with its complete evolution at a later period. Finally, by no means rare, subacid figures at the one-hour point may be followed by hyperacid figures at a later stage in digestion.

8. The ordinary method can give us evidence of nothing but the crudest anomalies in motor function. The fractional method enables us to determine precisely the end point of gastric digestion.

9. In our studies of the complete gastric cycle, we have found every form of secretory and motor disturbance and have been impressed by the fact that the symptom like the actual motor or secretory disturbance by no means respects the hour period and may be found depending on the nature of the case at any point in the gastric cycle.

My thanks are due to many physicians with whom I have worked, as well as to Drs. Bergeim and Fowler, who have spent many hours in the chemical studies of these cases, and to Dr. Hawk, as always, for his cooperation and assistance.

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THE THERAPEUTIC VALUE OF ORGANIC PHOSPHORUS COMPOUNDS*

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The prescribing of preparations of organically bound phosphorus rests mainly on the theory that such compounds are absorbed and stored as such by the organism, and that the needs of the body for organic phosphorus cannot be supplied by inorganic phosphates. Neither of these ideas, however, has any real scientific foundation, but the evidence is rather conclusive in the opposite direction.

Phosphorus as taken into the organism as a food material exists in inorganic form and organic, for instance lecithins, glycerophosphoric acid, phytin, nucleic acid and phosphoproteins. The problem as to the relative utilization and nutritive value of inorganic and organically bound phosphorus has been approached from three main aspects:

1. The search for enzymes in the organism capable of liberating phosphoric acid from organic compounds containing phosphorus.

2. Metabolism studies of the phosphorus balance, with the feeding of diets containing inorganic or organically bound phosphorus.

3. Studies on the ability of the organism to synthesize complex organic phosphorus compounds from inorganic phosphates by feeding experiments over long periods, and observations on the growth and general functional activity.

In various tissues of the animal body, enzymes have been found which hydrolyze complex organic phosphorus compounds so as to liberate the phosphorus in the form of inorganic phosphates. The occurrence of ferments capable of decomposing nucleic acids, with the liberation of purin bases and phosphoric acid, has been shown for various tissues of the body, and especially for the intestinal mucosa. A phytase which splits phytin into inosit and phosphoric acid has been found in the liver and blood by McCollum and Hart.[1] Lecithin is also apparently decomposed in the intestinal canal, yielding its phosphorus as glycerophosphoric acid, which Grosser and Husler[2] find to be completely decomposed by a ferment present in the intestines and kidney. Sebelien[3] first showed that the phosphorus of casein can be split off as phosphate by the action of trypsin. Plimmer and Bayliss[4] have recently extended this work, and find that trypsin dissolves the phosphorus of casein as phosphate almost completely. Plimmer[5] has systematically tested the action of various animal tissues as regards their ability to hydrolyze organic phosphorus compounds. He finds the intestine to be the most active, and that all organic phosphorus compounds tested (glycerophosphoric acid, hexosephosphoric acid, ethylphosphoric acid, phytin, nucleic acids from thymus, wheat and meat and phosphoproteins), except phytin, were hydrolyzed by it. He concludes that "the organism can synthesize its organic phosphorus from the inorganic form. . . . The organic phosphorus compounds are most certainly assimilated as inorganic phosphate and the organic radical with which the phosphorus is combined." This occurrence of enzymes capable of converting organic phosphorus into the inorganic form explains the fact that very little organically bound phosphorus occurs in either the urine or feces, normally or after feeding organic phosphorus.

The very numerous metabolism studies on the comparison of the phosphorus and nitrogen balances with diets containing organic phosphorus compounds, and the same in which inorganic phosphates alone supplied the phosphorus, have led to somewhat unsatisfactory results. Some investigators find the evidence from this kind of study to point to a more complete absorption and utilization of organic phosphorus than inorganic, while others find no difference in the results, whether the phosphorus be supplied in organic or inorganic form. The difficulty of drawing conclusions from such work, and also the conflicting results, are not surprising when we consider the many factors concerned. Such investigations must take into account the phosphorus eliminated in both the urine and the feces, it being remembered that the feces phosphorus is not alone unabsorbed material, but also absorbed material which is excreted by the intestine. The amounts excreted by the kidney and the intestine bear no constant relation to one another, but are dependent on a number of factors. Thus, the amount of calcium ingested directly influences the amounts of phosphorus excreted in the urine and the feces; the more calcium, the greater the amount eliminated by the intestines at the expense of the kidney. Furthermore, negative results in the feedings of material extracted with alcohol and ether to remove the organic phosphorus must be taken with great reserve, as it is now well known that substances not containing phosphorus (vitamins), but essential to the well-being and even life of the organism, are removed by this treatment.[6] The use of too short a period of observation, and the neglect of the fact that the ingested phosphorus may be excreted slowly, have vitiated many experiments.

* This investigation was undertaken at the suggestion of the Committee on Therapeutic Research of the Council on Pharmacy and Chemistry of the American Medical Association.

1. McCollum and Hart: Jour. Biol. Chem., 1908, iv, 497.
2. Grosser and Husler: Biochem. Ztschr., 1912, xxxix, 1.
3. Sebelien, from Biffi: Virchows Arch. f. path. Anat., 1898, clii, 130.
4. Plimmer and Bayliss: Jour. Physiol., xxxiii, 439.
5. Plimmer: Biochem. Jour., 1913, vii, 43.
6. Funk: Jour. Physiol., 1912, xliii, 395. Steff: Ztschr. f. Biol., 1911, lvii, 135.

Grosser,[7] on a careful critical review of the data, concludes that the balance of evidence from this kind of experiment is in accord with the view that no difference exists whether the phosphorus is supplied in organic or inorganic form.

Hart, McCollum and Fuller[8] found that in the case of growing pigs the quantity of phosphorus necessary is not dependent on the nature (organic or inorganic), but on the needs of the animal. Pigs fed on rations with extremely low phosphorus content at first developed as well as controls, but later there was loss of weight, followed by collapse. Supplementing this low phosphorus diet with either calcium phosphates or organic phosphorus compounds sufficed to produce normal growth and development. The phosphorus in the organic form gave no better results than the inorganic phosphates. McCollum, Hart and Humphrey,[9] working with a cow, conclude that neither the form nor quantity of potassium, magnesium or phosphorus in the diet affected the percentages of these elements in the milk.

Fingerling,[10] comparing the influence on the milk secretion of the feeding of organic phosphorus with that of inorganic phosphorus, found no influence on the quantity, amount of total solids, or percentage of calcium and phosphorus. The organic phosphorus was fed in the form of lecithin, phytin, casein and nucleic acid, and the inorganic as disodium phosphate. He concludes that the organism can satisfy its needs just as well with inorganic phosphates as with organic phosphorus. Other investigators (Wendt,[11] Holsti,[12] Gregerson[13]) have shown that the organism can synthesize organic phosphorus compounds out of inorganic phosphates. In regard to the relative ease and completeness of this synthesis, Fingerling has carried out some very interesting experiments on geese, and McCollum, Halpin and Prescher on hens.

Fingerling[14] selected a flock of geese and fed them during one year on food containing practically no organic phosphorus but only inorganic phosphates. The next year they were fed on a diet rich in organic phosphorus. It was found that the number of eggs laid, their weight and content in lecithin, nucleic acid and phosphorus were the same on the organic-phosphorus-free diet as on the one rich in organic phosphorus. McCollum, Halpin and Prescher[15] found hens capable of synthesizing complex phosphatids, for when fed on a phosphatid-free diet, they laid eggs containing the normal content of lecithin.

The recent experiments of Osborne and Mendel[16] on the amino-acids necessary for maintenance and growth are evidence in the same direction. Rats can be maintained and grow on a diet of phosphorus-free protein and an inorganic salt mixture, and when the growth curve diverges from the normal on this diet, it can be restored by the addition of butter-fat,[17] which contains no phosphorus.

We see that the evidence is very convincing of the view that the animal organism can synthesize its complex organic phosphorus constituents from inorganic phosphates, and that organic phosphorus is of no more value as a food than inorganic. If the organic phosphorus compounds possess any particular efficacy over the inorganic, it is probably due to their containing substances that are necessary in traces to normal nutrition, and not to their organically bound phosphorus. These materials are undoubtedly furnished by any ordinary mixed diet, and in cases in which the introduction of phosphorus is desired to attempt to make possible the synthesis of organic phosphorus compounds in the body, the inorganic phosphates are entirely suitable for this purpose.[18]

ALBUMIN IN THE SPUTUM AS A DIAGNOSTIC AID *

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The suppression and cure of tuberculosis depend largely on an early diagnosis of the malady. Any laboratory method, therefore, which would be of value in our diagnosis, since both history and physical findings are often inadequate, would be very desirable.

Among the various methods for the diagnosis of tuberculosis which have been exploited from time to time is one, the albumin-sputum method, which has attracted attention off and on for nearly sixty years, but which never yielded sufficient satisfactory results to warrant its general adoption by clinicians.

REVIEW OF LITERATURE

In 1855 Biermer,[1] investigating this subject, always found albumin positive in acute bronchitis, in pneumonia and in edema of the lungs, but negative in chronic bronchitis and in tuberculosis, the latter showing much mucin.

Renk[1] found albumin negative in chronic bronchitis but always positive in acute bronchitis, pneumonia and tuberculosis, the latter showing from 0.11 to 0.49 per cent.

Bamberger,[1] Panow, Starkow and Lanz found considerable albumin in bronchitis and emphysema, as well as in tuberculosis.

Wanner, after boiling with salt solution and acetic acid, found much albumin in tuberculosis, while there was only a trace or negative in chronic bronchitis and in asthma.

Beranzon and Young[1] found albumin in both tuberculosis and bronchitis.

The observations of Roger and Levy-Valensi[2] gave stimulus to numerous investigators, including Lantz and Hertz,[3] Lecaplain,[4] Terreira,[5] Lesieur and Prires,[6] and many others, all of whom came to the conclusion that a negative test excluded tuberculosis, while a

7. Grosser: Ergebn. d. inn. Med. u. Kind., 1913, xi, 119.
8. Hart, McCollum and Fuller: Am. Jour. Physiol., 1908-1909, xxiii, 246.
9. McCollum, Hart and Humphrey: Am. Jour. Physiol., 1909, xxiv, 86.
10. Fingerling: Biochem. Ztschr., 1912, xxxix, 239.
11. Wendt: Skand. Arch. f. Physiol., 1905, xvii, 211.
12. Holsti: Skand. Arch. f. Physiol., 1909, xxiii, 143.
13. Gregerson: Ztschr. f. physiol. Chem., 1911, lxxi, 49.
14. Fingerling: Biochem. Ztschr., 1912, xxxviii, 448.
15. McCollum, Halpin and Prescher: Jour. Biol. Chem., 1912, xiii, 219.
16. Osborne and Mendel: Ztschr. f. physiol. Chem., 1912, lxxx, 307, and articles in Jour. Biol. Chem., 1912-1913.
17. Osborne and Mendel: Jour. Biol. Chem., 1913, xvi, 423. McCollum and Davis: Ibid., 1913, xv, 167.

18. No attempt has been made to include a complete bibliography. A very good critical review of this question of the value of organic and inorganic phosphorus and the literature can be found in the article by Grosser in Ergebnisse der inneren Medizin und Kinderheilkunde, 1913, xi, 119.

* Tuberculous material from the Detroit Tuberculosis Sanatorium.

1. Quoted by Berkovitz and Rudas: Berl. klin. Wchnschr., 1913, L, 1752.
2. Roger and Levy-Valensi: Bull. et mém. Soc. méd. d. hôp. de Paris, Sept. 22, 1913; ibid., July 23, 1909; Presse méd., April 20, 1910; ibid., May 20, 1911.
3. Lantz and Hertz: Presse méd., July 18, 1911.
4. Lecaplain: Presse méd., March 11, 1911.
5. Terreira: Presse méd., April 15, 1911.
6. Lesieur and Prires: Paris méd., 1911, iv, 29.