...	1.18	...	0.78	...	14.46
D	...	11.12	...	75.75	...	1.44	...	1.05	...	21.76

The averages of the periods are here given.

From the foregoing table it will be seen that the proportion of nitrogen excreted in the most highly oxidised form (urea) remained practically equal during periods A and B, and reached its maximum in period C. As has already been mentioned, there had been apparently no ill effects from the large diet in this period, but the marked diminution in the percentage of nitrogen excreted in this form in period D might be taken as evidence to the contrary, if it were not that three clear days had been allowed to elapse

before the analysis in this week was carried out, during which time he had been taking the diet prescribed for this week; and it is hardly conceivable that there could have been perverted metabolism going on for a whole week without some clinical signs being apparent. We are, therefore, unable to offer any explanation of the low percentage in period D. The proportion excreted as nitrogen rest was decidedly above the normal throughout, but it fell to the minimum in period C. As has been mentioned, we know of no explanation of the very large percentage obtained in the fourth period.

The very small quantities of total sulphates passed in the urine of all the periods show that the breaking up of proteids was very slight, and, taken in conjunction with the low excretion of phosphoric acid, confirm the supposition referred to previously, that the proteid was being stored up as nucleo-albumen. The quantities passed as aromatic sulphates were, throughout, below the normal, there being a relative increase only in period A.

As referred to in discussing period A, the quantity of nitrogen excreted in the faeces was large owing to the administration of enemata, and slightly so in the following week owing to the same reason. In the third period it was above the normal, but not markedly so, while in period D it might almost be considered normal on account of the quantity ingested (25.56 grammes). There was consequently no great waste of proteid in this case. The quantity of fats excreted in periods A and B was large owing to the use of enemata, but that in period C was small considering the large quantity taken in the diet; and a similar remark applies also to period D.

The absorption of nitrogen increased from the very low amount in period A to a more normal one in period B, and then remained practically the same in the two later periods, although it was below the normal all through. The absorption of fats was extremely good in period C when it reached its maximum, but was also within normal in periods B and D.

From all the foregoing statements it appears that the best diet in this case was that given in period C, though probably that used in the following week would have given almost as good results.

Clinically the condition of the patient was excellent all through, except for the troublesome constipation of the first two periods, the gain in weight being very satisfactory.

During the period under observation the condition of his lesions improved.

Effect of Forced Feeding on Normal Individuals.

In order to compare the effect of over-feeding on patients suffering from pulmonary tuberculosis with that obtained in ordinary individuals, we think it advisable to give a short account of the results obtained in another series of experiments. The normal metabolism of some individuals having been ascertained, they were placed on diets containing from 60 to 80 calories per kilo. body-weight. These excessive diets were taken with a good deal of difficulty, and the condition of the individuals quickly altered for the worse, although considerable weight (2—3 kilos.) was put on during the six days that the experiment lasted. The bad effect of the diet was shown by the disturbance to digestion caused, as they all suffered a good deal from anorexia and feelings of distension during this period. Also, for some days after the termination of the experiment they suffered considerably from mucous colitis, and it required various periods of time (from 1—3 weeks) for them to get back into their normal condition. In these individuals the retention of nitrogen in the body was extremely small, except when the over-feeding was carried to its utmost extent, as practically the whole of the excess of nitrogen taken in the diet was immediately excreted.

One of the points of interest observed was that, on increasing the quantity of fluids taken, the quantity of

urine excreted per diem increased almost proportionately, and presented a very high specific gravity. There was a very marked increase in the quantity of total nitrogen in the urine, and the proportion of this substance excreted in the form of urea remained practically normal all through, while the proportion excreted as nitrogen rest tended to increase. Contrary to what was to be expected, there was no very marked change in the excretion of uric acid, the quantity of this substance not rising much above that found on ordinary diet; and the same fact was noticed with regard to the excretion of ammonia.

On turning to the inorganic constituents of the urine a very marked increase was noted in the quantity of phosphoric acid, the excretion of this substance increasing nearly threefold. Although no noticeable increase was made in the quantity of salt taken with the food, there was a very marked increase in the quantity of chlorides excreted in the urine, as, instead of the roughly normal quantity of 4 grammes per diem being eliminated, the excretion rose to between 9 and 10 grammes. As was to be expected from the increased proteid metabolism, there was a marked increase in the quantity of sulphates excreted in the urine, and the amount passed in the form of aromatic sulphates remained about normal, though, if we had been able to carry on the experiment for a few days longer, it is probable that these substances would have increased markedly, as there was evidence of increased intestinal putrefaction occurring, in proof of which may be mentioned the alterations observed in the urine when tested for indican. On the three following days the amount of this substance was markedly increased, Jaffé's test giving marked reaction with one drop of the urine.

No marked difference in the excretion of nitrogen in the faeces was noticed on forced feeding, in contradistinction to what was found in tubercular cases. The excretion of fats on the forced diet showed an enormous increase, and on some days more than 20 grammes were excreted in the faeces. This is the direct opposite to what was found in

the tubercular cases, when no marked increase was noticed, even when the normal quantity of fats in the diet was doubled.

As was to be expected from the fact that the excretion of nitrogen in the fæces was not increased during the period of forced feeding, there was a temporary increase in the quantity of this substance absorbed, as the amount taken in the food was very largely increased. The absorption of the fats tended to diminish on forced feeding, though this decrease was not as marked as would be expected from the enormous quantities found. On account of the very great increase in fats in the diet (in some cases as much as 289.15 grammes were taken in the diet, that is to say, roughly, three times the usual quantity) there was a very rapid increase in weight during the period of forced feeding; but this increase was lost in a very short time, the individuals returning to their normal weight in about a week, although effort was made to keep them as much as possible on their normal diet.

In conclusion, as has already been pointed out above, the forced feeding caused a marked deterioration in health in these cases, and it required a considerable amount of time for them to regain their normal health and energy, one of the things most complained of being that they were utterly incapable of doing any work whatsoever.

The tubercular cases, on the other hand, presented an entirely different sequence of events, for a decided increase in the quantity of food taken was well borne by them. We now give a short summary of the more important results obtained in the course of the experiment.

The number of calories per kilo. body-weight which gave the best results was between 50 and 70, as any increase above the latter number was quickly followed by great anorexia and dyspeptic symptoms, and complete inability to take the diet after a few days, in some cases vomiting being caused. When a very large number of calories was given, that is above 70 per kilo., there was a decided increase in weight during the week, but in no case were

the patients as well at the conclusion of this period as when taking a smaller diet. The only exception to this statement was Case 2, and this patient was a growing boy thirteen years of age, who naturally required a good deal more food in proportion to his weight than any of the other five, who were all adults. In this case, in the diet on which he apparently did best, 103.22 calories were given per kilo. body-weight; but, on continuing him on practically the same diet, a smaller quantity was eaten during the following week, as will be seen on referring to the tables in this case, and it appeared to us to be doubtful whether it would not have been advantageous to reduce the diet to a smaller amount after a short period.

As will be pointed out in discussing the excretion and absorption of nitrogen, the diets in the remaining cases, which gave the most satisfactory results, were those in which, as already mentioned, the number of calories did not exceed 70 per kilo. body-weight. This is especially brought out in Case 1, where the clinical condition of the patient was most satisfactory in the second week, where he retained the most nitrogen in his body at a very small expense to his digestive organs. In considering this question of calories, it is important to point out the fact that, as the condition of the patient—as regards his pulmonary disease—improves, it is very important to diminish the quantity of food given, so as to approximate it more closely to the normal standard. Case 3 is a very good example of this, as reducing the number of calories per kilo. body-weight from 56.65 to 49.85 was followed by a better absorption of both nitrogen and fats, while the weight increased more during this week than during any other period in the duration of the experiment.

In the tubercular cases the quantity of urine excreted was low in comparison with the amount of fluids imbibed, even when there were no noticeable night sweats; and there was no proportionate increase on increasing the quantity of fluids. The only exception to this was in

Case 3, when, in the third and fourth periods, the urine increased almost proportionally to the additional quantity of fluids given; but, as has already been mentioned, this case more nearly approached the normal than any of the others.

In comparison with the quantity of nitrogen given in the food, the excretion of total nitrogen in the urine was very low in the worst cases, and increased markedly when the conditions of the lesions improved. Notwithstanding the fact that the patients were on a diet containing a considerable amount of proteid, the excretion of uric acid was not increased more than would be expected, except in cases complicated by fever. On increasing the diets there was, as a rule, a decided increase in the quantity of ammonia excreted in the urine, pointing to diminished alkalinity of the blood.

The proportion of total nitrogen in the urine excreted in the form of nitrogen rest varied considerably, and was decidedly above the normal in all cases, and showed a decided increase when more than 70 calories per kilo. body-weight were given. In some cases—notably Cases 2 and 6—more than 20 per cent. of the total nitrogen was excreted in this form, so that the oxidation processes in the body were not proceeding actively.

As has already been noted by Russian observers, we found that the quantity of phosphoric acid excreted was very small in this disease, in some cases being less than 1 gramme per diem, while in cases with a considerable degree of arrest, the excretion rose to between 2.5 and 3 grammes. The excretion of chlorides was also below the normal in the cases which had the most advanced physical signs, and it was also possible to form an idea as to the bodily condition of the patient by watching the daily excretion of this substance. On increasing the diet there was generally a decided increase in the quantity of chlorides excreted, but in all cases this increase quickly disappeared.

Taken as a whole, the excretion of total sulphates in the urine was small, showing that there was a greatly diminished

proteid metabolism occurring in the body; and in some cases—notably Case 6—this was very marked, since in the second period an average of only 1.20 grammes was passed per diem. The excretion of the aromatic sulphates was within the normal limits, except when very large diets were given, when they increased to more than double (Cases 1 and 5), showing that there was an increased amount of intestinal putrefaction present. The ratio of the alkaline to the aromatic sulphates was about normal, except in cases complicated with a considerable amount of fever, or in those in which a very large diet was given; and in some of these the ratio fell to 6 : 1.

The excretion of nitrogen in the faeces on the ordinary diets remained about 1 gramme per diem, that is, about the normal quantity. On increasing the diet, however—especially in Case 1—a very marked rise in the excretion was observed, and in the largest diet given in this case the average daily excretion reached the very high quantity of 4.36 grammes. The excretion of fats remained always within the normal limits, and in some cases was small—as, for example, in the second period of Case 5, when an average of only 2.13 grammes was excreted.

The rate of absorption of nitrogen tended, on the whole, to be below the normal, the more so the greater the severity of the disease. On increasing the quantity of proteid given there was a lessened absorption of nitrogen per cent., so that when large quantities were given there was an enormous waste of food. This especially occurred in Case 1, when it was necessary to give more than 6 grammes of nitrogen, that is to say, 37 grammes of proteid, in order to get one gramme extra of nitrogen—or 6.25 grammes of proteid absorbed. Therefore, in this case, a great strain was thrown on the organism with very small results. The average rate of absorption of fats was extremely good in all the cases, averaging from 87 to 98 per cent., thus confirming the clinical observation that fat-containing foods are very well borne in pulmonary tuberculosis.

On turning to the consideration of the patients' weights it was found that a considerable gain could be obtained by increasing the diet, but that this increase was obtained at the cost of disturbing the digestive functions if a diet containing more than 70 calories per kilo. body-weight was given.

In considering the question of decreasing the number of calories according as the condition of the patient improves, it is interesting to notice that in Case 3 the larger increase in weight was obtained on reducing the number of calories per kilo. body-weight from 56 to 51 and also allowing the patient to take some exercise.

In dealing with the question of retention of nitrogen in the body, it is convenient to take Case 1 as an example. The quantity of proteids in the first diet in this case was 116.13 grammes, and in the following week the quantity was increased to 137.5 grammes—a difference of 21.37 grammes, that is to say, 3.42 grammes nitrogen. On this diet there was a diminished excretion of nitrogen in the urine and fæces, and an increased retention of 6.59 grammes of nitrogen in the body. On increasing the quantity of proteids in the following week to 232.5 grammes—an increase of 95 grammes of proteid—there was an increased excretion of nitrogen in the urine and fæces over the previous period of 6.84 grammes, so that only 9.23 grammes of this extra quantity of nitrogen given was retained in the body. However, on increasing the quantity of proteids to 271.13 grammes—an increase of 48.63 grammes over that given in the previous week—there was a further increase of nitrogen excreted of 5.27 grammes, and only 0.91 gramme of the extra nitrogen given was retained in the body, that is to say, only 5.69 grammes of proteid. As has already been pointed out, a considerable quantity of this increased amount of proteids was excreted in the fæces, so that practically no advantage was obtained by forcing the patient to eat such a very large diet. The above results may be taken as typical of those obtained in other cases.

The most suitable diets for patients suffering from

pulmonary tuberculosis that we had the opportunity of observing, consisted roughly of about 120 grammes of proteids, 140 grammes of fats, and 300 grammes of carbohydrates. This diet was for a patient weighing 52 kilos., and contained roughly 59 calories per kilo. body-weight.

As an example of the absolute diets given, we will take the second period of Case 1, when 137.5 grammes proteid, 136.46 grammes fats, and 296.32 grammes carbohydrates were given. On this diet, the rate of absorption of nitrogen was 97.45 per cent., and of fats, 98.15 per cent. During the following week the diet of this patient was increased to the following: 222.50 grammes proteids, 183.93 grammes fats, and 321.37 grammes carbohydrates. On this diet he only absorbed 94.20 per cent. of nitrogen, and 97.90 per cent. of fats, so that a considerable quantity of food was being passed through the intestinal tract unutilised; and, in addition, he suffered considerably from anorexia and dyspepsia.

As an example of a "cram" diet, the average daily quantity of food taken during the fourth period by this patient was: 271.13 grammes proteids, 231.22 grammes fats, and 392.17 grammes carbohydrates; and, on this diet, the rate of absorption of nitrogen was only 89.95 per cent., and of fats, 96.91 per cent., so that the quantity of food unutilised was considerably increased. This last diet caused a little vomiting towards the end of this period, and the patient's expression was that he was utterly unable to continue on it; although, if the weight only had been taken into consideration, it would have been considered a very satisfactory one, there being a gain of 2.1 kilos. during the week. On the diet first given, the gain in weight during the week was 1.1 kilos., which was satisfactory, especially as the condition of the patient improved during the period.

The diet given in the second period of Case 3 was as follows: 143.00 grammes proteid, 183.03 grammes fats, and 211.87 grammes carbohydrates; and his rate of absorption of nitrogen was 95.79 per cent., and of fats

98.28 per cent., his average weight during the period being 65.8 kilos. This was the most suitable diet given to him in any period; and the bad effects of trying to increase the quantity of food taken are well brought out by the results obtained in the fourth period, when 167.18 grammes proteids, 162.87 grammes fats, and 317.76 grammes carbohydrates were given. On this diet he only absorbed 92.66 per cent. of nitrogen and 95.53 per cent. of fats, so that practically no advantage was gained from the increased quantity of food given; and, in addition, the digestive system of the patient was seriously disturbed.

The most advanced case of disease that we had under observation was Case 5, and the most suitable diet we found in his case was that given in the second period, when 129.87 grammes proteid, 127.05 grammes fats, and 225.56 grammes carbohydrates were taken. On this diet, although he was entirely confined to bed and had a considerable degree of fever, he absorbed 94.41 per cent. of nitrogen, and 98.33 per cent. of fats. In the following week his diet was increased to 220.14 grammes proteid, 179.91 grammes fats, and 264.83 grammes carbohydrates, and the rate of absorption of nitrogen diminished to 91.67 per cent., and that of the fats to 97.54 per cent., so that the excessive quantity of food produced a worse result.

The above diets have been given as examples of the various ones tried during the course of the research, and we have included the rates of absorption of nitrogen and fats for the purpose of indicating some of the ways in which we based our conclusions as to the most suitable diets for these patients.

Conclusions.

(1) The tuberculous patients showed very satisfactory results, both clinically and experimentally, when their diets were slightly increased above the original, and, since the original diets were their own selection as regards the amount taken, it is evident that the state of the appetite

gives too low an estimate of their requirements. While comparatively large diets were well borne by those much below their weight, they were not so well tolerated by, nor did they give such satisfactory results in, patients up to weight and with arrested disease.

In all cases, however much they were below their proper weight, very large diets gave unsatisfactory results, as, although weight was gained, it was only at the expense of the general health, as indicated by failure of appetite, more marked digestive disturbances, increased intestinal putrefaction, and (in one case) vomiting.

(2) The mediumly large diets gave the best results, and could have been continued with advantage probably for an indefinite period.

(3) In spite of the various clinical conditions of the six patients, and the fact that the digestive system was obviously impaired in two of them at least, the digestion and absorption of both nitrogen and fats was good. This appears to be so even in patients with high pyrexia. The absorption of fats was excellent, although very large quantities were given; *e. g.* even with an intake of 231.32 grammes, 96.41 per cent. was absorbed. This supports the clinical observation that large quantities of fats are well borne in tubercular dietaries.

(4) It is noticeable that, while on the diets that gave the best results experimentally, the patients complained of the least discomfort, and the onset of severe dyspeptic trouble usually coincided with a deterioration in the experimental results.

(5) In at least one case in which the disease was practically arrested, increase in the time spent out of doors, and in the amount of exercise taken, materially improved both the appetite and digestion.

(6) It appears to be advisable to diminish the amount of food as the disease becomes quiescent and the patient approaches normal weight; but even at this period he will require a more substantial diet than in health.

	Normal.	Tuberculous.
Diet.	Took excessive diet with much difficulty and with lasting bad effects.	Took increased diets much better, and only failed with very excessive diets.
Retention of nitrogen.	Very small except on extreme forced feeding.	Considerable in all increased diets, and well marked in some.
Quantity of urine.	Increase more or less proportional to increased intake of fluids.	Very little connection between increase in quantity and increased fluid intake.
Specific gravity.	Very high.	For the most part low.
Nitrogen in urine.	Marked increase on forced feeding.	Below normal, most markedly so in patients much below normal weight, and approaching normal quantity in cases nearly up to their weight.
Urea.	Very large quantities passed on forced feeding. Proportion of nitrogen thus excreted remained normal all through.	Excretion lower than in normal cases on similar diets. Patients with active disease excreted smaller proportion of nitrogen as urea than those with tendency to arrest. This proportion falls further on excessive diets.
Uric acid.	Follows ordinary course.	Smallest excretion met with in those most below weight.
Ammonia.	Did not increase out of proportion on forced feeding.	No disproportionate increase noted. In excessive feeding, large quantities found.
Nitrogen.	Tendency to increase on forced feeding.	Increased on larger diets. Very large in cases with impaired digestion and active disease.
Phosphoric acid.	Marked increase on forced feeding.	Quantity diminished throughout. Only slight increase on larger diet.
Chlorides.	Marked increase on forced feeding.	Usually low on ordinary diets. Increased on increasing the diet, but this not usually maintained.
Sulphates.	Increased by forced feeding. Aromatic—normal. Ratio—normal.	Lowest in worst cases, increasing on larger diets. Aromatic—marked increase on forced feeding. Ratio—diminished on forced feeding.
Nitrogen in fæces.	No marked increase as a rule on forced feeding.	Diminished or normal on ordinary diet. Very marked increase on forced feeding.
Fats in fæces.	Usually an enormous increase on the forced diet.	Diminished or normal on ordinary diets. Increase not marked on excessive feeding.

	Normal.	Tuberculous.
Absorption of nitrogen.	Temporary increase on forced feeding.	Slightly below normal on ordinary diets. Increased on larger diets. Diminished on forced feeding.
Absorption of fats.	Tendency to diminish on forced feeding.	Extremely good all through.
Weight.	Rapid increase on forced feeding, but soon lost.	Satisfactory gain on ordinary diet. Further increase on forced feeding, but at expense of general condition, and could not be maintained.
General.	Forced feeding caused marked deterioration in health.	Stood large diets extremely well, and forced feeding did not cause such marked symptoms, but too many to continue it for long.

LITERATURE.

1. GRIEZDIEV.—Vrach 11, p. 123.
2. KURLOV.—'Inaug. Discuss.,' St. Petersburg, p. 48.
3. SWAVASTYANOV.—'Inaug. Discuss.,' St. Petersburg, p. 48.
4. BLUMENFELD (SPIRIG).—'Beiträge zur Lehre vom Stoffwechsel des Gesundes v. Kranken Menschen,' pt. 3, p. 116.
5. LEVIN.—Vrach 8, p. 878.
6. HARLEY AND GOODBODY.—'Brit. Med. Journ.,' 1896.

TABLES FOR METABOLISM IN PHTHISIS

Date.	DIET.				Calories per kilo.	URINE.					
	Nitro- gen	Fats	Carbo- hydrates	Fluids		Quantity	Sp. gr.	Total nitrogen	Urea	Uric acid	Ammono- nia
PERIOD A.											
8—9	18.59	123.55	295.07	1952	55.59	2025	1013	16.26	34.02	0.81	0.30
9—10	18.90	123.66	310.47	2176	56.89	1585	1012	13.09	21.19	0.55	0.16
10—11	18.43	123.48	287.37	2148	55.20	1600	1018	19.34	34.97	1.00	0.43
11—12	18.40	122.44	293.91	1840	55.43	1400	1019	17.85	32.62	1.00	0.29
Average.....	18.58	123.28	296.71	2029	55.78	1653	1016	16.64	30.70	0.84	0.30
PERIOD B.											
15—16	21.84	136.89	288.62	2232	58.81	1360	1016	15.23	27.66	0.66	0.23
16—17	21.69	136.82	280.92	1840	57.31	1740	1016	17.75	35.82	0.71	0.34
17—18	22.31	137.10	311.72	2232	59.63	1200	1014	12.45	—	0.65	0.19
18—19	22.16	137.03	304.02	2504	58.96	1670	1012	12.69	23.05	0.55	0.30
Average.....	22.00	136.96	296.32	2204	58.68	1493	1015	14.53	28.84	0.64	0.27
PERIOD C.											
22—23	37.21	186.80	322.87	2922	74.61	1775	1014	18.98	30.59	0.60	0.16
23—24	37.21	186.80	322.87	2782	73.53	2240	1013	23.58	42.11	0.84	0.23
24—25	37.37	186.87	324.57	2614	74.98	1560	1016	18.26	33.69	0.51	0.14
25—26	37.01	175.23	315.17	2922	71.17	2255	1012	22.34	35.85	0.88	0.30
Average.....	37.20	183.93	321.37	2810	73.57	1957	1014	20.82	35.56	0.71	0.21
PERIOD D.											
29—30	43.65	232.86	404.14	3444	88.23	2480	1011	23.33	36.95	0.87	0.35
30—31	43.21	238.49	382.58	3444	87.23	2270	1012	24.34	43.35	0.83	0.31
31—1	43.65	232.86	406.38	3444	87.88	2160	1012	22.46	38.44	0.73	0.20
1—2	43.02	221.08	375.58	3444	83.45	2240	1012	25.38	43.72	0.84	0.68
Average.....	43.38	231.32	392.17	3444	86.70	2288	1012	23.88	40.62	0.82	0.39

URINE.						FÆCES.				Absorbed per cent.		Weight, kilos.
H_2O_2	Chlo-rides	Sulphates				Quantity	Water per cent.	Nitro-gen	Fats	Nitro-gen	Fats	
		Total	Alka-line	Aro-matic	Ratio, A : B							
21.63	4.62	3.20	2.92	0.28	11.1 : 1	520	80.91	3.27	16.11	82.41	86.99	51.0
21.58	4.63	2.66	2.50	0.16	14.4 : 1	102	93.09	0.23	1.14	98.78	99.08	51.1
21.33	7.84	3.58	3.38	0.20	16.9 : 1	410	89.01	1.49	7.26	91.92	94.12	50.7
21.27	6.02	3.21	3.00	0.21	14.3 : 1	410	89.01	1.49	7.26	91.90	94.07	50.8
21.45	5.78	3.16	2.95	0.21	14.0 : 1	361	87.26	1.62	7.94	91.25	93.82	50.9
21.45	4.90	2.69	2.53	0.16	15.8 : 1	103	78.87	0.72	3.27	96.70	97.61	51.3
21.26	3.05	1.99	1.75	0.24	7.3 : 1	103	78.87	0.72	3.27	96.68	97.61	52.0
21.12	6.13	2.82	2.62	0.20	13.1 : 1	72	92.88	0.17	0.75	99.24	99.45	52.4
21.90	5.94	2.89	2.69	0.20	13.5 : 1	48	59.96	0.63	2.83	97.16	97.93	52.4
22.18	5.01	2.60	2.40	0.20	12.0 : 1	82	77.65	0.56	2.53	97.45	98.15	52.0
22.34	6.80	4.75	4.52	0.23	19.9 : 1	186	67.57	3.43	5.07	90.78	97.29	53.8
23.11	13.44	3.96	3.45	0.51	6.8 : 1	164	81.23	1.75	2.59	95.83	98.61	54.6
22.95	8.11	2.90	2.68	0.22	12.2 : 1	137	69.26	2.34	4.94	93.74	97.36	53.7
23.26	7.41	2.89	2.64	0.25	10.5 : 1	58	60.05	1.32	2.93	96.44	98.33	54.4
22.92	8.94	3.62	3.32	0.30	12.4 : 1	136	69.50	2.11	3.88	94.20	97.90	54.1
22.08	9.27	3.90	3.39	0.51	6.6 : 1	200	64.25	3.79	6.67	91.32	97.14	56.0
22.03	7.87	4.52	4.02	0.50	8.0 : 1	235	66.97	4.11	7.24	90.49	96.96	56.1
23.67	4.75	4.08	3.63	0.45	8.1 : 1	303	67.35	5.24	9.89	87.99	95.75	56.3
23.64	11.71	4.59	4.09	0.50	8.1 : 1	252	67.70	4.31	7.59	89.98	96.57	56.3
22.86	8.15	4.27	3.78	0.49	7.7 : 1	248	66.02	4.36	7.85	89.95	96.41	56.2

Date.	DIET.				Calories per kilo.	URINE.					
	Nitro- gen	Fats	Carbo- hydrates	Fluids		Quantity	Sp. gr.	Total nitrogen	Urea	Uric acid	Ammo- nia
PERIOD A.											
8—9	24.14	215.59	258.17	1868	109.26	1785	—	15.48	28.91	0.37	0.33
9—10	23.10	202.15	223.68	1868	101.16	1960	1015	8.64	14.69	0.20	0.30
10—11	23.16	215.84	207.22	1840	102.39	1018	1017	12.43	23.44	0.39	0.22
11—12	22.24	216.33	199.94	1840	100.05	1650	1013	16.28	29.56	0.60	0.28
Average.....	23.66	212.48	222.25	1854	103.22	1353	1015	13.21	24.15	0.39	0.28
PERIOD B.											
15—16	24.76	203.18	223.92	1952	100.65	1550	1012	16.12	28.18	0.39	—
16—17	23.57	205.18	219.57	1880	99.20	1100	1016	12.65	24.19	0.36	0.24
17—18	22.67	187.70	240.53	2008	95.73	950	1020	13.62	26.32	0.56	0.29
18—19	21.92	173.79	184.12	2232	83.39	1300	1013	16.23	29.25	0.56	0.20
Average.....	23.23	192.46	217.04	2043	94.74	1225	1015	14.66	26.99	0.47	0.24
PERIOD C.											
22—23	26.06	186.09	269.51	2586	100.38	1940	1012	17.61	26.38	0.35	0.37
23—24	25.70	169.27	254.17	2586	93.86	1840	1011	15.66	25.39	0.47	0.20
24—25	25.89	193.83	290.78	2586	104.52	1160	1014	14.26	26.68	0.42	0.22
25—26	24.97	167.13	291.22	2586	96.52	1800	1012	18.35	30.96	0.64	0.54
Average.....	25.66	179.83	271.45	2586	98.82	1685	1012	16.47	27.35	0.47	0.33
PERIOD D.											
29—30	25.79	184.66	334.67	2670	106.52	1430	1012	14.13	22.73	0.49	0.42
30—31	25.48	184.52	328.23	2726	105.23	1080	1012	11.10	16.41	0.46	0.27
31—1	24.14	156.01	297.43	2726	92.39	1160	1012	13.92	19.49	0.50	0.53
1—2	24.43	139.26	297.43	2670	88.97	2070	1012	18.63	31.05	0.64	0.62
Average.....	25.09	166.11	314.44	2698	98.28	1435	1012	14.22	22.42	0.52	0.46

URINE.						FÆCES.				Absorbed per cent.		Weight, kilos.
P ₂ O ₅	Chlo-rides	Sulphates				Quantity	Water per cent.	Nitro-gen	Fats	Nitro-gen	Fats	
		Total	Alka-line	Aro-matic	Ratio, A : B							
22.48	9.73	3.02	2.89	0.13	23.0 : 1	150	78.03	1.31	4.36	94.57	97.98	33.7
11.63	2.78	1.82	1.74	0.08	21.7 : 1	116	82.46	0.81	1.89	96.49	99.07	33.5
22.27	3.56	2.37	2.27	0.10	22.7 : 1	81	76.77	0.75	3.36	96.76	98.44	33.7
22.48	6.27	3.05	2.92	0.13	22.3 : 1	122	80.30	0.96	3.17	95.68	98.58	34.0
22.22	5.59	2.57	2.46	0.11	22.4 : 1	117	79.39	0.96	3.20	95.88	98.52	33.7
22.71	5.29	2.81	2.68	0.13	22.2 : 1	109	77.20	1.04	2.68	95.79	98.68	34.2
22.20	4.95	2.67	2.60	0.07	37.1 : 1	128	80.00	1.07	2.86	95.42	96.61	34.4
22.36	3.29	2.51	2.39	0.12	19.9 : 1	83	78.18	0.76	2.04	96.65	99.45	34.6
22.70	3.39	2.38	2.25	0.13	17.3 : 1	89	81.77	0.68	1.81	96.89	98.96	34.8
22.49	4.23	2.59	2.48	0.11	22.5 : 1	102	79.29	0.89	2.45	96.29	98.93	34.5
22.83	7.44	3.02	2.88	0.14	20.3 : 1	130	76.85	1.36	2.46	94.78	98.68	34.9
22.56	5.37	2.82	2.67	0.15	17.8 : 1	128	83.81	0.93	1.69	96.38	99.00	34.9
22.53	5.29	2.83	2.69	0.14	19.2 : 1	123	81.85	1.01	1.92	96.09	98.96	35.0
22.57	6.24	3.42	3.25	0.17	18.6 : 1	137	88.71	0.70	1.26	97.19	99.25	35.1
22.62	6.09	3.02	2.87	0.15	19.1 : 1	130	82.81	1.00	1.83	96.11	98.97	35.0
22.18	3.39	2.42	2.31	0.11	21.0 : 1	144	79.97	1.32	3.21	94.88	98.26	35.3
11.73	3.64	2.04	1.95	0.09	21.7 : 1	140	82.74	1.11	2.80	95.64	98.48	35.3
11.98	2.78	2.44	2.35	0.09	26.1 : 1	98	79.23	0.94	2.26	96.19	98.55	35.6
33.20	7.66	3.13	2.98	0.15	19.1 : 1	114	82.68	0.91	2.20	96.32	98.42	35.3
22.27	4.37	2.51	2.40	0.11	21.8 : 1	124	81.16	1.07	2.62	95.76	98.43	35.4

Date.	DIET.				Calories per kilo.	URINE.					
	Nitro- gen	Fats	Carbo- hydrates	Fluid		Quantity	Sp. gr.	Total nitrogen	Urea	Uric acid	Ammo- nia
PERIOD A.											
8—9	24.72	221.92	255.03	1896	57.20	1500	1015	18.15	32.40	0.75	0.32
9—10	20.66	206.49	238.98	1840	52.60	1000	1025	15.82	28.60	0.88	0.22
10—11	24.24	221.71	219.93	1840	55.07	720	1023	12.24	22.88	1.28	0.13
11—12	22.74	197.14	227.63	1840	51.21	1000	1024	16.52	29.49	0.90	0.19
Average.....	23.09	211.82	235.39	1854	54.02	1055	1021	15.68	28.34	0.95	0.22
PERIOD B.											
15—16	20.92	168.55	189.75	1840	44.60	1400	1018	19.04	33.10	0.84	0.28
16—17	23.59	190.23	244.68	1840	51.24	930	1026	16.00	30.78	0.86	0.14
17—18	22.40	183.29	210.07	2008	47.43	400	1022	7.64	15.08	0.85	0.24
18—19	24.59	190.01	206.98	2176	48.87	1675	1022	27.97	44.90	1.22	0.14
Average.....	22.88	183.03	212.87	1966	48.04	1101	1022	17.66	30.97	0.94	0.20
PERIOD C.											
22—23	26.53	203.76	280.42	2390	56.25	1770	1022	32.39	58.59	1.03	0.37
23—24	26.69	186.58	287.12	2502	54.24	1340	1022	22.28	39.13	1.21	0.52
24—25	27.27	220.14	295.82	2502	59.44	1325	1022	22.13	40.28	0.89	0.29
25—26	26.58	203.19	269.72	2502	55.04	1590	1016	20.67	37.37	0.76	0.40
Average.....	26.77	203.42	283.28	2474	56.24	1506	1021	24.37	43.84	0.97	0.39
PERIOD D.											
29—30	26.80	185.80	359.91	2726	57.04	1800	1014	24.48	45.56	0.97	0.31
30—31	26.49	197.16	344.51	2726	57.70	1480	1017	18.65	30.78	0.98	0.47
31—1	25.03	139.63	264.91	2726	44.58	1850	1010	20.35	35.34	0.93	0.37
1—2	25.46	128.90	301.71	2726	45.20	2640	1013	27.98	47.78	1.27	—
Average.....	25.95	162.87	317.76	2726	51.13	1943	1014	22.87	39.87	1.04	0.38

URINE.						FÆCES.				Absorbed per cent.		Weight, kilos.
P ₂ O ₅	Chlo-rides	Sulphates				Quantity	Water per cent.	Nitro-gen	Fats	Nitro-gen	Fats	
		Total	Alka-line	Aro-matic	Ratio, A : B							
2.38	6.01	3.36	3.19	0.17	18.7 : 1	120	76.08	1.05	5.60	95.75	97.48	65.4
2.38	5.75	2.94	2.77	0.17	16.3 : 1	219	83.74	1.68	7.95	91.87	96.15	65.2
1.73	3.96	2.39	2.15	0.24	8.9 : 1	110	79.20	0.85	4.43	96.49	98.02	65.1
2.16	6.84	2.28	2.62	0.16	16.3 : 1	110	79.20	0.85	4.43	96.26	97.75	65.4
2.16	5.64	2.87	2.68	0.18	14.1 : 1	140	79.67	1.11	5.60	95.09	97.35	65.3
3.08	2.35	2.99	2.79	0.20	13.1 : 1	130	80.01	1.04	3.42	95.03	97.97	64.6
2.07	6.32	2.38	2.21	0.17	12.1 : 1	149	79.22	1.23	4.07	94.78	97.86	65.9
0.88	2.56	1.25	1.18	0.07	17.1 : 1	102	81.16	0.77	2.54	96.51	98.67	66.2
4.19	7.37	4.94	4.70	0.24	19.6 : 1	103	81.16	0.78	2.62	96.83	98.62	66.4
2.56	4.65	2.89	2.72	0.17	16.1 : 1	121	80.13	0.96	3.16	95.79	98.28	65.8
3.97	7.79	4.43	4.20	0.23	18.2 : 1	259	82.88	1.72	7.54	93.52	96.29	66.2
2.28	6.16	2.24	2.07	0.17	12.3 : 1	246	76.65	2.22	9.77	91.68	94.76	66.3
2.54	5.83	2.36	2.21	0.15	14.7 : 1	141	81.93	0.94	4.33	96.55	98.03	66.6
2.45	6.20	2.88	2.74	0.14	19.6 : 1	214	81.34	1.47	6.79	94.47	96.66	66.8
2.81	6.47	2.98	2.81	0.17	16.5 : 1	213	80.70	1.59	7.11	94.06	96.44	66.5
2.48	6.48	3.33	3.17	0.16	19.8 : 1	238	75.04	2.43	8.68	90.93	95.33	68.2
2.62	6.07	3.01	2.82	0.19	15.7 : 1	91	84.93	0.56	2.00	97.89	98.98	68.0
2.66	4.44	3.63	3.44	0.19	17.0 : 1	225	79.21	1.92	6.84	92.33	95.11	67.9
3.96	13.45	4.43	4.17	0.26	16.0 : 1	301	78.59	2.68	9.42	89.47	92.69	68.0
2.91	7.61	3.60	3.40	0.20	17.0 : 1	214	79.44	1.90	6.74	92.66	95.53	68.0

Date.	DIET.				Calories per kilo.	URINE.					
	Nitro- gen	Fats	Carbo- hydrates	Fluids		Quantity	Sp. gr.	Total nitrogen	Urea	Uric acid	Ammo- nia
PERIOD A.											
8—9	18.69	128.55	245.26	1924	51.94	1070	1014	7.61	15.23	0.24	0.14
9—10	16.69	124.09	227.16	1924	48.70	1275	1013	10.25	17.66	0.44	0.19
10—11	17.73	127.08	204.06	1924	47.89	1250	1012	9.45	16.13	0.39	0.13
11—12	16.56	125.07	214.46	1812	47.62	1575	1017	13.67	24.26	0.66	0.21
Average.....	17.42	126.20	222.74	1896	49.04	1293	1014	10.25	18.32	0.43	0.17
PERIOD B.											
15—16	19.12	178.24	236.31	1952	59.70	1000	1006	5.12	8.51	0.19	0.13
16—17	17.40	144.95	198.10	1952	50.12	900	1012	7.86	14.64	0.26	0.17
17—18	18.38	162.78	210.50	2120	54.22	1200	1011	7.90	14.64	0.39	0.13
18—19	19.25	154.74	232.39	2232	54.75	900	1011	5.40	8.69	0.19	0.20
Average.....	18.54	161.18	219.33	2064	54.70	1000	1010	6.57	11.62	0.26	0.16

URINE.						FÆCES.				Absorbed per cent.		Weight, kilos.
P ₂ O ₅	Chlorides	Sulphates				Quantity	Water per cent.	Nitrogen	Fats	Nitrogen	Fats	
		Total	Alkaline	Aromatic	Ratio, A : B							
1:20	2.92	1.33	1.25	0.08	15.9 : 1	160	76.98	1.58	4.79	91.83	96.27	51.6
2:12	6.05	2.11	2.20	0.11	17.3 : 1	54	76.22	0.55	1.67	96.76	98.65	51.6
1:06	4.50	—	—	—	—	118	78.33	1.09	3.33	93.85	97.43	51.6
2:14	6.02	2.62	2.43	0.19	12.8 : 1	117	78.33	1.08	3.30	93.37	97.36	51.8
1:63	4.87	2.02	1.89	0.13	14.5 : 1	113	77.47	1.08	3.27	93.95	97.43	51.7
0:97	2.19	0.85	0.77	0.08	9.6 : 1	159	82.12	1.22	5.07	93.62	97.16	52.2
1:46	3.34	1.37	1.32	0.05	26.4 : 1	87	80.21	0.74	3.07	95.72	97.88	52.0
1:32	2.28	1.45	1.33	0.12	11.1 : 1	86	80.21	0.73	3.04	96.03	98.13	52.6
0:91	2.39	0.91	0.84	0.07	12.0 : 1	114	65.29	1.69	7.06	91.24	95.63	52.7
1:17	2.55	1.15	1.07	0.08	13.4 : 1	114	75.87	1.10	4.56	94.15	97.20	52.4

Date.	DIET.				Calories per kilo.	URINE.					
	Nitro- gen	Fats	Carbo- hydrates	Fluids		Quantity	Sp. gr.	Total nitrogen	Urea	Uric acid	Ammo- nia
PERIOD A.											
8—9	19.72	124.87	248.87	1952	50.32	1350	1020	15.66	27.47	1.01	0.14
9—10	19.26	124.74	233.47	1952	48.53	1050	1022	12.93	21.88	0.85	0.19
10—11	17.16	118.88	233.47	1952	46.69	850	1021	12.02	20.57	0.77	0.23
11—12	17.40	118.26	244.71	1952	47.73	950	1024	13.17	22.33	0.93	—
Average.....	18.39	121.69	240.13	1952	48.32	1050	1022	13.45	23.06	0.89	0.19
PERIOD B.											
15—16	21.33	130.24	249.94	2232	53.61	1000	1023	13.78	24.02	0.93	6.24
16—17	19.51	124.29	197.92	2176	—	940	1024	12.88	22.84	0.77	0.26
17—18	20.97	124.50	221.02	2120	—	950	1024	13.32	24.41	0.79	0.36
18—19	21.31	129.17	233.37	2204	51.12	850	1025	11.73	17.25	0.57	—
Average.....	20.78	127.05	225.56	2183	52.37	935	1024	12.93	22.13	0.76	0.29
PERIOD C.											
22—23	35.12	176.05	260.12	2754	66.86	1300	1022	17.25	27.60	0.78	0.31
23—24	33.56	174.27	243.40	2642	—	1200	—	16.68	27.12	0.90	0.44
24—25	35.28	183.33	280.60	2754	—	950	1026	13.49	23.56	0.67	0.19
55—26	36.95	185.99	275.20	2754	70.46	1100	1020	13.30	19.80	0.88	—
Average.....	35.23	179.91	264.83	2726	68.66	1138	1023	15.18	24.52	0.81	0.31
PERIOD D.											
29—30	40.79	220.16	323.92	3444	81.87	2250	1018	24.75	41.46	1.49	0.63
30—31	39.34	207.57	307.27	3164	77.75	880	1012	11.53	20.15	0.58	0.24
31—1	40.22	208.48	278.87	3164	75.47	2190	1018	21.46	26.72	0.99	0.41
1—2	40.22	196.90	278.97	3164	74.04	1370	1015	14.80	25.07	0.92	0.38
Average.....	40.14	208.38	297.26	3234	77.28	1673	1014	18.14	28.34	1.02	0.42

URINE.						FÆCES.				Absorbed per cent.		Weight, kilos.
P ₂ O ₅	Chlo-rides	Sulphates				Quantity	Water per cent.	Nitro-gen	Fats	Nitro-gen	Fats	
		Total	Alka-line	Aro-matic	Ratio, A : B							
11.44	5.40	2.44	2.17	0.27	8.0 : 1	185	80.15	1.70	8.38	91.43	93.29	53.4
11.76	5.27	2.36	2.13	0.23	9.3 : 1	196	89.32	0.96	4.77	95.02	96.18	53.8
11.35	3.10	1.80	1.61	0.19	8.3 : 1	159	78.21	1.10	7.97	90.68	93.29	53.6
11.34	4.47	2.06	1.85	0.21	8.8 : 1	59	76.11	0.64	3.22	96.32	97.29	53.4
11.47	4.56	2.17	1.94	0.23	8.4 : 1	150	80.95	1.10	6.09	93.36	95.01	53.6
11.78	3.65	1.99	1.74	0.25	7.0 : 1	100	76.13	1.21	2.22	94.33	98.29	51.9
11.60	4.14	1.92	1.74	0.18	9.6 : 1	100	76.13	1.21	2.22	93.79	98.21	—
11.33	4.33	2.11	1.85	0.26	7.1 : 1	73	69.63	1.12	2.06	94.66	98.38	—
11.49	3.10	1.70	1.43	0.22	6.7 : 1	72	69.63	1.10	2.03	94.84	98.42	52.9
11.55	3.81	1.93	1.70	0.23	7.4 : 1	86	72.38	1.16	2.13	94.41	98.33	52.4
11.29	6.39	2.18	1.75	0.43	4.1 : 1	347	81.01	4.48	6.59	87.24	96.26	53.9
10.68	5.28	2.41	2.10	0.31	6.8 : 1	114	77.04	1.78	2.61	94.69	98.50	—
11.64	4.18	2.16	1.90	0.26	6.1 : 1	166	91.53	0.95	1.60	97.31	99.13	—
11.32	5.28	2.06	1.75	0.31	5.7 : 1	300	77.17	4.65	6.85	87.42	96.26	54.0
10.94	5.26	2.21	1.88	0.33	5.7 : 1	232	79.44	2.97	4.41	91.67	97.54	54.0
11.37	9.47	3.99	3.36	0.63	5.3 : 1	138	76.28	2.16	4.25	94.71	98.07	54.0
10.79	2.73	1.97	1.73	0.24	7.2 : 1	138	77.72	2.16	4.25	94.51	97.95	54.0
11.75	8.32	3.33	2.92	0.41	7.1 : 1	163	75.39	2.64	5.22	93.44	97.49	54.5
11.64	6.17	2.31	2.05	0.26	7.9 : 1	144	71.49	2.71	5.34	93.24	97.29	54.1
11.39	6.67	2.90	2.52	0.38	6.6 : 1	146	77.72	2.41	4.77	93.93	97.70	54.2

Date.	DIET.				Calories per kilo.	URINE.					
	Nitro- gen	Fats	Carbo- hydrates	Fluids		Quantity	Sp. gr.	Total nitrogen	Urea	Uric acid	Ammo- nia
PERIOD A.											
8—9	18.01	123.89	248.87	1896	42.49	980	1012	8.91	13.82	0.35	0.088
9—10	18.17	123.96	256.57	1924	42.77	950	1009	5.30	8.74	0.13	0.050
10—11	17.69	123.75	233.37	1896	41.11	1000	1010	6.89	12.71	0.38	0.092
11—12	15.96	119.82	241.17	1952	40.19	960	1010	6.05	10.85	0.22	0.099
Average.....	17.46	122.86	245.00	1917	41.64	973	1010	6.79	11.53	0.27	0.082
PERIOD B.											
15—16	22.30	196.04	259.06	2120	54.87	1000	1011	8.18	13.47	0.28	0.10
16—17	23.03	198.16	259.06	2190	54.46	510	1020	6.63	11.80	0.26	0.10
17—18	19.22	175.99	234.36	2120	48.21	790	1010	5.14	9.80	0.22	0.09
18—19	20.52	191.66	243.66	2232	51.43	880	1014	7.53	12.66	0.28	—
Average.....	21.02	190.46	249.04	2166	52.24	795	1014	6.87	11.93	0.26	0.10
PERIOD C.											
22—23	36.60	197.99	288.76	2866	60.78	1280	1014	11.90	21.38	0.37	0.13
23—24	36.91	209.63	284.37	2782	61.72	1430	1012	13.30	21.59	0.42	0.09
24—25	35.78	197.61	276.12	2782	59.52	930	1014	8.56	15.25	0.34	0.08
25—26	36.91	186.63	283.37	2782	58.02	880	1012	7.39	14.50	0.29	0.08
Average.....	36.55	197.72	283.16	2802	60.01	1130	1013	10.29	18.18	0.36	0.10
PERIOD D.											
29—30	25.85	186.49	267.97	2670	52.64	1300	1015	12.74	21.45	0.68	0.09
30—31	26.01	185.56	275.67	2780	53.03	970	1014	9.12	14.16	0.39	0.11
31—1	25.70	186.42	260.27	2670	51.78	1200	1012	9.84	—	0.35	0.13
1—2	25.86	186.49	267.97	2780	52.33	1420	1012	12.78	20.87	0.51	0.22
Average.....	25.85	186.49	267.97	2725	52.45	1223	1013	11.12	18.83	0.48	0.14

URINE.						FÆCES.				Absorbed per cent.		Weight, kilos.
P ₂ O ₅	Chlo- rides	Sulphates				Quantity	Water per cent.	Nitro- gen	Fats	Nitro- gen	Fats	
		Total	Alka- line	Aro- matic	Ratio, A : B							
11·04	0·98	1·67	1·53	0·14	10·9 : 1	334	82·03	2·46	9·63	86·34	92·23	62·0
10·63	2·47	0·87	0·73	0·14	12·0 : 1	666	94·89	1·39	5·46	92·35	95·59	62·2
11·40	2·19	1·38	1·28	0·10	12·8 : 1	450	95·91	0·75	2·95	95·76	97·62	62·3
10·94	3·65	1·09	0·96	0·13	7·4 : 1	540	82·06	3·97	15·64	75·13	87·03	62·5
11·00	2·32	1·25	1·12	0·13	8·6 : 1	498	88·72	2·14	8·42	87·40	93·12	62·3
11·31	1·38	1·27	1·18	0·09	13·1 : 1	190	77·09	1·57	6·56	92·97	96·65	63·0
10·83	2·30	1·46	1·36	0·10	13·6 : 1	397	84·28	2·14	8·99	90·71	95·46	63·7
10·79	3·16	0·85	0·75	0·10	7·5 : 1	398	84·98	2·15	9·02	88·81	94·87	64·1
11·14	3·70	—	—	—	—	66	76·63	0·55	2·32	97·27	98·79	64·3
11·02	2·64	1·20	1·10	0·10	11·0 : 1	265	79·57	1·60	6·72	94·94	96·44	63·8
11·60	6·14	2·16	2·00	0·16	12·5 : 1	76	65·81	1·84	1·91	94·97	99·03	65·2
11·05	4·43	1·95	1·73	0·22	7·9 : 1	59	76·58	0·94	1·64	97·45	99·69	65·8
10·93	3·35	1·45	1·30	0·15	8·7 : 1	245	73·19	4·46	7·86	87·53	96·02	65·3
10·84	2·38	1·12	1·05	0·07	15·0 : 1	70	83·87	0·78	1·35	97·89	99·28	66·1
11·11	4·08	1·67	1·52	0·15	10·1 : 1	113	74·86	2·01	3·19	94·46	98·51	65·6
11·61	4·68	2·28	2·12	0·16	13·3 : 1	77	73·36	0·86	3·22	96·67	98·81	66·4
11·02	3·20	1·66	1·55	0·11	14·1 : 1	201	77·41	1·90	6·86	96·29	96·22	66·6
11·44	3·96	1·68	1·58	0·10	15·8 : 1	129	77·96	1·19	4·46	95·37	97·68	66·8
11·56	5·68	2·28	2·13	0·15	14·2 : 1	129	77·96	1·19	4·46	95·39	97·61	66·8
11·16	4·38	1·98	1·85	0·13	14·3 : 1	134	76·67	1·29	4·75	94·50	97·83	66·6

Date	Time	Temperature				Humidity				Wind				Remarks
		Air	Surf	Wet Bulb	Dew Point	Rel. Hum.	Wet Bulb	Dew Point	Rel. Hum.	Dir.	Force	Speed	Direction	
1901	12:00	60.0	58.0	55.0	52.0	75.0	55.0	52.0	75.0	W	10	10.0	270	
1901	1:00	61.0	59.0	56.0	53.0	74.0	56.0	53.0	74.0	W	10	10.0	270	
1901	2:00	62.0	60.0	57.0	54.0	73.0	57.0	54.0	73.0	W	10	10.0	270	
1901	3:00	63.0	61.0	58.0	55.0	72.0	58.0	55.0	72.0	W	10	10.0	270	
1901	4:00	64.0	62.0	59.0	56.0	71.0	59.0	56.0	71.0	W	10	10.0	270	
1901	5:00	65.0	63.0	60.0	57.0	70.0	60.0	57.0	70.0	W	10	10.0	270	
1901	6:00	66.0	64.0	61.0	58.0	69.0	61.0	58.0	69.0	W	10	10.0	270	
1901	7:00	67.0	65.0	62.0	59.0	68.0	62.0	59.0	68.0	W	10	10.0	270	
1901	8:00	68.0	66.0	63.0	60.0	67.0	63.0	60.0	67.0	W	10	10.0	270	
1901	9:00	69.0	67.0	64.0	61.0	66.0	64.0	61.0	66.0	W	10	10.0	270	
1901	10:00	70.0	68.0	65.0	62.0	65.0	65.0	62.0	65.0	W	10	10.0	270	
1901	11:00	71.0	69.0	66.0	63.0	64.0	66.0	63.0	64.0	W	10	10.0	270	
1901	12:00	72.0	70.0	67.0	64.0	63.0	67.0	64.0	63.0	W	10	10.0	270	
1901	1:00	73.0	71.0	68.0	65.0	62.0	68.0	65.0	62.0	W	10	10.0	270	
1901	2:00	74.0	72.0	69.0	66.0	61.0	69.0	66.0	61.0	W	10	10.0	270	
1901	3:00	75.0	73.0	70.0	67.0	60.0	70.0	67.0	60.0	W	10	10.0	270	
1901	4:00	76.0	74.0	71.0	68.0	59.0	71.0	68.0	59.0	W	10	10.0	270	
1901	5:00	77.0	75.0	72.0	69.0	58.0	72.0	69.0	58.0	W	10	10.0	270	
1901	6:00	78.0	76.0	73.0	70.0	57.0	73.0	70.0	57.0	W	10	10.0	270	
1901	7:00	79.0	77.0	74.0	71.0	56.0	74.0	71.0	56.0	W	10	10.0	270	
1901	8:00	80.0	78.0	75.0	72.0	55.0	75.0	72.0	55.0	W	10	10.0	270	
1901	9:00	81.0	79.0	76.0	73.0	54.0	76.0	73.0	54.0	W	10	10.0	270	
1901	10:00	82.0	80.0	77.0	74.0	53.0	77.0	74.0	53.0	W	10	10.0	270	
1901	11:00	83.0	81.0	78.0	75.0	52.0	78.0	75.0	52.0	W	10	10.0	270	
1901	12:00	84.0	82.0	79.0	76.0	51.0	79.0	76.0	51.0	W	10	10.0	270	
1901	1:00	85.0	83.0	80.0	77.0	50.0	80.0	77.0	50.0	W	10	10.0	270	
1901	2:00	86.0	84.0	81.0	78.0	49.0	81.0	78.0	49.0	W	10	10.0	270	
1901	3:00	87.0	85.0	82.0	79.0	48.0	82.0	79.0	48.0	W	10	10.0	270	
1901	4:00	88.0	86.0	83.0	80.0	47.0	83.0	80.0	47.0	W	10	10.0	270	
1901	5:00	89.0	87.0	84.0	81.0	46.0	84.0	81.0	46.0	W	10	10.0	270	
1901	6:00	90.0	88.0	85.0	82.0	45.0	85.0	82.0	45.0	W	10	10.0	270	
1901	7:00	91.0	89.0	86.0	83.0	44.0	86.0	83.0	44.0	W	10	10.0	270	
1901	8:00	92.0	90.0	87.0	84.0	43.0	87.0	84.0	43.0	W	10	10.0	270	
1901	9:00	93.0	91.0	88.0	85.0	42.0	88.0	85.0	42.0	W	10	10.0	270	
1901	10:00	94.0	92.0	89.0	86.0	41.0	89.0	86.0	41.0	W	10	10.0	270	
1901	11:00	95.0	93.0	90.0	87.0	40.0	90.0	87.0	40.0	W	10	10.0	270	
1901	12:00	96.0	94.0	91.0	88.0	39.0	91.0	88.0	39.0	W	10	10.0	270	
1901	1:00	97.0	95.0	92.0	89.0	38.0	92.0	89.0	38.0	W	10	10.0	270	
1901	2:00	98.0	96.0	93.0	90.0	37.0	93.0	90.0	37.0	W	10	10.0	270	
1901	3:00	99.0	97.0	94.0	91.0	36.0	94.0	91.0	36.0	W	10	10.0	270	
1901	4:00	100.0	98.0	95.0	92.0	35.0	95.0	92.0	35.0	W	10	10.0	270	
1901	5:00	101.0	99.0	96.0	93.0	34.0	96.0	93.0	34.0	W	10	10.0	270	
1901	6:00	102.0	100.0	97.0	94.0	33.0	97.0	94.0	33.0	W	10	10.0	270	
1901	7:00	103.0	101.0	98.0	95.0	32.0	98.0	95.0	32.0	W	10	10.0	270	
1901	8:00	104.0	102.0	99.0	96.0	31.0	99.0	96.0	31.0	W	10	10.0	270	
1901	9:00	105.0	103.0	100.0	97.0	30.0	100.0	97.0	30.0	W	10	10.0	270	
1901	10:00	106.0	104.0	101.0	98.0	29.0	101.0	98.0	29.0	W	10	10.0	270	
1901	11:00	107.0	105.0	102.0	99.0	28.0	102.0	99.0	28.0	W	10	10.0	270	
1901	12:00	108.0	106.0	103.0	100.0	27.0	103.0	100.0	27.0	W	10	10.0	270	
1901	1:00	109.0	107.0	104.0	101.0	26.0	104.0	101.0	26.0	W	10	10.0	270	
1901	2:00	110.0	108.0	105.0	102.0	25.0	105.0	102.0	25.0	W	10	10.0	270	
1901	3:00	111.0	109.0	106.0	103.0	24.0	106.0	103.0	24.0	W	10	10.0	270	
1901	4:00	112.0	110.0	107.0	104.0	23.0	107.0	104.0	23.0	W	10	10.0	270	
1901	5:00	113.0	111.0	108.0	105.0	22.0	108.0	105.0	22.0	W	10	10.0	270	
1901	6:00	114.0	112.0	109.0	106.0	21.0	109.0	106.0	21.0	W	10	10.0	270	
1901	7:00	115.0	113.0	110.0	107.0	20.0	110.0	107.0	20.0	W	10	10.0	270	
1901	8:00	116.0	114.0	111.0	108.0	19.0	111.0	108.0	19.0	W	10	10.0	270	
1901	9:00	117.0	115.0	112.0	109.0	18.0	112.0	109.0	18.0	W	10	10.0	270	
1901	10:00	118.0	116.0	113.0	110.0	17.0	113.0	110.0	17.0	W	10	10.0	270	
1901	11:00	119.0	117.0	114.0	111.0	16.0	114.0	111.0	16.0	W	10	10.0	270	
1901	12:00	120.0	118.0	115.0	112.0	15.0	115.0	112.0	15.0	W	10	10.0	270	



