SUBSTITUTE

FOR

HUMAN MILK.

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Artificial lactation is the subject of this paper. In order to prepare our minds for its proper consideration, it will be well to examine the natural function in its normal state.

Lactation exists as a function only among the Mammalia. These derive their title as a class from the existence of the organs of this function. Whether they spend their lives in the water or on the land, whether they swim or creep, or walk or climb, or fly, they all have milk-producing organs; they all suckle their young.

And yet there are foreshadowings of lactation far down the scale of being. The bees and wasps and ants prepare a supply of food for their young, and the larva on his emergence from the egg, finds this provision near at hand and amply sufficient for his wants.

Many birds bring insects and worms to their yet unfledged young. The swallow and the wren are familiar examples of this. Nothing can exceed the diligence and assiduity with which they devote themselves to this important work of artificial lactation. The pigeon comes still nearer to the mammalia in this matter, for it supplies to its young an abundance of partly-digested food. The fact has not escaped notice, and "*pigeon milk*" is the name of this article of diet.

The truth is, that most animals leave the egg or the womb in a state of development in which they are unable to obtain and use the ordinary food of their kind. In most cases their organs of locomotion do not enable them to obtain this food. The larva of the bee cannot fly, the puppy cannot walk, the monkey cannot climb, the beaver cannot swim. Nor can they in most cases masticate and digest such food as their parents use. The teeth are ordinarily still within the gum, and do not appear for some time after birth. Most of these animals, therefore, absolutely require for their sustenance and growth a peculiar food suited to their actual condition.

What then is lactation? It is the secreting from their own blood, in organs then and then only active, and the furnishing to their new-born young, a liquid food suited to the various degrees of their development at birth, and the continuing to furnish the supply, until the young animal has become able to use the ordinary food of his race.

This secretion is continued much longer in some animals than in others. The young are not born in the same state of development. The young of the Marsupials leave the womb while yet in an embryotic state. The ruminants stand at the other extreme. Between these the other orders range themselves. In order to fix this fact in our minds, let us compare those animals with which we are most familiar. Compare the rat, the puppy, the kitten, with the colt, the lamb, the calf. Blindness, weakness and deformity mark the former; while the latter are able to see and hear and walk. How soon do the young ruminants follow their dams, skipping and running as they go. The states of development at birth are thus seen to vary greatly.

The nature of the future food of the young animal has an important connection with the length of lactation. The digestion of grass and grain and roots requires more gastric energy than that of worms and insects and flesh. In conformity with this, is the fact, that the graminivorous animals furnish milk to their young until the latter are very much more developed than the carnivora are when they are weaned.

We have used the word Milk. What is Milk? It is a general term for the various products of the mammary glands of different animals. It is the name for the food furnished by these mothers to their young. Milk is a white, opaque, oily liquid. Its color is not pure white, but verging on yellow. In some animals it is sweet, containing notable quantities of sugar. But in all it contains three great constituents—butter, cheese and water.

We have said that milk is suited to the wants of the young animal. It consists universally of two classes of food; oily materials containing no azote, and caseous substances holding in combination mineral salts, and admirably adapted to the growth of the body.

It is suited to the wants of the young animal. What is the first want of a new-born animal of this class? Warmth. He has been, during the previous stage of his existence, surrounded by tissues of the temperature of 100°. He is now out in the open air, or in still colder water, the heat of his body rapidly radiated or conducted into these cooler media. This loss of heat does not lower his temperature, for there is an internal supply. At the moment of his birth, respiration commenced, and the oxygen of the air combining with the oil of his body, evolves heat sufficient to replace that which is lost. But this consumption of oil cannot be long continued, unless the supply be renewed. The body will be soon reduced to a state of extreme emaciation, and death from cold must follow.

A supply of oil is then the first want of the young animal. The lamp of life must be fed, or it will speedily go out. The milk contains oil in proper proportion for this purpose. This oil is butter.

But not only must the vital heat be maintained, the tissues of the child must grow. The materials for the growth of the tissues are supplied by the casein or albuminous portion of the milk. The name casein is applied to a group of substances having an almost identical chemical composition. Indeed it has until recently been supposed to be identical. But it has been ascertained by Quevenne, that while their organic composition seems the same, they hold in combination different proportions of mineral insoluble salts. Thus, phosphate of lime (the bone earth) exists in different proportions in suspended casein, in dissolved casein, in albumen, and albuminose. These four substances also differ in the effects produced upon them by different agents. Thus, while suspended casein is coagulated by a small quantity of rennet, the dissolved casein, the albumen, and the albuminose are unaffected by it. Thus, while the albumen is coagulated by ebullition of the milk, the other three constituents of the casein are unaffected. Nitric acid produces the same effect without the agency of heat.

In the present state of our knowledge on this subject, we can only say that these four substances, by the action of the gastric juice, seem to be all converted into albuminose, and to be in this form absorbed into the system.

Thus constituted, having both azotised and unazotised elements, the milk is suited to supply the wants of the animal, and to promote his growth and development.

These general statements concerning lactation are applicable to the function as existing in the woman. An element which is not universally but very generally found in milk, exists in human milk in the proportion of 0.075, we refer to the sugar. Of the uses of the sugar we are not so well informed. There is reason to believe that it contributes principally to the maintenance of the heat of the body.

We come now to the subject of artificial lactation. Sometimes by the death of the mother, more frequently by her failure to secrete enough milk, the child is deprived of the needed supply. Something must be done for the famishing infant. In a few cases, we may have recourse to another woman for the needed food. Few good nurses, however, can be found. In the cities, there are by no means enough to supply the demand for human milk; in the country, they can scarcely ever be obtained. In this country we can find no permanent, reliable supply of milk, except that furnished by the cow. The question is, Can artificial lactation be successfully performed by means of the milk of the cow? This is a question of great interest to medical practitioners, as well as to parents.

In using cow's milk as a substitute for the natural food of infants, great difficulties are found. These arise from the difference of composition of the two kinds of milk—thus:

Cow's Milk is composed of	Butter,	38.59	*While Human Milk is composed of*	Butter,	20.76
	Casein,	40.75		Casein,	14.34
	Sugar,	53.97		Sugar,	75.02
	Water,	866.69		Water,	889.88

If we so dilute cow's milk as to reduce the butter to 20.76, we shall have 21.92 of casein, or 50 per cent. more than in human milk. This excess of casein leads to serious indigestion, with consequent gastric and intestinal disorders.

If, on the other hand, we reduce by still farther dilution the casein to 14.34, we shall have only 13.58 of butter, or less than two-thirds of the proper proportion. This deficiency of butter does not produce such immediate disturbance as we have stated to follow the excess of casein, but its permanent influence is most injurious.

First, because there is a deficiency of the material needed for the production of heat. If the temperature of the body be lowered, all the functions languish, and the child is unable to resist the hurtful influence of atmospheric changes.

Secondly, this deficiency of butter implies a corresponding deficiency of the phosphureted oil (lecithine) of the milk, the proper and peculiar nutriment of the nervous system, which exists in butter in the proportion of 8 per cent. or one-twelfth. If there be a deficiency of one-third of the butter, there will be of necessity, a corresponding deficiency of one-third of this phosphureted oil. As the child, during the first year of his life, should take from 1,000 to 1,400 lbs. of milk containing from 20.76 to 29.06 lbs. of butter, the annual deficiency of this phosphureted oil would be from 0.5536 to 0.7749 lb.; that is, from nine to twelve ounces. The natural consequence of this deficiency of *nerve food* is failure of *nervous energy*, and imperfect performance of *nerve functions*. The various processes languish, and calorification, circulation, absorption, digestion and secretion all feel the depression.

The proper remedy for these evils, is to provide a milk much richer in butter than the ordinary milk of the cow. If we leave a quantity of cow's milk at rest for four or five hours, and then carefully remove and examine the upper third, we find that it contains about 50 per cent. more butter than at first. In round numbers, the butter is to the casein as 57 to 40, or as 100 to 70. Now this is the relation between these two substances in human milk. If we then so dilute this new milk as to reduce the casein to 14.34 thousandths, we shall have 20.76 thousandths of butter. This is just what we need (with the addition of sugar) as an accurate imitation of human milk, and, therefore, a good substitute for it.

Take, then, ordinary cow's milk and let it stand for four or five hours. For a child three months old, $2\frac{1}{4}$ quarts will be needed. Take the upper third, ($1\frac{1}{2}$ pints,) and add to it $2\frac{1}{4}$ pints of water; sweeten it with the best sugar, of which $2\frac{2}{3}$ ounces will be required. It should be made somewhat sweeter to the taste than ordinary cow's milk.

A child three months old will take from 48 to 60 fluid ounces, daily, in six or seven doses of a half pint each.

It should be given from a bottle—*suction being the only proper mode of feeding for a young child.*

Its temperature should be from 100° to 104°. It should be warmed again if it becomes cool while the child is taking it.

The child should be early trained to pass 6 or 8 hours at night without feeding.

The kind of bottle, which for cheapness and convenience is most advantageous, is a plain 8 ounce vial, of an elliptical form. The artificial nipple is best made by rolling a quill in soft muslin and forcing this into the neck of the vial, leaving about three fourths of an inch projecting from the neck. The ease with which the muslin may be unrolled and thoroughly washed, gives this arrangement a superiority over every other, especially in warm weather. The quill also may be readily cleaned.

The child should be fed at intervals of three or three and a half hours. Regularity in this respect is very advantageous.

During the first month, the child needs food of different composition. There should be more butter in proportion to the casein. In order to obtain this increased proportion of butter, let the upper *eighth* of the milk be taken instead of the upper *third*. This milk contains from 70 to 80 thousandths of butter. It should be diluted with 2.6 parts of water.

For a child from 3 to 10 days old.	Milk 1000	Water 2643	Sugar 243
" " 10 to 30 "	"	" 2500	" 225
" " 1 month old.	"	" 2250	" 204
" " 2 "	"	" 1850	" 172
" " 3 "	"	" 1500	" 144
" " 4 "	"	" 1250	" 124
" " 5 "	"	" 1000	" 104
" " 6 "	"	" 875	" 94
" " 7 "	"	" 750	" 84
" " 9 "	"	" 675	" 78
" " 11 "	"	" 625	" 73
" " 14 "	"	" 550	" 67
" " 18 "	"	" 500	" 63

By thus gradually diminishing the proportion of water, we furnish the child a milk containing an ever-increasing proportion of nutritive matter.

How long should artificial lactation be continued? The only answer to this is, "until the child has become able to use ordinary human food." The child should be fed with milk until his organs of mastication and his powers of digestion render it best for him to have other food. And at what age does this condition exist? Children vary so much in the rate of their development, that no answer can be given applicable to all cases. In a vigorous child the first dentition is usually completed at two years of age. Sometimes this appearance of the full complement of teeth takes place six months earlier, and sometimes six months later. Whenever this first dentition is completed, the child has the full masticating apparatus of childhood, and may receive other food than milk. In many cases, lactation must be continued until the age of three years. And it may be safely presumed, that no food will be found so suitable for the tardily-developed child as that which divine wisdom has prepared for the purpose of promoting this development. As an article of food for adults, milk is of great value. Entire races of men rely upon it, and it seems, when thus largely and permanently used, to promote strength and vigor. For the formation of teeth and bones, its phosphate of lime is indispensable, and no other food suited to a feeble child contains so much in intimate union with organic elements.

Nothing has been said of any other mode of artificial lactation. This omission is not accidental. The truth is, that milk is *the only* *material* that inspires or even warrants any hope of real success. By this is not meant to say that all children reared otherwise die, but that good, physiologically good results do not follow the use of any other food. Children may *survive* months of arrow-root or other farinaceous food, but a normal, healthy, happy, vigorous, steady, ever-advancing development was never yet attained in this way. The human stomach has no creative power. The materials must be furnished, or the building cannot rise. Lecithine must be given, or the nervous energy declines. Without phosphate of lime, how shall the teeth and bones be made?

If we examine the constitution of the blood, we shall find what materials go to make the human body. What are these? Oxygen, hydrogen, carbon, azote, chlorine, fluorine, iodine, sulphur, phosphorus, silicon, potassium, sodium, calcium, magnesium, iron and manganese. Of these sixteen substances, all are found in milk. And not only so, but they exist in the milk in the same combinations as in the blood. Not only have we chlorine and sodium, but we have chloride of sodium; not merely phosphorus and calcium, but phosphate of lime already prepared for use. Not only have we oxygen and hydrogen and carbon, but we have ten different oils already existing in the milk. We have four different protein compounds, each holding in combination a definite proportion of phosphate of lime. Thus, and in all probability thus only, can this invaluable, but insoluble salt be introduced into the tissues, and give strength and firmness to the frame. Why, then, with this evident adaptation of milk to the development of the body, should we look for other articles of food? Among all the substances now used, none can make any such claim. Indeed, it may be safely said, that milk is an article standing alone, prepared expressly for this one purpose, and challenging all competition.

If the attempt made in this paper to show that the milk of the cow may be so modified as to suit the peculiar wants and condition of the infant, has been at all successful, there is ground for hope that much suffering may be relieved, and many lives saved. The subject is one of great importance, and demands the earnest consideration of the medical profession. To them the eyes of anxious and sorrowful parents are turned for help; if aid can be given, let it not be withheld.