Ophthalmia, Conjunctivitis, and Vaginitis.—In two cases of gonorrheal ophthalmia, two inoculations in each instance sufficed, with the coincident local treatment, to effect a perfect recovery, which was hastened in a manner very surprising to those who witnessed it. So also an example of gonorrheal conjunctivitis of several months' duration has responded with complete disappearance of all conjunctival injection during the positive phase, to reappear as soon as this stage subsides, making the case one of the most striking symptomatic demonstrations of opsonic fluctuation that I have seen. Gonorrheal vaginitis in two little girls yielded to two inoculations each which reinforced the irrigation treatment.

In emphasizing my unusual experience in handling gonorrheal diseases I would lay particular stress on the fact that no other therapeutic measure was used in any of my personally treated cases except the stretching of a stricture in the worst example of gonorrheal arthritis. Because of my inconvenient situation it has not been possible to bring to the aid of the inoculation such other procedures as irrigation, sounding or what not, commonly practiced in the treatment of gonorrhea, and, of course, for the best results, particularly for handling the urethral discharge, such measures probably should be used in conjunction with the gonococcus vaccine. Nor have I been able to make a sufficient number of opsonic indices to furnish this additional guide in opsonic therapy. Still it is clear that therapeutic effects have been obtained entirely beyond anything heretofore possible, and these by the use of small, non-painful, simple subcutaneous injections at weekly intervals.

CONCLUSION.

In dismissing this account of my personal experience with Wright's method of treatment I will say that if the therapeutic results which have been presented were based solely on my own work I would not have the courage to make them public at this time, when but six months have elapsed since my first clinical experiments began. But because they duplicate the published reports made by Wright and his followers in England in connection with the various groups of infections except the gonorrheal, and since they correspond with the reports brought to the United States by those who have visited Wright's laboratory, I am somewhat less diffident.

Moreover, I believe the adoption of opsonic therapy in this country depends on the promulgation among practicing physicians of the actual clinical achievements, and this as speedily as accurate observation shall warrant; and it is my conviction that a method of practice with such vast humanitarian possibilities should be brought into the possession of the medical profession without delay.

Finally, from what I have already seen, which is tempered by a rather extensive experience in private and institutional medical work, I am prepared to assert that with the proper artificial autoinoculation we can obtain constitutional and local improvement in many subacute and chronic infections entirely beyond anything previously possible in medicine. And I am personally assured that in these bacterial inoculations we possess therapeutic agents of a specificity and potency exceeding anything heretofore employed in the treatment of disease except possibly the antitoxin of diphtheria.

ACCURATE MODIFICATION OF MILK, SIMPLE AND PRACTICABLE.*

DANIEL R. BROWN, M.D.
SALEM, MASS.

Accurate modification of milk involves the calculation of definite percentages of fat, mixed proteids, caseinogen, etc., for mixtures of cream and milk and of cream and milk and whey. The necessary operations are expressed most conveniently in algebraic equations.

Of the merits of percentage modification, the American method of preparing cow's milk for the infant, it is sufficient to say that it provides the instrument of precision; for this reason alone, if there were none others, it is desirable that it should be established on the mathematical principles which it involves and on which it depends. If formulas are employed to determine the required quantities of materials, they should accord with these principles and with the chemical facts; they should be accurate, also, and adequate. None of the published formulas meets these requirements; and generally accepted statements on the subject of the calculation and the preparation of percentage mixtures are, in certain important respects—practically important—misleading: As the formulas to be presented conflict with, or disregarded some of them, their integrity can not be established without reference thereto; moreover, in the absence of error or misconception, there would be no reason—no excuse—for further contribution to this part of the subject.

It is generally understood, for example, that a variety of creams, creams of different strengths, is essential to accurate and adequate modification of milk. What are known, respectively, as 8 per cent., 10 per cent., 12 per cent., 16 per cent. and 20 per cent. cream are commonly employed; directions are given, accordingly, for obtaining these creams by gravity, together with tables that show their proteid and sugar percentages, which are different for each variety of cream, and are differently given by different authors; other tables that show the limitations in the percentages of fat and of proteids that are obtainable by the use of creams of different strengths; others that show the percentages of the food-elements that are reciprocally obtainable, and still others by which the choice of the creams to be employed for particular modifications is directed. Under these conditions, confronted at the outset by these tables, the apparent necessity for the use of a variety of creams, ranging from 8 per cent. to 32 per cent., of which each must be computed by a slightly different equation, it is not surprising that one unfamiliar with the percentage method and mathematical formulas, should find accurate modification impracticable in advance.

But while all these factors may be employed very few of them are essential, either to the statement of the problem, or to its solution. A variety of creams is not only unnecessary, but undesirable, because of the confusion to which it gives rise; and of all the facts recorded in these tables, as factors, knowledge of two only is required, for practical purposes: (1) the analysis (the fat, proteid and sugar percentages) of cow's milk, (2) how to obtain adequate cream, a single variety of adequate cream, by gravity.

Of the published formulas, the series proposed by Dr. Westcott¹ in his admirable monograph are the only ones

[FOR THE DISCUSSION SEE PAGE 639.]

* Read in the Section on Diseases of Children of the American Medical Association, at the Fifty-seventh Annual Session, June, 1906.
1. Scientific Milk Modification, Internat. Clinics, Series 10, vol. III.

for which accuracy and completeness are claimed. But in the derivation of these formulas the principle on which the calculation depends is not recognized, or is not regarded; and the assumptions on which the working equations are based are untenable. The formulas are inadequate also: Westcott's equations for combining cream and whole milk depend on equality of the fat and proteid percentages of the milk; but, according to recent analyses, the mixed milk from a herd of cows contains 3.50 per cent. proteids and 4 per cent. fat; these equations fail accordingly for standard milk; and, of course, for all milk of which the fat and proteid percentages are not precisely equal. In the equations for cream and fat-free milk it is assumed that the proteid percentages of whole and fat-free milk are equal, which, since cream has a lower proteid percentage than milk, is mathematically impossible. His formulas for computing whey-cream mixtures are based on the proposition that the proteid percentage (?) of a mixture of cream and whey is equal to the proteid percentage of the cream plus proteid percentage of whey employed; but the former refers to mixed proteids, the latter refers to whey proteids alone. While together they make up the percentage of proteids in a mixture, they can not be added together to make a "proteid percentage." No provision is made for the computation of definite percentages both of fat and of (mixed) proteids; except for the small percentage of fat that may be contributed by the whey, the percentages of each that may be obtained depend on the strength of the cream employed, which is computed for a definite percentage of fat, or for a definite percentage of proteids (?). The number of modifications obtainable is limited, therefore, according to these formulas, by the number of creams available, and the equations are inadequate.

The formulas for combining cream and whole milk first proposed by Dr. Westcott "depended on the calculation of the amount of combined cream and milk required to give the desired proteid percentage of the mixture," the factor assumed to represent the "average proteid percentage of mixed cream and milk" depending on the strength (fat percentage) of the cream employed. These equations also are at fault; as will be shown in the succeeding analysis, the proteid percentage of the mixed, or mixture of, cream and milk required to yield a particular modification does not depend at all on the fat percentage of the cream, but is the same always, whatever the strength of the cream employed may be.

In the following analyses, and in the equations derived therefrom, it is assumed that whole milk contains 3.50 per cent. of proteids, 4 per cent. of fat, and 4.50 per cent. of sugar, unless otherwise specified. As far as common factors are employed, the usual symbols and equivalents have been adopted, with certain additions:

Q = quantity of food desired.

F = desired percentage of fat.

P = desired percentage of proteids.

S = desired percentage of sugar.

a = the fat percentage of cream.

b = the proteid percentage of cream.

c = the sugar percentage of cream and of milk.

a' and b' denote, respectively, the fat and the proteid percentage of the milk employed.

X = appropriate cream.

B = the proteid percentage of appropriate cream.

R = the ratio $\frac{F}{P}$.

The formulas herein presented are based on four especial considerations or propositions:

1. Since cream has a lower proteid percentage than milk, fat-free milk must have a higher proteid percentage than milk, which is essentially 4 per cent. cream; and on chemical analysis it appears, accordingly, that whole (4 per cent.) milk having a proteid percentage of 3.50 the fat-free milk has proteid percentage of 3.60. The loss of 4 per cent. fat, therefore, involves the gain of one-tenth of 1 per cent. of proteids, and, of course, conversely; whence the principle may be deduced that for each 4 per cent. gained in fat-value, cream loses one-tenth of 1 per cent. in proteid-value; or, for each gain of 1 per cent. in fat, loses .025 per cent. in proteid-value (and in sugar-value²).

2. The ratio of the fat percentage to the proteid percentage of a particular cream is the ratio of fat percentage to proteid percentage that is obtained by diluting the cream with water; thus, the fat percentage of 16 per cent. cream is 16; the proteid percentage is 3.20; the ratio, 16 to 3.20 is 5 to 1; if 16 per cent. cream is mixed (diluted) with an equal part of water, the mixture will contain 8 per cent. fat, 1.60 per cent. proteids; the ratio, 8 to 1.60 is 5 to 1.

3. A cream of which the ratio of fat percentage to the proteid percentage (a to b) is precisely the ratio of the desired fat percentage to the desired proteid percentage (F to P) is what may be termed the *appropriate cream* in each case, since by itself, without the addition of milk, it is capable of furnishing both the required quantity of fat and the required quantity of proteids. The ratio, F to P, therefore, indicates the *appropriate cream* in each case; thus, for a 20 oz. mixture to contain 4 per cent. F and .80 per cent. P, 16 per cent. cream is appropriate, because the ratio, 16 to 3.20 is the same as .80 the ratio of 4 to .80 and 5 oz. of 16 per cent. cream will supply both the .8 oz. of fat and the .16 oz. of proteids desired. Thus:

$$5 \times 16 \text{ per cent.} = .80 \text{ oz. fat.}$$

$$5 \times 3.20 \text{ per cent.} = .16 \text{ oz. proteids.}$$

The ratio 4 to .8 or 5 to 1 indicates 16 per cent. cream.

4. Theoretically, there is an infinite number of creams and an infinite number of ratios of fat to proteids; theoretically, therefore, there is *appropriate cream* for every ratio F to P that is attainable; but practically it is impossible to obtain directly, either by the centrifuge or by gravity, *appropriate cream* for all these ratios; it is necessary, therefore, to mix cream of known percentages with milk of known percentages, but in each case the mixture of cream and milk that is capable of furnishing the required percentages represents, is, essentially, *appropriate cream* and has the same fat, the same proteid and the same sugar percentages:

For example:

	Fat percentage.	Proteid percentage.
1 oz. cream.....	16	3.20
1 oz. of milk.....	4	3.50
Together are equal to 2 ounces of 10 per cent. cream:		
16 + 4		
— = 10 per cent. F.		
2		
3.20 + 3.50		
— = 3.35 per cent. P per cent. cream).		
2		

2. The sugar percentages of cream and milk obey the same laws that govern the proteid percentages.

In the application of these principles, two sets of formulas have been derived: General formulas of universal application and working formulas which provide specifically for the use of materials that are generally available for purposes of home modification.

SERIES I. GENERAL FORMULAS. MIXTURES OF CREAM AND MILK.

Modified milk is always diluted milk; rather, diluted cream, and, as we have seen, the ratio F to P indicates the cream to be employed—the *appropriate cream* in each case.

In the computation of percentage mixtures it is necessary to determine in the first place the quantity of *appropriate cream* that is required to obtain the desired mixture; either the fat percentage, or the proteid percentage may be taken as the basis for this calculation. The latter has been preferred, because the proteid percentages of the creams ordinarily indicated do not differ very much. Obviously, the proteids in the *appropriate cream* ($B \times X$, or $B X$) must equal the whole quantity of proteids desired ($Q \times P$, or $Q P$); that is, $Q P = B X$; and the quantity X required must depend on its proteid percentage, B . When cream is *appropriate*, the ratio a to b equals the ratio F to P ; that is,

$$\frac{a}{b} = \frac{F}{P} = R: \text{whence } a = b R. \text{ In creams of which the ratio } \frac{a}{b} \text{ is below } 7.50 \text{ (creams below 23 per cent. about),}$$

the proteid percentage decreases with the increase in the fat percentage in such proportion that three times the ratio $\frac{a}{b}$, plus 1 is in some cases precisely and in all other cases almost precisely equal to b times the ratio; that is, $\frac{3a}{b} + 1 = \frac{ba}{b}$; and, since cream loses .025 per cent. of proteids for each 1 per cent. gained in fat, .025

$\left[\frac{3a}{b} + 1\right]$ equals the proteid percentage lost in each case, which, deducted from the proteid percentage of fat-free milk, would equal the proteid percentage of the cream; but the proteid percentage of fat-free milk represents the loss of 4 per cent. of fat; wherefore, taking the proteid percentage of whole milk as the basis for the calculation, .025 $\left(\frac{3a}{b} + 1 - 4\right)$ deducted from the latter equals the proteid percentage of the cream in each case; that is, $3.50 - .025 \left[\frac{3a}{b} + 1 - 4\right]$,

or, $3.50 - .025 \left[\frac{3a}{b} - 3\right] = b$; whence, since $\frac{a}{b} = R$ when cream is *appropriate*: (B) $3.50 - .025 (3R - 3) = B$.*

3. When R (the ratio F to P) exceeds 7.50, the equation must be modified:

$$3.50 - .025 (3R - 4) = B. \text{ when } R \text{ is between } 7.50 \text{ and } 9.$$

$$3.50 - .025 (2R \times 5) = B, \text{ when } R \text{ exceeds } 9.$$

Practically, a ratio F to P as high as 7.50 is never indicated in mixtures of cream and milk; equation B, therefore, meets every requirement in practice, and is employed accordingly in the general formulas, subject to the exceptions noted. The same remarks apply to the equation for finding the sugar-percentage of *appropriate cream*. For certain ratios the percentage B thus determined is absolutely accurate; and in any case the error is very small, seldom more than a few thousandths of 1 per cent.

The fat and proteid percentages of *appropriate cream* (A and B) for all attainable ratios may be arrived at with absolute accuracy by the following calculations, B having been determined approximately:

$$\begin{aligned} B R &= a \\ (C) \quad 3.50 - .025 (a - 4) &= b \\ b R &= A \\ 3.50 - .025 (A - 4) &= B \end{aligned}$$

These operations are repeated until the desired ratio is estab-

lished; that is, until $\frac{A}{B} = R$. Many ratios are practically unattainable on account of the decimals involved. The general equations (in which p = the coefficient of proteid loss) are: $B R = a$; $b' - p (a - a') = b$, etc.

But in order to obtain *appropriate cream*, it is usually necessary to combine cream of known percentage with milk of known percentages; X , therefore, must be equal to the quantity of cream and milk required; that is, $X = C + M$, whence $X - C = M$. Any variety of cream that is adequate and any adequate milk may be employed; but in all cases, the cream and milk together must supply both the required quantity of fat and the required quantity of proteids; that is,

$$(1.) a C + a' M = Q F, \text{ and}$$

$$(2.) b C + b' M = Q P; \text{ by substituting for } M \text{ its equivalent } X - C, \text{ and transposing, equation (1) becomes}$$

$$Q F = a C + a' (X - C), \text{ or}$$

$$Q F = a C + a' X - a' C =$$

$$Q F - a' X = (a - a') C, \text{ whence}$$

$$\frac{Q F - a' X}{a - a'} = C \text{ (cream)}$$

$$\text{By transposition equation 2 becomes: } Q P = b C + b' M = \frac{Q P - b C}{b'} = M.$$

Five per cent. of lime water is required to make the mixture alkaline in reaction:

$$\frac{Q \times 5}{100} = \text{Lime water.}$$

Since the sugar percentages obey the same laws that govern the proteid percentages, they may be computed in the same way—taking the sugar percentage of whole milk as the basis for the calculation; accordingly, (E) $4.50 - .025 (3R - 3) = C$. In the case of cream and milk of the standard analysis, the sugar percentage equals the proteid percentage plus 1; that is, $B + 1 = C$.*

It may be desirable to know the strength of cream that is necessary in order to obtain a particular modification (percentages). *Appropriate cream* is always the weakest adequate cream; that is, the weakest cream that may be employed in combination with milk to obtain the desired percentages in each case. As we have seen, $\frac{3a}{b} + 1 = b R = a$; when cream is *appropriate* $\frac{a}{b} = R$, wherefore, (A) $3R + 1 = a$ (adequate cream).⁴

The *limitations* in the percentages of fat and of proteids obtainable by the use of a particular variety of cream are shown by the ratio a to b in each case; thus, when cream is diluted with water, the ratio a to b determines the ratio F to P ; that is,

$$\frac{F}{P} = \frac{a}{b} = R, \text{ whence, } R P = F \text{ and } \frac{F}{R} = P; \text{ any ratio } \frac{F}{P} \text{ below the ratio } \frac{a}{b} \text{ may be obtained by combining the cream with milk.}$$

If the milk in use is of other than the standard analysis, the coefficient of proteid loss, and the ratio $\frac{a}{b}$ must be determined, and the working equations modified accordingly. The proteid and sugar percentages of cream in each case depend, of course, on the analysis

* When R exceeds 7.50 the equation is modified.
4. When R exceeds 8, $2R + 9 = a$.

of the milk from which it is derived; but, in some of the published tables of analyses, these percentages are given apparently without reference to the analysis of the milk in use; for example, 12 per cent. cream from 4 per cent. milk (4 per cent. P) may be grouped with 16 per cent. cream from 3.50 per cent. milk. The tables of different authors do not agree, therefore, and for purposes of computation are unreliable for the most part. If the milk in use is deficient in fat, the strength of gravity cream therefrom is reduced in each case. In these cases, the coefficient of proteid loss is increased.

The fat and proteid percentages of the milk and the proteid percentages of a single variety of cream being known, other values (as factors) may be computed. The general equations are:

$$\frac{b' - b}{a - a'} = P$$

$$(C) \quad b' - p(a - a') = b$$

$$(D) \quad \frac{b' + a'p - b}{P} = a$$

The accuracy of the working formulas to be derived for the use of milk and cream of other than the standard analysis depends on the accuracy of the percentage B; for the ratios commonly required, this factor may be determined, approximately, by the formula

$$b' - p(3R - 2) = B; \text{ or}$$

$$b' - p(3R - 3) = B$$

(depending on the value of p); and accurately for all ratios by the calculations that have been indicated.³ For practical purposes an "average" percentage may be used.

Equations that provide for the use of whole milk containing 4 per cent. of proteids, and of milk deficient in fat are included in the series of working formulas (Series iv, B).

Mixtures in Which P Equals, or Exceeds F.—*Appropriate cream* for these modifications is, of course, separated milk, since there is no cream of which the proteid percentage equals, or exceeds the fat percentage. Any separated milk in which the ratio of fat to proteids is

$$\frac{F}{P}$$

not above the ratio — is adequate; and cream of any

$$P$$

strength, even 4 per cent. milk, may be combined with it.

The use of fat-free milk simplifies the computation of these mixtures, which, in this case, may be made by the special formulas for cream and fat-free milk. If separated milk is employed, its fat percentage should be computed (preferably), and the required quantities of cream and milk determined by the general formulas (Series 1). In these cases it is unnecessary to compute the percentage B, which, for standard milk, must always be between 3.50 and 3.60; the mean percentage 3.55 may be assumed accordingly.

SERIES II. SPECIAL FORMULAS. CREAM AND FAT-FREE MILK.

These equations depend on the same principles and are derived in the same way as the equations in the general formulas, but in this case it is unnecessary to find the quantity X, or the percentage B, since all the fat is supplied by cream, which is computed directly. Thus:

$$1. \quad \frac{QF}{a} = C \text{ Cream.}$$

$$QP = b + b'M \text{ whence}$$

$$2. \quad \frac{QP - b}{b'} = M \text{ (Milk).}$$

$$3. \quad \frac{QS - c(C + M)}{100} = S \text{ (Sugar).}$$

All mixtures to be prepared with cream and fat-free milk may be computed by these equations, if preferred.

SERIES III. GENERAL FORMULAS. WHEY-CREAM MIXTURES.

Three varieties of whey are recognized, depending on its source and the way it is prepared: 1. Whey from whole milk, separated with the least possible disturbance of the curd. 2. Whey from whole milk, separated after "thorough agitation" of the curd and whey. 3. Whey from fat-free milk.

In the text these varieties of whey are referred to, respectively, as, (1) Whole whey (which contains .32 per cent. F, .86 per cent. P, 4.80 per cent. S). (2) Two per cent. whey (which contains 2 per cent. F, .97 per cent. P, 4.80 (?) per cent. S). (3) Fat-free whey (which contains trace of F, 1 per cent. P, 5.00 per cent. S).

By the use of the whey-cream mixtures very low percentages of caseinogen with relatively high percentages of whey-proteids and of fat may be given. With low percentages of caseinogen, not above .50, a maximum percentage of whey-proteids of from .75 to .90, depending on the variety of whey employed, may be obtained. In the succeeding analysis, and in the equations derived therefrom, additional symbols and equivalents are employed as follows:

cas = desired percentage of caseinogen.

WhP = desired percentage of whey-proteids.

a" b" c" = respectively, the fat, proteid and sugar percentages of the whey in use.

F' = fat percentage supplied by cream (and milk).

P' = proteid percentage supplied by whey.

The calculation of whey-cream mixtures requires division of the proteids into caseinogen and whey-proteids, of which the former is furnished by the cream (and milk) alone. Each must be computed separately. The computation in detail may be made in different ways; the simplest, on the whole, requires the conversion of the desired percentage of caseinogen (cas) into the percentage of mixed proteids which it represents, at the outset.

According to chemical analysis, the percentage of whey-proteids in cream and milk is equal to one-fifth of the percentage of caseinogen (about); a given percentage of caseinogen (cas), therefore, represents a percentage of mixed proteids one-fifth greater, that is cas

$$+ \frac{\text{cas}}{5} = P. \text{ This simple calculation having been made,}$$

the equations for finding the required quantities of cream and milk are substantially the same as the corresponding equations in the general formulas (Series 1), and are derived in the same way.

The ratio F' to P indicates *appropriate cream* in each case, and the percentage F' depends, of course, on the kind of whey employed. The fat percentage of whole whey is equal to 37 per cent. of its proteid percentage (.32/.86). The fat percentage of 2 per cent. whey is equal to twice its proteid percentage (about) 2x.97; accordingly,

$$F - .37 P' = F' \text{ when whole whey is used.}$$

$$F - 2 P' = F' \text{ when 2 per cent. whey is used.}$$

$$F = F' \text{ when fat-free whey is used.}$$

The percentage of proteids furnished by the whey (P') must be equal to the desired percentage of whey-proteids less that contributed by the cream (and milk);

$$\text{that is, WhP} - \frac{\text{cas}}{5} = P'.$$

The necessary operations are expressed in equations as follows:

1. $\text{WhP} - \frac{\text{cas}}{5} = \text{P}'$
2. $\frac{\text{QP}'}{.86} = \text{whole whey}; \quad \frac{\text{QP}'}{1} = \text{fat-free whey, or 2 per cent. whey.}$

The required quantity of whey having been computed, it is simpler to determine the percentage F' by the following equation, which expresses the fact that the required quantity of fat is equal to the fat in the cream and milk plus the fat in the whey employed; that is,

$$\text{QF} = \text{QF}' + \text{a'' whey, whence } \frac{\text{QF} - \text{a'' whey}}{\text{Q}} = \text{F}';$$

the ratio $\frac{\text{F}'}{\text{P}}$ indicates appropriate cream $\frac{\text{F}'}{\text{P}} = \text{R}$

The equations for cream and milk, respectively, are the same as the corresponding equations in the general formulas (Series 1), except that the former provides for the use of whey containing fat:

$$\begin{aligned} \text{QF} &= \text{a C} + \text{a' M} + \text{a'' whey, whence, since X - C = M,} \\ \frac{\text{QF} - (\text{a' X} + \text{a'' whey})}{\text{Q}} &= \text{Cream.} \\ \frac{\text{QS} - (\text{c X} + \text{c'' whey})}{100} &= \text{Sugar} \end{aligned}$$

RECAPITULATION.

SERIES I.—MIXTURES OF CREAM AND MILK. GENERAL FORMULAS.

1. $\frac{\text{F}}{\text{P}} = \text{R}$
2. $350 - .025 (3 \text{ R} - 3) = \text{B}$
3. $\frac{\text{QP}}{\text{B}} = \text{X}$
4. $\frac{\text{QF} - 4}{\text{a} - 4} = \text{Cream}^5$
5. (a) $\text{X} - \text{C} = \text{M.}$ (b) $\frac{\text{QP} - \text{bC}}{3.50} = \text{M}^6$
6. $\frac{\text{Q} \times 5}{100} = \text{Lime water}$
7. $\frac{\text{QS} - \text{cX}}{100} = \text{Sugar}$

SERIES II.—CREAM AND FAT-FREE MILK. SPECIAL FORMULAS.

1. $\frac{\text{QF}}{\text{a}} = \text{Cream}$
2. $\frac{\text{QF} - \text{bC}}{\text{b'}}$ = Milk
3. $\frac{\text{QS} - (\text{cC} + \text{aM})}{100} = \text{Sugar}$

SERIES III.—WHEY-CREAM MIXTURES. GENERAL FORMULAS.

1. $\text{cas} + \frac{\text{cas}}{5} = \text{P}$

5. If other than 4 per cent. (F) milk is in use, substitute its fat percentage for the factors 4 and its proteid percentage for the factor 3.50.

6. When the percentage B is computed accurately the equations (a) and (b) in No. 5 for finding the required quantity of milk are precisely equal.

2. $\frac{\text{Q} \left(\text{WhP} - \frac{\text{cas}}{5} \right)}{\text{b''}} = \text{Whey}$
3. $\frac{\text{QF} - \text{a'' Whey}}{\text{Q}} = \text{F}'$
4. $\frac{\text{F}'}{\text{P}} = \text{R}$
5. $3.50 - .025 (3 \text{ R} - 3) = \text{B}$
6. $\frac{\text{QP}}{\text{B}} = \text{X}$
7. $\frac{\text{QF} - (\text{a' X} + \text{a'' Whey})}{\text{a} - \text{a'}} = \text{Cream}$
8. $\frac{\text{QP} - \text{bC}}{\text{b'}}$ = Milk
9. $\frac{\text{QS} - (\text{cX} + \text{c'' Whey})}{100} = \text{Sugar}$

SERIES IV.—WORKING FORMULAS.

In practice, the use of the general formulas is very seldom necessary; every mixture of cream and milk, and, with very few if any exceptions, every whey-cream mixture that is indicated may be computed with substantial accuracy by the working formulas.

For the mixtures commonly required, the maximum error in the results obtained by these equations is five one-hundredths of 1 per cent. of fat, or of proteids (according to the equation employed for finding the required milk) and for the greater number of modifications required it is between one and two hundredth of 1 per cent.

Any varieties of cream and of milk that are adequate may be employed. Of the creams generally in use and readily obtainable by gravity, both 16 per cent. and 20 per cent. cream are adequate: every mixture of cream and milk, with a few possible exceptions, and there are very few, if any, every "whey-cream" mixture that is indicated, may be obtained by combining 16 per cent. or 20 per cent. cream⁷ with milk, or with whey, or with milk and whey. Both of these varieties of cream are well adapted for purposes of home modification. The former has the special advantage that it is always readily available in sufficient quantity.⁸ On the whole, it is probably the best selection that can be made. The use of whole milk simplifies the preparation of the food; and it is more constant in composition (percentages) than that separated, or fat-free milk obtained by gravity. The working formulas provide accordingly for the use of 16 per cent. cream and whole milk.

Whatever variety of cream is employed, the full quantity obtainable by gravity from a given quantity of milk should be removed (preferably the separated milk should be discharged by a siphon) and well mixed before any part of it is used in the preparation of the food,

7. A mixture of the top 6 oz. of a quart of 4 per cent. milk, "set" 8 hours or longer, represents 16 per cent. cream, of which the top 4 oz. (mixed) is 20 per cent. cream. Four (4) ounces of 20 per cent. cream may be obtained from a quart of 4 per cent. milk "set" 4 hours (Rotch).

8. Six ounces of 16 per cent. cream in combination with whole (4 per cent.) milk will furnish sufficient fat for the daily ration of the infant at all ages, presuming that the usual, or "average" mixtures are employed. This statement is based on the feeding-chart issued by the Walker-Gordon Milk Laboratory.

as the surface cream is always very much richer than other portions of it.

The working equations are based on the consideration that *appropriate cream* for the mixtures (ratios) usually to be employed is between 5 + per cent. and 10 per cent. cream, of which the proteid percentage is between 3.46 + per cent. and 3.35 per cent.; the mean percentage, 3.40 is taken accordingly to represent the "average" percentage B for these ratios, and the general equation $\frac{QP}{B} = X$ becomes $\frac{QP}{3.40} = X$. Sixteen per cent. cream has a proteid percentage of 3.20.

3.50 per cent. — .025 (16.4) = 3.20 per cent. (b).

The fat in the cream (16 C) plus the fat in the milk (4 M) must equal the required quantity of fat (Q F); and the proteids in the cream (3.20 C) plus the proteids in the milk (3.50 M) must equal the required quantity of proteids; that is,

$$(1) \quad QF = 16C + 4M; \text{ and}$$

$$(2) \quad QP = 3.20C + 3.50M$$

Substituting the value $X = C$ for M in equation (1), it becomes $QF = 16C + 4X - 4C$, whence

$$\frac{QF - 4X}{16 - 4} = \text{Cream.}$$

$$(a) \quad X - C = \text{Milk, and, since } QP = 3.20b + 3.50M,$$

$$(b) \quad \frac{QP - 3.20C}{3.50} = \text{Milk.}$$

When the percentage B is accurately determined, equations (a) and (b) for finding the required quantity of milk are precisely equal. The error involved in the use of an "average" factor B affects either the fat percentage alone, or the proteid percentage alone, according to the equation employed for milk; equation (a) ($X - C$) determines the fat percentage of the mixture accurately; by the use of equation (b) the proteid percentage is correctly obtained. Generally the latter is the more important; but for the mixtures commonly required the error is so small that the simpler equation $X - C$ yields satisfactory results.

The sugar percentage of cream and milk is equal to the proteid percentage plus 1; accordingly $C = 3.40 + 1$, or 4.40 per cent.; and $\frac{QS - 4.40(C + M)}{100} = \text{Sugar,}$

The quantity of sugar to be added is usually very nearly equal to 5 per cent. of the quantity of food to be prepared. The fat percentage of mixtures of 16 per cent. cream and whole milk may be decreased, or increased, without materially affecting the proteid and sugar percentages, simply by changing the relative qualities of the cream and milk employed. Of the mixtures ordinarily prescribed (quantities and percentages) each ounce of cream and milk exchanged decreases (or increases) the fat percentage from .40 to .60 per cent.

Denoting the quantity (in ounces) of cream and milk exchanged by the symbol y, the fat percentage obtained is determined by the equation: $\frac{QF \pm 12y}{Q} = F$.

SERIES V. WORKING FORMULAS. WHEY-CREAM MIXTURES.

These formulas are for mixtures of 16 per cent. cream, whole milk and fat-free (or 2 per cent.) whey. The ratio of fat to caseinogen in 16 per cent. cream is a little above 6 to 1; 16 per cent. cream, therefore, in combination with fat-free whey is adequate for the greater number of whey-cream mixtures required. The

use of 2 per cent. whey as a diluent increases the ratio F to cas obtainable with 16 per cent. cream from 6 to the 1 to 12.8 to 1—with low percentage of caseinogen—not exceeding .50 per cent. While, of course, a larger number of modifications may be made with *appropriate cream* and fat-free whey, the number obtainable with 16 per cent. cream and 2 per cent. whey is large enough to warrant the statement made as to the adequacy of 16 per cent. cream for the preparation of these mixtures. Usually, with low percentages of caseinogen, it is desirable, and, except for the youngest infants, essential (in order to provide for nutrition) to give the highest possible percentage of whey-proteids, which is obtained, of course, by the use of whey as a diluent in place of water. In these cases it is not necessary to compute the whey at all. By the use of fat-free or 2 per cent. whey as a diluent, from .75 per cent. to .90 per cent. of whey-proteids is obtained with low percentages of caseinogen (not exceeding .50).

Since the ratio F to cas in the whey-cream mixtures ordinarily indicated is considerably higher than the

corresponding ratio $\frac{F}{P}$ in mixtures of cream and milk,

richer creams are required, and the average percentage B is correspondingly lower; but to avoid confusion the factor 3.40 is retained to represent *appropriate cream*. Moreover, the slightly increased error affects only the fat percentage of the mixture, which is comparatively unimportant. For home modification it is probably most convenient to obtain whey from the separated milk (after the removal of the 16 per cent. cream); or to use 2 per cent. whey from whole milk. The former may be regarded as fat-free for purposes of computation.

The equations for finding the required cream and milk, respectively, are the same as the equations therefor in Series iv, except that the equation for cream, No. 4 (b), provides for the use of 2 per cent. whey.

SERIES VI.

This series is for mixtures of 16 per cent. cream and its separated milk, containing 1.23 per cent. F, 3.57 per cent. P, and 4.57 per cent. S.

The term "separated milk" as here employed refers to the milk that remains after the removal of the full quantity of 16 per cent. cream obtainable by gravity from a quart of 4 per cent. milk. This milk, in combination with cream, is adequate for the preparation of all mixtures of which P exceeds, or equals, F, provided the ratio P to F is not above 2.90 (3.57 to 1.23)—practically all mixtures that are indicated; but, except for young infants and for infants with deficient digestive power, is inadequate for the mixtures ordinarily to be employed, for the reason that a sufficient quantity of fat for the daily ration can not be obtained. Equations for the computation of mixtures of which P exceeds (or equals) F are included in the series of working formulas.

SERIES IV (A)—WORKING FORMULAS.

For the use of milk of the standard analysis—16 per cent. cream and whole milk.

$$\begin{aligned} &QP \\ 1. \quad &\frac{\quad}{3.40} = X \\ &QF - 4X \\ 2. \quad &\frac{\quad}{16 - 4} = \text{Cream} \end{aligned}$$

$$\begin{aligned}
 &3. \quad \begin{aligned} &(a) \quad X - C \\ &QP - 3.20C = \text{Milk}^9 \end{aligned} \\
 &\quad \begin{aligned} &(b) \quad \frac{3.50}{QS - 4.40(C + M)} \\ &= \text{Sugar} \end{aligned}
 \end{aligned}$$

For cream and milk of the standard analysis equations (A), (B), (C), (D), (E), respectively, are:

(A) $3R + 1 = a$ (adequate cream)

(B) $3.50 - .025(3R - 3) = B$

(C) $3.50 - .025(a - 4) = b$

(D) $\frac{3.50 + 4(.025) - b}{.025} = a$

(E) $4.50 - .025 - (3R - 3) = C$; or, $B + 1 = C$

SERIES IV (B).

For the use of milk and cream of other than standard analysis.

For milk containing 4.00 F per cent., 4.00 P per cent., 4.50 per cent. S—16 per cent. cream and milk—(p = .03).¹⁰

$$\begin{aligned}
 &1. \quad \frac{QP}{3.85} = X \\
 &2. \quad \frac{QF - 4X}{16 - 4} = \text{Cream} \\
 &\quad \begin{aligned} &(a) \quad X - C \\ &QP - 3.64C \end{aligned} \\
 &3. \quad \begin{aligned} &(b) \quad \frac{4}{QS - 4.35(C + M)} \\ &= \text{Milk} \end{aligned} \\
 &4. \quad \frac{4}{100} = \text{Sugar}
 \end{aligned}$$

For cream and milk of other than the standard analysis equations (A), (B), (C), (D), (E), respectively, are:

(A) $3R + 2 = a$ (adequate cream)

(B) $4.00 - .03(3R - 2) = B$

(C) $4.00 - .03(a - 4) = b$

(D) $\frac{4.00 + 4(.03) - b}{.03} = a$

(E) $4.50 - .03(3R - 2) = C$; or, $B + .50 = C$

SERIES V. WHEY-CREAM MIXTURES.

Working Formulas.

For combining 16 per cent. cream, whole milk, fat-free, or 2 per cent. whey.

$$\begin{aligned}
 &1. \quad \text{cas} + \frac{\text{cas}}{5} = P \\
 &2. \quad \frac{Q \left(\text{WhP} - \frac{\text{cas}}{5} \right)}{1} = \text{Whey} \\
 &3. \quad \frac{QP}{3.40} = X
 \end{aligned}$$

9. By the use of equation (a) for milk, the fat-percentage of the mixture is obtained accurately; by the use of equation (b) for milk the proteid-percentage is accurately obtained.

10. According to published analyses the coefficient of proteid-loss increases with increase of the proteid percentage of the milk.

11. If the ratio $\frac{P}{F}$ exceeds 4, employ $\frac{QP}{3.20} = X$.

$$\begin{aligned}
 &4. \quad \begin{cases} (a) \quad \frac{QF - 4X}{16 - 4} = \text{Cream, (with fat-free whey)} \\ (b) \quad \frac{QF - (4X + 2 \text{ Whey})}{16 - 4} = \text{Cream (with 2\% W)} \end{cases} \\
 &5. \quad \frac{QP - 3.20C}{3.50} = \text{Milk} \\
 &6. \quad \frac{QS - 4.40(C + M) + 4.80 \text{ whey}}{100} = \text{Sugar}
 \end{aligned}$$

SERIES VI (A).

For mixtures in which P equals or exceeds F (16 per cent. cream and its separated milk containing 1.23 per cent. F, 3.57 per cent. P, and 4.57 per cent. S).

$$\begin{aligned}
 &1. \quad \frac{QP}{3.55} = X \\
 &2. \quad \frac{QF - 1.23X}{16 - 1.23} = \text{Cream} \\
 &3. \quad \begin{cases} (a) \quad X - C \\ QP - 3.20C \end{cases} \\
 &\quad \begin{cases} (b) \quad \frac{3.57}{QS - 4.57(C + M)} \\ = \text{Milk} \end{cases} \\
 &4. \quad \frac{4.57}{100} = \text{Sugar}
 \end{aligned}$$

SERIES VI (B).

These mixtures may be obtained also by combining whole milk (4 per cent. cream) with fat-free milk. The equations are:

$$\begin{aligned}
 &1. \quad \frac{QP}{3.55} = X \\
 &2. \quad \frac{QF}{4} = \text{Cream (whole milk)} \\
 &3. \quad X - C = \text{Milk (fat-free)} \\
 &4. \quad \frac{QS - 4.57X}{100} = \text{Sugar}
 \end{aligned}$$

PERCENTAGE MODIFICATION IN PRACTICE.

The practical objections to this method for home modification may be grouped under three heads: 1. The number of creams required and the consequent confusion both in the computation and in the preparation of percentage mixtures, since each cream must be computed by a slightly different equation, and different instructions must be given in each case for obtaining by gravity the cream to be employed. 2. The difficulty of keeping in mind the percentages that are indicated for the infant at different ages. 3. The number of modifications to be made, and the time and care that must be given in the case of the normal infant in order to meet the requirements according to the feeding charts.

Occasionally objection is made on the ground of expense. None of these objections is valid; and they rest for the most part on difficulties that do not present themselves in practice. As we have seen, a variety of creams is not necessary; 16 per cent. cream (or any

richer cream) is adequate for all mixtures of cream and milk, and, probably, for all whey-cream mixtures that are indicated; the directions for obtaining by gravity the cream to be employed may be the same always, therefore to be followed throughout the period of substitute feeding; and all mixtures may be computed by a single series of formulas. With a little "practice," the calculation takes hardly more time and less effort than are required to compute a mixture of drugs.

As to the difficulty of remembering the "percentages" that are indicated at different ages, it is not necessary to remember them. Until the child is 10 or 11 months old, at any rate, the ratio of fat to proteids in the mixtures ordinarily to be employed is somewhere between 3 and $1\frac{1}{2}$ to 1; that is, the fat percentage is not more than 3, nor less than $1\frac{1}{2}$ times the proteid percentage (or, the proteid percentage is not less than one-third, nor more than two-thirds the fat percentage). A fat percentage above 4 is not indicated. Since the ratio F to P decreases as the age increases, from 3 to $1\frac{1}{2}$ to 1, one should never be at a loss as to the suitable modification for the infant at any age.

The impression that frequent changes must be made in the quantities of food and in the percentages prescribed is a mistaken one.¹² To be sure, the infant can not be fed properly, as Japan fought her battles in the recent war, by "previous arrangement;" and the physician can not direct the feeding by this, or by any method, without some effort. But, while in the case of the infant with feeble powers of digestion percentage modification gives opportunity for the exercise of great skill in adapting the food to the needs of the individual and to particular conditions, it permits, also, in the case of the healthy child, a considerable degree of routine practice. For example, assuming that the physician directs the feeding from the beginning, the first prescription may call for 16 ounces, 2 per cent. F, 0.70 per cent. P, ten days later the percentages are advanced to 2.50 per cent. F and .85 per cent. P; between the third and fourth weeks, the preparation of 24 ounces, 3 to 3.25 per cent. F and 1 to 1.10 per cent. P, is directed, and at the end of six weeks 32 ounces, 4 per cent. F and 1.50 per cent. P, is ordered. No further changes may be made until the child is four months old, when 40 ounces, 4 per cent. F and 2 per cent. P, may be prescribed. At the end of the eighth month the quantity of food and the percentages are increased to 48 ounces, 4 per cent. F and 2.50 per cent. P, respectively. In this assumed case, six mixtures have been prescribed, two of them within the puerperal two weeks, another two within the next four or five weeks; the increase in the quantity of food required has been provided for in each instance by the addition of 8 ounces to the quantity previously prescribed, the number of ounces to be prepared having been increased successively from 16 to 24, to 32, to 40, to 48. While each of these quantities is larger than the infant requires at the beginning of the period for which it is employed, the excess represents so little value in cream and milk that the actual waste is very small.

Very little saving is made by the use of fat-free or of separated milk, except for the preparation of whey, since materials sufficient for the preparation of the mixtures ordinarily required for infants above the age of 4 or 5 weeks can not be obtained from a quart of milk. Generally it is best that two quarts of milk

should be provided from the outset, one for the supply of the required cream, the other for the supply of the whole milk. Up to the age of 6 or 8 months a pint of milk will furnish a sufficient quantity of the latter. Two quarts of milk a day will not only provide for the infant throughout the period of substitute feeding, but for the infant's family also; that is, the "modified milk" having been prepared, there will be left of the two quarts from 58 ounces (about) of milk, containing 3.33 per cent. of fat, when the child is a month old, to (about) 30 ounces, containing 2 per cent. of fat, when the child has reached the age of 11 months. With milk at 10 cents a quart, the daily cost of the cream and milk consumed by the infant up to the age of about 11 months, ranges from 2 cents at the beginning to 12 cents at the end of the period.

In the use of the percentage method, both in the case of the normal infant in health and of the infant with less than the normal powers of digestion, the limitations in the ratios of fat to proteids compatible with the maintenance of nutrition must be kept constantly in mind. While the infant can not be fed properly by rules, the principle may be laid down that except in certain abnormal, or diseased conditions, mixtures of which the ratio of the fat percentage to the proteid percentage, that is, to the percentage of total proteids, exceeds 3, should not be employed continuously for any length of time at any period, since they do not contain food enough; on the other hand, the use of mixtures of cream and milk of which this ratio is below $1\frac{1}{2}$ taxes the digestive organs needlessly and invites digestive disorders. In whey-cream mixtures containing high percentages of whey-proteids, lower ratios may be employed, though they are seldom indicated.

Substantially every mixture that is required may be obtained by combining 16 per cent. cream, whole milk, fat-free, or 2 per cent. whey; and in practice it is best to make use of these materials only. Whey that is practically fat-free, however carelessly prepared, may be obtained from the milk from which the 16 per cent. cream has been removed. Twenty-six ounces of this milk will yield about 20 ounces of whey, a quantity sufficient for the preparation of any of the whey-cream mixtures that ordinarily are required.

In practice it is seldom necessary to carry the percentage of caseinogen above 1 per cent.; that is, if the infant is able to digest 1 per cent. of caseinogen, together with the associated percentage of whey—proteids, further division of the proteids is not required as a rule.

The fat percentage of the top milk (cream) does not increase materially even if the milk is allowed to "set" long after the cream has risen; the top 6 ounces of a quart of 4 per cent. milk which represents 16 per cent. cream at the end of 8 hours (and the top 4 ounces, which is 20 per cent. cream) will not have increased in fat-value materially at the end of 12 or 14 hours. In the case of 20 per cent. cream the fat percentage increases but 2.5 per cent. in 24 hours.¹³ The thickening of the cream is due almost altogether to the growth of bacteria.

If, therefore, a quart of milk is "set" at 7 o'clock in the morning, 6 ounces of 16 per cent. cream,¹⁴ (or 4 ounces of 20 per cent. cream), may be taken therefrom

13. Holt: "Diseases of Children."

14. The mnemonic "16"—"2" may assist the remembrance of the instructions to be given for obtaining 16 per cent. cream by gravity; thus, 1 quart of milk yields 6 oz. of 16 per cent. cream at the end of $16 \div 2$ (8) hours; its proteid percentage is $16 \div 2$ (8.2 per cent.)

12. This statement refers to the feeding of the normal infant in health.

at any time after 3 o'clock in the afternoon, and preferably before 9 o'clock in the evening. But, of course, the sooner the cream is removed after the full quantity obtainable by gravity has arisen, the more closely it will represent the desired fat percentage in each case. It appears, therefore, that a single variety of cream, which may be 16 per cent. or 20 per cent. cream, serves every purpose; that the required quantities of cream and milk for all the mixtures ordinarily required may be computed by a single series of equations; that for the normal infant but few modifications need be made, the percentages that are indicated at different ages being readily determined by the ratios of fat to proteids required, without having reference to the feeding chart; that the simple instructions to be given for obtaining by gravity the cream to be employed are the same in all cases, to be followed throughout the period of substitute feeding; that the preparation of mixtures of cream and milk presents no difficulties and that even at an advanced price for suitable milk the necessary materials cost very little.

The complexity, and therefore the perplexities, of percentage modifications depend altogether on the use of a variety of creams and of milk of different analyses; if suitable milk is in use, or if the analysis of the milk to be employed is known, the mixtures usually required, at any rate, may be computed by the working equations with substantial accuracy and as readily as mixtures of drugs. If, therefore, modified milk is to be employed as a substitute food for the infant, under the immediate direction of the physician, as all artificial feeding should be, percentage modification furnishes a very simple and a very practicable method for its preparation and its use.

The real difficulty in the way of the scientific method, and of other methods as well, is the lack of suitable milk for the preparation of infant food; and until suitable milk is generally available, the milk-laboratory offers the best solution of the problem. Here and there "baby-milk" is furnished; and always, it is understood, the supply, at largely increased prices, is unequal to the demand that has been quickly created—among the laity; the family physician appears to be content to leave the matter of the milk supply to the average milkman, and the feeding of the infant to the enterprising and insistent manufacturers of patent foods; and the records of infant mortality, ill development, malnutrition and disease, the direct results of imperfect or improper food and feeding, continue to be written.

It is true that the great majority of bottle-fed babies live, and the greater number of them thrive, apparently, in spite of dietetic adversity. They live because they were born to live. Infant mortality is unnatural. And it is not less true that many of these fair, fat babies—all of them are fat—have less than the normal powers of resistance and recuperation; while the less vigorous, or the imperfectly developed, are subject to disorders and diseases which the well-fed infant escapes. The strong survive, for precisely the same reason that the Scotchman survives his diet of oatmeal. But in the case of the feeble infant, and of the dyspeptic infant in particular, health and growth and life, it may be, depend on its having the right food, which is suitable milk, suitably modified.

The production of suitable milk is perfectly practicable; and the effort, even the organized effort, of physicians may well be directed to this end. In view of the diminished and diminishing birth rate in American

families, and of the growing indisposition and inability of the American mother to nurse the baby, the question of artificial feeding has become of vital importance to the community. There is no subject within the domain of medicine, not even the control of tuberculosis, that concerns common interests and the common welfare more intimately. Indeed, tuberculosis is in itself a disease of imperfect nutrition, and to provide for the nutrition of the infant may well be among effective measures for its prevention. It is not unreasonable to believe that the constitution of the individual may be affected in some manner, to some degree, by the character of the food during the period when, normally, the physical development is most rapid.

SIMPLICITY IN INFANT FEEDING.*

CHARLES W. TOWNSEND, M.D.

BOSTON.

The average physician is generally appalled by the mathematics which play so important a part in present-day papers on infant feeding. He either comes to look on infant feeding as in the highest degree a difficult problem, and babies' digestions habitually delicate, requiring complicated formulæ and frequent minute changes in percentages, or he discards all theories in disgust and leaves the feeding of the baby to the mother or nurse, or even resorts to the wares and printed directions of the advertising food manufacturers. Both of these extremes are undesirable.

While there is no doubt that a fairly accurate idea of percentages is of great value in infant feeding, and that the difficult cases can be managed best by keeping these well in view, yet it is perfectly possible for a physician to feed babies successfully without this expert knowledge and to give simple directions for the preparation of the food without the use of formula lists or patent foods.

NEED OF SIMPLE RULES.

It is evident that the simpler the rules and formulæ for making up the daily food of the baby, the less liability will there be for error on the part of the mother or nurse and the easier it will be for the physician to prescribe. It is also reasonable to suppose that the less the milk is manipulated in order to obtain the desired formula the more easily will it be digested by the infant.

The physician who looks on the baby's stomach as a test tube and on the food merely as so much per cent. of different ingredients is apt to disregard every factor but the percentages and to blame the baby and not the food if the former does not thrive. Theoretically the food is right and the baby at fault.

NEED OF STUDYING CASES INDIVIDUALLY.

Some infants thrive on mixtures made up of centrifugal cream and fat-free milk recombined so as to give the theoretical percentages required. But the fact that others do not, and yet will thrive on similar percentages made up of gravity cream, shows that there is something besides chemical percentages that must be considered—some vital characteristic as yet but little understood. In the same way the fact that while many infants thrive on Pasteurized or even sterilized mixtures, yet others grow pale, lose their appetite and develop scurvy, shows that certain characteristics of the milk destroyed or

* Read in the Section on Diseases of Children of the American Medical Association, at the Fifty-seventh Annual Session, June, 1906.