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Impure Milk in Relation to Infantile Mortality.

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IMPURE MILK IN RELATION TO INFANTILE MORTALITY.

BY GEORGE M. KOBER, M.D.

Last winter I had the pleasure of assisting our respected President in the collection of evidence on milk infections; the task proved so profitable that, by his encouragement, the investigation was extended in other directions and I present to you the results in one of these fields.

According to Oesterlein's statistics, it is safe to assert that the average death rate during the first year of life is 188 out of 1000 infants born. In England the average is 141.8; in France 223.2; in Italy 273.3. (Farr). These are mean rates for rural and urban districts. In towns and cities the mortality is always higher, amounting to 33.6 per cent., as compared with a rural mortality of 27.8 per cent. In some of the large cities the infantile mortality is simply frightful, having reached as high as:

480 per 1,000 at Chemnitz,
360 " " " St. Olave,
320 " " " Glauchau,
290 " " " Paris,
277 " " " New York,
276 " " " Brooklyn,
268 " " " Baltimore,
261 " " " Boston,
256 " " " Washington,
250 " " " Liverpool,
230 " " " Philadelphia.

The still-births are excluded in the American statistics. From these figures it appears, that, in many cities, out of every 100 children born alive, over one-fourth perish before the completion of the

first year, but fortunately for the perpetuation of the human race, the average infant mortality all over the world is only about one-sixth of those born.

Of the twelve months during the first year of life, the first month furnishes the highest mortality, followed by the second, third and fourth month, next, by the twelfth month; this jump from the fourth to the twelfth month is quite suggestive, as it is the usual period of weaning with its attending danger from digestive diseases incident to artificial feeding; next to the twelfth month comes the fifth, sixth, seventh, eighth, ninth, tenth and eleventh months. During the second and subsequent years the mortality gradually decreases, and of children between the age of 1 and 5 years, there die annually 37 out of 1000; a loss of 188 during the first year, with 148 during the next four years, making a total loss of 336 out of every 1000 children born.

The mortality is greatly influenced by climate and seasons, as shown by a higher rate in the polar and equatorial regions with extremes of heat and cold. Generally speaking, the mortality is higher during the cold months than during the moderate months, on account of the greater prevalence of diseases of the respiratory organs, but the hot months like June, July and August are the most dangerous, at least, in this country and Europe, on account of the disastrous attacks of gastro-enteric diseases. The fatal influence of heat and cold upon infantile mortality is well illustrated by the tables published in Dr. Busey's essay on the "Mortality of Young Children," and while they apply to the city of Baltimore, because the essay was written at the request of the trustees of the Thomas Wilson Sanitarium for Children of that city, they are no less true of other large manufacturing cities.

It would lead me too far to consider the various meteorologic conditions which influence the mortality rates as shown in these tables; but we should at least bear in mind, that sudden changes in tempera-

ture are especially liable to offend the peripheral nerves and thus cause an irritation, which is transmitted by reflex action to other parts of the body, where it may induce congestions, especially in the respiratory and digestive tracts. During the heated term the blood too, owing to an excessive function of the skin, is deprived of some of its constituents; it is taken away too much and too long from the internal organs; the proper distribution of the blood supply is interfered with; in consequence the tone of the stomach, heart, brain and other tissues is lowered, appetite and digestion suffer, the red corpuscles are decreased and not only infants, but adults experience languor and general debility; but apart, from this, and more intimately connected with the subject, remains the fact that heat not only tends to diminish the power of resistance of every cell to disease, but also favors the development of germ life in the milk.

This excessive infantile mortality has always been considered the opprobrium of the healing art. Dickson asked in vain: "How shall we prevent the early extinction of half the new-born children of men?" West truthfully asserts: "At least a third of all your patients will be children, and so serious are their diseases that one child in five dies within a year after birth and one in three before the completion of the fifth year;" and Swayne pathetically exclaims: "May it fall to the lot of some reader ere long to solve this startling problem."

While powerless to solve the mysteries connected with this subject, many of which are doubtless connected with the mortality laws in general, an attempt will be made to answer the practical question, Can they be reduced? I can not enter into details of infant hygiene, but must at least point out the fact that the mortality can be greatly reduced by improving the original stock, *i.e.*, the physique and habits of the parents, and placing them as well as their offspring under more suitable environments, especially

with reference to fresh air, sunlight, exercise, suitable clothing and habitations and, last, but not least, proper food. The influence of favorable hygienic conditions is demonstrated by Casper's statistics published in 1825, showing that the mortality rate among royal children was only 57 per 1,000, as compared with 345 per 1,000 among the infants of the poor. Clay calculates that of every 100 children born in England, 90 will be alive of those born in aristocratic families, 79 in the mercantile class and 68 among the laboring classes. The difference in the mortality of legitimate and illegitimate children is very great, and varies according to Uffelmann as follows:

	Legitimate children	Illegitimate children
In France, mortality of	15 per cent.	30 per cent.
" Austria, " "	22.9 " "	35.1 " "
" Sweden, " "	18.0 " "	24.8 " "
" England, " "	14.0 " "	35.0 " "

But the most frightful mortality rates are everywhere furnished by the hand or bottle-fed children, amounting in Berlin 40 to 47 per cent., in Hamburg 29.4 per cent., and in Paris, according to Monat, it has reached as 70 to 75 per cent. Professor Kehrer informs us that of 8,329 infants six months of age and under, that died in Munich between 1868–1870, 1,231, or nearly 15 per cent., had been suckled from the breast, and 7,098, or over 85 per cent., had been hand or bottle-fed.

If we stop to inquire into the immediate cause of the excessive infantile mortality during the first twelve months, we find that about 40 per cent. perish from diseases of the digestive system, about 21 per cent. die from affections of the respiratory organs; next in frequency are the infectious diseases like diphtheria, scarlet fever, measles, whooping cough, mumps, scrofulosis and tubercular affections, rickets, etc. The extreme incident of a mortality of 40 per cent. from gastro-enteric disorders and the mortality of 2.5 per 1,000 from primary tubercular diseases of the abdominal lymphatics, can not fail to force them-

selves on our attention, and certainly points with more than mere suspicion to the fact that the morbific agent in these cases is introduced into the body with the food.

Notwithstanding these startling arguments against artificial feeding, the facts are that there will always be a large percentage of infants deprived of their natural food, and the question therefore confronts us, What is the best possible substitute for human milk, the requirements of which are:

1. That it must offer the same character and amount of nutritive elements, and in the same proportion as human milk.

2. The nutritive elements must be present in the same assimilable form, of the same consistency, and should be introduced into the stomach at a temperature not less than 98 degrees F. by means of suction and at proper intervals.

3. This substitute must not contain any morbific or infective agent, whether originally present or introduced during the preparation or keeping of the same. A moment's reflection upon the physiology of infantile digestion will at once suggest the propriety of rejecting all farinaceous foods before the expiration of the tenth month, except in very limited quantities, and previously converted into maltose by boiling as in barley water, but as milk is the natural food of all mammalia, few will be disposed to doubt that some modification of cow's milk offers the best possible substitute.

Comparison of cows' milk and human milk: the average composition of

	Albuminoids.	Fat.	Sugar.	Salts.
Cows' milk is	3.76	3.75	4.42	0.68
Human milk	2.00	4.13	7.00	0.20

Human milk contains, therefore, less albuminoids and salts and more sugars and fats; there is also a decided difference in the quality of the casein of the two secretions. The addition of dilute acid to cow's milk precipitates the casein in hard coagula or lumps, while in human milk it separates into a fine

powder giving the appearance of light flocculent curds, which readily dissolve in an excess of acid. Since the coagulum in the same quantity of human milk is but one-fifth as large as that of cow's milk, this difference, which is solely one of compactness and solubility, can not fail to influence the digestibility of the two secretions, and explains at once why even moderate quantities of undiluted cow's milk are liable to overtax the digestive apparatus of the infant. (Leeds, Starr, etc.) In addition to this, and perhaps greater in importance, is the fact that human milk from a healthy subject rarely contains any microorganisms, while cow's milk is never free from bacteria and may moreover be the vehicle of infectious germs and other morbific agents. Apart from the fact that unscrupulous dealers not infrequently lower the nutritive value by skimming or watering the milk, Dr. Busey and myself in a joint contribution have elsewhere pointed out how the quality of the milk may be impaired by improper food and care of the animals, and how the milk may produce mischief if derived from animals while being treated with strong remedial agents, or as the product of diseased animals, especially those suffering from inflammatory lesions of the udder, tuberculosis and other communicable diseases. We have collected 138 epidemics of typhoid fever, 74 of scarlet fever and 28 of diphtheria, which have been caused by infected milk, and indicated the various ways by which it is possible for disease germs to be carried in this way. Permit me to direct your attention to a very common milk fault, which may be considered a source of constant danger in infant feeding and perhaps the most important factor in swelling the mortality rates of our helpless babes.

Every consumer of milk has doubtless observed the presence of more or less foreign matter found at the bottom of the vessel or bottle in which it is kept —indeed it is a matter of such common occurrence that it hardly excites our attention. Professor Soxh-

let was perhaps the first to point out that these deposits are largely made up of excrementitious matter from the cow which, adhering to the udder of the animal, gained access to the bucket in the act of milking. Professor Renk, of Halle, brought this subject to the attention of the Section of Hygiene at the International Medical Congress in 1890, and few of his audience are likely to forget the valuable object lesson presented by him, consisting of filtrates of milk samples from different German cities, each representing the amount of filth contained in a liter of milk, and furnished at once a positive index of the degree of cleanliness observed at the various milk farms. The average weight *dried* at a temperature of 212 degrees F., of these sediments was 3.8 mgrs. at Leipzig, 9.0 mgrs. at Munich, 10.3 mgrs. at Berlin, and 12.2 mgrs. at Halle. These filtrates were so disgusting in appearance that we were not disposed to accept them as a standard for American milk, and with the courteous consent of the Health Officer, Dr. Woodward, Professor Hurd prepared filters from twenty-four specimens of Washington milk, taken at random, with the result that they presented even a greater amount of impurities, weighing all the way from 5 to 30 mgrs. per pint or quart, and as fecal matter contains about 85 per cent. of moisture, the weight of undried filth in the maximum specimen would have been about 180 mgrs. per quart.

Now it is not at all likely that the average American housewife would permit any one to throw this amount of filth into her milk pitcher and yet, practically, we suffer it to be done, and there is no law to prevent it. If these sediments are subjected to microscopic examination, we will find, as shown in the micro-photographs, prepared through the kindness of Dr. Reed by Dr. Gray, of the Army Medical Museum, that they are composed of epithelial *débris*, hairs of the cow, excrementitious matter, vegetable cells and fibers, organic and inorganic dust particles, bacteria, fungi and spores of every description; fully

90 per cent. of the bacteria found in such specimens are fecal bacilli, all of which is not only disgusting but extremely suggestive of danger. We know that the number of microörganisms in such milk is largely increased and bacterial development and consequent decomposition is materially hastened in such a medium. Dr. Plant, of Leipzig, found, as a rule, that in warm weather the so-called fresh milk delivered in the morning has already passed the period of incubation and is unfit for use by young children on account of the germ development, and of forty-seven infants whose milk supply was carefully investigated by him, eighteen developed digestive disorders and six died.

The greatest danger from milk of this class is the possible presence of tyrotoxicon and other bacterial products. Professor Vaughan believes that the former poison is developed by the growth of a germ which, under favorable conditions, multiplies very rapidly. The presence of the very filth referred to, a summer heat, and the pernicious habit of placing the milk before cooling in covered cans or bottles, perhaps dirty beside, constitute favorable environments for the production of bacterial toxins. The relation of this poison and of milk bacteria to cholera infantum and the summer diarrheas in bottle-fed children is gaining ground and will doubtless result in a great reform of our milk establishments.

Cow's milk, no matter how great the care exercised in milking, contains the germs which bring about fermentation and decomposition. These bacteria of different species abound in the atmosphere whenever the temperature is above 60 degrees F., cling to the udder and teats and even invade the lacteal ducts and finding there an excellent culture tube, multiply with great rapidity. Dr. Schultz has shown that the first half gill or so of milk obtained from the cow may contain 1,360,000 germs per cubic inch, while the milk drawn later is free from bacteria, hence we may safely conclude that the bulk of these organisms get

into the milk from external sources, such as the air and dust of the stable, the hands and clothing of the milker, the hair or udder of the cow, the hay and straw, and last, but not least, the water, in which the milk vessels are washed, and with which the milk is not infrequently diluted.

Sedgwick and Batchelder have shown that with special precautions on the part of the milkman, the number of bacteria in fresh milk may not exceed 500 to 1000 per c.c., but when he uses the ordinary flaring milk pail, with more or less rough disturbance of the bedding and shaking of the udder, as many as 30,500 have been counted in 1 c.c. When we recall the fact that these germs during the heated term multiply with alarming rapidity, so that the average sample of Boston milk contains as many as 2,300,000 bacteria per teaspoonful, many of which are capable of evolving poisons, we can readily appreciate how the injection of such milk may give rise to the so-called summer diarrheas of infants and swell their mortality.

It has been proved, bacteriologically, that milk is not only a favorable culture medium for many saprophytic germs, but also for the germs of typhoid fever, erysipelas, tuberculosis, glanders, diphtheria, pneumonia streptococci and other pyogenic organisms, and this fact alone points at once to the necessity of a rigid control of our milk supply.

A review of the evidence on milk contamination, both in this country and Europe, shows that the laws which have been enacted to protect the public, deal largely with the prevention of milk sophistication, and even in this respect have fallen short of their aim. Indeed, it is doubtful whether legislation in matters of this kind is as effective as public education. The importance of a pure milk supply was recognized as early as 1878 in connection with some of the milk-cure institutes in Germany. The system then originated has been improved by time and experience, and lately introduced into Boston, New York and

Philadelphia, and appears to offer, by trade competition, the best solution of an important problem; those of you who are familiar with the surroundings of our milk farms and the habits of the average dairy employes need no arguments for the necessity of sanitary reform. No family ever thinks of employing or keeping a cook afflicted with a communicable disease, and yet not the slightest restriction is placed, or question asked, about the persons who handle our milk supply, which is notoriously one of the most sensitive and susceptible articles of food to contaminating influences, but the absolute necessity of such milk laboratories are based upon the following facts:

1. It has been demonstrated that milk may be morbific by reason of an abnormal number of ordinary milk-bacteria and the presence of saprophytic germs capable of producing toxins, such as tyrotoxicon, resulting in cholera infantum and other gastro-enteric diseases.

2. Milk may be rendered unfit for use by reason of improper food and care of the animal, or while the animal is being treated with arsenic, copper, iodin, lead, mercury, tartar emetic, aloes, atropia, colchicum, croton oil, senna, strychnin, salicylic acid, turpentine, veratrum viridis and other remedial agents.

3. Milk itself may be morbific as the product of a diseased animal. Dr. Busey and myself have elsewhere pointed out that inflammatory conditions of the udder and teats, especially the condition known as garget, are doubtless responsible for a large number of cases of pseudo-membranous diphtheria and other septic infections. The milk of animals suffering from acute specific enteritis, puerperal and other septic fevers, foot-and-mouth disease, cowpox, anthrax, pleuro-pneumonia, rabies and tetanus has also been known to prove injurious to the consumer.

4. It has been proved by Ernst, of Harvard, that three out of twenty-five samples of Boston milk transmitted the germs of tuberculosis in the animals experimented upon, and Dr. Fries found that the

ordinary market milk of Copenhagen proved infectious in six out of twenty-eight rabbits, showing a corresponding degree of danger to delicate infants, and of which Dr. Busey and myself have collected a large amount of clinical evidence.

5. Milk may acquire infective properties after it leaves the udder of the animal, in support of which Dr. Busey and the speaker have tabulated 138 epidemics of typhoid fever, 74 of scarlet fever and 28 of diphtheria, the analysis of which showed that the poison may reach the milk by soakage of the germs into the well water with which the utensils are washed, or by the intentional dilution with infected water; that the infection can be conveyed by animals wading in sewage polluted water, or by the dairy employes acting as nurses, or suffering themselves from some mild infection while continuing their usual duties, or are convalescents from the disease; that infection has taken place through the agency of scrubbing brushes, flies and other insects, exposure of the milk in sick rooms, or washing the patients with the same cloth used in wiping the dairy utensils. Surely this is sufficient evidence, enough to show that something should be done to protect the public; and I believe this can best be accomplished by encouraging the establishment of milk depots, like the Walker-Gordon Laboratory of Boston, and of which Dr. T. M. Rotch, of Boston, and Dr. R. T. Taylor speak so approvingly.

"The farm and herd are under the absolute control of the laboratory and are used for laboratory purposes only; the cows, their food, their stables, their pasture and their drinking water are subjected to the frequent, paid, critical examination of the best veterinary surgeon that can be procured in Boston. The dairymen dress in white suits before milking, having each previously had a bath. The milk pails are of glass, and the milk, after being aerated and cooled to about 44 degrees F. in a tank of ice and water, is delivered at the laboratory in Boston within

four hours after the milking. The average and almost stable analysis of this original milk shows a percentage of:

Fat	3.90
Milk sugar	4.30
Proteids	4.00
Salts	0.65
Total solids	12.85
Total liquids	87.15

"At the laboratory a ventilating engine keeps up a constant change of air and a hose keeps the enameled brick walls and stone floors wet to prevent contamination of the milk from dust, while it is being modified.

"The whole milk, after being pasteurized, passes through a Stockholm separator, which makes 6,800 revolutions a minute and yields a cream of an almost constant 16 per cent. fat. It not only does this, but it removes all dirt that, from unavoidable causes, has gained access to the milk, thus yielding a clean skimmed milk practically free from fat, only 0.13 per cent. remaining.

"The modifier has, as a result, stable component parts of the original milk to work with, made up by analysis as follows:

	Fat.	Sugar.	Proteids.
Cream giving	16.00	4.00	3.60
Skimmed milk giving	0.13	4.40	4.00

"In addition to this, the modifier has a 20 per cent. solution of sugar of milk, freshly prepared with distilled water each day, and is therefore able to put up correctly a prescription which calls for certain percentages of fat, sugar and the albuminoids. After copying the formula or prescription in a book kept for that purpose, the "modifier" picks up a basket with as many compartments as meals are ordered, and fills each compartment with a tubular bottle holding the number of ounces ordered for each feeding. After mixing the ingredients *en masse*, as ordered,

each bottle is filled and the basket passed to the stoppler, who plugs it with cotton. The whole is then pasteurized for half an hour, and after proper labeling the basket is ready for delivery. The delivery wagon is divided into two compartments; the back which is lined with zinc and easily cleaned is for the fresh milk and baskets, and the front for soiled tubes, baskets, etc., which are sterilized at the laboratory before being taken into the modifying room." (R. F. Taylor).

For a long time it was assumed that the composition of human milk varied with the age of the child, but Professor Leeds' long series of analyses show that after the function of lactation is once fairly established, the composition of woman's milk remains practically the same; and while the child receives more nutriment, day by day, it is in consequence of larger doses, rather than of a stronger quality. This is quite in harmony with reason and common sense.

Now if we wish to order a humanized milk as prepared at these laboratories, say for a child one month old, we would order the following mixture:

Cream	f℥vi	180
Milk sugar solut. 20 per cent.	℥vi	180
Skimmed milk	℥ivss	135
Lime water, 1–20.	f℥i	30
Distilled water	f℥vi	180

This is divided into twelve feedings, 2 ounces each. As the infant grows older, the intervals are lengthened and the doses increased. A child from two to five months old should receive eight feedings of 4 ounces each, and a strong child from five to eight months old, may receive from 6 to 7 ounces at each of the eight feedings, according to the indications which are best studied by the weight chart. Professor Rotch uses lime water for the purpose of partially neutralizing the acidity of the gastric juice, in consequence of which the casein coagulates more slowly and the formation of firm undigestible curds is thus prevented. Professor Leeds, instead of lime water,

strongly recommends the addition of peptogenic milk-powder, which is a preparation of pancreatic lactose and alkalin milk salts, originated by Fairchild Brothers & Foster of New York.

There is nothing strained in the requirement of an ideal milk supply, as good and sufficient reasons have been given, and by means of which we may hope to obtain such a standard of milk as will not only effect a decided reduction in infantile mortality, but will render the dissemination of infectious diseases through the milk supply a matter of history only. Apart from these advantages the proper way to manufacture condensed milk suitable for infant feeding is to modify the milk before evaporation, a plan which, as far as I know, has not been attempted and is urgently called for.

In the meantime, it will be well to educate the public in the matter of milk sediments, which can readily be seen at the bottom of the bottle after a few hours standing. If we tell our dairyman the source of this pollution and how it can be prevented, something will be accomplished. No milk supply is absolutely safe without pasteurization; and for infant feeding, until we can do better, I advise the following combination recommended by Professor Leeds:

Milk	½ pint	240
Water	½ pint	240
Cream	2 ounces.	60

Peptogenic milk powder one large measure. This mixture should be placed on a hot range or gas stove and with constant stirring slowly heated for ten minutes to bring it to the boiling point; it is then removed and quickly cooled, and should be kept on ice and again pasteurized before feeding. While milk thus prepared can never take the place of breast-milk from a healthy mother, it is very near in all respects to human milk and is perfectly sterile, as far as the ordinary disease germs are concerned.

Prevention of the disease is perhaps the central idea and object of sanitarians, but as hygiene also deals

with the art of improving health, the question of a pure milk supply is not only important in the feeding of infants, but also the sick and invalids, and I trust, therefore, one of general interest to the profession.