remain up and about, later in the day. Of the twenty-five deaths four were from non-cardiac causes, in five the cause was unknown, and sixteen resulted from cardiac causes.

These conclusions would seem to indicate that "angina pectoris"—to use the inaccurate and general label—is not a dangerous symptom; for death does not occur during the attack of pain, and except in so far as it is the manifestation of a terminal coronary thrombosis the pain itself is not the fatal condition it is so commonly thought to be. This being so, it is the duty of the medical profession to discard the attitude of terror and taboo which is still so prevalent when dealing with and discussing this symptom, and to teach the general public that "angina" is in most cases not a dangerous or fatal condition; that, on the contrary, it is compatible with many years of useful life and is amenable to treatment; that danger is only to be feared from the underlying vascular disease.

Factors Influencing Prognosis

It can be said at once that the numbers in this series are too small for any accurate statistical analysis, but the following facts appear to emerge. Cardiac asthma, as would be expected, is a dangerous symptom, for all three patients died within two years. Abnormalities in the T wave of the electrocardiogram in Leads I and II seemed to be the next most serious finding. Seven out of ten patients in whom the T wave was inverted in Lead I or Lead II, or both, died, and two out of three patients died in whom the T wave was diphasic in Lead I or II. Thus nine out of thirteen patients with abnormalities of the T wave in Leads I and II died. This abnormality was not the transient electrocardiographic change of coronary thrombosis, but was persistent and permanent. Dyspnoea on exercise of a moderate degree was not more common in patients who subsequently died; not enough evidence was obtained that the presence, the absence, or the degree of dyspnoea resulting from exercise was helpful in prognosis. Coronary thrombosis is obviously likely to be a common cause of death in this group; but it is remarkable that the twelve patients in whom angina of effort started with a coronary thrombosis all remain alive. Active syphilis produced death in two cases out of eight; a third syphilitic patient died, but with coronary thrombosis in an atheromatous vessel. Diabetes appeared to make no difference to the prognosis.

It would thus seem that the cardiac prognosis ultimately depends upon whether or not a fatal coronary thrombosis is likely to develop, and upon the state of the left ventricular muscle. The only safe guide to determining this second point would be the amount of exercise that such a patient can undertake. This is of course generally restricted by the exercise pain. Some patients, however, can on some days undergo far more exertion without suffering pain than they can on others, and in these circumstances ability to climb hills or to walk reasonably well during a painless period is the most valuable prognostic point obtainable. Other complications of vascular disease, such as cerebral thrombosis, may prove fatal; this occurred in four cases in the present series.

Conclusions

1. Angina of effort is a clear-cut and definite symptom.
2. Angina of effort is associated in a very high percentage of cases with provable organic cardiovascular disease.

3. In our opinion, taking into account the impossibility in some cases of proving during life that coronary disease exists, angina of effort does not occur without coronary disease, except possibly in some cases of severe anaemia.

4. This coronary disease may be severe or slight, and probably in the majority of cases does not cause obstruction to the blood flow in the resting heart, but produces its effect by interfering with the normal stretching of the coronary arteries which occurs during exertion.

5. Angina of effort is in itself not a dangerous symptom: patients do not die in an attack. Danger is only to be apprehended from the occasional occurrence of coronary thrombosis, from the results of coronary atheroma on the ventricular muscle, or from other vascular accidents.

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THE SHORTAGE OF CALCIUM IN THE "POORER-CLASS" DIET

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Certain routine tests carried out in this laboratory gave results which emphasized the fact that the ordinary diet of the poorer classes, consisting largely of bread, margarine, jam, potatoes, some meat, and a little milk and fresh vegetables, might be seriously deficient in bone-forming elements. An experiment designed to test this point has amply confirmed the suspicion.

Simpson and Wood (1935) investigated the influence of supplements of (a) cod-liver oil, (b) halibut-liver oil plus dried milk, and (c) virol to the diet of children attending various infant welfare centres in a typical London area. The children were mostly from working-class homes, and their diet was not controlled by the investigators. The doses of the three supplements were adjusted so that each child received an additional 75 calories a day. The amount of vitamin D received daily as cod-liver oil by each child was 2,080 international units, contained in 8 grammes of oil, which was therefore a very rich sample. (The *British Pharmacopoeia* 1937 Addendum requires a minimum vitamin D content of 85 international units per gramme.) The dose of halibut-liver oil gave approximately three and a half times as much vitamin A (as judged by "blue units") and a quarter as much vitamin D as the dose of cod-liver oil. Since the daily dose of halibut-liver oil was only 0.2 gramme, an extra half-ounce of dried milk was given to bring the calorie value of the total supplement up to that of the cod-liver oil supplement. The daily dose of virol was 20 grammes, stated to have a

calorie value of 74. Its vitamin content was said to be not so high as that of the doses of cod-liver oil or halibut-liver oil, but "sufficient to obviate the possibility of a complete lack of vitamins in the basic diet." Its special value as a supplement was thought to be due to its balance of protein, fat, and carbohydrate. The result of this investigation, stated briefly, may be said to show that the giving of cod-liver oil or of halibut-liver oil plus milk was beneficial, but that virol was more beneficial still. An elaborate statistical examination of the results showed that the observed differences might be considered significant.

The question that interested us was what might be the deficiency in the children's diet that was being made good by the addition of 20 grammes of virol a day. It seemed scarcely possible that about three-quarters of an ounce of a "well-balanced" food could seriously affect the increase in weight of a child. Moreover, when the 22.4 per cent. of volatile matter, probably mostly water, was allowed for, it left only 16.52 grammes of well-balanced food—very little more than the half-ounce (14.17 grammes) of dried milk which had not had a beneficial effect, although milk must surely be one of the best-balanced foods known. This, then, did not appear to account for the result obtained.

An examination of the published list of contents of virol—namely, marrow fat, glycerin, extract of red bone marrow, eggs, salts of calcium, iron, etc., malt extract, and the juice of fresh lemons—suggested that the vitamin B it contained might be high enough to produce beneficial effects when the basic diet was low in these factors. A biological determination of the vitamin B₁ value of a sample of virol purchased in the open market was made in this laboratory. It was found to be 0.7 international unit per gramme. Thus the daily dose of virol given to each child contained about 14 international units, and since a child of 4 years requires about 55 international units of vitamin B₁ a day, this cannot be considered a very large contribution to its needs. Moreover, the supplement of dried milk would contain 6 to 9 units of vitamin B₁ if none had been lost in the drying. It is unlikely that modern methods of drying milk would reduce the vitamin B₁ potency much, and it was concluded from these calculations that it was probably not the presence of vitamin B₁ in the virol that accounted for its beneficial effect on the children.

First General Nutrition Experiment on Rats

It was therefore decided to repeat the whole experiment on rats as it had been carried out on the children. Four groups of eight rats each were used, to correspond to the four groups of children. Litters of four or eight rats were divided among the groups so that each litter was represented equally in each group, which comprised three male and five female rats. Each rat was kept in a separate cage throughout the experiment, and the cage was provided with a grid so that the animal had no access to faeces. Fresh tap-water of the Bloomsbury district was supplied daily.

The experiment was carried on for six weeks. Throughout that time the rats were weighed twice a week. The diet given to all the rats was chosen so as to be as much like the diet of the poorer classes as possible. The scheme drawn up at the beginning and followed with almost no variation is given in Table I.

The groups of rats received supplements similar to those given to the groups of children—namely: Group 1, no supplement; Group 2, cod-liver oil; Group 3, halibut-

liver oil; Group 4, virol. The doses of cod-liver oil, halibut-liver oil, and virol respectively were determined from the following consideration. The calorie requirement of children from 2 to 3 years is 1,100 to 1,400; that of children of 3 to 6 is 1,400 to 1,700 (Ministry of Health Nutrition Report, 1934). If the average require-

TABLE I.—*Diet Sheet for the First Nutrition Test*

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
White bread, 12-15 gm.*	White bread, 12-15 gm.*	White bread, 12-15 gm.*	White bread, 12-15 gm.*	White bread, 12-15 gm.*	White bread, 12-15 gm.*	Hovis bread, 12-15 gm.*
Margarine, 0.1 gm.	Meat, cooked, 0.5 gm.	Butter, 0.1 gm.	Meat, cooked, 0.5 gm.	Butter, 0.1 gm.	Greens, boiled, 1 gm.	Sausage, cooked, 1 gm.
Jam, 0.2 gm.	Tea with milk, 2 c.cm.	Jam, 0.2 gm.		Jam, 0.2 gm.	Milk, 2 c.cm.	
Boiled potato, 1 gm.		Boiled potato, 1 gm.		Boiled potato, 1 gm.		
Greens, boiled, 1 gm.		Greens, boiled, 1 gm.		Tea with milk, 2 c.cm.		
				Fish, cooked, 0.5 gm.		

* Never all eaten, but excess given so that the rats should not be hungry.

ment of the children in the experiment was 1,500 calories, then the 75 calories given as a supplement would be one-twentieth of their daily needs.

A rat of 40 grammes weight requires 4 to 5 grammes dry weight of fat-free food a day. The rats' supplement for this experiment should supply one-twentieth of the calorie intake—that is, 1/20 of 20 calories, which is 1 calorie. The dose of cod-liver oil given to each child of Group 2 was 8 grammes; therefore the dose for each rat of Group 2 was 1/75 of this, which was 0.11 gramme. This would yield 1 calorie.

Similarly the dose of halibut-liver oil given to each child of Group 3 was 0.2 gramme, and therefore the dose for each rat of Group 3 would be 1/75 of 0.2 gramme, which was 0.0027 gramme. This would yield 0.025 calorie. Also 1/75 of 1/2 oz. of dried milk would be 1/75 of 14.17 grammes = 0.19 gramme—yielding about 1 calorie. The dose of oil was given as one drop of a dilution of halibut-liver oil (27 in 200) in olive oil. The dose of dried milk was weighed for each rat and given on a small dish, moistened with water. It was stated that 20 grammes of virol had a calorific value of 74, therefore 0.27 gramme of virol would have a calorific value of 1. This was given on a small dish. It was always taken readily.

It is recognized that giving supplements to experimental rats was not necessarily comparable to giving supplements to children, for it is possible that the children did not receive enough food (calories) for their needs, whereas the rats were given more food than they ate. Experiments on rats are almost always carried out in this way, for a rat eats only enough each day for its needs, the amount having often been shown, from records of food given and food left, to be fairly constant from day to day.

The cod-liver oil and halibut-liver oil used for the rats were as nearly as could be judged of the same vitamin A and D content as the oils used for the children. The vitamin D content of the oils used for the children was stated in international units, but the vitamin A value was only given in "blue units," and other oils with similar "blue value" cannot be regarded as having necessarily the same vitamin A values. Oils of nearly similar vitamin D and "blue" values were used for the rats, and the

doses of both cod-liver and halibut-liver oils were so high that they must have contained abundance of vitamins A and D to satisfy the rats' needs.

Result of First Experiment

(a) *Increase in Weight.*—The effect on the weights of the rats may be seen in the accompanying chart of the

Chart showing the effect of giving (a) no supplement, (b) cod-liver oil, (c) halibut-liver oil plus dried milk, (d) virol on the increase in weight of rats fed on a diet as much as possible like that of the poorer classes. The three supplements are of equal calorific value.

growth curves. The variation between the rats of any one group is not great. The results are summarized in Table II. The average increase in weight of the control

TABLE II.—Average Increase in Weight in Six Weeks of Four Groups of Rats given a Mixed "Poorer-class" Diet, with Supplements in Three of the Groups

Group	Supplement	Average Increase in Weight in Six Weeks (grammes)		Average Increase in Weight of Males and Females (grammes)
		Males	Females	
Group 1 (No supplement)		43.7	42.2	42.95
" 2 (+ Cod-liver oil)		69.7	65.6	67.65
" 3 (+ Halibut-liver oil and milk)		84.3	73.6	78.95
" 4 (+ Virol)		42.7	48.8	45.75

rats given the "poorer-class" diet only was 42.95 grammes in six weeks; that of the rats receiving the cod-liver oil supplement was 67.65 grammes; and that of the rats given the halibut-liver oil plus dried milk was

78.95 grammes—clear evidence of the lack in this diet of factors (for example, vitamins A and D) which can be supplied by cod-liver oil and by halibut-liver oil plus a little dried milk. On the other hand the increase in weight of the rats given the supplement of virol was 45.75 grammes, which was only slightly, certainly not significantly, greater than that of the rats receiving no supplement. We have completely failed to reproduce in rats the effect which Simpson and Wood obtained on children and to discover what determined the effect.

(b) *Further Comparison of the Supplements by a Different Criterion—"Ash Content of the Bones."*—Before the termination of the experiment we decided to compare the four groups of rats by another criterion—namely, the ash content of the bones—to see whether some constituent of the virol might have had an effect on calcification which could not be brought about by vitamin therapy alone. Accordingly, the percentage of ash of the dry extracted bone (one femur and one humerus, separately, of each rat) was determined in four rats in each group. The result may be seen in Table III.

TABLE III.—The Percentage of Ash in the Dry Extracted Bone (Femur and Humerus) of Four Rats of Each of the Groups 1, 2, 3, and 4

Group	Supplement	Litter	Rat	Ash in Dry Extracted Bone	Average Ash Content
1	None	6472	9308 (M)	F 43.31	40.19
			9334 (M)	H 40.28	
		6473	9317 (F)	F 38.07	
			9342 (F)	H 38.73	
2	Cod-liver oil	6475	9306 (M)	F 37.34	37.59
			9332 (M)	H 39.44	
		6476	9315 (F)	F 42.85	
			9340 (F)	H 41.18	
3	Halibut-liver oil + milk	6472	9305 (M)	F 36.69	39.48
			9331 (M)	H 36.62	
		6473	9314 (F)	F 35.77	
			9339 (F)	H 37.54	
4	Virol	6475	9307 (M)	F 36.12	38.70
			9333 (M)	H 40.14	
		6476	9316 (F)	F 37.90	
			9341 (F)	H 39.96	

There is no significant difference between the average ash contents of the four groups, and they are all very much below the normal (which is 50 to 55 per cent.) for rats of their age and weight, although two groups at least received abundance of vitamin D. It seems highly probable, therefore, that none of the rats received enough calcium or phosphorus, or both, for normal calcification to take place. This was an alarming possibility. It has been generally recognized that the value of fresh milk as a food is partly due to its calcium and phosphorus content, but it had not seemed possible to us that the ordinary mixed poorer-class diet could be so seriously deficient in these elements as to reduce the percentage of ash in the bones of growing rats from 55 to 40 per cent. in six weeks. Another experiment was therefore carried out to determine whether it really was a shortage of calcium and phosphorus in the diet that had led to the low calcification.

Second General Nutrition Experiment on Rats

Six groups of eight rats (five males and three females), weighing about 40 grammes each, were fed for five weeks on the same diet as the rats in the first experiment, each rat being housed in a separate cage with a grid raised one inch above the floor. The same Bloomsbury tap-water was supplied daily. Each rat in every group was given six drops (approximately 0.12 gramme) of a good sample of cod-liver oil daily directly into its mouth. One group received no other supplement, three groups were given graded amounts of a mixture of salts containing calcium and phosphorus, and two groups had different amounts of milk.

The salt mixture was made up of the salts which contained calcium and phosphorus in Steenbock's salt mixture No. 40, in the proportion in which they occur there. It therefore consisted of:

	grammes
Disodium hydrogen phosphate, $\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$	35.8
Dipotassium hydrogen phosphate, K_2HPO_4	69.6
Calcium phosphate, $\text{Ca}_3(\text{H}_2\text{PO}_4)_2 \cdot 4\text{H}_2\text{O}$	68.8
Calcium lactate, $\text{C}_6\text{H}_{11}\text{O}_5\text{Ca} \cdot 5\text{H}_2\text{O}$	15.4
	189.6

These salts constitute about 75 per cent. of Steenbock's salt mixture No. 40, and as this mixture furnishes abundance of calcium and phosphorus when supplied as 4 per cent. of the diet for vitamin A or B₁ tests, 3 per cent. of the new salt mixture should provide plenty of calcium and phosphorus when given to rats receiving a mixed diet. Assuming a young rat eats 5 to 6 grammes dry weight of food per day, he should be given 0.15 to 0.18 gramme of salt mixture to supply the necessary calcium and phosphorus. The salt mixture contains 9.5 per cent. calcium and 14.8 per cent. phosphorus; therefore 0.18 gramme of mixture would furnish 0.017 gramme calcium and 0.027 gramme phosphorus daily. The supplements given to the different groups of rats were thus:

- Group 1: No supplement.
- Group 2: 0.02 gramme salt mixture daily.
- Group 3: 0.06 gramme salt mixture daily.
- Group 4: 0.18 gramme salt mixture daily.
- Group 5: 5 ml. pasteurized milk daily.
- Group 6: Pasteurized milk *ad lib.* (average 13.6 ml. daily at the beginning of the experiment, up to 20 ml. later).

The doses of salt mixture were given in separate dishes, mixed with a little dextrin and moistened with water to prevent scattering. The rats took their portions readily. Group 1 received a similar amount of dextrin.

Result of Second Experiment

(a) *Increase in Weight.*—The effect of the supplements on the increase in weight of the groups of rats may be seen in Table IV. The groups were very small, consisting of five males and three females each, therefore slight differences in averages cannot be considered seriously. Thus the supplements of the salt mixture cannot be regarded as having had any influence on the increase in weight of the rats, but the milk supplements certainly had a beneficial effect. It is, of course, impossible to say which constituent of the milk it was that made good a deficiency in the mixed diet. It may have been the proteins of high biological value or some part of the vitamin B complex. It would not be the vitamin A or D content, as the rats were receiving so much of both of these factors in their doses of cod-liver oil that a little more could not have any effect. The mineral content of the milk will be considered in the next section of the results.

TABLE IV.—Average Increases in Weight of Groups of Rats (five male and three female) given a "Poorer-class" Diet plus a Liberal Dose of Cod-liver Oil Daily, and, in addition, Graded Doses of a Calcium-Phosphorus Salt Mixture or Graded Doses of Pasteurized Milk Respectively.

Group	Supplement	Average Increase in Weight in Five Weeks (grammes)		Average Increase in Weight of Males and Females (grammes)	
		Males (5)	Females (3)	Weighted Means	Means as if from Equal Number of Males and Females
1	None	52.0 (4 only)	47.3	50.0	49.65
2	0.02 gm. salt mixture	53.2	55.7	54.1	54.45
3	0.06 gm. " "	55.8	51.7	54.3	53.75
4	0.18 gm. " "	54.7	63.5 (2 only)	57.2	59.10
5	5.0 ml. milk ..	76.6	80.3	78.0	78.45
6	Milk <i>ad lib.</i> , average 13.6 ml. during the first three days; unmeasured later, but less than 20 ml.	120.0	80.3	105.1	100.05

(b) *Calcification of Bones.*—The percentage of ash in a dry fat-extracted femur and humerus of each rat was determined in the usual way. The results are shown in Table V.

It is quite evident that the mixed diet similar to that of the poorer classes is seriously deficient in calcium and phosphorus. The bones of the rats receiving the mixed diet plus liberal amounts of cod-liver oil contained only 39.70 per cent. of ash, which is similar to the results found in the first experiment. The addition of graded quantities of a mixture of salts containing calcium and phosphorus brought about increased calcification, the greater the dose of salt mixture given the greater being the calcification of the bones. The highest dose of salt mixture produced 52.12 per cent. of ash, which may be considered a normal amount for rats of their age.

The small dose of milk, 5 ml. daily, produced an ash content of 45.74 per cent., slightly less than that obtained from the addition of 0.06 gramme of the salt mixture. The high dose (20 ml. daily, of which 2 or 3 ml. was generally left) produced an ash content, 52.03, equal to that yielded by the highest dose, 0.18 gramme, of salt mixture. Unfortunately no determination of the calcium and phosphorus content of the milk given to the rats was made, but the following calculation leads to an instructive conclusion.

Apparently 5 ml. of the milk contained less calcium than 0.06 gramme of the salt mixture given. We may suppose that 5 ml. of the milk had as much calcium as 0.04 gramme of the salt mixture—that is, 0.0038 gramme. Therefore the milk apparently contained 0.76 gramme of calcium per litre. This result seems to have some bearing on the question of the availability of the calcium in milk. It is generally stated that milk owes a great part of its value as an antirachitic agent not merely to its high calcium content but to the fact that the calcium is present in a specially available form. Now the average calcium content of milk is 1.12 grammes per litre. The milk used in this experiment apparently contained 0.76 gramme per litre, judging from the effects produced on different groups of rats given 5 ml. of milk and known graded amounts of calcium respectively. Now, if the calcium of the milk were more easily available than the calcium of the salt mixture a *smaller* amount of calcium than 0.0038 gramme in 5 ml. of milk

TABLE V.—*The Percentage of Ash in the Dry Extracted Bone (Femur and Humerus) of the Rats of Each of the Groups 1, 2, 3, 4, 5, and 6*

Group	Supplement	Litter	Rat	Ash in Dry Extracted Bone	Average Ash Content
1	None	6951	2627 (M)	F 40.18	39.70
				H 39.30	
		6952	2631 (M)	F 40.14	
				H 37.22	
		6958	2567 (M)	F 39.34	
				H 40.00	
		6960	2675 (M)	Died	
		6978	2777 (M)	F 40.00	
				H 38.71	
2	0.02 gm. salt mixture	6952	2636 (F)	F 43.25	42.83
				H 41.93	
		6958	2658 (M)	F 41.94	
				H 41.84	
		6960	2676 (M)	F 40.52	
				H 40.73	
		6978	2776 (M)	F 43.37	
				H 45.24	
		6963	2704 (M)	F 42.12	
3	0.06 gm. salt mixture	6951	2625 (M)	F 48.74	48.33
				H 50.00	
		6952	2632 (M)	F 48.22	
				H 49.00	
		6958	2659 (M)	F 45.49	
				H 47.53	
		6960	2677 (M)	F 45.84	
				H 46.28	
		6978	2775 (M)	F 46.71	
4	0.18 gm. salt mixture	6951	2624 (M)	F 50.30	52.12
				H 52.79	
		6952	2635 (F)	F 54.49	
				H 54.11	
		6958	2660 (M)	F 50.23	
				H 47.98	
		6960	2678 (M)	F 52.35	
				H 50.73	
		6978	2780 (F)	Died	
5	5 ml. milk	6951	2623 (M)	F 44.78	45.74
				H 47.46	
		6952	2634 (F)	F 45.47	
				H 46.60	
		6958	2661 (M)	F 44.04	
				H 42.63	
		6960	2679 (M)	F 43.89	
				H 42.82	
		6978	2778 (F)	F 47.77	
6	Milk <i>ad lib.</i>	6951	2622 (M)	F 49.72	52.03
				H 50.00	
		6952	2633 (M)	F 47.82	
				H 48.06	
		6958	2662 (M)	F 53.54	
				H 55.85	
		6960	2680 (M)	F 52.07	
				H 51.33	
		6978	2779 (F)	F 56.39	

would have produced the effect obtained. But it is very unlikely that our milk contained much less than 0.76 gramme of calcium per litre, since the average value is 1.12 grammes. Therefore it seems highly probable from this experiment that the calcium of milk is no more easily available to the rat than is the calcium of inorganic salts. This point will be investigated by direct experiment later.

Each day during the first and fifth weeks a typical ration for a rat was dried at 100° C. The seven weekly rations were bulked separately. The dry weight of the first week's ration was 100 grammes and of the fifth week's ration 85 grammes. As an excess of bread was given each day these amounts exceeded the quantity of food eaten by each rat daily. The first week's ration contained 40.5 mg. calcium and 157 mg. phosphorus. The fifth week's ration contained 26.2 mg. calcium and 165 mg. phosphorus. The averages of these—33.3 mg. Ca and 161 mg. P—may be taken as an approximation of the average weekly supply of calcium and phosphorus to each rat, and 4.8 mg. Ca and 23 mg. P as the average daily supply. The amounts eaten would be somewhat less than these, as a little white bread was always left. The London tap-water was found to contain 6.38 mg. calcium per 100 ml. Thus a rat drinking 15 c.cm. of water daily would obtain about 1 mg. Ca per day or 7 mg. per week from this source. The amounts of calcium received by the rats of the first four groups would then be:

Group	Mg. Calcium Received per Rat per Day from			
	(a) The Diet	(b) Tap-water	(c) Supplement	Total
1	4.8	1	0	5.8
2	4.8	1	1.95	7.75
3	4.8	1	5.85	11.65
4	4.8	1	17.55	23.35

Since the medium dose of calcium salts was not sufficient to bring about perfect calcification and the highest did so, the amount of calcium needed for perfect calcification must lie somewhere between the two. A curve relating the average ash content of the groups and the quantities of calcium received indicates that the amount of calcium required by the rat for perfect calcification is about 15 mg. a day, which is some two and a half times the amount that the rats received from their diet without any supplement.

Leitch (1937) in a long review on the determination of the calcium requirements of man has concluded that a child of 2 to 9 years needs 0.9 gramme of calcium per day. The amount obtained by a child from the diet described here may be estimated from the following consideration. Assuming the ratio of the calorie intake of the child to that of the young rat (as in this experiment) to be 75:1, as calculated in the early part of this paper, the child would receive 360 mg. of calcium per day from the diet, and, assuming he drank two pints of water a day, he would receive about 70 mg. of calcium from the water. This makes a total of 430 mg. of calcium actually received, and he needs 900 mg.

Summary

A comparison of (a) cod-liver oil, (b) halibut-liver oil plus dried milk, and (c) virol, given as supplements to different groups of young rats fed liberally with a mixed diet of white bread, potatoes, cabbage, margarine, jam, tea, a little butter, milk, brown bread, sausage, etc.,

failed to confirm the results obtained by Simpson and Wood (1935) in a similar experiment on children. As judged by the increase in weight of the rats, the cod-liver oil had a decidedly beneficial effect, the halibut-liver oil plus dried milk had a slightly better effect, whilst the virol was almost without influence as compared with the control rats receiving no supplement. As judged by the percentage of the ash content of the bones of the rats, all three supplements were equally without effect. This suggested that the mixed diet was deficient in the elements required for calcification.

A second experiment was carried out on six groups of rats, all of which were fed liberally with the same mixed diet and given six drops each of a good sample of cod-liver oil daily—a very large dose for a rat. One group received no other supplement, three were given graded doses of a mixture of salts of calcium and phosphorus, and two had graded doses of milk.

The salt mixture had no significant influence on the increase in weight of the rats, but the doses of milk had a distinctly beneficial effect.

The graded doses of salt mixture produced graded results in the percentage of ash in the bones, ranging from 42.83 per cent. for the lowest dose (0.02 gramme) to 52.12 per cent. for the highest dose (0.18 gramme), which is about the normal percentage for rats such as these. The bones of the rats given no supplement contained 39.7 per cent. ash. This proves quite clearly that the ordinary mixed diet of the poorer classes is seriously deficient in the elements required for the calcification of bone.

The lower dose of milk, 5 ml., produced 45.74 per cent. of ash in the rats' bones; the higher dose, about 15 to 16 ml., produced 52.03 per cent. of ash. A comparison of the submaximal effects from the lower dose of milk and the lower doses of salt mixture showed that the milk apparently contained 0.76 gramme of calcium per litre. As this is less than the average calcium content (1.12 grammes per litre) of cows' milk it is concluded that the calcium of cows' milk is no more easily available for the rat than the calcium of inorganic salts.

The serious shortage of calcium in the mixed "poorer-class" diet was confirmed by analysis of typical bulked days' rations as given to the rat.

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SONNE DYSENTERY

BY

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Although for some years Sonne dysentery has been known in paediatric circles as one of the bugbears of children's hospitals, there are many busy practitioners who have seen nothing of the disease and remain unfamiliar with its characteristics. In view of the present epidemic in London and the home counties a brief account of the disease may perhaps be considered opportune.

Bacillary dysentery may be described with sufficient accuracy as consisting of three types, due respectively to (a) the Shiga bacillus, (b) the Flexner group of bacilli, and (c) the Sonne bacillus. The differentiation of these three types is ultimately a bacteriological matter, but clinically there are important general differences between them. Shiga dysentery, the most serious and fatal type, is practically non-existent among the ordinary population of London, and probably of the country: in seventeen years no example of this infection has occurred at the Paddington Green Children's Hospital. Flexner-group dysentery, as compared with Sonne dysentery, is less common but more severe, prolonged, and dangerous. Sonne dysentery, with which we are here concerned, is therefore the commonest of the three types but runs the mildest and shortest course.

Epidemiological Features

Sonne dysentery, although probably commonest in the summer months, may occur at any time of the year. No age is exempt from it, and while it is most frequently seen in young subjects, infants do not seem to be preponderantly affected. In these two particulars it differs from the so-called epidemic gastro-enteritis, which is essentially a summer disease and strictly confined to infants.

The disease spreads with such ease and rapidity that it is tempting to think that transmission may be by air-borne infection. There is, however, as yet no clear proof that transmission can occur by any means other than the ingestion of the specific bacillus, the ultimate source of which is the infectious faeces of the patient. Thus, as in typhoid fever, patients and those in attendance on them must be regarded as the source of contamination of food, drink, feeding utensils, etc. Transmission in the same way by flies is a possibility.

Outbreaks of Sonne dysentery usually arise in a children's ward from the admission of a case in which the stools are not typical of the disease on inspection. Thus very mild cases and convalescent cases constitute the chief danger. D. Nabarro and A. G. Signy (1932) report that children who have recovered from an attack may continue to pass Sonne bacilli in the faeces "for months." This must, I think, be very rare, and it does not seem that the chronic carrier constitutes a problem of importance among children. The bacilli may disappear from the stools within as short a time as ten days from the onset of symptoms, and in my experience, in the absence of any relapse, tests have always proved negative by the end of three or four weeks. The incubation period is from one to eight days, usually two or three days.

Morbid Anatomy

Necropsies on cases of Sonne dysentery are so rare that I have not been able to obtain any first-hand information