SOME STUDIES IN FAT INDIGESTION *

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The studies which we are carrying on at the Infants' Hospital in cases of chronic indigestion from fat do not yet include a sufficient number of cases to permit me to present a mass of statistical evidence from which positive conclusions can be drawn. It is difficult to accumulate evidence of final value in a clinical study of this kind. So many cases cannot be investigated as thoroughly as we could wish, and there are so many adventitious circumstances which interfere with the value of our conclusions, that I realize that the evidence they afford is at best but a general impression, not supported by real proof. At present, all I can do is to describe the method which we are employing, and to state the provisional conclusions which we have formed at the present stage of our investigations.

The diagnosis of chronic indigestion from fat is based on the fact that there is evident in these cases a marked intolerance of cow's milk fat. This intolerance shows itself in the inability of the child to take the amount of fat which the majority of artificially fed infants can take, without showing signs either of failure of fat absorption, or disturbance of digestion, or both. In other words, the cases of babies in whom the giving in the food of a moderate amount of fat is followed by the appearance in the stools of free fat or excessive soap, or in whom an increase in the amount of fat given in the food produces immediately symptoms of indigestion and nutritional disturbance, are classified and treated as cases of fat intolerance. In most cases the two conditions of indigestion and deficient fat absorption coexist.

The number of cases of fat indigestion treated in the hospital since it was opened on March 3, has been greater than the number of cases of indigestion from overfeeding, from protein, from carbohydrate, or with fermentation. This does not mean that this is the most frequent form of indigestion seen in infants. The cases received at the Infants' Hospital are, to a large extent, selected cases, chosen from a number of out-patient clinics, and referred to the hospital because they are not doing well. I think it safe to say that a great many of the worst cases come to us. The preponderance of cases showing fat intolerance means

* Received for publication Dec. 14, 1914.

* Read before the New England Pediatric Society, Dec. 4, 1914.

only that this form of indigestion is the most serious, resistant and difficult to treat. The majority of the patients, when received at the hospital, showed the most extreme degree of malnutrition, being in appearance typical of atrophy, some of them being actually moribund. The number of cases studied was actually no more than thirty-five. This number is so small that it seems hardly worth while to present the results of the studies in statistical form, with tables and figures.

Cases of fat intolerance show a certain constancy in their clinical behavior. This constancy, however, is not found in the clinical symptoms of indigestion, but rather in the manner of their response to attempts to feed them. I mean by this that there is not a constant or typical macroscopic appearance of their dejecta. The movements may or may not look undigested, with soft so-called "fatty curds," or may be white, or brown, or green. They are apt to appear abnormal in some respect, but may not. Vomiting may be absent, or occasionally present, or it may be the only symptom of overfeeding with fat. The typical feature of fat indigestion may be summarized in these words: inability to gain with fat, and inability to gain without it. I mean by this, that if these babies are given a quantity of fat so small that they show no signs of fat intolerance, they lose weight or fail to gain; when more fat is given they show signs of fat intolerance and continue to lose. One peculiarity of these cases we have noted again and again — when the quantity of fat given is increased, in the hope of obtaining a gain in body weight, the babies are apt apparently to respond. They show a gain in weight, and the signs of fat intolerance do not develop at once. Excessive soap, however, appears in the stools, while they are gaining in weight, and then, often after many days, suddenly, within a day or two, they lose all the weight they have accumulated, and more. This phenomenon is so frequent and striking that at the hospital it has come to be commonly called a "blow-up." These "blow-ups" are usually attended by a reappearance of such symptoms as vomiting, bad movements, or even diarrhea. Sometimes they have been accompanied by marked signs of collapse, with cold extremities, cyanosis, and slow pulse. In two of our cases, such "blow-ups" have been fatal.

We have been, and still are, studying these cases by giving various foods, controlling our observations by frequent microchemical examinations of the stools. I realize that such a method of study cannot reach the bottom of the nutritional questions involved, and at best can only give us a clinical basis for procedure. We must look to more complicated studies on metabolism for a final decision.

The points which we have studied are the following:

1. Are there any striking predisposing causes for fat indigestion?

2. Can we successfully compensate for deficient power to digest and absorb fat, by increasing carbohydrate or protein, and if so, to what extent?

3. Is the microchemical examination of the stools for fat a reliable guide to the feeding of these infants, and if so, to what extent?

4. What are the relative values of maltose and lactose as the carbohydrate element in these cases?

5. What are the relative values of precipitated casein and unmodified protein in these cases?

6. What is the value of lactic acid milk in these cases?

The conclusions we have reached have been the following:

1. In looking over our records I have been much struck by the frequency of some evidence of tuberculosis or syphilis in these cases, especially tuberculosis. In two fatal cases tuberculosis was found at necropsy, and in quite a number of others there were some signs, either a tuberculin reaction, signs in the chest or a suspicious radiogram. I am inclined to think that tuberculous babies are especially prone to fat intolerance.

The study of the previous feeding in those cases gave a very unexpected result. In extremely few instances was there any history of overfeeding with fat. In general, the history in these cases is one of overfeeding with carbohydrate. Milk mixtures with excessive sugar, especially cane-sugar, condensed milk, and the various carbohydrate foods, are the usual previous feeding. In a large proportion of cases the previous history suggested carbohydrate indigestion, the clinical features being frequent green irritating movements, vomiting, regurgitation, and much gas and colic.

This finding is interesting in connection with our theories as to the cause of fat intolerance in artificially fed babies. There is some difference of opinion as to whether, in these cases of atrophy, the first injury comes from the nature of cow's milk fat, from the nature of the cow's milk salts, or from excessive carbohydrate fermentation. Our evidence would point to the last of the three. Of course, feeding with various carbohydrate patent foods, or with excessive sugar, is such an extremely common method that the frequency of its general use may account for the frequency of its occurrence in our series. Nevertheless, I am strongly inclined to the view that it is an important cause of failure to digest and absorb fat. These infants after they entered the hospital usually presented an entirely different picture from that described in their histories. They took care of all the carbohydrate we gave them, but they showed this marked intolerance of fat. The effect of long-continued fermentation from overfeeding with

carbohydrate may well be a failure of the power of digesting fat, the carbohydrate injury being primary, but the fat indigestion coming to dominate the picture.

2. In answer to the question as to how far we can compensate for deficient fat digestion by the giving of more carbohydrate and protein, I would say, to a very slight extent. Some cases of fat indigestion, the milder ones, yield readily to proper feeding, and the babies gain weight for a long time with very little fat, or even no fat, in their food. These, however, are babies who seem to have a low caloric requirement; at any rate the quantity of carbohydrate and protein given is not excessive. The majority of the severe cases, such as we get at the hospital, will not gain on moderate quantities of carbohydrate and protein as a substitute for fat. If these quantities are increased, signs of indigestion quickly appear. We have had several cases in which edema and tetany have suddenly appeared, and it is curious that they were all cases on a food relatively high in protein.

3. As to the value of the microchemical examination of the stools, I believe that frequent examinations of the stools for fat are absolutely essential to the proper treatment of these cases. No case of "blow-up" from fat has occurred without the finding of an excess of soaps (and sometimes free fat) in the stools before the occurrence of the upset. The important question, however, is whether the finding of an excess of soap in the stools is a positive indication for reducing the fat in the food. A certain number of babies would not gain in weight until the quantity of fat was increased to such an extent that excessive soap was present in the stools. In some of these the excess of soap lessened and finally disappeared. Others continued to gain until their discharge from the hospital without any lessening in the excess of soaps found. Excess of soap is not incompatible with prolonged gain in weight. On the other hand, in so many cases in which the patients were gaining in weight and showing excessive soap in the stools a "blow-up" did occur, that there is undoubtedly a great risk in continuing to feed the babies so much fat. Moreover, I find that some of the patients that were gaining at the time of discharge with excessive soap in the stools, experienced a "blow-up" subsequently, after quite a long time. Therefore I believe that, in cases in which the patients are gaining, one should make frequent examination of the stools for fat, and if the quantity of soap does not lessen or increases, the fat must be cut down, even if the babies have to undergo a further period of failure to gain, or even of loss in weight. Free fat in the stools should always be a positive indication for cutting down the quantity of fat in the food.

4. The question of the relative value of maltose and lactose as the extra sugar added in cases of fat intolerance was studied as follows:

In cases in which there was intolerance of a definite quantity of fat when lactose was used, a fresh start was made, maltose being used instead as the extra sugar, and the fat was increased in exactly the same way as before. If the babies appeared to be able to gain on maltose, the sugar was changed back to lactose, without any other change, in order that we might see if they became worse. In some cases, when intolerance of a certain quantity of fat developed with lactose, the extra sugar was changed to maltose without reducing the fat, in order that we might see if their tolerance of fat improved.

We have concluded that, in general, cases of fat indigestion do better with maltose than with lactose, and we believe that in the feeding of these patients maltose is the preferable extra sugar. Nevertheless, the evidence is somewhat contradictory. The conclusion supported by the most consistent evidence is that patients with fat intolerance will gain weight and do well on a smaller quantity of fat when maltose is used. A number of patients that would not gain before the fat was increased sufficiently to produce signs of fat intolerance, did gain and do well on a smaller quantity of fat when maltose was used. And in some of these, changing the fat back to lactose caused a failure to gain in weight. No patient did better on lactose than on maltose. There is much less evidence, however, that the use of maltose actually increases the tolerance of fat. It is true that in some cases in which the fat was gradually increased a second time, with maltose in place of lactose, an increased tolerance for fat was found. This occurred, however, no oftener than might be accounted for by a general tendency toward improvement after a period of diminished quantity of fat in the food. In other cases, the fat intolerance developed with the same quantity of fat with maltose as with lactose. Some patients who showed increased tolerance for fat with maltose showed less tolerance when the sugar was changed back to lactose, but this has not occurred often enough to seem very significant.

I believe that the chief value of maltose in these cases is that it is the best carbohydrate to replace the deficiency of fat—to meet the caloric need created by the fat intolerance. The action of maltose in this respect may easily be explained theoretically. Maltose is split during the process of digestion into the two molecules of the monosaccharid dextrose, of which it is composed. Dextrose is probably less fermentable and more easily absorbed than either the galactose of lactose or the levulose of cane-sugar. It has the further merit of being the only carbohydrate which, after absorption, can be immediately utilized for energy production, without undergoing glycogen storing.

It is possible, but by no means evident, that the maltose actually aids the power of digesting and absorbing fat. If this is the case, it

could be explained easily under the theory that sugar indigestion and fermentation is a predisposing cause of fat indigestion. The maltose, being so easily absorbed, leaves behind less fermentable residue, and in consequence, we have less sugar fermentation and better digestion of fat. This, however, is at present only speculative. It would account for the improvement in fat tolerance seen with maltose, but this, as I have said, can also be accounted for by a tendency toward improvement sometimes seen with careful regulation of the amount of fat given in the food.

5. The value of precipitated casein was studied in the same way as maltose by increasing the fat with a definite percentage of unmodified protein, and then with the same percentage of precipitated casein, and by alternating the two forms of protein with the same percentage of fat. Albumin milk was not used; as it is a combination of precipitated casein and lactic acid milk, we believed that its use would not throw so much light on the questions in which we are interested as would the use of its essential elements separately. I am quite ready to admit that albumin milk may be a better food for these infants than any we have tried. But it appears to me to be a sort of shotgun prescription, based on somewhat mixed theoretical conceptions.

The question of the value of precipitated casein is of interest chiefly in connection with the possible rôle of the cow's milk salts in cases of fat intolerance. The essential features of precipitated casein are: first, that its use in place of fat-free milk in modification enables us to diminish the mineral salts without diminishing the protein; second, that it enables us to diminish the lactose to a very small amount, and third, that the casein, being already precipitated in a finely divided form, does not have to undergo precipitation in the stomach. The last feature would not appear to have any direct bearing on the question of fat indigestion, unless there was also protein indigestion. In such a case, more protein might be digested and absorbed with precipitated casein, but we have no evidence pointing toward this. On the contrary, patients that developed signs of protein intolerance with fat-free milk did no better with precipitated casein. The diminution in the lactose with precipitated casein mixtures may be a feature of value, but in view of the effect of changing the extra sugar from lactose to maltose, it does not seem likely that the small quantity of lactose in the fat-free milk is harmful in many cases. If precipitated casein showed a marked superiority in these cases, I should be inclined to attribute it to the diminution in the cow's milk salts.

But it did not show a marked superiority. Here again the evidence is somewhat contradictory. The majority of cases in which precipitated casein was tried did not do better than with the regular form of

protein. Fat "blow-ups" occurred with the same quantity of fat with precipitated casein as with unmodified protein. We have as yet had no case which gave evidence of being able to digest without symptoms more protein with precipitated casein than with total protein. On the other hand, we have had patients who gained better on precipitated casein than on total protein. Some continued to gain when the form of protein was changed back again; others did not gain so well. We have had one case in which the fat tolerance was found increased when precipitated casein was substituted for the usual form of protein, and in which fat intolerance developed when the protein was changed back again.

I cannot conclude that precipitated casein may not be of value in some cases of fat indigestion. In the majority of cases it promises no advantage over the usual protein. Our results have been rather against the rôle of the cow's milk salts in producing fat indigestion, but I believe this to be still an open question, in view of the opposite results which many observers have published.

6. Lactic acid milk has not been sufficiently studied to afford the drawing of even provisional conclusions in fat indigestion. We have not as yet found evidence of its value. We have had cases of protein indigestion develop under its use.

I might give the following summary of the ideas which we now hold at the Infants' Hospital as to the treatment of these severe cases of fat indigestion:

The milk modifications used must be low in fat, average in carbohydrate, comparatively high in protein. The extra sugar should be maltose. A certain number of the milder cases will do well on this treatment. Severe resistant cases are those in which the patients cannot gain on a low quantity of fat and cannot tolerate an increase. A large number of cases are so severe and resistant that they can be saved only by human milk. Breast-milk will save most of these cases, even the severe ones, if used in time. It should always be used in resistant cases, whenever it can be obtained. Even a little breast-milk is of value, and may save a patient that would otherwise be lost. After a period of breast-milk feeding, many cases are found no longer severe and resistant to artificial feeding. If breast-milk cannot be obtained, the feeding is very difficult and the outcome uncertain. Excessive increase of carbohydrate or protein will not help these severe cases, and may do harm; I do not believe that more than 7 per cent. carbohydrate or 3 per cent. protein should be given. Whey mixtures are of no help except sometimes in very young babies who vomit curds; they may do harm. Giving the protein in the form of

precipitated casein may be tried, and may help in some cases. There is not sufficient evidence of its value to indicate its use as a routine.

The only way we have of managing these resistant cases without breast-milk is to keep the fat low, and we must be prepared for a period of loss of body weight which may be prolonged. If they begin to gain when the fat is increased, it is no sign of permanent improvement; they may go to pieces at any time. Frequent examinations of the stools for free fat and excessive soap must be made. In the presence of free fat, or in the continuous or increasing presence of excessive soap, the fat should be reduced, even if the baby is gaining. If a "blow-up" occurs when the fat is increased, the fat in the food should be reduced to zero, and then worked up again, slowly. Frequent "blow-ups" diminish the tolerance for fat. The best hope of eventually obtaining an increase in tolerance of fat sufficient to permit a gain in weight is to avoid overfeeding with fat for a long time, even if much weight is lost.

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