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## ORIGINAL ARTICLES.

### INFANT FEEDING—A REVIEW.

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**I**N the last decade great and successful strides have been made in medical therapeutics as well as in surgical. The former have been improved partly through the aid of pharmaceutical preparations and of the products of biological research, partly through new methods and appliances for hygienic and preventive purposes. It is mainly the infectious diseases which have been served by the former, and both public and individual hygiene by the latter. Early life has been particularly benefited, and by nothing more than by careful endeavors to improve the diet of the young, and thereby to remove the dangers of intestinal disorders and the sources of excessive mortality.

**Sterilization.**—Nothing has been more successful in that direction than the widespread practice of sterilization (and pasteurization) of cow's milk. Both are the logical development of the plan of treating milk by boiling, which I persistently advised these thirty-five years at least, and detailed in my "Infant Diet," in Gerhardt's Handbook, in Buck's Hygiene, in "Intestinal Diseases of Infancy and Childhood"\* and in my clinical lectures delivered during the last third of a century.

Now what is it that boiling can and will do? Beside expelling air it destroys the germs of typhoid fever, Asiatic cholera, diphtheria and tuberculosis, also the *oidium lactis* which is the

\*P. 18. "After boiling, milk destined for the use of a baby during the day should be kept in clean bottles containing from three to six ounces, filled up to the cork, and the bottles then turned upside down in a cold place; such will keep longer than milk preserved in the usual way. Before being used it should be heated in a water bath; and by repeating this heating of the whole amount of the day's milk, several times during the twenty-four hours, fermentation will be retarded, and digestibility improved."



cause of the change of milk sugar into lactic acid and of the rapid acidulation of milk with its bad effects on the secretion of the intestinal tract. Some varieties of proteus, and most of bacterium coli are also rendered innocuous by boiling. Thus it prevents many cases of infant diarrhoea and vomiting—not all of them. For the most dangerous of all the bacteria are not influenced either by plain boiling or the common methods of sterilization. Besides, “diarrhoea” is but a symptom of many causes, and “cholera infantum” is a name for a condition occasioned by many. Ebstein emphasizes the fact that babies at the breast are subject to cholera infantum, particularly in southern climates, also in public institutions. The influence of external temperature is a very important factor; its sudden changes produce intestinal disorders. Babies, taken from a hot railroad car to the deck of a lake steamer, from a warm bed to a draughty room, may develop a catarrhal enteritis which disposes to worse forms of disease. For the morbid condition of the epithelium caused by such sudden changes is a proximate cause of disease because it opens the way to all sorts of infecting substances. Poisons in the food of cows, indigestible baby foods—either indigestible *per se*, or through a morbid condition of the digestive organs—produce diarrhoea of many varieties. It need not even depend on ingested food; for according to W. Schild's recent investigations (*Zeitsch. f. Hyg. u. Infect XIX.*) germs of diseases may be found in the intestine of the newly born in from ten to seventeen hours after birth (min. 4, max. 20). The meconium of the newly born being free of germs, is supplied through the mouth with the bacterium coli and through the anus with the bacillus fluorescens, subtilis and proteus (even adults are infected through the same inlet). Linen, the bath, the air, the blood are sources of local invasion. In such cases, what is the sterilization of artificial food to accomplish? They are not reached by it.

Not even the natural food, breast-milk, is free of germs possibly attended with dangers. M. Cohn and H. Neumann found germs in the healthy breast-milk even after the mamma and nipples had been washed with alcohol and with solutions of corrosive sublimate. A. Palleske met with the staphylococcus pyogenes albus in one-half of all healthy women, F. Honigmann (*Z. f. Hyg. u. Inf. XIV*) in most of them, and H. Knochenstein (*Inaug. Diss. 1893*) in the mammæ of eight puerperal and nursing women. Evidently they had immigrated from outside; they proved innocuous. But who can doubt but that if the epithelium of the milk ducts had been morbid, there would have been a chance for a mastitis, or if the staphylococcic milk had got into contact with a sore stomach or intestine, there would have been an opportunity for gastritis or enteritis.

Nor is boiling, nor sterilization, a safe protection under all



circumstances. Aerobic bacteria, the so-called hay or potato bacilli, with very resistant spores, which are found in cow dung and in the dust of stables, of the soil and streets, and of hay, peptonize casein and liquefy it and render the milk bitter. They are very poisonous; their pure culture gives young dogs a fatal diarrhœa. It takes hours of sterilization to kill them; in some instances it required five or six hours. Even the bacillus butyricus takes an hour and a half. But such a protracted sterilization, beside being far from certain in its effect, is at all events a clumsy procedure and one not calculated to benefit the milk. Thus hay feeding is an absolute necessity, for the bacilli are destroyed by a six weeks' drying. Besides, it is urged to keep the stables carefully clean, to avoid dirt and dust, to employ peat instead of straw for bedding, to wash the udder and tie the tails before milking, to waste the first milk, and to remove foreign material from the milk by centrifuging. But no absolute security can be guaranteed. That is why Flügge adds to his expositions a warning against some wholesale manufacturers who, always anxious about somebody's—their own—welfare are known to conceal by coloring the glass of their bottles the changed condition of the milk and the separation of butter particles.

Whatever I have here brought forward, is certainly not to disparage the boiling of the milk; it is meant to prove the danger of relying on a single preventive when the causes of intestinal disorders are so many. It is true, however, that the large majority of the latter depends on causes which may be met by sterilization; but not by sterilization only; also by pasteurization, that is, heating the milk to  $70^{\circ}\text{C}=165^{\circ}\text{F}$ , and keeping it at that uniform temperature for thirty minutes—a procedure which destroys the same germs that are killed by a more elevated temperature, without much change in flavor and taste.

One of the questions connected with the employment of sterilized or pasteurized milk is this, whether the milk to be used for a child ought to be prepared at home, or whether the supply may be procured from an establishment where large quantities of milk believed to become immutable by sterilization for an indefinite period, are kept for sale. In regard to this problem Flügge plaintively expresses his regrets that "we have allowed ourselves to be guided by people who are neither hygienists nor physicians, but chemists, farmers, or apothecaries, and whose actions have been based on three false beliefs. Of these the first is that boiling for three-quarters of an hour destroys germs, the second that whatever bacteria remain undestroyed are innocuous, and the third, that proliferating bacteria can always be recognized by symptoms of decomposition." Nothing is more erroneous. Soxhlet himself, the German originator of sterilization, knew at an early time, that the fer-



menting process is now and then but partially interrupted by boiling, that butyric acid may be found in place of lactic acid, that a strong evolution of gas may be caused after such boiling, and that such milk may give rise to flatulency. Aye, milk which happens to contain the resistant spores of bacteria becomes a better breeding ground for them by the very elimination of lactic acid, and the longer such sterilized milk is preserved and offered for sale, the worse is its condition. It may be true that these conditions are not met with very frequently, but an occasional single death in a family caused by poisonous milk will be more than enough. Therefore, the daily home sterilization is by far preferable to the risky purchase from wholesale manufacturers who can not guarantee, because in the nature of things they cannot know, the condition of their wares.

Another alteration of a less dangerous character, but far from being desirable, is the separation of cream from sterilized milk which is preserved for sale. Renk, (*Arch. f. Hyg.* XVII) found it to take place to a slight extent during the very first weeks, but later to such a degree that 43.5 per cent. of all the cream contained in the milk was eliminated.

Sterilization has been claimed to be no unmixed boon because of its changing the chemical constitution of milk. Still, the opinions on that subject vary to a great extent, the occurrence of changes being both asserted and denied by apparently competent judges. But what I have said a hundred times, is still true and borne out by facts, viz: That no matter how beneficial boiling, or sterilization, or pasteurization may be, they cannot transform cow's milk into woman's milk, and that it is a mistake to believe that the former, by mere sterilization, is a full substitute for the latter. It is true, that when we cannot have woman's milk, we cannot do without cow's milk. There is no alleged substitute that can be had with equal facility or in sufficient quantity. But after all it is not woman's milk. Babies may not succumb from using it, and may but seldom appear to suffer from it, indeed they will mostly appear to thrive on it, but it is a makeshift after all and requires modifications. Hammarsten was the first to prove the chemical difference between the casein of cow's and woman's milk. Whatever was known on that subject at that time I collated in Gerhardt's *Handb. d. Kind.* 1st Vol. 1875, (2 ed. 1882). But lately Wroblewski demonstrated the difference in solubility of the two milks. Woman's casein retains, during pepsin digestion, its nuclein (proteid rich in phosphorus) in solution, it is fully digested; in cow's casein the nuclein is not fully digested, a "paranuclein" is deposited undissolved and undigested. Besides, woman's casein contains an additional albuminoid which is not identical with either the known casein or albumin. (*H. Koplik in N. Y. Med. Journal*, April 13th, 1895.)



Ergo : Cow's milk is not woman's milk. It is not identical with it. Sterilization does not change its character. It merely obviates such dangers as result from the presence of pathogenic germs, and from premature acidulation. The substitution of cow's milk, or of sterilized milk for woman's milk as the *exclusive infant food* is a mistake. Experience teaches that digestive disorders such as constipation or diarrhoea, and constitutional derangements such as rhachitis are frequently produced by its persistent use, and it appears to be more than an occasional (at least cooperative) cause of scurvy.

Admixture of Cereals.—Since the advisability of finely dividing and suspending the casein of cow's milk and of adding to the nutritiousness of the latter caused me always to teach the admixture of cereals to it, even in the very first days of infancy, the subject of infant feeding has never been lost sight of by medical men, pure scientists and tradesmen. No subject has been treated more extensively, more eagerly, sometimes even more spitefully, than that of infant feeding. The philosopher's stone has not been so anxiously sought for, nor been so often found in medical journals, books and societies, as the correct infant food and the appropriate treatment of cow's milk. After the finally faultless thing had been discovered very many times, it was therefore not a surprise but a source of gratification to me to meet, in the *Berl. Klin. Woch.*, No. 10, 1895, an article of Heubner's who, after having contributed for years as much as any writer, if not more, to the literature of the subject, recommends the "utilization of flour in the intestines of young nurslings." Basing his remarks firstly on the researches of Schiffer, Korowin and Zweifel, (quoted in my early writings on that very topic more than twenty years ago) who by experimentally proving the digestibility of a certain amount of starch in the saliva (and pancreatic juice) of young infants\* justified my empirical findings of many previous years, and secondly, on what he is pleased to call "Jacobi's practical experience,"—the Berlin physician recommends in intestinal diseases of the very young the simplest flours, mainly of rice and oats (which have a finer microscopical structure than wheat). He pointedly adds: "very young infants do better on a dilution of milk with a thin . . . rice decoction than with mere milk sugar solution. Practical experience surpasses theoretical conclusions."† There is but one point in which the famous teacher does not yet agree with me, for in his

\* Bias dies hard. While it took Heubner more than twenty years to avail himself of very accessible physiological experience, a celebrity of equal rank (Philip Biedert, *Handbuch der Kinderkrankheiten* 11th ed. 1894. p. 39) still appears to approve of the opinion that a nursing must have "no amylacea" because of their indigestibility, before the protrusion of teeth. Before long, more than to-day it will be a generally accepted axiom that cereals must be given to make teeth when milk food alone does not suffice for their development.

† "Probiren geht über Studiren."



expositions we meet with the remark, that he "cannot approve of the colossal dilution recommended by the authority of Jacobi." The "colossal dilution" alluded to is that of milk in 4 or 5 parts of oatmeal or barley water for the use of the newly born. In regard to this dilution also I trust I shall see my illustrious colleague siding with me yet. The demands of pepsin digestion, and of rapid growth and of the necessity of restitution of losses experienced by eliminations and excretions are just as many reasons for extra allowances of water in the diet of very young infants who have to rely on the services of others. Older children know how to find it and how to serve themselves. In addition, it is certainly true that a large amount of water passing through the kidneys removes the inconveniences and dangers of the peculiar physiological process which takes place in the first three weeks of every life, viz., uric acid infarctus, the results of which are gravel, renal calculus (by no means rare) and nephritis. Indeed, since the rather frequent adoption of my plan of supplying the very young with quantities of water, I hear less of renal complaints in them than I did dozens of years ago.

Perhaps the tide is beginning already to turn in my direction. Norbert Auerbach, whose researches on the difficulty of destroying the hay bacillus and the bacillus butyricus are very meritorious, recommends larger percentages of water in infant feeding than the customary ones. His mixtures for the first and second months of life are three parts of water and one of milk, for the third and fourth, two and one, for the fifth and sixth, one and one, for the seventh and eighth, one and two. His figures are, therefore, not exactly like mine, but even they may appear heretic to my critic. In connection with this subject I am also pleased to state that Auerbach agrees with me on another subject. The sugar he adds to the milk food of infants, is not milk sugar but cane sugar, of which he gives twenty grammes daily, and, also according to my old teaching, more during constipation. He prefers cane sugar undoubtedly for the reasons which guided me in my recommendations, though it is true that milk sugar is being stripped of its dangers in the same degree as boiling, sterilization, or pasteurization are carefully practiced.

Virtually, sterilization has been practiced by me these more than forty years, and has been taught by me these thirty-five years, both in lectures and in books and essays. My method has been referred to. I always urged that safety increased with the number of boilings. Still even lately New York gentlemen have been pleased to say, and one of them has printed though he was told of his mistake before printing, that Jacobi was an opponent of sterilization.

Actual sterilization according to Soxhlet was introduced in New York by A. Caille. Then, manufacturing firms took it up



as a matter of course. One of them was prevailed upon by me to execute a device of Dr. A. Seibert, who advised the determination of the amount of sterilized food, and the graduation of the feeding bottles, according to the weight of the infant. In most cases this plan is good, for the condition of the child can mostly be measured by the increase of its weight. Only fat, clumsy, rachitical children make an exception; in them the rapid increase of weight is rather a morbid condition than a symptom of healthy development. Besides, he improved his food by adding, in conformity with my practice and sterilizing at the same time with the milk, either barley or oatmeal water. A recommendation of his sterilizer is its cheapness, which makes it more accessible to the poor. His plan—developed later—to filter milk before sterilization, is identical with that recommended by Auerbach.

The writings and practical instruction of Dr. Rowland Godfrey Freeman have been a great advantage to New York, particularly to its poor population. He insists upon pasteurization as a sufficient method of safety. As the adviser of Mr. Nathan Strauss in his successful endeavors to supply thousands with a safe article of food, he has benefited the city and aided in setting an example which should and will be imitated.

**Modified Milk.**—Pasteurization is also employed by Rotch. In a paper read before the American Pediatric Society at Boston, May 4th, 1892,\* he presented amongst others the following statements which I gladly repeat as I know his teachings to have done a great deal of good. Indeed I was so much impressed by them that I encouraged the gentleman who had conducted a milk laboratory on Dr. Rotch's plan in Boston to establish a similar institution in New York. Some of Dr. Rotch's lucid statements are as follows:

“What the profession needs is the knowledge that they may have milk laboratories where the materials are clean, sterile, and exact in their percentages. Slight changes in the three elements of the milk, of which we have the most accurate knowledge, namely, the fat, sugar and albuminoids, are of real practical value in managing the digestion and nutrition of the infant. (normal percentage in milk of fat 2.02-4.37, of milk sugar, 5.70-7.10, of albuminoids 1.08-3.07, of mineral matter 0.12-0.20.) The digestive capabilities of the infants differ, just as those of adults, and nature, therefore, provides a variety of good breast-milks adapted to the individual idiosyncrasy of the special infant. With this fact impressed upon us, we can well see that in artificial feeding no routine mixture will, in all cases, prove successful.† We are in need of a means by which we can prescribe

\*The value of milk laboratories for the advancement of our knowledge of artificial feeding. By T. M. Rotch, Trans. Am. Ped. Soc., 1892, iv. 244.

†All this proves also that nature allows a great deal of latitude, for the milk of a woman is changing and sometimes quite rapidly so, and still the baby continues



exactly according to the idiosyncrasy of the digestion we are dealing with."

"A separator with many thousands of revolutions in a minute, separates from the milk foreign material and divides it up into a cream of a stable percentage and separated milk. The milk sugar and the albuminoids, also the mineral matter of this milk is fairly well-known, and thus the laboratory worker is enabled to put up any prescription, which for a healthy baby of four months would read fat 4, milk sugar 7, albuminoids 1.50. Put up 8 tubes, each 4 ounces, (with lime water 5 per cent.) Pasteurize (75°C-167°F) for twenty minutes. In this mixture the lime water is just sufficient to slightly alkalize the cow's milk.\* In this way the food of the child can be modified according to age, and to changed conditions of health."

to thrive. It also proves that an attempt at regulating the percentages of milk according to invariable rules, while circumstances of surroundings and individual health—perceptibly changed or not—may differ, is liable to be very deceptive. Altogether, no iron clad rule holds good for a living body, in which organic assimilation is not regulated by the fixed laws of crystallization. This is, indeed, proved by nothing better than by the variability of the constituents of good milk. According to the very figures presented by Dr. Rotch himself fat may vary from 2.02 to 4.37; albuminoids from 1.08 to 3.27, and still the milks exhibiting these wide differences are "normal."

In regard to the percentages of fat in cow's and in woman's milk the results of chemical analysis have lately changed in favor of the latter. But the general principles in regard to fat feeding, its effect on digestion, and the normal occurrence of fat in the healthy fæces of an infant fed on normal nourishment (breast-milk) are not therefore altered.

Neither mathematics nor chemistry alone direct the organic economy. If that were so, the chemist Soxhlet—otherwise so deserving and justly famous—would be justified in the advice he coolly gives the physician, to add milk sugar when there is no fat in the food and thereby to obtain the necessary amount of carbon-hydrates. Fortunately organic chemistry is not identical with physiology

The methods of Biedert and Arthur Meigs are based upon these modern analyses of milk. The former prepares a cream mixture which contains 1 per cent of casein, 2 of fat and 4 of sugar. It is to be mixed with milk in different proportions. One of the reasons urged by him for the addition of cream is the greater dilution (accomplished by my cereal decoctions) of the cow casein, the difficult digestion of which he takes for granted. The mixture of Dr. Meigs is well thought of by many physicians. But it is too easily influenced by irregularities and by accidents happening to the cream while being obtained, and to the milk sugar solution, to be proof against frequent failures and to become popular among the masses. (Jacobi, *Intestinal Diseases*, p. 32.)

\*Cow's milk is either alkaline, or neutral, or acid. The constant recommendations of five per cent. of lime water for the purpose of alkalization is therefore far from exact, and from strictly scientific. Besides, how much alkalization is effected by one and a half drachms of lime water? They contain exactly or are presumed to contain, one-eighth of a grain of lime.

Lime water, the liquor calcis, is a saturated aqueous solution of calcium hydrate whose percentage varies with its temperature. At 59° F it contains somewhat over 0.17 per cent (1:600), in rising temperature less, at the boiling point 1 part of lime in 1300 of water. It redissolves as the liquid cools. If the food containing lime water be given at a temperature of eighty or ninety degrees, part of the lime is thrown out. Lime water warmed loses most of its alkaline reaction; it is markedly alkaline when cold, only faintly so when boiled. An experiment made with good milk from the household supply gave the following results; reaction acid, also on boiling. One-twentieth part of lime water added to it changed the reaction but slightly, it remained acid. The mixture being boiled, reaction remained the same. When again cooled and shaken up, it was still acid, but slightly less so than before the dilution of the milk with lime water.



In a case of duodenal jaundice, in a girl of six years, the doctor prescribed fat 0.5, milk sugar 6, albuminoids 4, give 4 ounces every 2 hours. Send 12 tubes, each 4 ounces, lime water one tenth. In a case of summer diarrhoea in a girl of four months fat 2, milk sugar 5, albuminoids 1, send 20 tubes, each 1 ounce and 1 drachm. At time of each feeding, add lime water 3 drachms. Sterilize at 212°F.

One of the beliefs guiding the author of this method is as follows: "The constituents of the nutriment which nature has provided for the offspring of all animals and human beings that suckle their young, is essentially animal and not vegetable. Human beings in the first 12 months of life are carnivora. An animal food entirely and always free from any vegetable constituents, has been proved to be the nutriment on which the greatest number of human beings live and the least number die."

Those who followed my teachings at any time during this one-third of a century, know that I take some exception to this broad statement. Saliva and pancreatic juice are good for something better than idle elimination, and "nature" prepared the animal young from the first moment for more than mere pepsin digestion. The proof Dr. Rotch refers to can be experience only. Mine has taught me somewhat differently from the axiomatic positiveness of his assertion. But it must be far from me not to present Dr. Rotch's case in full. His standing and merits are such as to give him a hearing wherever and whatever he discusses. His rules, which moreover may be modified by my method at any time, are thoroughly good, they are scientific, exact and well thought out. Moreover, they are proven to be practicable. No matter whether it is the careful handling of a cautiously prepared milk, the methodical composition according to percentages, or the faithful pasteurization, or all of them, the results are good. I know of a number of babies who in health and disease have done well on the protracted use of the laboratory milk. Only one observation struck me in a few cases. The formation of the muscles and particularly of the bones appeared to be slow, the teeth came a number of weeks or even months too late, the cranial bones turned slightly soft in a few instances. In a few such cases I had to add animal broths or juice before the usual time; in one I tried phosphorus (elixir phosphori) which was rejected; in others it was well borne and useful. But taken all in all, the method appears to be sound and successful, as far as it can be so with cow's milk and the casein of cow's milk. It is to be deplored that for the present, it is a method only for the rich; mine has the advantage of being one for the people, both rich and poor. If, or as long as, the circulars of the laboratory will keep free of pretentious exaggerations—they have been taking that turn lately—



the profession will do well to rely on it, or its like, as one of the means of furnishing the baby a food deprived of dangers, and in most cases sufficient. When found insufficient as regards tissue building, cereals can always be furnished in the same mixture. The empirical knowledge of their beneficial effects, with which we have been furnished for more than a generation, has lately again been tested experimentally by Springer, of Paris, who improved the development of bone by a decoction of mixed cereals boiled for hours in succession. This long duration of the boiling process is, however, not demanded.

Like Professor Rotch, Professor G. Gaertner,\* of Gratz, employs the centrifuge† for the purpose of obtaining a milk resembling that of woman. The latter was found by Escherich to contain casein 1.82, fat 3.10, sugar 6.23 per cent. The average of many examinations of cow's milk resulted in casein 1.76, and fat 1.81, and sugar 2.4 per cent. That of "fat milk" contained casein 1.76, fat 3, and sugar 2.4 per cent. This "fat milk" is obtained by so arranging the tube which expels the cream from the centrifuge separator that just one-half of the milk contained therein is expelled and collected. In this way, as casein, sugar and minerals are not affected at all by the process of centrifuging, the percentage of the latter is not changed at all, while that of the fat is doubled. The difference between Gaertner's and Rotch's methods is this that the former is applicable to the large majority (but that only) of infants who require cow's milk appropriately prepared; and that the latter permits of all sorts of changes and percentages, and of all adaptations to the requirements of both the well and the sick, according to the opinions and intentions of the physician in every individual case.

\* Über die Herstellung der Fettmilch.

Prof. Escherich, Die Gaertnersche Fettmilch, eine neue Methode der Säuglingsernahrung. Both in Wiener Med. Woch. 1894.

†Recommended for the preparation of children's milk in my "Intestinal Diseases." 1887. p 23.

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Green Urine due to Indigo. Dr. Archibald Garrod showed before the Clinical Society of London, a specimen of urine from a child who had sucked a piece of carpet colored with indigo. The green coloration was due to the combination of the yellow tint of the urine with the blue of indigo. On passing the urine through filtering paper it lost much of its green tint, whilst the paper was stained blue. The indigo was, therefore, in suspension. Some years ago, a favorite treatment for epilepsy was indigo to the extent of 6 drachms a day. Those patients had green alkaline urine. *Brit. Med. Jour.*, 1895, j, 365.