Diet in typhoid fever ... / By John Benjamin Nichols.

DIET IN TYPHOID FEVER

NICHOLS

FISKE FUND PRIZE DISSERTATION. NO. L.

DIET IN TYPHOID FEVER

MOTTO:

"Jobeni."

BY

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THE Trustees of the Fiske Fund, at the annual meeting of the Rhode Island Medical Society, held at Providence, June 6, 1907, announced that they had awarded a premium of two hundred and fifty dollars to an essay on "Diet in Typhoid Fever," bearing the motto:

"Jobeni."

The author was found to be JOHN BENJAMIN NICHOLS, M. D., of Washington, D. C.

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DIET IN TYPHOID FEVER

BY

JOHN B. NICHOLS.

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Diet in Typhoid Fever.

While to the great majority of physicians it may seem that the question of feeding in typhoid fever has been definitely and finally settled, there are a few who believe that finality and the best methods have not yet been attained. It is the purpose of this paper to consider the subject in all its phases.

History of Dietetics in Typhoid Fever.

The evolution of dietetic methods in typhoid fever, even of concepts dominant at the present day, can be traced back for ages before typhoid was differentiated as a separate disease, even to the dawn of medical history, the era of Hippocrates. Prior to the time when typhoid was definitely distinguished from typhus and other fevers the ideas of the medical profession as to the causes, nature, and classification of the febrile diseases were very hazy and confused, and numerous distinct affections were considered and jumbled together under the general and common head of "fever" or "continued fever."

In the time of Hippocates the conceptions of fevers were extremely crude and indefinite. As to bleeding and the emptying of the alimentary tract by emesis

and purgation in fever, the teachings of Hippocrates were not very definite, systematic, or emphatic. On the question of diet even in those early days there were conflicting views, some insisting on absolute starvation for a greater or less period, others advocating what was regarded as liberal feeding, one Petronos being mentioned by Galen as even allowing his patients flesh and wine. Hippocrates seems to have held a middle ground between the starvation and feeding systems.

The article of food mainly and almost exclusively recommended by Hippocrates in fever was "ptisan" or barley decoction, which he allowed rather liberally; he discourses at great length on its preparation and use, whether strained or unstrained, thick or thin, and the proper time for commencing it. The use of ptisan was, according to Galen, based on the principle that as fever is essentially a combination of heat and dryness, the use of a cooling and moistening material (like ptisan) is accordingly indicated. Hippocrates also allowed, under proper conditions, the use of wine, hydromel (honey boiled in water), and oxymel (honey acidulated with vinegar or acetic acid); he was not favorably disposed to the free use of plain, unflavored water in fever. While little is expressly said, the use of solid food and of beef tea and soups, etc., made of animal matter was apparently entirely rejected by the ancients, and Hippocrates explicitly states that milk is a bad thing to give in fevers.

In the course of the centuries following Hippocrates the phlogistic theory and antiphlogistic therapy of fevers became definitely crystallized until it universally and completely dominated the mind and practice of the medical profession. It was at its height in the seventeenth century (the time of Sydenham), and was not finally overthrown until toward the middle of the last century. According to this doctrine fevers were due essentially and primarily to local or general inflammation, or excessive action of the heart and arterial system; they were of sthenic type and characterized by over excitement. The antiphlogistic treatment, based on this conception of the pathology of fever and for centuries practically universally employed, consisted in the use of vigorous lowering and depleting measures to subdue the excitement, especially copious and repeated bleeding and the withholding of food. Vigorous emesis and purgation were employed, especially at the beginning of the disease, to remove noxious and exciting material from the stomach and bowels. The food allowed, in general, was limited to gruels (barley water and the like), along with a liberal amount of flavored drink (acidulated, sweetened, mucilaginous, aromatic, etc.), and occasionally acid fruits. These were selected as being unstimulating and unirritating; the ingestion of large amounts of water was supposed to dilute the acrid humors of the body; and the acidulous and other materials used being refreshing and grateful to the taste seemed to be cooling and refrigerant to the fever process.

Animal food of all kinds was rigidly excluded from the dietary, as it was believed to increase the body heat, to be a source of excitement and stimulation, to be incapable of digestion, to undergo excessive putrefaction, and to introduce into the alimentary canal noxious and acrid matters. The prohibition of animal food embraced not only meat, but also eggs, milk, broths, beef tea, meat extracts, etc.; and so deeply was the professional mind imbued with the essential harmfulness of animal food that a marked prejudice against even broths and bouillon persisted down to a recent date. Many dietetic theories were propounded by different authorities which in the light of modern knowledge of the physiology of digestion and metabolism seem grotesque. The digestive powers during fever were believed to be in total abeyance. Solid food was regarded as totally inadmissible. The use of stimulants and tonics was utterly contrary to the antiphlogistic regimen.

In the course of the eighteenth century and down to about the year 1815 the antiphlogistic treatment was greatly abated in rigor. During this period it began to be appreciated that there were different varieties of the continued fevers, such as, in the terms of those days, inflammatory fever or synocha, typhus, putrid fever, nervous fever, synochus, etc.; but while, in the absence of knowledge of their visceral lesions, the distinctions drawn between these varieties were vague and dim, yet a greater discrimination in diagno-

sis and treatment was developing. It was especially recognized that there was an asthenic or adynamic element involved in fevers as well as an inflammatory or phlogistic element; and the distinction between the two was regarded as of vital importance in treatment, since, as was generally agreed, while inflammatory conditions required vigorous lowering treatment, the adynamic condition required stimulation. There was, however, difficulty and question in the practical application of these principles, the determination whether particular cases or diseases were essentially inflammatory or asthenic arousing almost endless speculation and discussion. Many for instance, held that the appearance of asthenia in fevers was deceiving, and that the symptoms observed were really due to over excitement. In the treatment of the continued fevers there were thus two squarely opposed systems of practice, the antiphlogistic and the stimulant; the advocates of each reproached their opponents with having caused the loss of untold lives by their vicious methods, and strenuous controversies were waged as to the employment of bleeding, purgatives, emetics, blisters, food, tonics (cinchona), stimulants, etc. On the whole, the antiphlogistic habit was firmly implanted in the professional mind and strongly influenced the practice even of those who did not concur in the phlogistic theory of fevers.

During this period (down to about 1815) the mode of treatment of continued fevers was on the whole

stimulant or mildly antiphlogistic, the adynamic element being freely recognized. Bleeding and other vigorous depleting measures were regarded with disfavor, unless at the very onset of the disease or in distinctly sthenic cases or stages of fever. What was considered a liberal amount of food was allowed, mainly of vegetable character. The food employed was chiefly farinaceous, in thin liquid or pultaceous form, as gruels or ptisans like barley water, thin oatmeal gruel, sago or arrowroot preparations, and "panada" (toast water, or toast made into a fluid mass with boiling water). Fruit juices and soft, pulpy fruits were also allowed. What was regarded as a fairly liberal amount of such vegetable food was given, especially after the first few days of the fever. Milk (especially diluted milk) and even eggs (Heberden) were permitted, with caution and reserve, by some authorities. Animal food was in general, however, proscribed. In the latter period of the fever and early convalescence the farinaceous dietary was amplified by the addition of broths, diluted milk, jellies, and gradual return to animal food.

Free drinking was generally encouraged and regarded as an important part of the treatment, to dilute the blood and promote excretion. Besides plain water, drinks acidulated with lemon or currant juice, etc., or flavored with aromatics or otherwise, were in high favor. Two or three quarts of such drinks were given daily. In the eighteenth century, as at the present

time, there were some who carried the use of water to an extreme, believing in the sufficiency of an aqueous diet, that is, the withdrawal of all other food and giving water in large amount, four quarts or so daily.

From about 1815 to 1835 or 1840 continued fevers were again treated on a very vigorous antiphlogistic plan, and an extremely restricted diet was in general use.

An extensive fever epidemic prevailed in Great Britain and Ireland about 1817-1819, during which, largely under the teachings of Clutterbuck, Mills, and others, the theory that fever was essentially a phlogistic or inflammatory process came into general favor, and the corresponding practice of vigorous depletion, chiefly by profuse venesection, was generally followed in these countries. A starvation regimen was enforced; the drinking of watery fluids in large amounts was encouraged, but wine and stimulants were prohibited.

In France the adoption of antiphlogistic practice during this period was due to the teachings of Broussais (1772-1838), whose writings date from 1816 and who had a strong influence on French practice for a couple of decades. Arguing from the fact that alimentary disturbances are common in fevers and many other disorders (without any knowledge of the intestinal lesions in typhoid), he taught that gastroenteritis was the primary and underlying cause and essence of manifold disorders, and especially of the various febrile diseases. So firmly did this idea become estab-

lished that for a considerable period the term "gastro-entérite" was one of the principal names for typhus and typhoid fevers. The treatment of fevers practiced by Broussais and his followers in accordance with this conception of their pathology consisted mainly in copious withdrawal of blood by leeches and in starvation. The diet allowed — the "*diète absolue*" it was called — was practically no diet at all. All foods requiring digestion and which would therefore embarrass the supposedly inflamed alimentary tract,— broths, farinaceous food, fruits, etc.— were prohibited, broths being regarded as especially harmful. All that was allowed was sufficient drink to satisfy thirst, consisting of slightly sweetened mucilaginous drinks, or acidulated drinks like weak lemonade, gooseberry or raspberry water.

The next epoch in the history of typhoid dietetics was that of Graves (1797-1853) of Dublin, who has the reputation of having established the practice of liberal feeding in fevers. His deliverances covered the period from about 1835-1850. He rejected the phlogistic theory and antiphlogistic therapy of fevers, and believed that the current practice needlessly added the "horrible consequences" of starvation to the symptoms of the fever, and that it was "as hard to escape the physician as the disease." He therefore advocated what he regarded as liberal feeding, and so closely is his name identified with this practice that a jocular suggestion for his own epitaph — "He fed fevers"—

once made by him, has become historical. This incident is thus related by Stokes, the associate of Graves: "Once, when he and I were going through the convalescent wards, he expatiated on the healthy appearance of the patients, many of whom had gone through long fevers. 'This is all owing to our good feeding,' he said. 'Will you, when the time comes, write my epitaph, and let it be — He fed fevers?'" As a matter of history, it may be stated that this was not actually used in his epitaph.

The diet recommended by Graves was as follows: For the first three or four days, water, weak barley-water, and whey. After that mild nutriment was to be used, his preference being for well-boiled gruel made of groats, with sugar and lemon juice; also thin panada. Of the gruel and panada a spoonful of either was given every third hour. In the middle and late stages of the fever mild animal jellies and broths (preferably chicken broth) were given. Arrowroot was also allowed. Fruits were to be avoided. Food was to be given in the daytime only and not at night. Too much drinking was not permitted. This diet was much the same as the farinaceous diet used in the eighteenth century, which was therefore reintroduced by Graves. Judged by present dietetic standards, it can hardly be regarded as a very generous diet; and if it was considered liberal in Graves's time, the dietary previously in use must have been scanty indeed.

It was during the latter half of Graves's life that the

true pathology of typhoid fever was discovered and the disease came to be recognized as a distinct affection, different from typhus. There had previously been glimmerings of clinical differences between different kinds of continued fevers, as in Huxham's distinction between "slow nervous fever" (typhoid) and "putrid, malignant, petechial fever" (typhus) in 1750, and the synochus and typhus of Cullen in 1769; the intestinal lesions in cases of typhoid had also been observed in a few instances; but the morbid anatomy of typhoid fever was first put on a substantial and enduring basis by Louis (1787–1872), whose classical researches on this subject were first published in 1829. The continued fevers of France that came under Louis's observation, however, were exclusively typhoid, and not having had a chance to become familiar with typhus he did not realize that there were two distinct diseases and he regarded the lesions observed by him as pertaining to typhus. In America, also, the prevailing fevers were mostly typhoid; but typhus occasionally occurred, and it was through an opportunity of observing an epidemic of the latter that Gerhard of Philadelphia, who had become familiar with typhoid in Paris, was enabled, in 1837, to announce definitely that typhoid and typhus were two distinct diseases. This, the first clear elucidation of the distinctions between these two diseases, based on sound pathologic principles, stands to the credit of American medicine; and the distinction very soon became generally recog-

nized in the United States. In Great Britain and Ireland, however, the prevailing fever was typhus, and typhoid was so exceptional that the intestinal lesions occasionally seen at autopsy and described by the French writers were regarded as secondary and occasional complications of typhus. It was not until a series of papers on the subject was presented by Sir William Jenner, in 1849–1851, that a clear understanding of the distinctions between typhoid and typhus was finally attained by British physicians.

The recognition of the distinct character and intestinal lesions of typhoid fever at first had no influence on the dietetic management of the disease, and a farinaceous regimen much as re-introduced by Graves was generally followed down to the late sixties and the seventies of the last century. The medical manuals of this period specify the use of gruel, arrowroot, panada, and similar farinaceous food, with refreshing drinks flavored with fruit juices, for typhoid feeding. Some, but not all, of the writers also admitted broths, jellies, diluted milk, and the like. As late as 1874, Liebermeister argued for a carbohydrate or farinaceous diet, and against a proteid or animal diet, on much the same grounds as had been previously adduced for centuries.

During the seventies of the ninteenth century milk came into practically universal use as the main and almost exclusive article of diet for typhoid fever patients, and in the medical manuals since 1875 or

1880 the milk diet has been almost unanimously advocated. There appear to have been no special papers or authorities (except possibly the teachings of Austin Flint) that led to the abandonment of the farinaceous and adoption of the milk regimen, and the change was brought about by a process of gradual evolution. This diet has been in vogue ever since.

The purpose of this consideration of the history of typhoid dietetics has been, as will later appear, not the mere academic one of presenting the history of defunct methods, but the more practical one of attempting to throw real light on this important question by endeavoring to trace out the actual worth and validity of the grounds on which the present methods have been developed.

PRESENT DIETETIC METHODS IN TYPHOID FEVER.

At the present time a diet consisting chiefly of milk, with broths and similar fluids as accessories,— the so-called "liquid diet,"— is almost universally employed in typhoid fever. The firmest faith and confidence in the adequacy and superiority of this diet are entertained; it is by the great majority of practitioners enforced unvaryingly, indiscriminately, and mechanically in all cases of the disease; and the gravest fears are held of departures from it, or of the use of solid or even of soft food. So firm and fixed are the general convictions on this doctrine that it is regarded as impregnable, final, and beyond question; it has attained

almost the sanctity of a creed, and dissent from it is viewed as folly or heresy.

There are, nevertheless, not wanting a few who venture to question the entire superiority and efficacy of the present dietetic methods in this disease; some, on the one hand, advocating a return in more or less degree to the old starvation system; others urging a more liberal and more varied diet than that usually given. In the discussion of this subject there are, therefore, three contrary dietetic systems to be taken into consideration, the starvation regimen, the milk or "liquid" diet, and the liberal and varied diet. At the very outset we are confronted with the fundamental question, should typhoid patients be starved, or should they be liberally fed and nourished? In order satisfactorily to elaborate the subject of the diet in typhoid fever it will be necessary to consider the grounds of the different dietetic systems in the field and to determine the fundamental guiding principles on which the dietetic management of typhoid fever can be rationally and firmly established.

THE STARVATION TREATMENT OF TYPHOID FEVER.

The old antiphlogistic arguments for starvation in fever are now obsolete. The arguments advanced by recent writers against feeding are various.

One writer would withhold all food in the early period, in order to arouse the patient's hunger, claiming that when that is evoked the symptoms will sub-

side and the disease can be thus aborted. Another authority advocates withholding proteid food in the early part of the disease, so that, by intensifying proteid starvation, when the capacity for regenerating the nitrogenous tissues returns proteid food will then be taken up with greater avidity, and convalescence proceed more rapidly; forgetting that the less there is lost the less there is to regain.

Several writers urge the withholding of other food and the administration of large amounts of water as practically the sole diet in typhoid fever; some extremists have advocated the giving of excessive amounts, up to 6 or 7 liters daily, not only by the mouth, but also by the rectum, by hypodermoclysis, and even intravenously. The advocates of the water diet argue that water is the principal element of food and claim that it alone is a sufficient diet for typhoid patients. It requires but the slightest consideration, however, to see that such a diet necessarily results in starvation as to the proteid and other essential food elements that are withheld.

Another objection to milk and other foods besides water is that they afford a culture medium in the bowel for bacterial growth and toxin production; but food always does that, and in typhoid fever the seat of the toxin-generating bacterial growth that does the harm is in the tissues, not in the lumen of the bowel. Even in the fasting condition there is always an abundance of fecal debris in the bowel, derived from intes-

tinal cells and secretions, amply sufficient for bacterial growth. The supposed impairment of the digestive powers, the disadvantage of fermentation, and the possibility of overloading or clogging the circulation with metabolic material, are also advanced as reasons for withholding all food in this disease. Some, seeing the objections to milk, and not conceiving the possibility of giving other articles of diet, would withhold all food except water. It might also be argued that as typhoid fever attacks by preference healthy and robust individuals, the bacilli finding that kind of soil most favorable for their growth, the wasting and enfeebling of the patients is a sort of effort of nature to impoverish the soil so as to stop the growth of the bacilli; and that a starvation regimen would promote that result.

Again, the results of clinical experience are appealed to in support of the claimed utility of the starvation treatment. Series of cases so treated, with low mortality, are reported. Typhoid patients as a matter of fact often maintain a surprisingly good grade of general body nutrition for comparatively long periods under starvation conditions; and eminent authorities, of wide experience, have expressed the opinion or impression that they will actually do better on an insufficient diet. As to this point it must be remembered that the normal human body can exist and nutrition be maintained for several weeks without any food whatever, except water, being taken; and the maintenance

of typhoid-fever patients under such conditions depends on the utililization of the reserve material afforded by the body tissues. It by no means follows that, because nutrition can for considerable periods be comparatively well maintained in typhoid patients on a starvation basis, that regimen is therefore beneficial to the patients. No one would contend that abstinence from food by a healthy person for four or five weeks would be beneficial, or would result in anything but harm to nutrition and impairment of body functions and activities. It is equally illogical to suppose that starvation could of itself benefit a typhoid patient. If it is harmful to a well person, it would be far more injurious to an ill person; if typhoid-fever patients do well under a starvation regimen, it is not because of that regimen but in spite of it. As for the idea frequently expressed that the feats of Tanner and others who fasted for long periods on nothing but water can serve in any way as a precedent for the management of typhoid patients, it should be remembered that these fasts were tests of endurance for strong, healthy men, which brought them to the verge of fatality; and it would be as reasonable to expect a typhoid patient to undertake them as to engage in a football game or a century bicycle run.

The writer is convinced that all the arguments advanced in favor of starvation in typhoid fever are fallacious and untenable. The starvation regimen is utterly contrary to all recognized physiologic and

dietetic principles. During the long antiphlogistic era the system was given a universal trial, lasting for centuries; and the sweeping condemnation passed upon it by the entire medical profession, after a world-wide observation of its effects, may be accepted as final. The sporadic attempts to revive a practice that belonged to the dark ages of medicine can but be regarded as atavistic recrudescences of medieval error and unenlightenment.

THE MILK OR "LIQUID" DIET IN TYPHOID FEVER.

At present the nearly universal practice is to limit the diet of typhoid-fever patients to milk, with broth, — so-called "liquid" diet, — while solid and even soft foods are rigidly excluded and regarded as highly injurious and dangerous. Various arguments are presented in favor of this practice.

A characteristic example of the way in which the subject is usually presented, and one embodying most of the points involved, is afforded by the following passage from Hutchinson's article on typhoid fever in 1885: "The food must . . . be not only nourishing, but also readily digestible, and not likely to create irritation in its passage through the intestine. All solid food should therefore be excluded from the dietary of the patient as long as the fever lasts. . . . Milk as an article of diet is unquestionably to be preferred to all others in typhoid fever."

Under the practice now prevalent typhoid patients generally receive about 1½ to 2 liters (3 to 4 pints) of milk daily, or its equivalent. These amounts of milk yield about 1,000 to 1,300 calories of energy, and 50 to 70 grams of proteid (8 to 11 grams of nitrogen); these figures may be accepted as representing the approximate daily nutritive standard of the present typhoid dietary.

The general premises that the typhoid diet should be nutritious, digestible, and innocuous are generally agreed on. But whether the current dietary completely fulfills these premises has been contested. The inadmissibility of solid food and the intrinsic superiority of milk are not self-evident; the conclusions on this point brought out in the average statements of the subject made in the current manuals of medicine (as exemplified in the above quotation from Hutchinson) do not necessarily and obviously follow from the premises as stated. The superiority of the present dietetic method should be established, not on vague impressions or dogmatic assumptions, but on a rational analysis of the physiologic and dietetic factors involved, as checked by the results of adequate experience. The milk diet has not (so far as known) been subjected to or based on that scientific critique and analysis which its importance demands or which would warrant the firm faith generally entertained as to its efficacy and superiority.

The present milk dietary has been assailed on various grounds, such as: that it does not supply suffi-

cient nutriment; that milk is not the most digestible of foods; that milk is unusually productive of intestinal indigestion and more apt to cause intestinal injury than many other foods; that soft and solid food are much more digestible and much less harmful in typhoid fever than has been generally supposed; that even if solid food were contraindicated, milk (which immediately coagulates in the stomach and may pass through the intestine in solid curds) is far from being a really liquid food; and that the results of clinical experience, when fairly interpreted, do not support the contention for the exclusive use of milk and the exclusion of other articles.

THE LIBERAL AND VARIED DIET IN TYPHOID FEVER.

There are a few of the medical profession who, in spite of the censure they thereby incur, venture to dissent from the doctrines firmly held by the generality of the profession as to the superiority and finality of the milk diet and the inadmissibility of other food. They hold that the prevalent milk diet, while far better than a deliberate starvation regimen, is still insufficient for adequate nutrition, and should and safely can be amplified by the addition of other articles; that the dangers of soft and solid food are largely mythical and have been greatly overestimated; and follow in general along such grounds as are pointed out in the preceding paragraph. They advocate and use a diet

more liberal and varied than that in general use, including not only soft food like eggs, puddings, cereals, etc., but even meat (when needed). The adherents of liberal mixed feeding in typhoid fever, while comparatively few in number, are apparently increasing; they are found in all parts of the world, and include among their numbers some authorities of the highest eminence.

The points involved between the milk diet and the mixed diet will be developed and considered in detail in the course of the present discussion.

BASIC PRINCIPLES.

With the exception of the few adherents of a definite starvation therapy the profession is professedly practically unanimous in favor of feeding typhoid fever patients. The arguments in favor of liberal feeding are cogent. Insufficient nourishment during so long a period as that covered by typhoid fever will necessarily add the symptoms of starvation to the already bad enough symptoms of the disease, and make the typhoid state far more typhoid. It is plainly advisable to eliminate starvation effects from the symptom-complex. It would also seem reasonable that the maintenance of the patient's strength and nutrition at the highest point possible would increase and promote the resistant, reactive, and recuperative powers of the system against the disease; just as tuberculous and septic patients are now fed to the highest limit as part of the contest against the infectious process.

From these considerations, and others which may appear in the course of this discussion, in this study is adopted as the guiding principle in the dietetic management of typhoid fever the proposition that —

Typhoid-fever patients should be fed and nourished as liberally as is possible, within the limits of their capacity for digestion, and avoiding special harmful effects.

The proposition thus stated will, it is believed, be assented to by nearly all; and without anticipation or prejudgment of the conclusions to be arrived at will serve as a basic principle upon which and from which the subject can be rationally elaborated.

There is nothing occult or esoteric in the subject of the dietetics of typhoid fever. The organism affected with this disease must manifest definite physiologic processes and laws of nutrition and metabolism; and the attempt of the ensuing discussion will be the elucidation of those processes and laws by means of methods and data analogous to those employed in the establishment of the principles of scientific dietetics in health and in general. In addition to working out the theory of typhoid dietetics, the results of actual practice will be presented and their correlation with the theory brought out.

ESSENTIAL REQUIREMENTS OF TYPHOID-FEVER DIET.

Having formulated the forgoing principle for guidance, it next becomes necessary to determine and establish the essential requirements for the diet in

typhoid fever. These requirements can be grouped under four heads — nutritive value, digestibility, palatability, and innocuousness.

NUTRITIVE REQUIREMENTS IN TYPHOID FEVER.

With regard to to the nutritive value requisite in an adequate typhoid fever diet we have to consider the total energy needed and the amounts required of proteid, fat, carbohydrate, and water. The elaboration of these points involves the question of metabolism in typhoid fever,— the metabolism of matter and the metabolism of energy.

Metabolism of matter. — The most striking and obvious fact in the metabolism of typhoid fever is the constant metabolic balance against the body, that is, the continuous net loss of body tissue, as manifested in the progressive decrease in weight. Under ideal normal conditions, the tissue losses of the body are entirely replaced from the food. During the pyrexia of typhoid fever, however, there is necessarily a greater destruction of body tissue than can be made good by the food. It has been found that (excepting in occasional cases for brief periods) no matter how much the food is increased, the destruction of body tissue continues to keep in excess; there is a constant balance against the body, and a certain amount of emaciation seems to be inevitable with the most favorable diet.

The average loss of weight of typhoid patients during the febrile period ranges ordinarily from about 200 to

600 grams (7 to 20 ounces) daily, or about 0.3 to 1.0 per cent of the body weight. In 57 of the cases summarized in Table I the average daily loss of weight during pyrexia was about 320 grams, or 0.59 per cent of the body weight. Different subjects show great individual differences in their changes of weight in typhoid fever; occasionally for brief periods a patient may maintain or even gain weight on a small diet during the febrile period. Weight observations are not often made on typhoid patients during the course of the disease; so that a close approximation to the average changes in weight in these cases, or a reliable basis for comparisons, can not be made from the data now available. A few investigators present results indicating that the amount of food given governs to some degree the extent of loss of weight; and while the figures of different observers do not always show marked agreement, there can be no doubt that in general less emaciation is to be expected with generous feeding. Under these circumstances, one fundamental principle should obviously be that the diet in typhoid fever should be of such amount, other things being equal, as to reduce the inevitable loss of body weight to the minimum.

This loss of weight comes from losses of the nitrogenous and fatty tissues of the body, and of the water in these tissues.

The loss of nitrogenous tissue is easily determinable from nitrogen analyses of the food, urine, and feces,

and computation of the nitrogenous exchanges and metabolism. With an adequate diet, as discussed below, the average loss of protein or nitrogenous body substance can probably be brought down to about 30 grams daily, or less.

The exact loss of body fat and water can not be determined except by elaborate tests in the respiration chamber. The largest part of the total loss of body weight, probably two thirds or more, is made up of water. It has been generally held that the amount of body fat consumed in typhoid fever is comparatively small, that is, less in proportion to the loss of protein than occurs in ordinary starvation. A general estimate of fat loss is afforded by the respiratory quotient, a low quotient in general indicating a large oxidation of fat, a high quotient a predominant oxidation of carbohydrate, while the oxidation of protein yields a medium quotient. Such respiratory observations as have been made in cases of typhoid fever indicate a low respiratory quotient during the febrile period, as shown in the following summary:

Investigator.	No. of Cases.	Average Respiratory Quotient.
Regnard	7	.65
Kraus	4	.81
Loewy	2	.68
Robin and Binet	3	.73
Riethus	5	.67
General average	21	.70

The low respiratory quotient of .70 would indicate a relatively large oxidation of fat. In the fasting experiments conducted by Atwater on a healthy subject, at rest, in the respiration calorimeter, the ratio of body protein to fat lost was 1:2.42, with a respiratory quotient of .73. We might therefore assume that during the febrile period of typhoid fever, with a similar low quotient, the loss of body fat would probably be at least double the loss of body protein. A daily loss of 30 grams of body protein, 70 grams of body fat, and 200 grams of body water would therefore account for a total daily loss of body weight of 300 grams.

During convalescence the power of the tissues to regenerate is restored, and they greedily utilize and retain the food material offered.

Metabolism of energy: Unfortunately, in the lack of accurate and reliable respiratory and calorimetric investigations on human subjects, our ideas of the oxygen intake, carbon-dioxid output, and energy metabolism in fever are very vague. On superficial view it would seem that in fever there would be a total increase of oxidation and energy output; but this is by no means certain, and some investigations seem to have shown a decrease rather than an increase. The one essential point about energy metabolism in fever is that heat dissipation is relatively lowered as compared with heat production; but this indicates nothing as to the absolute amount of heat exchanges, and both heat formation and heat output through the twenty-four

hours could be less than normal compatibly with the febrile condition.

The recorded respiratory investigations in cases of typhoid fever * are all made by comparatively imperfect methods, and yield no marked or certain results. Experiments, more satisfactory on animals have shown an increase of oxidation in fever, and it is the general impression of the authorities on the subject that in fever the consumption of oxygen, output of carbon dioxide, and energy eliminated are ordinarily about 5 to 15 per cent more than in health at rest; still more when the cardiac and respiratory activities are greatly accelerated. Exact determinations of the increase, which are greatly needed, would require the use of the respiration calorimeter.

Total energy: In the lack of such observations we can derive an estimate of the total energy or caloric value required in the typhoid-fever diet only in an indirect and tentative way. The physical situation of a typhoid fever patient is the same as that of a person at rest, and we may adopt as the standard of nutrition that of a healthy resting person, with such modifications as are imposed by the conditions of the disease.

The daily metabolism of total energy in a normal adult at rest is about 33 kilocalories per kilogram (15 calories per pound) of body-weight, or about 2,300

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* Respiratory investigations in cases of typhoid fever have been made by Schroeder (1869), Liebermeister (1872), Buss (1878), Regnard (1878), Wertheim (1878, 1882), Kraus (1890), Loewy (1891), Robin and Binet (1896), and Riethus (1900).

calories daily for a person weighing 70 kilos (154 pounds). If in the febrile condition there is an augmentation of the heat elimination of 13 per cent (Von Noorden), this would increase the energy metabolism by 300 calories, making 2,600 calories as an approximate estimate of the daily energy output in typhoid fever.

This energy evolved is derived from the katabolism of food material and body tissue. Under ideal conditions the energy output of the body is supplied entirely by the food. This output is mainly independent of the amount of food taken; and if the food is not sufficient to yield all the energy required for carrying on the body activities, enough body tissue will be burned in addition to supply the remainder of the energy needed.

In typhoid fever, as noted above, however liberal the diet may be, a certain amount of the body tissues will inevitably be consumed in excess of the food supply. This inevitable oxidation of body tissue will furnish a part of the total energy required by the organism; the remainder must be supplied by the food, and the diet should be sufficient in amount to reduce consumption of body substance to the minimum.

Supposing the body loss to be reducible to 30 grams of protein and 70 grams of fat daily, the oxidation of these amounts of these materials would afford about 800 calories of energy. Deducting this 800 from the total energy requirement of 2,600 calories leaves us 1,800 calories to be supplied by the food. While there

are some uncertain and variable elements in this computation, with our present data we may tentatively accept 1,800 calories as a moderate estimate (subject to future revision) of the daily amount of energy which should be supplied by the diet, to a person of 70 kilos weight, during the febrile period of typhoid fever.

During convalescence the requirement is much greater, and the food should then be sufficient not only to yield the 2,300 calories required by the organism at rest, but also to supply the material being stored up in the body tissues.

The energy required can be distributed ad libitum among the proteid, carbohydrate, and fatty elements of the food, provided that a certain minimum amount of proteid necessary for nitrogenous metabolism is supplied. The coefficients by which the energy value of the different kinds of food can be computed are, for each gram of

Protein	4.1 calories
Carbohydrate	4.1 "
Fat	9.3 "
Alcohol	7.1 "

Proteid and nitrogen: The nitrogenous equilibrium which the organism tends to maintain in health is profoundly disturbed during typhoid fever. In this condition the destruction of protein and elimination of nitrogen during the pyrexia is practically always much in excess of that introduced in the food; and it is practically impossible by increasing the nitrogenous ele-

ments of the food to make good the deficit and attain a nitrogen balance. This is due to destruction of the protoplasm of the body cells by the typhoid toxins in excess of their capacity for regeneration. Since it is impossible to attain the ideal result of giving a protein ration sufficient to meet the protein loss, it seems obvious that the amount of protein food given should be such as will reduce the drain on the tissue proteids and the net nitrogenous loss to a minimum.

In order to determine this optimum proteid ration and as an exhibit of nitrogenous metabolism in typhoid fever, I have prepared from all published reports of metabolism investigations in this condition * the accompanying Table I, showing the average daily nitrogenous exchanges during both the febrile and convalescent periods. This table presents the results of 215 metabolism observations, made by approved methods in 81 cases of typhoid fever by 20 different observers, and covering a total of 974 days of investigation.

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* Studies of nitrogen metabolism in typhoid fever have been made by Renk (1877), Bauer and Künstle (1879), Hoesslin (1882), Müller (1884), Engel (1885), Riess (1886-'87), Walter (1886), Khadgi (1888), Aikanov (1889), Müller (1889), Diakonov (1890), Matzkevich (1890), Grammatchikov (1890), Gruzdiev (1890), Geisler (1890), Puritz (1892), Dünschmann (1892), von Leyden and Klemperer (1898-'99), Ladenburger (1901), and Mohr (1904).

TABLE I. AVERAGE DAILY NITROGENOUS METABOLISM AND EXCHANGES IN TYPHOID FEVER.

Observations in which the amount of nitrogen in the daily ration was:—	Number of Cases.	Number of experiments.	Total duration of experiments. Days.	Nitrogen ingested in food. Grams.	Nitrogen in feces. Grams.	Nitrogen digested and absorbed. Grams.	Per cent of food nitrogen digested and absorbed. Per cent.	Nitrogen in Urine. Grams.	Nitrogen loss(—) or gain (+). Grams.
During pyrexia:									
0 to 3.9 grams	11	15	50	1.9	.8	1.1	57.9	13.1	–12.0
4 to 7.9 "	29	58	218	6.6	1.7	4.9	74.2	14.8	– 9.9
8 to 11.9 "	30	36	173	9.3	1.3	8.0	86.0	15.8	– 7.8
12 to 15.9 "	23	40	154	14.3	2.0	12.3	86.0	20.4	– 8.1
16 to 19.9 "	7	11	34	17.7	2.1	15.6	88.1	19.3	- 3.7
20 to 23.9 "	8	9	64	22.0	3.3	18.7	85.0	25.2	– 6.5
24 to 27.9 "	5	5	53	25.3	3.0	22.3	88.1	26.9	– 4.6
Over 28 "	3	4	20	34.3	5.5	28.8	84.0	42.0	–13.2
General average..	79	178	766	11.1	1.9	9.2	82.9	17.8	– 8.6
During convalescence:									
Under 15 grams	13	15	83	10.4	1.1	9.3	89.4	13.6	– 4.3
Over 15 grams	21	22	125	24.0	3.0	21.0	87.5	17.7	+3.3

Average weight of 57 of the subjects (126 experiments), during the pyrexia, 54.2 kgms; average daily loss of weight .32 kgm., or 0.59 per cent of the body weight.

In this table the observations are classed and averaged in groups, according to the amount of nitrogen in the daily ration. The figures in the last column show that the daily nitrogen loss, or excess of nitrogen outgo over nitrogen income, decreases from the smallest ration to a ration of 16 to 20 grams, remains quite low with a nitrogen ration of 20 to 28 grams, and over that amount again markedly increases. While a greater number of experiments with the ampler diets

are desirable to settle the point well, the data at hand indicate that a daily ration containing from 16 to 20 grams of nitrogen, averaging about 17.7 grams, reduces the nitrogen waste to a minimum and would seem the optimum amount for typhoid diet. As proteid substances contain an average of about 16 per cent of nitrogen, 17.7 grams of nitrogen would be equivalent to about 110 grams of protein.

The amount of protein as thus determined agrees very closely with the amount generally recognized as daily required for the maintenance of nitrogenous metabolism at rest in health, namely, about 1.5 grams per kilo of body-weight, which with a person weighing 70 kilos would amount to 105 grams of protein daily.

As for the contention of Chittenden of the adequacy of a proteid ration far below that generally regarded as necessary, his views have not received general acceptance; and whatever he may have shown as to the dietetic requirements under the conditions presented by the subjects of his experiments, we have in the foregoing analysis a clear indication that in typhoid fever a daily supply of a hundred grams or more of proteid food gives results superior to those of a more limited ration.

In Table I the figures in the column for nitrogen loss are no mere theoretical abstractions, but represent very obvious and very important clinical conditions, that is, the continuous loss of body-weight. The minimum nitrogen deficit, 3.7 grams, represents the destruction of 23.1 grams of body protein, or with the

associated water a daily loss of body-weight of about 115 grams. The difference between this smallest nitrogen deficit and that in the next preceding group, 4.4 grams daily, would mean a daily saving in body-weight of 135 grams (4½ ounces). This is not much for a single day; but continued through the course of the disease it accumulates to a considerable aggregate; and this loss does not include, be it noted, the loss of the comparatively unimportant body fat, but embraces solely the destruction of the far more valuable body protoplasm. Furthermore, the extra weight lost as the result of the difference between the most efficient ration and a less efficient ration is entirely a starvation result and not at all due to the conditions of the disease itself.

On these grounds and so far as the available data indicate, the ration of protein food which would seem to give the best results in typhoid feeding during the febrile period may be placed at about 100 to 110 gram (3½ oz.) per day for an average-sized person; certainly at more rather than less than 100 grams.

During the first few days of apyrexia nitrogen metabolism and nitrogen waste are much the same as during the period of fever; after a few days, however, the capacity of the body for nitrogenous assimilation and regeneration is restored and nitrogen is rapidly and greedily absorbed by the system. During this period the nitrogen ration may be advantageously amplified.

Facts and Carbohydrates.— As is the case with proteid, there is an excessive destruction of the fatty body tissues in typhoid fever above the power of the food to replace. Exact studies of carbon metabolism in this disease have not yet been found practicable and have not yet been made, so that we have not the same data for determining the ration of fats and carbohydrates that will reduce the body waste to a minimum as we have with protein. We can deal with this question only in a tentative way.

The 100 grams of proteid required in the daily diet will yield about 400 calories, which, deducted from the total energy required from the food, 1800 calories, leaves 1400 calories to be supplied by the fats and carbohydrates. This energy we can divide between these two food elements in any convenient or practicable proportions. We might, for instance, give as much fat (which has the highest energy value) as can be tolerated and well digested, and then make up the remainder of the quota of energy with carbohydrate. Thus, if we give 50 grams of fat daily (energy value, 465 calories) it would require 230 grams of carbohydrate to make up the 1400 calories required; or 75 grams of fat and 200 grams of carbohydrate would yield 1400 calories; and so with other combinations.

The *salts* required in typhoid diet present no special problem.

Water.— There is now, as there has nearly always been among medical authorities, general agreement as

to the advisability in typhoid fever of giving water in liberal amount. It is always and constantly an essential element of food. There is a large loss of water from the tissues in typhoid that needs to be replaced. Investigations have shown that the drinking of large amounts of water promotes the digestion and absorption of foodstuffs, especially during the febrile period of typhoid. Ingested cold, it is by some considered antipyretic. It flushes out the bowel, keeps the feces soft, washes out the products of intestinal putrefaction, dilutes the toxic blood, promotes the elimination and excretion of toxins by the kidneys and skin.

About 2 to 3 liters (or quarts) of water is generally deemed the proper amount to include in the typhoid diet daily.

To summarize, the approximate daily nutritive requirements of a proper typhoid-fever diet for a person of average size, so far as can be estimated from the data available, appear to be 1800 calories of energy, 100 grams or more of protein, fat and carbohydrate enough to yield about 1400 calories, and 2 or 3 liters of water, during the pyrexia; more in convalescence.

DIGESTION AND DIGESTIBILITY IN TYPHOID FEVER.

Having attempted to establish a nutritive standard, the important qualifying question next arises as to the ability of the typhoid patient to digest, absorb, and assimilate the food that theoretically seems to be needed.

It is generally asserted and believed that the digestive powers in typhoid and other fevers are very greatly impaired and even altogether abolished. In such a profound disturbance of the body functions as occurs in a severe disease like typhoid fever it seems on superficial view natural and almost obvious that digestion must be enormously lowered, and this view, accordingly, has prevailed almost unchallenged for ages, though it has been based more on general impressions and a priori deductions than on exact observations.

The dry tongue and mouth often seen in typhoid fever naturally suggests deficiency of the salivary secretion and salivary digestion.

Beaumont in the classical observations on digestion (1833) claimed that in the "febrile diathesis" very little or no gastric juice is secreted and digestion is much impaired; it is obvious from his statements, however, that his conception of fever was very vague, and that his subject at no time during the experiments suffered from real fever, but only from transient attacks of acute indigestion. A number of modern observers agree fairly well that in typhoid and other acute fevers there is usually a diminution or suppression of hydrochloric acid in the gastric juice, while the pepsin is but little lowered (Pavy, Manassein, Von den Velden, Hoppe-Seyler, Edinger, Glucinski, Von Noorden, Von Leyden and Klemperer). Sticker and Zweifel found gastric absorption materially retarded

in typhoid fever. The motor functions of the stomach were found little impaired by Von Noorden.

Few reliable observations as to intestinal digestion in typhoid fever has been made. The presence of the lesions and the occurrence of diarrhea would, however, be expected to impair the digestive activities of the bowel.

These observations indicate some lowering of the digestive secretions and powers. This, however, does not tell the whole story of digestive activity, since it is a matter of common observation that patients with decided diminution in the secretion of the elements of the gastric juice may nevertheless be capable of digestion sufficient to maintain a good degree of body nutrition.

Fortunately we have at our command accurate, reliable, and comparatively simple methods by which the amount of food material digested and absorbed can be determined with great precision. This consists in making exact determinations of the amount of food material — protein, fat, or carbohydrate — ingested during a definite period, and also determining the amounts of these materials as discharged in the feces for the corresponding period. The difference between the material ingested and that dejected necessarily represents the amount digested and absorbed. By the use of this method we are able to determine the exact degree of digestion in cases of typhoid fever, and estimate with precision the average falling off that may be expected.

Digestion of protein.— The difference between the amount of nitrogen introduced in the food and that excreted in the feces indicates the amount of nitrogen that has been digested and absorbed. The percentage of nitrogen absorbed is always really somewhat more than this difference indicates, as a part of the fecal nitrogen is derived from the residue of bile and other intestinal secretions, cellular debris from the intestinal mucosa, etc.; but as this part is indeterminate it has to be disregarded, and digestion is always somewhat more complete than the figures indicate.

The observations summarized in Table I comprise a large body of data affording a substantial basis from which we can form a definite conception of the power of digesting proteid food possessed by typhoid-fever patients. In many of the individual cases the digestion of protein is very low; but in the general average the impairment is far less than is generally supposed.

Referring to Table I, the figures in the eighth column show the average percentage of food nitrogen digested and absorbed in the typhoid cases there summarized. It will be seen that the amount of the daily nitrogen ration seems to have a distinct effect on the proportion of food nitrogen absorbed, the ratio of the latter increasing from 57.9 per cent with a ration of under 4 grams to 88.1 per cent with a ration of 16 to 20 grams and also 24 to 28 grams of nitrogen, and then again decreasing. These figures, for the reasons

stated, are below the real values, and the disparity or error is greater with the smaller rations; yet they seem to show clearly that the highest digestive efficiency for proteids in typhoid is found when the daily nitrogen ration is from 16 to 20 grams and over, the same ration that gives the smallest nitrogenous deficit. This is perhaps because the digestive powers are keyed up to their maximum efficiency when the general body nutrition is at its best, and is another reason for regarding the nitrogen ration of 16 to 20 grams or over as the best one for typhoid.

The general average digestion and absorption of nitrogen, or protein food, in the entire series was 80.9 per cent during the febrile period (88.1 per cent with the optimum diet), 88.5 per cent during convalescence. These figures, compared with the coefficients of digestibility of protein in health, namely, 97 per cent for animal protein, 84 per cent for vegetable protein, and 92 per cent for protein of mixed diet (Atwater), indicate a general average falling off in the digestibility of nitrogenous food of about 9 per cent (4 per cent with the optimum diet) during the pyrexia and 5 per cent during the convalescence of typhoid fever.

In order to obtain a measure of digestibility of different kinds of proteid food during the pyrexia in typhoid fever, I have reclassified the metabolism observations summarized in Table I according to the kind of food given. The results are presented in Table II.

The next to the last column of this table shows the percentage of food nitrogen or protein ingested that is digested and absorbed, and ranges from 93.9 per cent for white of egg to 70.2 per cent for milk and soup. Compared with the general standard of digestion and absorption in health, the various foods mostly show a falling off of five to ten per cent.

TABLE II. AVERAGE DAILY DIGESTION OF PROTEIN OF VARIOUS KINDS OF FOOD DURING THE FEBRILE PERIOD OF TYPHOID FEVER.

FOOD (MAINLY).	IN TYPHOID FEVER (PYREXIA).							FOOD NITROGEN ABSORBED IN HEALTH (ATWATER).
	Number of Cases.	Number of experiments.	Duration of experiments. Days.	Nitrogen in food (daily). Grams.	Nitrogen in feces (daily). Grams.	Nitrogen digested and absorbed. Grams.	Percentage of food nitrogen absorbed. Per cent.	Per cent.
Eggs - yolks	2	2	5	12.4	1.0	11.4	91.9	97
Eggs - whites	1	1	2	19.8	1.2	18.6	93 9	97
Meat juice	2	2	4	14.6	.9	13.7	93.8	97
Ham	2	2	5	18.4	1.6	16.8	91.3	97
Milk under 8 grams nitrogen daily	3	5	12	6.0	.8	5.2	86.7	
Milk over 8 grams nitrogen daily	6	6	20	12.2	1.1	11.1	91.0	97
Milk and soup	6	10	32	6.7	2.0	4.7	70.2	
Milk, soup, and tata albumen	4	4	20	10.1	2.1	8.0	79.2	
Milk and bread	17	26	164	14.1	2.6	11.5	81.6	92
Milk, bread, and alcoholics	18	41	163	6.4	1.5	4.9	76.6	
Milk and oatmeal	1	1	4	7.2	1.2	6.0	83.3	92
Milk, cream, and lactose	1	2	4	10.4	1.2	9.2	88.5	97
Milk and meat powder	1	9	9	17.2	1.7	15.5	90.1	97
Milk, bread, and meat	10	14	83	13.2	2.1	11.1	84.1	92
Milk, bread, eggs, meat, etc	6	6	95	23.5	4.5	19.0	80.9	92
Milk, cream, eggs, bouillon, etc	2	2	17	13.9	1.0	12.9	92.8	97
Milk, eggs, soup, etc	8	23	67	14.6	2.0	12.6	86.3	
Rice	1	1	2	2.5	.5	2.0	80.0	85
Porridge (of fine grits)	2	2	8	17.4	1.9	15.5	89.1	85
General average	71	159	716	11.7	1.9	9.8	83.6	92

Digestion of fat.— Studies of digestion and absorption of fat during typhoid fever have been made, secundem artem, by Hoesslin, Tschernoff and Ladenburger in 17 cases of the disease. A summary of their results is given in the accompanying Table III.

TABLE III. DIGESTION AND ABSORPTION OF FAT IN TYPHOID FEVER.

Food.	Percentage of food fat digested and absorbed.	Number of Cases.	Number of Experiments.
Milk:			
Pyrexia.....	90.6	10	12
Convalescence.....	85.6	4	4
Milk, eggs, soup, etc.....	91.6	5	5
Eggs — yolks.....	94.3	2	2
Ham	72.9	3	3
Porridge.....	91.9	2	2
General average	88.5	17	28

NOTE. Four experiments with milk and one with ham were made during apyrexia, the others during pyrexia. Total duration of experiments 109 days.

Comparing these results with the average digestibility of fat in health, namely, 95 per cent for fat in animal food, 90 per cent for fat in vegetable food and 95 per cent for fat of mixed diet (Atwater), it appears that in typhoid fever the digestion of fat falls off, with ordinary diet, about 1 to 10 per cent, or in the general average 6.5 per cent.

Digestion of carbohydrate.— Aside from a single observation by Ladenburger I have found recorded no investigations of the digestion of carbohydrates in typhoid fever. As carbohydrates are in health ordinarily

more easily and completely digested and absorbed than is protein or fat, it is probable that any diminution in their absorption in typhoid fever would be less, or certainly no greater, than that for protein or fat.

Total solids.— Some experiments on the digestion and absorption of the total solids of the food (dry solids of food minus dry solids of feces) made by Hoesslin in 8 cases of typhoid fever (18 experiments, all but one being during pyrexia) are summarized in Table IV for comparison with the corresponding data for health:

TABLE IV. DIGESTION AND ABSORPTION OF TOTAL SOLIDS IN TYPHOID FEVER.

FOOD.	Per cent of solids of food digested and absorbed.	
	In Typhoid Fever (Hoesslin).	In Health (Rubner).
Milk	93.2	90.9
Milk, eggs, soup, etc.	91.2	
Eggs — whites	91.2	
Eggs — yolks	92.4	94.7
Ham	88.8	
Roast meat		94.9
Meat juice and soup	86.3	
Porridge	91.0	
Macaroni		94.3
Rice	90.6	95.1
General average	90.8	94.0

In general, then, it appears from precise determinations that the average falling off of digestive and absorptive power for all sorts of food material during the febrile period of typhoid fever does not exceed 5 or 10

per cent. This decrease is far less than is generally believed to be the case. The difference between digestion in health and typhoid fever is less than the difference in health between various articles of food ordinarily regarded as digestible; for instance, the difference between the digestibility in health of the protein of eggs and of bread, both digestible foods, is about 13 per cent. The high average digestibility of 88.1 per cent with a diet containing 100 grams or more of protein daily, shows that typhoid patients can easily utilize that amount of protein. It may be concluded, therefore, that the digestive powers in typhoid fever ordinarily are or may be so little lowered as to be entirely adequate to meet all proper demands that may be made upon them.

It is to be expected that in different cases of the disease will be manifested different degrees of impairment of digestion, and that in the bad cases the falling off of digestive power may be much greater than I have indicated. The observations that I have collected show, however, how great digestive ability can be expected in some cases, average and typical cases of typhoid fever. Some patients obviously digest well; and because in bad cases the patients are unable to digest a certain food is no reason for withholding it from a patient who can readily digest it.

What may be called subjective digestibility — the subjective sensations and phenomena accompanying digestion, personal likes and dislikes, the ease or the dis-

comfort with which differant kinds of food are digested by different persons — is not amenable to scientific analysis, but is a matter of personal peculiarity and idiosyncrasy that can be determined only by experience or trial in each individual case. Considerations of this character apply as much to milk and soup as to any other diet.

While we can often count on much better digestive power than has been generally supposed, it is obvious that the typhoid dietary should include only the most digestible, plain, and substantial articles of food, excluding those that are notoriously indigestible. Theoretically, foods should be chosen that will be digested and absorbed in the stomach and upper part of the small intestine, where the involvement of the alimentary structures is least; but practically such a distinction would be difficult and unnecessary to make.

When necessary the usual measures can be employed to stimulate digestion.

PALATABILITY.

A requirement in typhoid diet which should be more generally recognized is that it be made as palatable, appetizing, and agreeable to the patient as possible. This will conduce greatly to the patient's comfort; it may induce him to take a needed larger amount of nourishment, it should, according to Pawlow's teachings, materially increase his digestive powers. Food

that is not relished or is actually disliked is apt to be poorly digested and badly borne. Variety in the diet will similarly conduce to efficiency, as monotonous continuance in any unaccustomed or limited diet excites discomfort, repugnance, revolt, and active indigestion.

INNOCUOUSNESS.

The diet in typhoid fever shonld not cause harm under the special conditions present in this disease. Numerous bad effects are charged, with more or less justice, to dietetic improprieties.

Gastric indigestion.— Gastric irritability, vomiting, nausea, and intolerance of food sometimes occurring in typhoid fever are usually due more to the conditions of the disease than to improper food. If the food should cause or contribute to the gastric trouble it should be changed accordingly, but the kinds of food that will be best borne must be determined for each case individually.

Intestinal indigestion.— The food should so far as possible be such as not to conduce to undue bacterial growth in the intestine, resulting in fermentation, gas formation, aud the production of flatulence and tympanites, or in abnormal putrefactive processes with the generation and absorption of troublesome toxins. It should not irritate the bowels or tend to cause or increase diarrhea. These troubles are usually due to

the lesions and conditions of the disease quite irrespective of food; but the diet selected should obviously be such as will be the best borne, and to the extent to which the intestinal indigestion and irritation may be caused by the food should the diet be corrected and rearranged. The cases must be individualized, and the causes and remedies for the troubles specially determined for each. With a large diet list to choose from there is a better chance in both gastric and intestinal indigestion of being able to find articles of food than can be well borne.

Effect on ulcers.— It is held of the utmost importance that the food in typhoid fever should be such as to cause the least possible disturbance or harm to the ulcerated patches in the bowel. The primary and chief cause of the ulcerative process is the action of the bacilli in the tissues; but it is possible or conceivable that the solution of continuity and the resulting danger of hemorrhage or perforation could be secondarily increased through the action of improper food. (a) Great distension of the bowel by gas, causing tension on a thinned, ulcerated area might produce further rupture or perforation. This is a question of intestinal indigestion, to be corrected by careful selection of the food, emptying of the bowel, intestinal antiseptics, or other treatment. (b) Continuous peristaltic motion of the ulcerated area is not a condition most conducive to healing. It is however, impossible to secure absolute rest for the healing of typhoid ulcers.

There is necessarily some peristalsis, and the amount of motion induced by ordinary and proper food is probably much less than is caused by the use of those purgatives which there is no hesitation in using in the cases presenting constipation. The conceivable danger from normal peristalsis may therefore be disregarded, beyond the obvious necessity of arranging the diet so as to minimize diarrheal tendencies. (c) Just as poor nutrition retards the healing of superficial ulcers, so insufficient feeding may be supposed to retard the healing of typhoid ulcers; and the same reason would seem to exist for liberal feeding to promote the healing of the latter as prompts the surgeon to feed liberally to hasten healing of surface ulcers. (d) The pressure of solid or bulky masses of food residue upon the ulcers may conceivably cause them to rupture or irritate them to additional inflammation. This possibility introduces the very important requirement that the food in typhoid fever should be such, and so prepared, that the residue in the intestine shall be fluid, or in a state of fine division, non-irritating, of minimum bulk, and kept well softened or in a semifluid or pasty condition by water.

As may easily be seen at autopsies, all ordinary food material, liquid or solid, during its passage through the small intestine is normally in a pasty condition, with the solid elements reduced to a state of very fine division, bland and mechanically unirritating. Three kinds of solid food masses of size sufficient to be me-

chanically injurious may be present in the small bowel: (a) Solid food that is not sufficiently masticated or otherwise comminuted; (b) indigestible portions of food, chiefly undivided fragments of vegetable tissue containing much cellulose, as skins of fruits, grains, etc.; and (c) lumps of curdled milk. In the large intestine, in addition, solid fecal masses may be produced by inspissation of the intestinal contents into scybala.

These considerations teach that in typhoid fever the food should be liquid, or soft and easily divisible; or if solid (supposing solid food to be permissible), it should be given in a finely divided condition, with all large undivided masses, as of cellulose, excluded. The food should in general be such as yields a small fecal residue. Plenty of water should be given, that the intestinal contents may be kept properly moistened. The bowels should be kept open (if constipated), to prevent accumulation, inspissation, and hardening of the feces. With these precautions, the food material as it passes through the bowel ought to be, as nearly as can be made, of the bland, finely-divided, semifluid, and non-irritating character indicated in this disease.

This leads to the question as to the necessity that the food in typhoid fever be fluid. From time immemorial solid food has been regarded as totally inadmissible in fever. In the literature, however, this doctrine is laid down dogmatically and without proof, as if it were self-evident and did not require critical consideration and demonstration. A great deal is taken for

granted in this assumption, and if it is true it is certainly worthy of being established on scientific dietetic principles rather than on dogmatic assertion or vague impressions. It is, nevertheless, all but universally held that in this disease exclusive liquid diet is absolutely essential, that milk is the ideal liquid food, and that solid and even soft food is dangerous and contra-indicated. In spite of its general acceptance, the advocates of a more liberal and varied diet disagree with this view in every particular.

The idea seems to be that solid food is less digestible than liquid food, more irritating to the intestines, goes through the alimentary canal in a more solid and bulky form, or in some occult manner augments the disease processes in a way that a corresponding amount of liquid food will not. None of these suppositions is necessarily true. Well-divided solid proteid is practically as easily digestible as the liquid proteid of milk or eggs. The liquid forms of albumen have to go through the same process of digestion as the solid forms before they can be absorbed; raw egg albumen, for instance, even if diluted and thinned, is utterly incapable of direct absorption as such, and it is doubtful if raw egg is much more easily digestible than is cooked egg. The digestive juices are amply sufficient to convert solid proteid and carbohydrate material into liquid form. As to leaving less fecal residue, the solids of milk in health yield much more fecal residue than do hard-boiled eggs or meat; according to some

determinations two and three times as much; and no solid food can cause more intestinal indigestion or irritation than milk often does.

Liquid foods offer certain distinct disadvantages. Owing to their bulk and degree of dilution, it is often impossible to introduce an adequate amount of nutritive material by their exclusive use. Their diluted condition may actually impair their digestibility, by causing too great dilution of the gastric juice; just as in the treatment of ordinary dyspepsias the drinking of to much liquid at meals is discouraged on that ground.

What is to be regarded as liquid and what as solid food? The idea that solid food will remain solid, and liquid food remain liquid, in their passage through the alimentary canal is contradicted by common experience. Proper and properly prepared solid food enters the bowel in pasty or practically fluid form. For the purposes of typhoid diet, which has the better claim to being termed liquid food, previously solid food that becomes fluid in the stomach and intestine, or previously liquid food, like milk, that becomes solid in the stomach? Of all foods, certainly of all foods that could reasonably be given to very ill patients, milk is or may be the most solid; since no other food is capable of passing through the entire intestinal canal and being ejected with the feces in such large or hard masses. The previous form of a food may be very deceptive as to its solid content; milk, for example, contains more

solids than do turnips. It would seem rational that the previous condition of fluidity or solidity of the food is quite irrelevant; it is its consistency in the intestine that is of importance in typhoid feeding.

Metabolic excess.—It is conceivable that relative overfeeding in typhoid fever might overload or clog the circulation with superfluous nutritive materials, or an excess of katabolic products, to the detriment of the patient's general condition. With the present attitude of the profession such as it is, overfeeding is little likely to occur, and the error, if recognized, could be easily corrected.

Renal effects.— Obviously the kidneys in typhoid fever should not be overburdened with the necessity of excreting an excessive amount of katabolic material. Fortunately the kidneys ordinarily suffer comparatively little impairment and nearly always retain remarkably good functional power in this disease, and only rarely would they require to be specially considered in the arrangement of the diet.

Effect on body temperature.— The diet in typhoid fever should be so managed as to minimize any tendency it may have to increase fever or cause the recurrence of pyrexia in the postfebrile stage. It is around this point that much of the controversy on the diet question centers.

If the body temperature depended directly on the amount of heat production then it would be influenced by the amount of food eaten and would show great

fluctuations according to the diet. From a superficial view, a large amount of food by liberating a larger amount of energy convertible into heat might be expected to raise the body temperature, or at least not to lower it; and in starvation conditions there is a lowering of the body temperature. Body temperature is not, however, a resultant of body oxidation alone, but of the balance between heat production and heat dissipation. Heat production may vary widely, up and down, but the balance and the body temperature normally remain constant, as heat dissipation varies correspondingly. It is a disturbance of the heat regulating apparatus that results in the retention of heat and elevation of the body temperature that constitutes fever. A certain amount of oxidation is necessary to supply the energy needed for the performance of the body activities of the fevered organism; and any lack in the energy supplied by needed food will be compensated by a correspondingly increased combustion of body tissues which will maintain oxidation and the fever at the same level. Nor have experiments (Hoesslin) shown any material difference in the body temperature under a spare and a liberal diet.

The amount of heat required to raise the temperature of the body a few degrees (58 calories being sufficient to raise a body weighing 70 kilograms 1° C.) is only a small part of the total heat production; thus, so little as three ounces of milk would yield enough energy (if not otherwise expended) to raise the tem-

perature of an average sized individual two degrees Farenheit (90 c. c. of milk would raise it 1° C.). Even on the lowest diet there is far more heat produced than is sufficient (if retained) to cause high fever, and the temperature changes of the body represent but a small part of the energy metabolism of the organism.

That the condition of pyrexia *per se* is essentially affected by the kind of food, or within ordinary limits is materially aggravated by or is a contraindication to an abundance of food, properly given, is not therefore, shown. The effect of food is certainly not feared in the fever of such conditions as tuberculosis. The temperature in both the febrile and apyretic periods of typhoid fever is subject to sudden and inexplicable fluctuations. Such sudden changes occurring coincidently with some slight change in diet are apt to be wrongfully charged to the food. These fluctuations may occur under any diet, and are usually entirely unconnected with the food.

Relapses are often charged to dietetic improprieties. The occurrence of relapses after a change in diet is more apt to be coincidental than causal. Relapses occur under a milk diet or any diet, and when no change has been made in the feeding. That true relapses can be caused by food is being doubted more and more; relapses are now regarded as being due to reinfections and repetitions of the disease process, and it is difficult to see how food can have any agency in causing these, any more than in producing the original attack.

Only one febrile condition is clearly chargeable to food, the febris carnis, or food fever. The true febris carnis is due not so much to the kind of food as to an abrupt change or increase in its amount. An amount of food that if suddenly given will cause fever can be gradually worked up to without any symptoms. The cause of febris carnis is unsettled; some regard it as of nervous origin, similar to the fever that may be aroused by excitement, etc., in ill persons; or, in the unstable condition of the heat-regulating apparatus after typhoid, this apparatus being unable to accommodate itself quickly to abrupt changes in diet, the sudden liberation of a large amount of heat energy from the unwonted quantity of food may cause a rise in body temperature. Some regard the liability to food fever as largely a starvation effect, and that the tendency to it is increased on insufficient nourishment. Even when it occurs, the true febris carnis is generally of brief duration and very little importance, very different from a genuine relapse.

The advocates of liberal diet therefore believe that, while no exaggerated fear need be felt of the effect of food on the fever, changes in the typhoid dietary should be made gradually, watchfully, and cautiously, never suddenly.

Effect on coagulation of blood.— The effect of food materials on the coagulation of the blood has an occasional bearing on the selection of the diet in typhoid fever. In intestinal hemorrhage it would be desirable

to have the coagulability of the blood increased; in the cases of thrombosis, the contrary effect would be advantageous. According to Wright, the coagulability of the blood is diminished during the febrile period in typhoid fever; during convalescence it is increased, largely, apparently, as the result of liberal ingestion of milk. Calcium salts being essential to the clotting of blood, the administration of lime salts may greatly accelerate coagulation; as milk contains these salts in abundance it has been found capable of markedly shortening coagulation time. Gelatin is also supposed to favor coagulation. When it is desirable to increase coagulation, therefore, as in actual or threatened hemorrhage, milk and gelatin would be of service; but when thrombosis threatens or occurs they would be contraindicated, or if used should be so prepared as to abolish their coagulating properties (decalcification of milk).

THE DIETARY IN TYPHOID FEVER.

Having considered the essential requirements of typhoid diet as to nutritiveness, digestibility, palatability, and innocuousness, it is next in order to consider the acceptability in these respects of the various articles of food available for use. The discussion of this part of the subject rests largely on the composition and digestibility, the proportion of solids absorbed and the proportion of fecal residue, etc., of the various foods, according to the standard determinations of Voit,

Rubner, Atwater, and others; also on the data brought out in Tables II, III, and IV.

Milk.— To yield the amount of protein and energy which I have presented reasons for regarding as standard, about 3 liters (or quarts) of milk would have to be given daily, representing about 100 grams of protein and 2,000 calories. If this amount could be given continuously to all typhoid patients without ill effects, the question of typhoid diet would be a simple one; but it is not often practicable to give this amount. Under the present system typhoid patients generally receive 1,500 to 2,000 c. c. (3 to 4 pints) of milk a day or its equivalent, a quantity entirely insufficient for proper nutrition, not much more than half the amount needed. The present general dietetic method in typhoid fever must be characterized as one of partial starvation, by which, thoughtlessly and unknowingly perhaps, but usually unnecessarily, conditions of starvation are added to the conditions of the disease. The fact that patients are deliberately compelled to suffer for weeks the distressing pangs of hunger, which might be taken as a call of nature for more food, without any attempt at relief, is another reason for suspecting that typhoid patients are underfed.

The constituents of milk show a very satisfactory average digestibility in typhoid fever, though not manifesting any superiority in this respect over eggs or meat. The fecal residue left from milk (in health, at least) is greater than that from eggs, beef, fish, or white wheat bread.

Some patients dislike milk, and it is apt to become especially obnoxious when continuously given in large amounts. Milk is capable of causing the severest kind of intestinal indigestion, as often in infants, with fermentation, gas formation, production of irritant toxins, diarrhea, etc.; none of the ordinary animal foods is worse, if as bad, in this respect. The bacterial contamination of ordinary commercial milk may (as shown by Edsall) cause fermentative and putrefactive disturbances in the weakened condition of typhoid patients, when in healthy adults there is sufficient resisting power to overcome this tendency.

That milk is self-evidently the best food for adults is open to question. If it were necessary to limit the diet to a single article of food, milk would unquestionably be the best, and it is one of the most important ingredients in any diet. It presents, however, certain disadvantages, as coagulability, fermentability, bulk, etc., and while it is a natural and complete food for infants it is not adapted to exclusive nourishment of adults except in amounts that are practically prohibitive. A great trouble with its digestion consists in its coagulation in the stomach, an unfortunate condition that occurs with no other food. No other food that could reasonably be given is capable of passing through the intestine in such large and solid masses as the milk curds that are frequently passed with the stools in typhoid fever. It does not necessarily follow that because milk is fluid it is on that account more easily

digestible, less irritating to the bowels, or leaves less fecal residue.

In view of these manifest disadvantages, it is difficult to see how the general esteem in which milk is held as the safest, most efficient, and best food for this disease is justified. The objections that are urged against solid food apply with equal and even greater force against milk. When milk is badly borne, as frequently occurs in typhoid, it is one of the worst of foods, and under these circumstances it produces just the conditions that make it especially objectionable and dangerous in typhoid fever. The appearance of curds in the stools should constitute an unvariable indication for immediate reduction or entire withdrawal of milk from the diet. In acute intestinal disorders in infants milk is regarded as highly harmful; there is no reason why it is not equally contraindicated in similar disturbances during typhoid fever. In thrombosis the free use of milk (from its coagulating effect) may be questionable, unless it is decalcified according to Wright's method by the addition to it of .25 to .5 per cent of sodium citrate (20 to 40 grains to the pint).

When milk is well digested and well borne, however, as it is in the majority of cases, it is within its limitations one of the best of foods, and must constitute one of the most important items in the typhoid dietary. Its largest content of salts is an advantageous feature, and during the febrile period may

materially promote coagulation of the blood and hence tend to lessen intestinal hemorrhage. From its bulk and from the fact that it is especially apt to disagree when given in excessive quantity, it is quite impracticable to give enough milk (3 liters daily) for the sole proper nourishment of adult patients; and it would therefore seem that it should necessarily be supplemented by more concentrated food. The necessity for practically confining typhoid diet to the one article, milk, however good a food it may be, and for excluding other articles that would afford greater variety and more nourishment, is not obvious.

Without placing any exaggerated faith in the value or exclusive use of milk, or entertaining any undue fears of its occasional objectionable action, the physician should exercise the same critical judgment in the employment or rejection of milk in each individual case as in the use of any other food stuff or medicament.

With a view to increasing digestibility or "cutting the curds," milk is often given peptonized, in the form of junket, or diluted with water, lime-water, etc. The practice of giving milk diluted is open to the objections that the bulk is thus increased and the amount of nutritive material that can be given decreased, and that the concentration of the gastric juice is thus much lowered. Dilution with lime-water or other alkaline fluid is open to the further objection — perhaps more theoretical than practical — that these

alkalies neutralize hydrochloric acid in the gastric juice and may thus really hamper digestion. The use of milk with a minimal bacterial contamination, or of pasteurized milk, may be necessary to obviate intestinal fermentation and indigestion.

Cream, if well borne, ought to form a specially valuable item in the typhoid dietary, since from its high fat content it has nearly three times the energy value of milk. If the fat of milk is badly borne, for the sake of variety, buttermilk and skimmed milk are available for use, but their fuel value is only about half that of milk.

Soup.— Soups, broths, bouillon, beef tea, meat extracts, etc., are at present extensively used in typhoid feeding as substitutes for milk or for the sake of variety. These articles are usually satisfactorily digestible, lack some of the special objectionable features of milk, and markedly stimulate the flow of gastric juice. Yet not infrequently broths are badly borne by typhoid patients; and of the diets presented in Table II, the combination of soup and milk shows a surprisingly (and unexplainably) low digestibility of protein. The nitrogen and carbohydrate contents of various soups differ much, but average near those of milk; the fat content runs very low and the total energy value of soups is in general much lower than that of milk. The energy value of bouillon, for example, averages less than a sixth that of milk. The nitrogenous material of soups, broths, etc., is mainly or entirely of the character of

meat extractives, which have been repeatedly demonstrated to be quite devoid of nutritive value. The high estimation in which they are held by the laity and the generality of the medical profession is quite undeserved, and it may be accepted that broths and the like have very little food value in proportion to their bulk; it is futile to attempt to give an adequate amount of nourishment by their use in substitution for or addition to milk; patients are often brought to a state (unrecognized) of extreme starvation by too free use of them, to the exclusion of useful food materials; and they are among the least efficient and useful articles for typhoid feeding.

Barley water and other gruels are open to similar objections. Soups thickened with flour or starch, or regular porridges, may, however, have satisfactory nutritive value and form useful foods.

Eggs.— One hen's egg on the average yields about 7.5 grams of protein, 5.3 grams of fat, and 80 calories of energy. The nitrogenous and fatty constituents and the total solids of eggs are among the most highly digestible of all foods,— slightly more so than those of milk. Eggs are quite free from objectionable features, and they should form one of the most valuable articles for typhoid diet, especially for furnishing proteid.

While the value of eggs in typhoid feeding is generally recognized, there are great differences of opinion and practice as to the best method and amount of

administration. Some prefer the yolk, others the white. The yolk contains practically all the fat of egg, is richer in protein, and has seven times the energy value of an equal weight of the white.

Albumen water is much in vogue at present, made by mixing the white of an egg with a considerable amount of water. This method of administration is apparently based on the supposed necessity that the food be liquid and dilute in typhoid. This is an extremely inefficient way of giving egg. Only an insignificant amount of food material can be thus given, and that the least nutritious part of the egg. No reason is apparent for supposing that egg albumen is more digestible in this dilute and liquid form; on the contrary, the dilution might weaken the action of the gastric juice.

It would seem on general principles that the best and an unobjectionable way of giving eggs in typhoid is poached or soft-boiled; or, if the patient prefer, raw or even hard-boiled or scrambled. Beginning with half an egg or a whole egg a day, the amount may be gradually increased until, in many cases, four or more eggs are taken with advantage and safely daily.

Custards (preferably steamed or baked) and plain ice creams are highly nutritious, digestible, and palatable, combining as they do the elements of eggs, milk, and sugar, and to those not committed to an absolute liquid diet seem almost ideal articles for use in typhoid fever. Ice cream is often especially well borne when

there is gastric irritability. Egg-nog, milk punch, and Stokes's mixture (2 egg yolks, 50 c. c. of brandy, 120 c. c. of aqua aurantii florum, sugar or syrup enough to sweeten) have considerable nutritive as well as stimulant value and are eligible for use when such a combination is indicated.

Meat.—It may seem revolutionary to feed meat to typhoid patients, yet most of the advocates of liberal feeding do not hesitate to do so under proper conditions, and the objections commonly raised seemingly disappear on critical examination. Meat is the most concentrated and most efficient natural source of proteid, and is one of the most digestible and least irritating of all foods. The protein of meat is in health rather more digestible than that of milk. The total solids of meat are almost entirely absorbed, leaving in health a fecal residue of only 4 or 5 per cent less than milk. If properly divided before reaching the stomach, meat becomes practically fluid in the alimentary passages, forming in the bowel a bland, pasty, unirritating mass ; to insure this result, it is only necessary that the meat, if not properly masticated, be given in minced or finely divided form. For these reasons it would seem as if meat, instead of being esteemed the worst, should be regarded as a perfectly eligible food for typhoid fever, its main use being to furnish, in conjunction with milk and eggs, the proteid needed. No one contends that meat should be given in every case, or that it would be needed if suf-

ficient protein could be obtained from other sources; but it is held that the alleged dangers of meat are largely mythical, and that if for any reason its use is desirable, to furnish protein, to satisfy the patient's appetite, or for other objects, there need be no hesitation in giving it.

In selecting the kind of meat, the least digestible meats, like pork and veal, may be excluded. Oysters are eligible on the ground of digestibility and palatability, but from their low nutritive value have little efficiency. Beef, lamb, chicken, and fish are regarded as acceptable for typhoid feeding and afford considerable field for selection and variety. These all have a similar protein content, 15 to 24 per cent, but vary much in fat content, from practically zero to 20 or 30 per cent. The loin steaks of beef (sirloin, tenderloin, porterhouse), contain much more fat than does lean round steak. Lamb, both leg and chops, is rich in fat. Young chicken contains little fat; fowl and turkey contain more. Most fish (bass, cod, flounder, etc.) are poor in fat; salmon and shad are among those containing a considerable amount. Meats made up of short and loosely united muscle fibers, like the breast of chicken and the flaky meat of fish, are more digestible than those with long and closely united fibers; the more fatty meats are also sometimes somewhat less digestible. If the fatty meats are well digested, however, they yield much more energy than the lean ones. In the preparation of meat, the visible fatty and indi-

gestible portions should be removed; it should be cooked in wholesome manner, as by broiling or roasting, and finely minced either before or after cooking, provided the patient is unable to masticate properly.

Jellies.— Chicken jelly, wine jelly, etc., are nutritious, palatable, digestible, and seemingly unobjectionable, and may be freely and advantageously used. They may be especially and liberally employed on the occurrence of intestinal hemorrhage, to take advantage of whatever hemostatic action the gelatin may exert.

Fats are the richest source of energy, and within the limits of their easy digestibility are for that reason an advantageous ingredient in the diet. They are apt to be indigestible, especially in large amount, and to lower the digestibility of the protein with which they are associated. The fat in egg, milk, and butter is highly digestible; that in meat slightly less so; that of vegetable origin much less. Given as freely as possible within the limits of tolerance, cream and butter should seemingly form an excellent source for this class of food in the typhoid dietary. It has been recommended that fat — such as lanolin — be administered by inunction or rubbing through the skin when there is difficulty in giving it by the mouth in this disease (Lehlbach); but it is doubtful if any material amount of nutriment can be introduced in this way.

Carbohydrates and vegetable food. Carbohydrates are highly digestible, their chief disadvantage being

that they may ferment and produce gas. They must be relied on to furnish the energy required beyond that supplied by the protein ration and the fat that can be taken. Except for the sugar in milk, we must look to vegetable products for our supply of carbohydrate. Vegetable food has two disadvantages, the low digestibility of vegetable protein and the presence of a residue of undigestible cellulose. Vegetable protein is about 15 to 25 per cent less digestible than that of animal origin; and although vegetable food nevertheless in health furnishes an efficient supply of protein, it is doubtless advisable to look to animal food for the bulk of the proteid ration, taking only such vegetable protein as necessarily accompanies the carbohydrate needed. The undigestible cellulose adds to the fecal residue, and if in large undivided masses may conceivably cause intestinal injury in typhoid fever. Different vegetable foods vary much in the amount of fecal residue; white wheat bread yielding (in health) only about 5 per cent, vegetables two or three times as much. For the typhoid dietary vegetable foods can be selected that yield the smallest undigested residue; fibrous and membranous vegetable tissue, skins, seeds, etc., being excluded; and the vegetable material used being finely divided and having its cellulose well broken up, by mechanical means (flour, cornstarch), by thorough cooking (rice, potato), or otherwise.

Theoretically the most efficient form of carbohydrate food is sugar, which is pure and free from cellulose,

protein, and fat, and being the end-product of carbohydrate digestion should be immediately absorbable without requiring any digestive preparation. For these reasons, sugar, syrups, honey, etc., might well be introduced into the food for the typhoid patient as liberally as possible. Unfortunately sugar is not tolerated as food in unlimited quantities; and typhoid patients often seem especially intolerant of it. Possibly other sugars than cane sugar, as maltose, would be better borne.

Cornstarch is regarded by the advocates of soft diet as a very useful material for typhoid feeding, given in the form of puddings, blanc mange, chocolate pudding, etc., or used to thicken soups. Rice and other cereals, thoroughly cooked, flour products like milk toast, bread or crackers or milk, bread and butter, and bread pudding, also mealy baked potato, are also available, cautiously introduced.

Fruits have low energy value, and the chief use of such as are admissible, as the pulp of baked apple, orange juice, etc., would be to add relish to the diet or act on the bowels.

Beverages.— Coffee and tea are allowable as beverages or for their stimulant action, though they have little nutritive value. Cocoa often makes a welcome addition to the typhoid diet, and has food value.

Alcohol has been shown to be capable in health of furnishing a portion of the energy needed for the body, taking the place of fat and carbohydrate for this purpose, and to this extent it is a food. Whether, in

view of other possible counterbalancing detrimental effects, it would be advisable to use alcohol regularly for its food and energy value in typhoid fever is an open question. If its use were advisable it would have the advantage of being easily absorbable, and of having high caloric value.

Proprietary foods.— There are a large number of predigested and otherwise specifically prepared foods on the market which are highly exploited by their proprietors for use in disease conditions, typhoid fever included. Most of these foods yield but a small amount of actual nutriment in comparison with what is needed by the body or what is afforded by ordinary food. Experiments (in health) do not show any great difference between the absorbability or efficiency of native albumins and artificially predigested proteids (albumoses and peptones). Meat extracts and meat juices yield an insignificant and entirely inadequate amount of utilizable nitrogenous material. The foods described as "predigested carbohydrates" are simply one or another kind of sugar. Most of the liquid proprietary foods contain from 10 to 25 per cent of alcohol, and if given in the quantities recommended are not only insufficient for nourishment, but yield a dosage of alcohol which should be distinctly recognized and and appreciated by the physician. Ordinary food if satisfactorily digested is far superior to proprietary foods. The only field of usefulness for the latter in typhoid fever is found in the cases in which there is

great gastric intolerance of food; in such cases the proprietary foods may be tried in the hope that some of them may be borne by the stomach, and such nutriment and stimulant as they yield may be utilized.

The acceptability of various food articles for the typhoid dietary has now been considered in critical detail, and their sufficiency to meet what seem to be the essential requirements of an adequate and safe diet in this disease. The list is quite extensive, affording considerable field for selection; the articles mentioned are all such as are recommended by advocates of a more liberal and varied diet than is now customary; and a consideration of the dietetic and physiologic principles involved, as well as the results of actual practice, indicates that they may be safely and advantageously employed.

The diet list available for typhoid feeding may be summarized as follows:

Milk, raw, pasteurized, peptonized, decalcified, or otherwise modified; cream, skimmed milk, buttermilk, junket, butter.

Soups, broths, gruels; especially thickened with flour or corn starch.

Eggs.

Custards; ice cream; eggnog or Stokes's mixture.

Meat; beef, lamb, chicken, fish; minced, etc.

Jellies.

Cornstarch pudding, chocolate pudding, rice and cereals, milk toast, bread or crackers and milk, bread and

butter, bread pudding, sago or tapioca pudding, porridges, baked potato, fruit, sugar.

Coffee, tea, cocoa, alcoholic drinks.

Proprietary foods.

METHOD OF FEEDING.

Success and safety in liberal feeding depend not only on the kind of food, but also on the manner in which it is given. Each case should be individualized and managed on its own merits; the patient should be treated "rather than the name of his disease." The supervision of every detail of the feeding will require and repay the constant attention of the physician. The intervals between feedings should not be less than two hours, perhaps more. The feedings should be timed to follow and not precede the baths.

The advocates of liberal diet are unanimous in following, as the main guide in feeding, the patient's appetite and digestive powers. Due attention is, of course, paid to the general condition, but the temperature is left largely out of consideration, and need cause no great hesitation in feeding. Hunger is taken as a reliable indication that food is needed and can be assimilated; and whenever a genuine appetite and desire for food is evinced, when the patient answers affirmatively to the daily question, "Are you hungry?" there should be no hesitation in immediately increasing his diet and putting it on a generous basis.

Food should not ordinarily be forced or urged unduly on an unwilling patient, nor should he be permitted to gorge himself to an uncomfortable stage of excessive satiety. It is possible, however, that patients in a low, nervous, restless condition, who obstinately resist taking nourishment, and who are apt to do badly and whose nutrition becomes greatly lowered, might be benefited by forced feeding; and if, as frequently occurs in these cases, there is much gastric irritability and intolerance of food, gastric lavage and gavage may produce good results.

Abrupt changes should be avoided, and increase in the amount of food should be made gradually, with careful observation of the accompanying effects. In many cases the appetite continues from the first, and is not at any time completely lost; in such the feeding may be more or less liberal from the beginning. In cases in which the appetite is entirely lost and the diet falls to a low plane, the food should be carefully and gradually increased when the appetite returns.

When there is extreme gastric intolerance of food and nutrition is greatly lowered, rectal and possibly also subcutaneous alimentation may be employed in order to obtain whatever benefit these procedures are capable of affording.

PRACTICAL RESULTS.

The final settlement of the question of liberal feeding in typhoid fever must rest, not on theoretical con-

siderations, but on the results of actual trial and experience, and the demonstration of superior advantages and efficiency for the method. Numerous observers in all parts of the world, Russia, Australia, England, America, have reported results with an enlarged dietary.

A notable and forceful contribution in advocacy of generous feeding in typhoid fever, based on 31 cases, was made by Barrs (England) in 1897, which has attracted much attention.

In 1900 Marsden, of Manchester, reported the results of treatment of 200 consecutive typhoid cases according to the methods of Barrs. He does not mention his mortality, but there was no case of perforation, only six of hemorrhage, relapses were no more numerous than the average, and in no instance were any of the complications clearly chargeable to the diet.

Bushuyeff of Russia, in 1895-'96 out of 154 hospital patients, treated 80 on a diet consisting chiefly of bread and meat, while a colleague who adhered to the orthodox system treated the other 74 chiefly on milk. The comparative average results were:

RECOVERED.

	Mixed diet.	Milk diet.
Number of patients	72	65
Average day of illness on admission	7.5	5.8
Duration of fever after admission, days	18.9	22.3
Duration of stay in hospital, days	42	49.2
Day on which recovery was complete	49.5	55
Incapable of duty on dismissal:		
Number	6	10
Per cent	8.3	15.4

DIED.

	Mixed diet.	Milk diet.
Number	8	9
Per cent	10	12.1
Average day of illness on admission	8.5	5.8
Average day of death	28.6	26.7

During 1897, out of 318 patients on the solid diet, Bushuyeff lost 26, or 8.2 per cent, the average typhoid mortality of the hospital for the 10 years previous being 12.4 per cent.

Metabolism studies and liberal feeding in typhoid fever have been especially carried out by Russian observers. The mortality statistics in typhoid patients treated on a generous diet by Russian authorities are summarized by Pauline Gourari (1901) as follows:

	Number of Cases.	Number of Deaths.	Mortality, Per cent.
Kassetzky	180	10	5.5
Kissel	276	11	4.
Gournitzki	150	4	2.7
Bushuyeff	[398	34	8.6]
Timen	96	10	10.9
Total	1,100	69	6.3

These mortality rates are almost incredibly low.

Brummitt, of Australia, in 1901 reported 98 cases fed on bread, milk, minced meat, eggs, etc., with 5 deaths.

In the United States, the leading advocate of generous feeding in typhoid fever, in the boldness of his

methods, the vigor of his arguments, and the extent of his experience, has been Shattuck, of Boston. During 1886 to 1893, he treated 233 patients on exclusive milk diet, with a mortality of 10 per cent; from 1893 to 1902, with 246 patients liberally fed, he had a mortality of 8.45 per cent. Hemorrhage, perforation, and relapses were not increased in frequency.

In a study of the statistics of typhoid fever at the Massachusetts General Hospital, to 1899, presented by Fitz, further comparisons may be made between the patients of Shattuck, which are included in the statistics, and those treated by his colleagues on the usual restricted diet, as follows:

	Mixed diet. Per cent.	Milk diet. Per cent.
Mortality	11.3	14.6
Hemorrhage	9	10.6
Relapses	10.2	13.1

Kinnicut, of New York (1906), reports 74 cases well fed, with 9 deaths. He presents the following analysis of reported statistics showing comparative results in patients fed on the liberal and the milk diet:

	Liberal diet.	Milk diet.
Total numbers of cases	733	4,654
Relapses (based on 325 well-fed cases), per cent	11.4	10.9
Hemorrhage, fatal cases, per cent	4.8	8.8
Perforation, fatal cases, per cent	1.4	2.4
Mortality (based on 633 well-fed cases), per cent	9.5	10.6

Manges, Le Fevre, Hare, Claytor, and numerous others, in this and other countries, have also presented favorable views and results from the generous feeding of typhoid patients.

From the reports covering considerable series of cases may be collected the following 1518 cases of typhoid fever treated with the enlarged diet, with 104 deaths, a mortality of 6.9 per cent.

	Cases.	Deaths.
Russian observers	1,100	69
Brummitt	98	5
Shattuck	246	21
Kinnicutt	74	9
Total	1,518	104

In the cases of typhoid fever treated by more or less liberal feeding that have come under my own care or observation, forty or more in number, the same highly satisfactory and gratifying results noted by other writers on the subject have been found by me, and in not a single instance was there any bad effect resulting from the food given.

Among all the reports that I have found, not one observer who has given the liberal diet a candid and sincere trial condemns it. All agree that the evil results generally feared were not produced. Tympanites, diarrhea, hemorrhage, perforation, and relapse did not seem to be increased in frequency, if indeed they were

not decreased. The general average mortality of 6.9 per cent just noted certainly does not support the prevailing notions as to the dangers of mixed feeding.

The liberal diet to be justified, however, must have not only the mere negative quality of safety, but must present positive advantages and superiority of efficiency and results over the present system. Those who have given generous feeding in typhoid fever a trial are quite unanimous and emphatic in the expression of their convictions that the method is far superior in its results to the present restricted diet. The special advantages that have been observed or may be expected are the following:

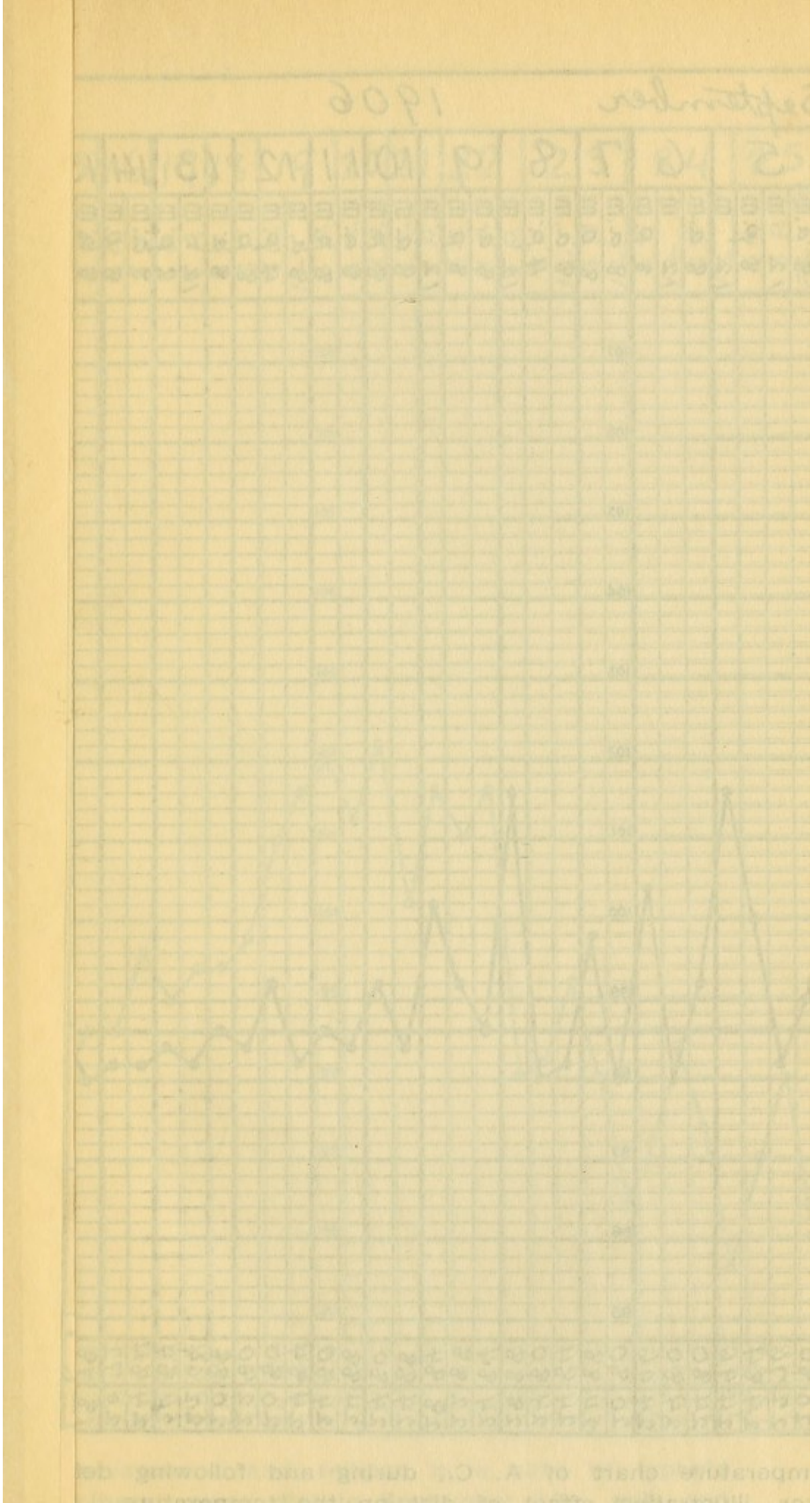
The comfort and contentment of the patients are far greater under generous feeding than under the customary diet. The writers are unanimous in their emphatic and gratified expressions on this point. The patients suffer much less from hunger, and, especially, the distressing hunger ordinarily present in the early convalescent period, while not entirely abolished, is greatly diminished, and the temptation to indulge surreptitiously in forbidden food is much lessened.

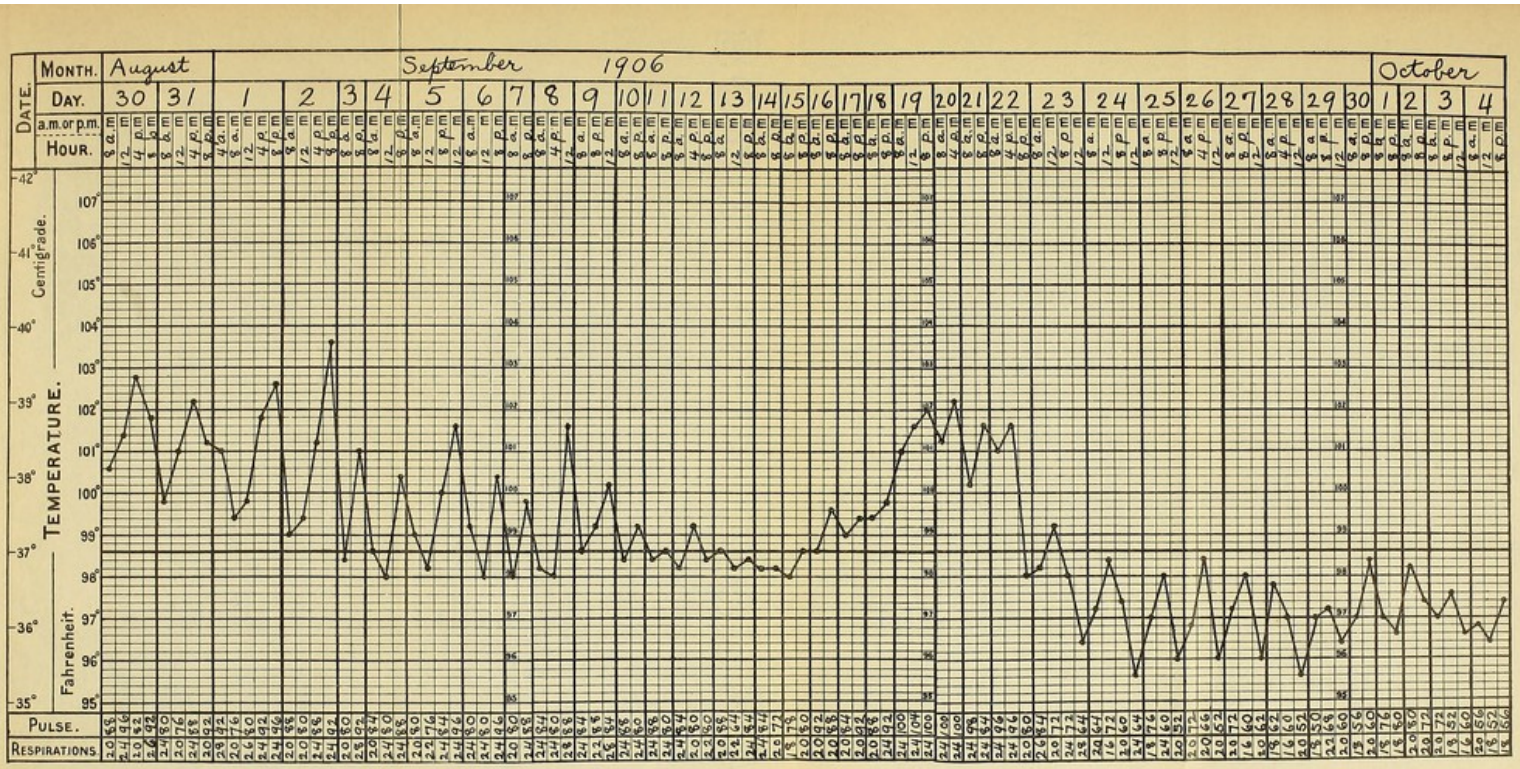
With a large diet list to choose from, the special likings of the patient can be met and greater variety introduced into the feeding. In case of indigestion and intolerance of food, with a large list to select from there is a greater chance of being able to find some food that is satisfactorily borne by the stomach, while the physician who uses only milk and soup is at a loss what to do when these disagree.

The adequate diet should, so far as is possible in this disease, eliminate the effects of starvation; and it is probable that it is not even yet entirely known what symptoms are due to insufficient nutrition and what to the disease proper.

For example, the subnormal temperature characteristic of the beginning of the apyretic period is undoubtedly a starvation symptom, due to the fact that at that time the organism having regained the power of anabolism greedily stores up food material in its tissues, and if the food supply is inadequate does not liberate enough food energy to maintain body temperature. In patients well fed during the pyrexia the depression of body temperature of early convalescence is usually much less in range and duration than in ill-fed patients; and it is possible to tell from the temperature chart in most cases how the patient has been fed and nourished. While it has not been customary to attach any great significance to the marked post febrile depressions of temperature ordinarily seen, they even being regarded with satisfaction as a harbinger of convalesence, it is highly probable that when excessive they indicate unduly lowered nutrition and insufficient feeding. The temperature range at this period of the disease is therefore an index of the patient's nutrition and dietetic management, and a minimum of subnormal temperature is a testimony of proper feeding.

The accompanying temperature chart illustrates typically the effect of feeding on the post-febrile tempera-





Temperature chart of A. C., during and following defervescence and relapse in a case of typhoid fever, illustrating effect of diet on the temperature. Liberal mixed diet to September 18; milk and broth after September 18.

ture. The patient was fed on a generous mixed diet during the primary period of pyrexia, but on the occurrence of a relapse received the conventional milk and broth diet. Following the primary pyrexia the temperature did not fall below 98°; following the relapse the temperature was markedly and continuously depressed, ranging between 96.6° and 98°.

The patient's strength, nutrition, and general condition should be better maintained on the liberal diet. On theoretical grounds no lowering of the fever is to be expected with a large diet; but if there is any increase in the patient's powers of reacting against the disease, a shortening of the period of pyrexia might be expected. So far as can be judged from general impressions, in the absence as yet of sufficient exact comparative statistics, it is probable that liberal feeding may be shown to be capable of slightly shortening the course of the fever. There is general and positive agreement among the writers that the duration of convalescence is materially shortened in the well-fed patients. This is to be expected, since the less the patient is allowed to lose the less he has to regain; and the customary delay of seven to ten days after the fever subsides, before the resumption of feeding, is done away with.

Writers on the subject make little mention of the effect of free diet on the nervous complications and profound toxemic conditions sometimes occurring in typhoid cases. In cases presenting these complications

it is often difficult to administer food even in small quantities, and it is probable that these bad conditions are made much worse by the aggravated innutrition thereby enforced. It is these cases in which it is practically impossible to feed at all that swell the mortality rates in typhoid fever.

The better maintenance of strength and nutrition through ample feeding should be manifested in the long run by a lowering of the death rate, since in cases in which the issue is delicately balanced the bettered nutritive condition may turn the scale in favor of recovery. The statistics of Shattuck and Bushuyeff, so far as they go, show a difference in mortality of from 1.5 to 4 per cent in favor of the liberal diet.

While the practice of generous feeding in typhoid fever will seem revolutionary to most physicians and is contrary to the teachings of most of the clinical leaders and manuals of medicine, yet it has the approval of some of the very highest authorities. It is the belief of its advocates that the fears of deleterious consequences generally held against mixed feeding in typhoid fever are groundless. All the complications which it is generally asserted would arise from the use of soft and solid food occur under the strictest milk regimen. While it is recognized that dietetic improprieties may cause trouble in typhoid fever, as great and even greater trouble and danger can be caused by the improper use of milk as by any other food. Even if in some one respect mixed diet were deleterious and

yet on the whole its general effects were beneficial, its use would be warranted; just as, in spite of the admitted fact that the cold-bath treatment seemingly increases the frequency of hemorrhages and relapses in typhoid fever, the bath method is nevertheless approved.

The object and the advantage of adequate feeding in typhoid fever (as in other conditions) is the maintenance of body nutrition at the highest point possible under the circumstances. In other diseases, as tuberculosis, indigestion, and the like, the importance of attaining a high state of nutrition — the measure and index of which is the body-weight — is generally appreciated. In typhoid fever the condition of body nutrition and the dangers of malnutrition are as generally quite ignored; yet there is no reason to suppose that the organism suffering from typhoid fever is not subject to the same laws of nutrition, metabolism, and dietetics as apply under other circumstances. If it could be made practicable to weigh typhoid fever patients at proper short intervals, so that changes in body nutrition could be followed as closely and exactly as can changes in body temperature, the weight record in its bearings on treatment and prognosis might be found to have a practical importance approaching that of the temperature record; and the reduction of emaciation to a minimum might be found an object in its actual results worthy of the keenest and most solicitous endeavors of the physician.

The evolution of the current methods of feeding in typhoid fever seems to have been largely fortuitous and empirical, and the present practice has not been established on or subjected to the critique of scientific dietetic and physiologic principles, as has been done, for instance, in the matter of infant feeding. The history of feeding in fever shows a progressive advance from a starvation regimen in the direction of more and more liberal diet.

Methods and foods in one epoch regarded as highly injudicious and dangerous have, in succeeding periods, come into general use, and the feared objections proven groundless. We have come to the use of a diet of medium nutritive value, but there is still room for further advance. In the antiphlogistic era the profession imbibed a deep seated fear of giving food in many diseases, that caused enormous harm by deliberate and wholesale starvation of patients.

The habit of antiphlogistic therapy was through centuries of belief and practice firmly impressed on the professional mind, and it has been with difficulty and with fearful and cautious steps that the profession was emancipated from that practice. Indeed, vestiges of the antiphlogistic habit are still apparent in the treatment of fever; physicians no longer bleed and purge and puke their patients to death; but they still partially starve them, and practice with complacency and good faith a system that subjects the sufferers to the tortures of the most distressing hunger and semi-

starvation for weeks. Much harm is still caused by needlessly starving patients, not only in typhoid fever, but in other conditions. Physicians ought to be just as solicitous about the very real and certain dangers of starvation as they now are about the occasional or fancied or mythical evil results of feeding; and if they were as bold in giving food as they are now willing to withhold it, results might in many instances be better.

The argument is often offered that the superiority of the present dietetic methods in typhoid is shown by universal experience and approval. The appeal to universal practice and experience on its face seems a strong argument, yet a consideration of the history of medicine shows that it is an argument to be accepted with great reserve. There have been scores of theories and systems and methods of practice that for a time enjoyed universal approval and claimed justification on the ground of the results of general experience, which nevertheless in the end were found erroneous and were utterly discarded. What general experience may fairly be claimed to have demonstrated in the matter of typhoid feeding is this, that the present milk diet, one of medium nutritiousness, gives better results than any of the more restricted diets previously in use. An equally general trial of a diet even more liberal than the present one might give a showing of results better still. The claim that experience has shown the essential danger and inadmissibility of a diet more generous than the present one, or of the

use of solid or soft food, is open to this objection, that such liberal feeding has never been given widespread trial, and there has been no general experience with it to show its inadvisability. The starvation treatment was once universally tried and universally condemned by the profession; the present medium diet has likewise been universally tried and found more satisfactory. Trial of liberal mixed diet has not, however, been made on a like extensive scale; and if its advantages have not had a chance for demonstration, neither have its alleged dangers been really shown. The grave fears once entertained of the use of milk and broth were shown by actual trial to have been groundless; and the present similar fears of soft and solid food might likewise, on trial, prove to be unfounded. Because a ravenous starved patient develops a fever (almost always brief and harmless) from surreptitious over-indulgence in unaccustomed food is no proof that a liberal and varied diet, properly regulated, is essentially harmful; nor does the fact that most patients recover on milk prove that other food is dangerous.

Some of the conclusions and estimates presented in this study are of a tentative character, based on such data as are now available and subject to such revision as may be required by future investigations. Some of the directions in which further studies can be advantageously prosecuted for the more precise settlement of the questions involved are: metabolism studies, especially of nitrogenous exchanges with the larger

amounts of nitrogen in the food, the effect of varying amounts of carbohydrates and fats in lessening nitrogenous waste, etc., to determine the optimum proteid ration; a close study of body-weight changes as influenced by food of different amounts and different kinds; and above all a closer determination of the total energy requirement in fever, such as could be best obtained only by accurate measurements of the carbon, hydrogen, and oxygen exchanges, and especially by calorimetric investigations.

While further investigations are desirable to settle some of the details, it is believed that the data already available are ample to warrant the conclusion that a generous and varied diet yields by far the best results in the treatment of typhoid fever. If, indeed, liberal feeding can effect a lowering of anywhere near two per cent in the general mortality of typhoid fever, the aggregate results attainable would be of the highest order.

REFERENCES.

Aikanov, A. Inaugural dissertation, Saint Petersburg, 1889.

Aronsohn, E. Allgemeine Fieberlehre, Berlin, 1906.

Atwater, W. O. Chemistry and Economy of Food, Bulletin 21, Office Experiment Stations, U. S. Department of Agriculture, 1895.

Atwater, W. O. Principles of Nutrition and Nutritive Value of Food. Farmers' Bulletin 142, U. S. Department of Agriculture, 1906.

Atwater, W. O., and Langworthy, C. F. Digest of Metabolism Experiments. Bulletin 45, Office Experiment Stations, U. S. Department of Agriculture, 1898.

Atwater, W. O., and Bryant, A. P. Chemical Composition of American Food Materials. Bulletin 28, Office Experiment Stations, U. S. Department of Agriculture, 1906.

Atwater, W. O., and Benedict, F. G. Experiments on the Metabolism of Matter and Energy in the Human Body, 1900-1902. Bulletin 136, Office Experiment Stations, U. S. Department of Agriculture, 1903.

Barrs, A. G. British Medical Journal, January 16, 1897, 125.

Barth, E. Krankenpflege, 1901-'02, I, 888.

Bartlett, E. Fevers of the United States. Philadelphia, 1842.

Bauer, J., and Künstle, G. Deutsches Archiv für klinische Medicin, 1879, XXIV, 53.

Beauloce, A. Thesis, Toulouse, 1901.

Beaumont, William. Physiology of Digestion. Plattsburg, 1833.

Benedict, H., and Schawrtz, N. Münchener medicinische Wochenschrift, 1899, XLVI, 176, 219.

Boggs, T. R. Deutsches Archiv für klinische Medizin, 1903-'04, LXXIX, 539.

Broussais, François-Joseph-Victor. Various works from 1816. (Also Exposition of the Principles of the New Medical Doctrine, by J. M. A. Goupil, translated by J. C. Nott, 1831.)

Brummitt, R. Australasian Medical Gazette, 1901, XX, 514.

Bushuyeff, V. F. Vrach, 1898, XIX, 786, 852, 898. (Progressive Medicine, I, March, 1899, 327.)

Buss, C. E. Ueber Wesen and Behandlung des Fiebers. Stuttgart, 1878.

Claytor, T. A. Medical Record, 1906, LXIX, 414.

Clutterbuck, Henry. Seat and Nature of Fever. London, 1825.

Cullen, William. Synopsis Nosologiae Methodicae, Edinburg, 1772. Practice of Physic, 1778.

Delafield, F. Medical Record, 1903, LXIV, 401.

Diakonov, D. I. Inaugural dissertation. Saint Petersburg, 1890.

Dünschmann, H. Inaugural dissertation. Berlin, 1892.

Edinger, L. Deutsches Archiv für klinische Medicin, 1881, XXIX, 555.

Edsall, D. L. Pediatrics. New York, 1905, XVII, 562.

Engel, C. Inaugural dissertation. Würzburg, 1885.

Fitz, R. H. Boston Medical and Surgical Journal, 1899, CXLI, 509.

Flint, Austin. Clinical Reports on Continued Fever. Philadelphia, 1855. Principles and Practice of Medicine, 1st, 4th, and 5th editions, 1866, 1873, 1884.

Geisler, F. K. Vrach, 1890, XI, 429.

Gerhard, W. W. American Journal Medical Sciences, February and August, 1837, XIX, 289, and XX, 289.

Glucinski, L. A. Deutsches Archiv für klinische Medicin, 1887-'88, XLII, 481.

Gourari, Pauline. Thesis, Paris, 1901.

Grammatchikov, A. I. Inaugural dissertation. Saint Petersburg, 1890.

Graves, Robert James. Clinical Lectures on Practice of Medicine, 1843.

Gruzdiev, V. S. Vrach, 1890, XI, 156.

Harbin, R. M. Medical Record, 1904, LXVI, 771.

Hare, H. A. Therapeutic Gazette, 1904, XXVIII, 577.

Heberden, William. History and Cure of Diseases, 1803.

Hippocrates. Works. (Translation by Francis Adams. London, 1849.)

Hoesslin, H. von. (Virchow's) Archiv für pathologische Anatomie, etc., 1882, LXXXIX, 95, 303.

Hoppe-Seyler, F. Physiologische Chemie. Berlin, 1881, 241.

Hutchinson, James H. Pepper's System of Practical Medicine, I, 1885, 323.

Huxham, John. Essay on Fevers. London, 1750.

Inglis, D. Philadelphia Medical Journal, 1901, VII, 308.

Jenner, Sir William. Lectures and Essays on Fevers and Diphtheria, 1849 to 1879. London, 1893.

Khadgi, L. Inaugural dissertation. Saint Petersburg, 1888.

Kinnicutt, F. P. Boston Medical and Surgical Journal, 1906, CLV, 1.

Kraus, F. Zeitschrift für klinische Medicin, 1890-'91, XVIII, 160.

Ladenburger, H. Inaugural dissertation. Würzburg, 1901.

Le Fevre, E. Medical News, 1904, LXXXIV, 11.

Lehlbach, C. J. Medical and Surgical Reporter. Philadelphia, 1891, LXV, 889.

Lévy, L. Ungarische medizinische Presse, 1899, IV, 225.

Leyden, E. von, and Klemperer, G. Handbuch der Ernährungstherapie und Diätetik, II, 1898-'99, 391.

Licorish, R. F. Medical Record, 1890, XXXVII, 268.

Liebermeister, C. Deutsches Archiv für klinische Medicin, 1872, X, 452.

Liebermeister. Von Ziemssen's Cyclopedia of Practical Medicine, I, 1874, 231.

Loewy, A. Archiv für pathologische Anatomie, etc., 1891, CXXVI, 218.

Louis, Pierre-Charles-Alexandre. Recherches sur la maladie connue sous les noms de gastro-entérite, fievre putride, etc. Paris, 1829.

Manassein, W. Archiv für pathologische Anatomie, etc., 1872, LV, 413.

Manges, M. Medical Record, 1900, LVII, 1.

Marsden, R. W. Lancet, January 13, 1900, 90.

Matzkevich, V. G. Inaugural dissertation. Saint Petersburg, 1890.

Mills, Thomas. Blood-letting in Fever, etc. Dublin, 1813.

Mohr, L. Zeitschrift für klinische Medicin, 1904, LII, 371.

Moorehouse, G. W. Boston Medical and Surgical Journal, 1900, CXVLIII, 494.

Müller, F. Centralblatt für klinische Medicin, 1884, V, 569.

Müller. Zeitschrift für klinische Medicin, 1889, XVI, 541.

Nichols, J. B. American Medicine, 1905, IX, 726. Medical Record, 1905, LXVIII, 171.

Page, C. E. Medical News, 1894, LXXXV, 71. Medical Record, 1894, XLV, 518. New York Medical Journal, 1900, LXXI, 299.

Pavy, F. W. Treatise on digestion, etc. 2 ed., London, 1869, 51.

Peabody, G. L. Medical Record, 1892, XLII, 620.

Puritz, C. Journal Russkago Obshestva ochranenija narodnago zdravija, 1892, II, 28. Archiv für pathologische Anatomie, etc., 1893, CXXXI, 327.

Regnard, P. Thesis. Paris (Versailles), 1878.

Renk, F. Untersuchung der Kost (Voit, etc.), 1877, 114.

Riess, L. Archiv für experimentelle Pathologie und Pharmakologie, 1886-'87, XXII, 127.

Riethus, O. Archiv für experimentelle Pathologie und Pharmakologie, 1900-'01, XLIV, 239.

Robin, A., and Binet, M. Archives Générales de Médicine, 1896, I, 641; 1896, II, 385, 515. Bulletin de l'Académie de Médicine. Paris, 1896, 3rd series, XXXVI, 496.

Robinson, B. Medical Record, July 4, 1891, XL.

Romme, R. Tribune médicale, 1892, XXIV, 453.

Schroeder, L. Deutsches Archiv für klinische Medicin, 1869, VI, 385.

Shattuck, F. C. Journal American Medical Association, 1897, XXIX, 51. Boston Medical and Surgical Journal, 1903, CXLVIII, 151.

Speidel, E. New York Medical Journal, 1899, LXX, 961.

Sticker, G. Berliner klinische Wochenschrift, 1885, 553, 580.

Stockton, C. G. Albany Medical Annals, 1897, XVIII, 193.

Stokes, William. Medical Times and Gazette, London, 1854, n. s., VIII, 1. Lectures on Fever. London, 1874, 328.

Tschernoff, W. Archiv für pathologische Anatomie, etc., 1884, XCVIII, 231.

Vaquez. Bulletins et mémoires de la Société Médicale des Hôpitaux de Paris, 1900, 3 ser., XVII, 153.

Von den Velden, R. Berliner klinische Wochenschrift, 1877, XIV, 613.

Von Noorden, Carl. Lehrbuch der Pathologie des Stoffwechsels. Berlin, 1893.

Wright, A. E., and Knapp, H. H. G. Medico-Chirurgical Transactions. London, 1903, 1. Lancet, December 6, 1902, 1531.

Wright, A. E., and Paramore, W. E. Lancet, October 14, 1905, 1096, 1101.

Walter, P. Inaugural dissertation. Saint Petersburg, 1886.

Welch, W. H. Medical News, 1888, LII, 365, 393, 539, 565.

Wertheim, G. Wiener medizinische Wochenschrift, 1878, XXVIII, 865, 915, 941. Bericht der k. k. Krankenanstalt Rudolph-Stiftung in Wien, 1882 (1883), 263.

Zjenetz, M. Wiener medizinische Wochenschrift, 1890, XL, 1825, 1869.

Zweifel, P. Deutsches Archiv für klinische Medicin, 1886, XXXIX, 349.

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Diet in Typhoid Fever

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