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INFANT MORTALITY AND ITS REDUCTION, ESPECIALLY IN NEW YORK CITY *

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The awakening of the world to a consciousness of the immense sacrifice of infant life is recent. Most of it has come within the last twenty years. It is shown by the convocation of both national and international congresses assembled to discuss the questions associated with these conditions and by the formation of special societies whose purpose it is to affect one or other of the causative factors. It has been accompanied by statistical studies on an extensive scale showing how colossal has been this slaughter of the innocents.

The economic importance of this subject in certain of the European countries, especially Germany and France, has engaged the attention of the governments, and there the question of infant mortality is being studied with great interest. This has been forced on the attention since in all European countries a steadily declining birth-rate is evident. This decline in the last twenty-five years in eleven European countries has been from an average of 33.7 per thousand of population to 30 per thousand, or about 10 per cent. of births. The fall is least in Ireland, Norway and Sweden, and greatest in England, Germany, Italy, Austria and Hungary. No such decline is as yet apparent in this country, owing to the influx of immigrants into our large cities. But for this it would be great, as is indicated in the statistics of rural communities where a marked decline is reported. How great a factor immigration is in maintaining the birth-rate of our cities may be illustrated by comparing different parts of New York City. In the best residential portion, the present birth-rate is 4 per

* Read in the Section on Diseases of Children of the American Medical Association, at the Sixtieth Annual Session, held at Atlantic City, June, 1909.

thousand of population; while in districts occupied chiefly by Italians and Russian Jews it is from 40 to 45 per thousand.

Infant deaths—i. e., deaths under one year—in different places and under different conditions form at the present time in civilized countries from 20 to 25 per cent. of all deaths. Eröss,[1] in 1894, collected data from thirteen European countries for a period extending from 1879 to 1892, the years not being always the same for each country, and found that in a total mortality of 28,660,733 the deaths under one year were 7,708,978, or 26.9 per cent. of all.

Taking the average estimate of many writers, it may be said that, of every 1,000 infants born, one-fifth die during the first year. While the impression prevails that the death-rate in infants has recently fallen considerably, this view is contradicted by some who have given special attention to this subject, by whom it is urged that the fall in the death-curve is simply due to the decrease in the number of births.

In order to arrive at a correct idea of the infantile death-rate, it must be considered from several points of view. I have studied it in several centers of population, but chiefly in New York City, (1) in relation to the total population, (2) in relation to the total death-rate, (3) in relation to births, (4) in relation to the estimated population under one year.

The results of these studies are embodied in the accompanying charts. Chart 1 gives the death-rate for New York City (Boroughs of Manhattan and Bronx) for one hundred years. During this time the population has increased from 91,618 to 2,620,447; and the total deaths per year from 2,038 to 44,061. Thus, while the population has increased 29 times, the total deaths have increased but 22 times. The upper curve gives the mortality for all ages and indicates the city's health for the century. The figures for the earlier years are probably not absolutely correct; but they are taken from official sources and are the best obtainable.[2]

Beginning with a death-rate of about 22 per thousand, an irregular but steady increase is seen up to about 1866, when the general rate was about 35 per thousand; in exceptional years it was much higher than this. From

1. Eröss: Archiv. f. Kinderh., 1894, ix, 249.

2. Documents of the Board of Aldermen, 1809-1842, were chiefly used for early New York records.

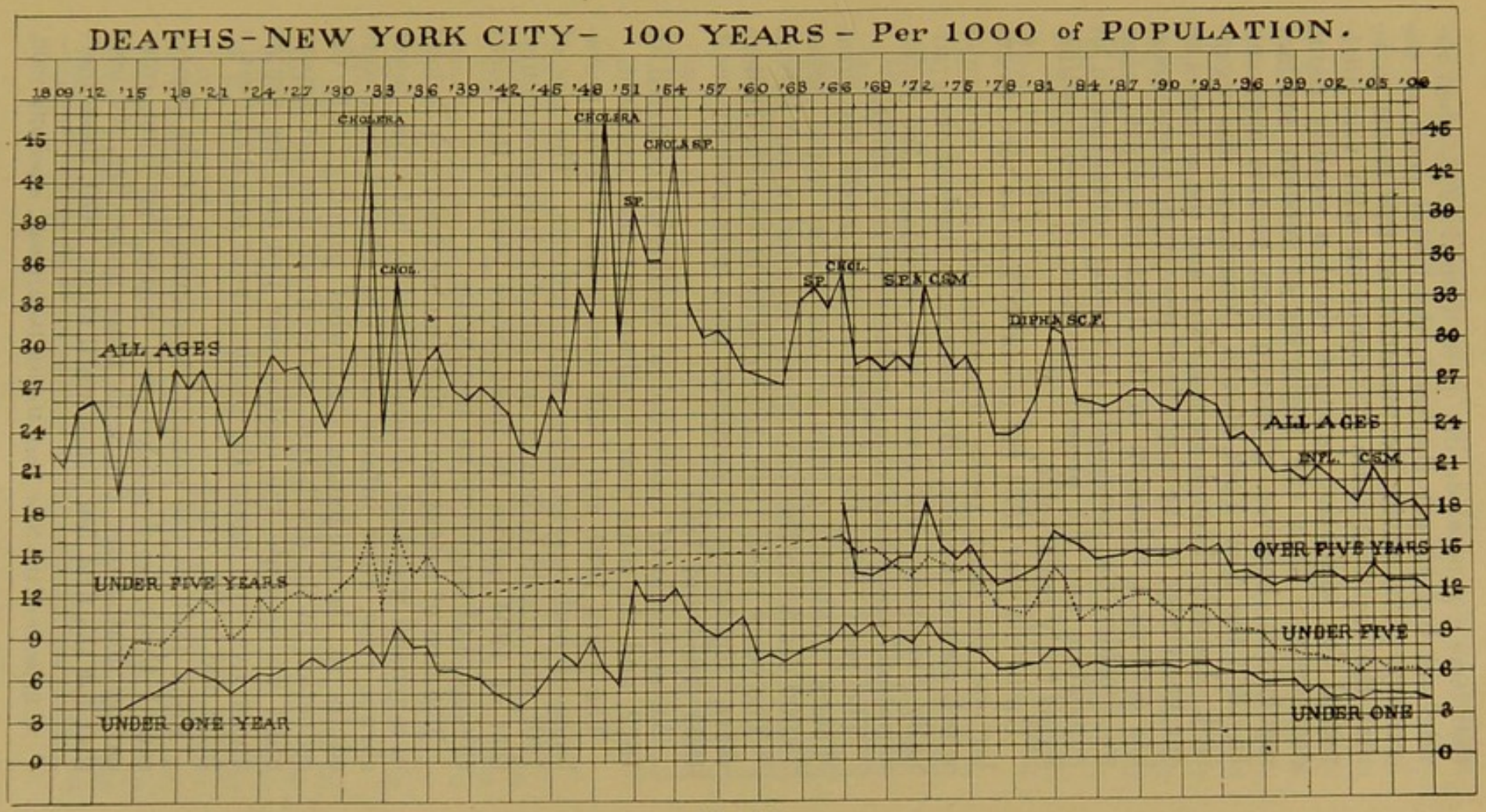
DEATHS - NEW YORK CITY - 100 YEARS - Per 1000 of POPULATION.
1809 '12 '15 '18 '21 '24 '27 '30 '33 '36 '39 '42 '45 '48 '51 '54 '57 '60 '63 '66 '69 '72 '75 '78 '81 '84 '87 '90 '93 '96 '99 '02 '05 '08
45 42 39 36 33 30 27 24 21 18 15 12 9 6 3 0
CHOLERA
CHOLERA
CHOLASP.
SP.
CHOL.
SP.
CHOL.
SP & CSM
DIPHA SCF.
ALL AGES
ALL AGES
ENT. CSM.
OVER FIVE YEARS
UNDER FIVE YEARS
UNDER FIVE
UNDER ONE YEAR
UNDER ONE

Chart 1.

that time a general decline is seen until 1908, when the rate was but 17 per thousand, the lowest point in the century. The obvious explanation of this seems to be that the rapid increase of population with very little regard for sanitation brought about a steadily rising death-rate. With the beginning of modern sanitary regulations, however, a change soon became apparent. In 1866 the New York Health Department was organized. Largely through its activities and the advances in our knowledge of the methods of preventing disease there has ocurred a reduction in the death-rate which, when we consider the constantly increasing concentration of population and the present condition of overcrowding, seems truly remarkable.

Up to the year 1854 the mortality line is a very irregular one, the sharp peaks indicating the great epidemics which visited the city. But these wide fluctuations gradually disappear, and since 1882, especially, the yearly variations are within comparatively narrow limits.

The year 1832, the first great rise, marks the great cholera epidemic; a similar one to-day would mean 35,000 deaths in the boroughs of Manhattan and Bronx.

The years 1834, 1849, 1854 and 1866 were also cholera years. Epidemics of smallpox were witnessed in 1849, 1851, 1854 and 1865.

An epidemic of cerebrospinal meningitis occurred in 1872, and the same year smallpox was also prevalent.

The years 1881 and 1882 were years of great prevalence of both scarlet fever and diptheria. The rise of 1901 was due to influenza and complicating pneumonia; that of 1904 marks the most severe year of the recent epidemics of cerebrospinal meningitis.

The line of infant mortality (under one year) follows in a general way that of total mortality, but shows fewer abrupt rises, since infants were less affected than were adults in the epidemics. At what period of life the reduction in the death-rate has occurred does not appear until we separate the deaths over five and the deaths under five, and again the deaths under one and deaths from one to five years.

From 1866 to the present the accuracy of the figures can, I think, be depended on.[3] Since that time, comparing deaths over five with those under five, we note that for the first few years, until about 1870, these mor-

3. Reports of the New York Health Department, especially 1906.

tality lines repeatedly cross each other, indicating that at that time half the total deaths, some years even more, were in children under five. A gradual divergence of these two curves is noted from this period. There is a slight fall in the line for over five years, but a very marked one in that for under five years. In 1908, at the end of the period, the death-rate under five is only half that over five, or one-third the total. Since 1866 the death-rate over five has fallen from 18.4 to 11.2 per 1,000; that under five has fallen from 16.4 to 5.8 per 1,000. It is, therefore, with children under five that the principal reduction in the death-rate has occurred.

Separating now the deaths under one year and those from one to five years, we find that a slightly greater

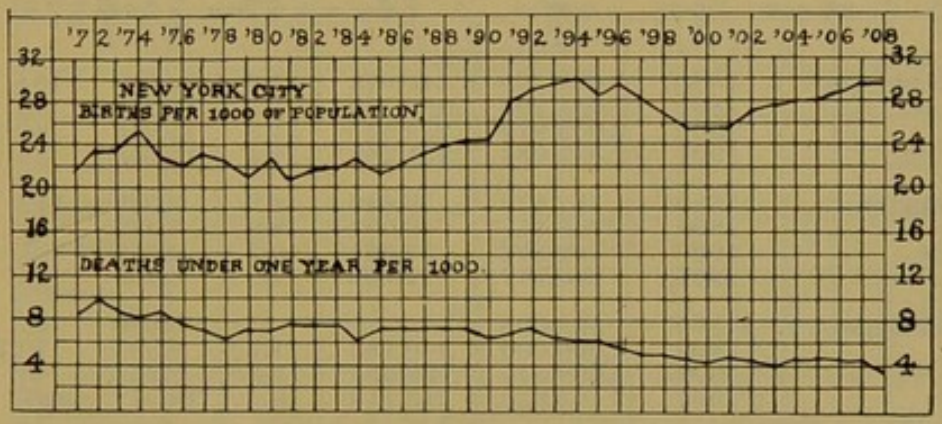

Chart 2.

reduction has occurred in the latter than in the former group. The death-rate for children under one has fallen from 10 to 3.8 per thousand; that from the ages one to five has fallen from 6.3 to 1.9 per thousand. In proportion to the population, therefore, the mortality for these ages is approximately one-third what it was about fifty years ago.

But since those who doubt the fact of a reduction in infant mortality argue that these figures are only one result of a declining birth-rate, there is shown in Chart 2 a comparison of the births per thousand of population for the same period. The birth-line shows an irregular but steady rise for the period. This is not, however, wholly to be trusted. The registration of births in New York City is by no means as uniform as are the death reports, or as the birth records of many European cities.

The Registrar of Vital Statistics of New York estimates that for the early part of the period under consideration only about 70 per cent. of the births were recorded, while at the present time only about 92 per cent. are recorded. Even making this correction, we have a birth-line which tends slightly upward, to compare with a death-line which tends steadily downward. The rise in the birth-curve is due, as already mentioned, to the great influx of foreign population.

TABLE 1.—STATICS OF POPULATION AND DEATH-RATE OF CHILDREN IN VARIOUS LARGE CITIES

City.	Year.	Population.	Population under 5 yrs.	Per cent. of Children to population.	Deaths under 5 years.	Deaths under 5 yrs. per 1,000 of population under 5 yrs.
New York..	1880	1,209,268	140,673	11.6	14,650	104
	1890	1,631,232	189,760	11.6	16,305	85
	1900	2,053,979	233,537	11.3	15,646	66
	1907	2,541,084	291,208	11.4	15,645	53
Boston	1880	362,839	29,649	8.2	3,349	112
	1890	448,477	40,001	8.9	3,349	83
	1900	560,892	57,361	10.2	3,752	65
	1907	609,757	72,166	11.8	3,160	43
Chicago ...	1880	503,298	.....	....	5,639	95
	1890	1,200,000	140,783	11.7	9,954	70.7
	1900	1,698,575	190,355	11.2	8,282	43
	1907	2,107,620	213,713	10.1	10,077	47
Philadelphia.	1880	846,980	91,544	10.8	6,594	72
	1890	1,046,964	103,847	9.9	7,913	76
	1900	1,293,697	.....	....	8,078	...
	1907	1,500,596	147,988	9.8	7,669	51
London	1880	3,771,139	497,044	13.1	36,220	72
	1891	4,221,452	501,558	11.8	33,340	66
	1900	4,589,129	546,570	11.9	31,139	56
	1905	4,684,794	518,794	11.0	24,838	47
Paris	1880	2,239,938	148,601	6.6	17,159	115
	1891	2,424,705	150,490	6.1	14,048	93
	1900	2,511,629	.....	....	8,966	...
	1905	2,722,731	170,694	6.6	8,617	50.4
Berlin	1880	1,123,749	183,060	16.2	19,249	105
	1890	1,579,524	164,370	10.4	17,630	107
	1900	1,864,203	.....	....	15,498	...
	1907	2,096,318	183,441	8.8	10,833	59
Vienna	1880	721,016	58,023	8	8,219	141
	1891	1,378,530	130,808	9.4	15,610	110
	1900	1,656,662	160,233	9.6	13,650	85
	1905	1,897,630	213,884	11.2	13,282	62

Precisely the same result is shown if we take another standard of comparison, viz., the deaths under one year and the population for this age. The records for the population under one year are available since 1888.

These are derived from the actual enumeration in census years and are estimated for the intervening periods.

In 1888 the deaths under one year were 10,411, or 24.4 per cent. of the estimated population under one year. In 1908 the deaths under one year were 10,073, or 15.1 per cent. of the estimated population under one year.

The evidence seems, therefore, conclusive that during the period of the last twenty-five to thirty years there has been in New York a very great and steady reduction in the mortality of infants and young children, that this has been both relative and actual, and that the actual mortality is now only about one-half what it would have been had the old conditions prevailed.

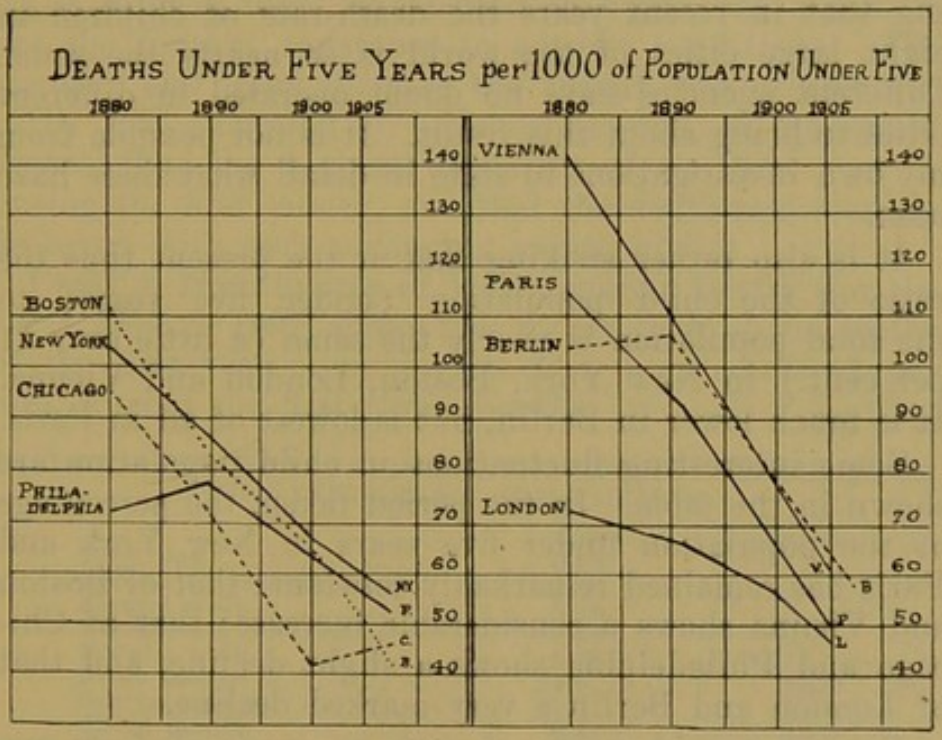

Chart 3.

Similar conditions have been found to exist, but to varying degrees, in all the other large cities which I have studied—Chicago, Philadelphia, Boston, London, Paris, Berlin and Vienna. Table 1 gives for these cities since 1880 the variations in the total population, in the child population (under five years), the deaths under five, and the deaths per thousand of child population.

The most significant figures in the table are those indicating the change in the death-rate of children compared with the child population in the period studied. This is graphically shown in Chart 3.

The figures for deaths under one year were not available for all the cities hence I have used those of deaths under five years for the comparative study. This is quite proper, since the deaths under one year bear everywhere a fairly constant relation to the deaths under five; i. e., two-thirds, or 66 per cent. They are very slightly less than two-thirds the total for the beginning of the period and slightly more than two-thirds the total for the latter part of the period. In other words, the fall in the death-rate from one to five years has been slightly greater than that under one year.

Such a correspondence in results in all these different places is too close to be accidental. It is certainly striking that in recent years the death-rate of children in eight large cities of the world is so nearly the same. Different agencies have no doubt operated in different cities to bring about this result. It is not possible from my own investigations to state in detail what these have been.

It is also rather striking that at the present time the ratio of the child population (under five years) to the total population is nearly the same (a little over 11 per cent.) in New York, Boston, London and Vienna. It is much lower in Berlin, but is lowest of all in Paris.

Some interesting fluctuations in child population are shown in the table. In the period taken, the percentage of the population under five years in New York and Paris has remained remarkably constant; that of Boston and Vienna shows a considerable increase; that of Chicago and Philadelphia shows a slight decline, and that of London and Berlin a very marked decline.

From a consideration of such an array of facts one might be inclined to think that the problem of infant mortality was being satisfactorily solved, and that we might devote our attention to things of greater importance. Far from it! The struggle is only fairly begun. In the Boroughs of Manhattan and Bronx alone more than 10,000 infants, over 15 per cent. of our entire population under one year, are dying every year. If any epidemic disease, an earthquake or other calamity, should cause anything approaching such a loss of life, the city would be stirred from one end to the other. Yet this thing happens, not once, but every year. Its recital falls on deaf ears. It is an old story. Most persons, I fear, have come to accept it as inevitable. But what has

been accomplished already gives only a suggestion of what is possible.

All the advances in modern medicine have, after all, done very little to reduce adult mortality. It is true that cholera and smallpox have been practically eliminated, that typhoid has been curbed and tuberculosis reduced, but pneumonia, cardiac disease and Bright's disease are steadily increasing. Adult deaths are inevitable, but infant deaths are very largely preventable, and herein is the hopeful sign of this problem.

CAUSES OF INFANT MORTALITY.

The most fundamental cause of high infant mortality is infancy itself, the period in which the organism has the feeblest resistance to adverse conditions. The younger and more delicate the infant, the greater the perils that surround it. Hence we find, as we would expect, that the highest mortality of the first year is during the first month, and that the death-rate steadily decreases with each advancing month of life.

Chart 4, from figures of Westergaard,[4] Berlin, for the years, 1893 to 1897, shows that 25 per cent. of the deaths of the first year occur in the first month and 47 per cent. during the first three months.

TABLE 2.—PERCENTAGE OF DEATHS UNDER ONE YEAR FOR THE DIFFERENT AGE PERIODS

	London.	Berlin.
First day	9.64	....
Second to seventh day	11.09	....
Second week	5.08	....
Third week	4.98	....
Fourth week	3.78	....
First month	34.6	25.3
Second month	11.4	11.3
Third month	8.4	10.4
Fourth month	6.9	8.7
Fifth month	5.9	7.7
Sixth month	5.25	6.9
Seventh month	5.20	6.3
Eighth month	4.8	5.7
Ninth month	4.7	5.2
Tenth month	4.5	4.7
Eleventh month	4.2	4.2
Twelfth month	4.1	3.8

In Table 2 these Berlin figures are compared with those of London[5] for 1907. They correspond in a very striking manner. The London figures, moreover, indicate how large a part of the first month's mortality is in the first week. This group, which forms over 20 per

4. Pfaundler and Schlossman: Diseases of Children; American Translation, i, 294.

5. Reports of the Registrar-General, London.

cent. of the deaths of the first year, is largely made up of hopeless cases.

Brothers,[6] writing in 1896, is authority for the statement that in four years, 1889-1892, there were recorded 173,126 births. During the same period there were 16,888 deaths within the age of one month, not including premature births. Making the estimated correction for the incompleteness of birth returns already referred to, it would appear that at that time about 8 per cent. of children born did not survive the first month.

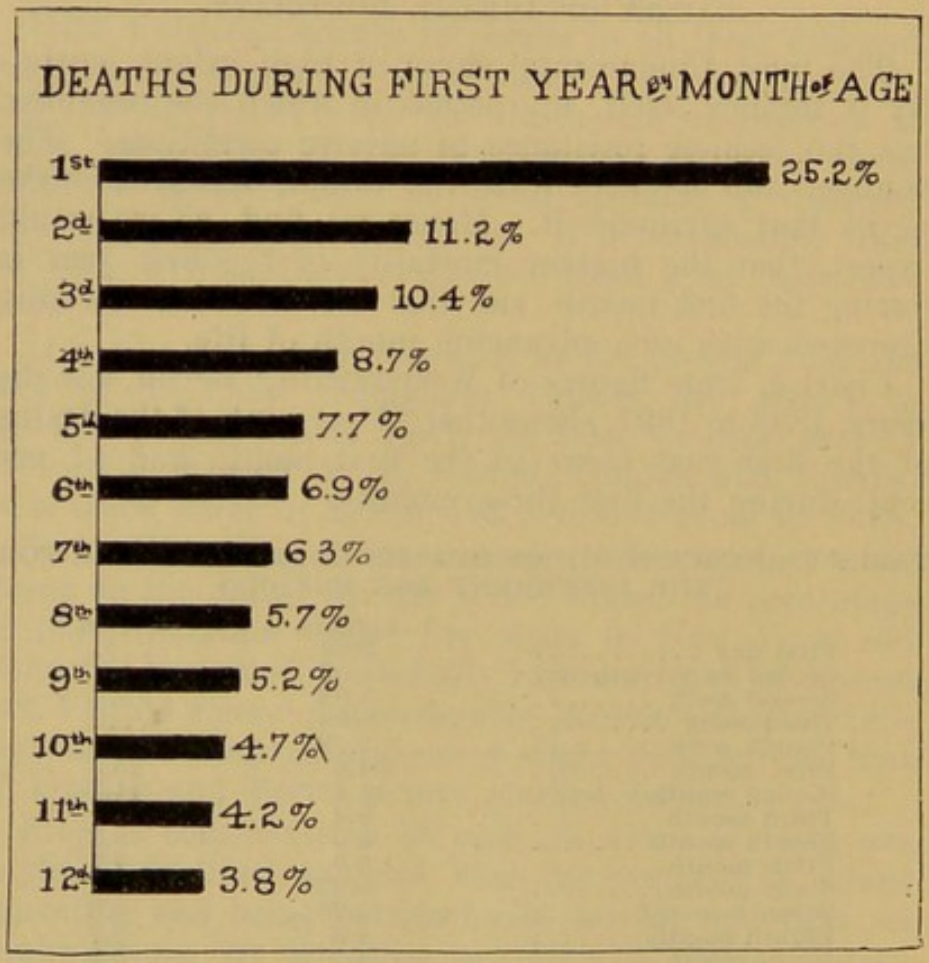

Chart 4.

Eröss[1] in 1894 gives even higher mortality figures for the first month. From figures collected from sixteen large European cities, including 1,439,056 births, he states that 9.5 per cent. died during the first four weeks, and that during this time the number of deaths was as great as in the remainder of the first year. A great reduction in the mortality of this month has been

6. Brothers: Infant Mortality During Child-Birth and Its Prevention, 1896.

brought about since the time of which he wrote by the general introduction of aseptic methods in obstetrics, sepsis in the new born being once a common cause of death.

A certain proportion of infants born die because of premature birth, or a feebleness at birth too great to support an independent existence. Alcohol, vice, syphilis and some other forms of inherited disease are factors of considerable importance in the production of these conditions. Again, there occur certain malformations of heart, intestines or brain which are incompatible with normal development or even with life. A certain number of infants perish from unavoidable accidents at birth. But these combined groups of the cases which might be called hopeless probably make up not more than 25 per cent. of the total.

The loss of infant life is, in large measure, due, not to inherited disease, malformations, or congenital feebleness, but because of the failure to furnish the proper conditions not only for healthy growth, but even for life itself. These conditions are proper food, suitable housing and intelligent care. Most infants die primarily, therefore, not from inherent causes, but from accidental and, therefore, preventable ones.

The fundamental causes of infant mortality, as we may call them, are mainly the result of three conditions—poverty, ignorance and neglect. As direct results of poverty we have bad housing and overcrowding in cities, the necessity for mothers to work both late in their pregnancy and very soon after confinement, insufficient food to nursing mothers, improper food for children deprived of mother's milk and the inability to escape the consequences of bad surroundings, such as excessive heat in summer or cold in winter. Ignorance of the simple facts of hygiene and feeding in those to whom the care of such children is intrusted is a factor of immense importance, quite as disastrous in its consequences as is the use of bad milk or other improper food. Neglect may be due to intemperance or vice in the parents, but often is one of the results of poverty.

Infant mortality is much greater everywhere in cities than in the rural districts; but it is not the mere fact of city residence, but because in cities are combined all the other important conditions which cause a high infant mortality. The death-rate, therefore, does not depend

on the size of the city, but on the hygiene, sanitation and the character of the population.

The following figures are from the U. S. Census of 1900, and give the death-rate of infants under one year per thousand births.

New York State	159.8
New York City	189.4
Nashua, N. H.	261.0
Lowel, Mass.	275.5
Fall River, Mass.	304.7
Mobile, Ala.	344.5
Savannah, Ga.	387.5
Charleston, S. C.	419.5

Density of population is, therefore, only one of many causes affecting the infant death-rate. Nashua, Lowell and Fall River are typical factory towns, but not large ones. A similar very high death-rate is seen in factory towns in England. The excessively high death-rate of the Southern cities is doubtless explained by the large colored population. While in general the figures above given point the truth, they should not be too implicitly believed. Conditions are certainly bad, but I do not think they are so bad as indicated, for the reason that in most of our cities and towns the registration of births is notoriously imperfect, while that of deaths is usually reliable.

All who practice medicine among children and all who study the question of infant mortality statistically are struck with the marked contrast between the death-rate of the children of the poor and those of the rich. Clay estimates that in England in the aristocratic families the mortality of the first year is 10 per cent; in the middle class, 21 per cent; in the laboring classes, 32 per cent. This difference in the infant mortality of the various classes is most striking in the case of acute intestinal disease. Halle states that of 170 deaths from this cause investigated in Graz in 1903 and 1904 there were 161 among the poor, 9 among the well-to-do, and none among the rich. It may not be true in adult life, but in infancy money may purchase not only health, it may purchase life, since it puts at the disposal of the infant the utmost resources of science, the best advice, the best food and the best surroundings for the individual child. To relieve, or even greatly to diminish, infant mortality these basal conditions of modern city life—poverty and ignorance—must be attacked.

HOW THE CAUSES OPERATE

Having glanced at the fundamental or primary causes it is interesting in the next place to see how these operate in causing the deaths of infants. This would be a comparatively simple matter if the actual cause of death in each child under one year were known. But mortality records are not so complete as one could desire for such a study as we are making. The return made to the health department often covers only the last thing which happened to the child; the real causes which are back of this terminal condition cannot be ascertained

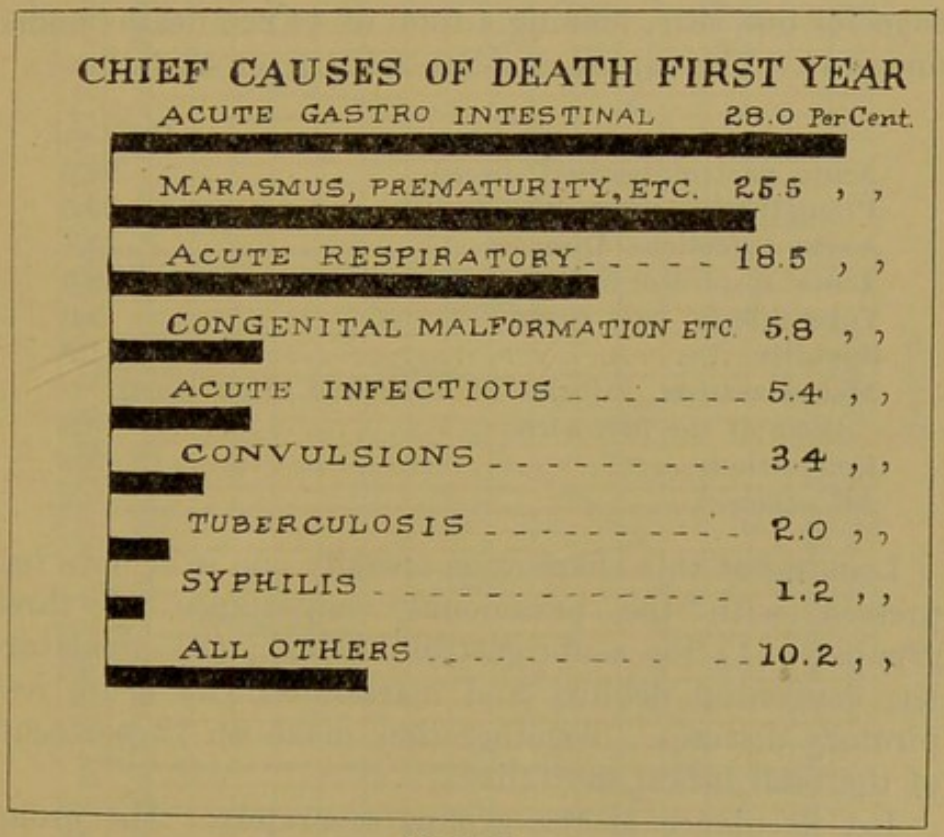

Chart 5.

from the records. Thus, a death is recorded as due to acute diarrhea in summer, but the facts very often are that a condition of malnutrition or marasmus with disturbed digestion due to improper feeding had existed for weeks or months before the final two or three days of acute illness, and were the real important factors. It is not easy from the classification made in the records of vital statistics to get at these fundamental causes which we are now seeking, for we wish to learn not what the last illness chanced to be, but why it was that the child succumbed to that particular acute disease.

Again, death certificates are of necessity accepted from a great number of persons who possess very indifferent qualifications for correct diagnosis, and many faulty ones are thus recorded from which one must be careful in drawing inferences. Bearing in mind, however, the foregoing points, much information can still be gained from a study of the causes to which death in infancy is ascribed in the records of our cities.

In Chart 5 are represented the most important groups making up the mortality of the first year in cities generally, combining the records of New York and Philadelphia for two years, Boston for three years and Chicago for one year, making a total of 44,226 deaths under one year. The causes of death were given as follows:

	Per Cent.
Acute gastrointestinal disease	28.0
Prematurity, congenital debility and marasmus.	25.5
Acute Infectious Diseases	5.4
Acute respiratory diseases	18.5
Tuberculosis (all forms)	2.0
Syphilis	1.2
Malformations, injuries at birth and other conditions of the new-born	5.8
Convulsions	3.4
All others	10.2

Looking at this chart even casually one is at once impressed with the paramount importance of three groups: (1) the acute gastrointestinal; (2) prematurity, congenital debility and marasmus; (3) acute respiratory diseases. Together they make up 72 per cent. of the total infant mortality.

Let us glance at the groups separately. The group "acute gastrointestinal disease" is the largest and is so in nearly every large city in the temperate zone. The percentage of deaths from this cause is considerably higher in Chicago and Philadelphia than in New York, while in Boston it is lowest of all. The curve of diarrheal diseases is so important that it practically controls the curve of infant mortality. This group embraces acute gastritis, gastroenteritis, all forms of acute diarrhea, dysentery and chlorea infantum and makes up the largest part of the immense summer mortality. It is these diseases which cause regularly each year the sharp rise in the death curve in July and August.

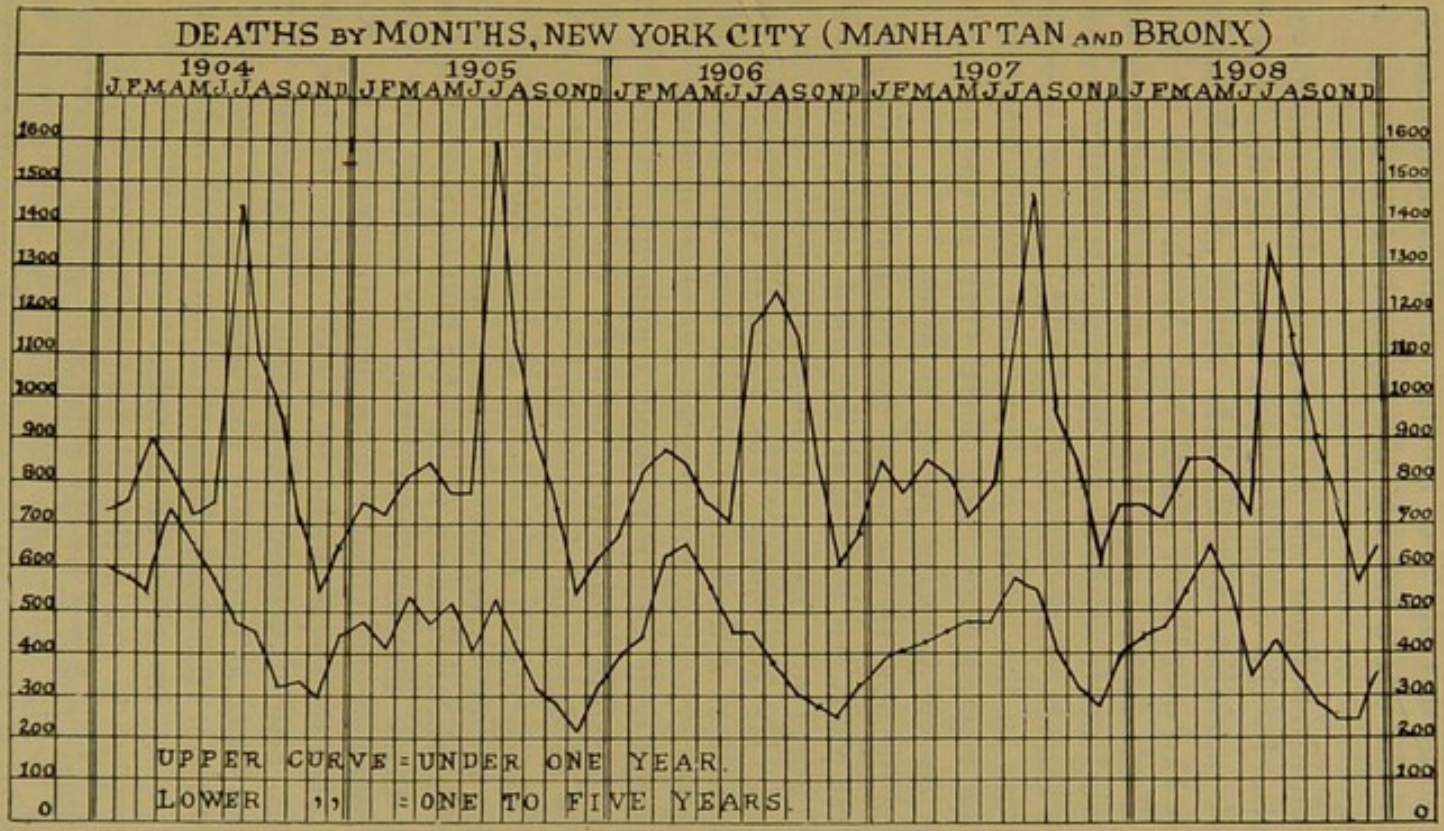
DEATHS BY MONTHS, NEW YORK CITY (MANHATTAN AND BRONX)
1904
1905
1906
1907
1908
J F M A M J J A S O N D
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
UPPER CURVE = UNDER ONE YEAR.
LOWER " " = ONE TO FIVE YEARS.

Chart 6.

Chart 6 shows the deaths in New York City for the past five years by the different months in infants under one year and in children from one to five years. The regularity of the summer rise is very striking. It is most acute during the month of July and most frequently the curve touches the highest point during that month.

In children from one to five years old, no such summer rise in the death curve is seen. At this age the highest mortality is in the late winter and early spring, usually the months of March and April. This is due in New York to the prevalence of acute respiratory diseases and acute contagious diseases, especially measles.

The curves show for both ages the lowest mortality each year in the month of November, which may, therefore, be regarded in New York City as the healthiest month in the year for young children.

Turning now to the acute gastrointestinal diseases of the first year, we note that the most important underlying causes are three: atmospheric heat, method of feeding, city residence. The scope of this article does not permit of a discusssion of the ways in which a high atmospheric temperature causes diarrheal diseases. The fact is too well known to need argument. There is the closest possible connection between the frequency and fatality of diarrheal disease and methods of feeding. Hope of Liverpool has shown that in 1,000 breast-fed infants under three months there were only 20 deaths from diarrheal disease; while of 1,000 bottle-fed infants under three months there were 300 deaths. Of 1,000 fatal cases of diarrheal disease investigated by the New York Health Department in 1908, only 90 had previously been entirely breast-fed. Newsholme gives almost identical figures for England, viz.: 10 per cent. of deaths from diarrheal disease in breast-fed infants and 90 per cent. in bottle-fed infants.

But that is not artificial feeding *per se* which is to be blamed is shown by the relatively small proportion of deaths in the artificially fed that are seen among the well-to-do. Among the poor it is not simply the method of feeding which is responsible for the results, but the other conditions which are apt to accompany such feeding, such as bad surroundings, lack of maternal care (many of these children are illegitimate) and even gross neglect. Besides, we must reckon with bad milk or other

improper food and, even when the milk-supply is good, bad methods of feeding due chiefly to ignorance. Among the most common mistakes may be mentioned: the giving of proportions of milk quite unsuitable to the infant's age or condition; the use of the large bottles filled and placed in the crib beside the infant, allowing him to take as much as he wants and when he wants it, hot or cold; the general habit of overfeeding and of feeding the child every time he cries; the use of dirty nipples and bottles; the giving of unsuitable articles, such as tea, beer, etc., to young infants; the practice of giving solid food to infants a few months old, and the failure to make proper changes in the food for slight disturbances of digestion, which in consequence are very likely to become serious.

At the Babies' Hospital it is a common experience in summer to have children brought for admission with diarrheal disease so desperately ill that they survive but a few hours, and to learn on inquiry that the child had been sick for one or more weeks, that no change in the food had been made and no medical advice had been sought until the day of admission to the hospital, and that the first physician who saw the child referred it at once to the institution. Up to that time the mother had usually depended on the advice of friends. Not until alarming symptoms had developed was the case deemed of sufficient importance for outside aid to be sought. It is my own belief that ignorance in feeding causes quite as many deaths as bad milk. But ignorance in matters of feeding is by no means confined to the poor. Even the best milk, badly handled in the home and improperly fed, is capable of doing great harm.

City residence is an important factor in the production of diarrheal disease. In proportion to the population there are three times as many deaths from diarrheal diseases in the cities of New York State as in the rural districts. But in some of the smaller factory cities, Troy, Cohoes and others, the mortality is higher than in New York City, showing that other unhygienic conditions may be even more important than density of population.

Owing to the difference in classification adopted by different cities, it is not possible to separate accurately the various factors which we have combined in the second group, viz.: prematurity, congenial debility, maras-

mus and inanition. They have been grouped together since they have this in common, that death is the result of a condition of feeble vitality or failure of nutrition rather than some local or general disease.

Prematurity is not classed separately in New York City or in Boston; but statistics for New York State for 1907 and 1908, Philadelphia for 1907, Chicago for 1906, Washington, D. C., for 1906 and London for 1907, combined, show that in a total infant mortality of 81,680 there were 13,757 cases, or 16.8 per cent., in which prematurity was recorded as the cause of death. This is, therefore, a factor of the first importance, since it is apparently the cause of about one-sixth the deaths of the first year.

Dr. G. H. Ryder has furnished me with some statistics regarding the frequency of premature births from the Sloane Maternity Hospital. In 10,000 consecutive births in that institution 7.5 per cent. were classed as premature; i. e., 8½ months or less, and of a viable age. In the homes of the poor such children rarely survive. They are the most infantile of all infants and require special care and feeding and the most favorable hygienic conditions if they are to be saved.

In the second part of this great group, figuring in statistical tables as marasmus, malnutrition, congenital debility, inanition, etc., death is due in part to faulty hygiene and care, but still more to the manner of feeding. The manner of feeding is, therefore, a factor of the first importance in infant mortality. Artificial feeding is the chief etiologic factor in these first two groups, which taken together make up 53.5 per cent. of the total mortality of the first year.

The extent to which artificial feeding is practiced in New York City at the present time is a subject on which it is difficult to obtain exact information. From data collected through various agencies, the Health Department estimates that at present about 85 per cent. of the infants in New York are breast-fed and about 15 per cent. are bottle-fed. These data are gathered chiefly from the tenement districts and seem to me rather low for the artificial fed. I believe that, for the entire population, 18 to 20 per cent. would be nearer the truth.

The difference in the mortality of these two classes is most striking. The Health Department estimates that 85 per cent. of all infantile deaths are in those artifi-

cially fed. This statement is borne out by figures drawn from other sources. Tyson states that of 150,000 infantile deaths in Great Britain 75 per cent. were in those who were artificially fed. Kober states that of 54,047 infantile deaths investigated at home and abroad with reference to feeding 86.6 per cent. were artificially fed. In Munich the mortality in breast-fed infants is stated to be 15 per cent., while in bottle-fed infants it is 85 per cent. In Würtemburg the mortality of breast-fed infants is placed at 13 per cent.; that of those artificially fed at 42 per cent. The whole question may be summed up in a few words:

Breast-feeding requires but little experience and may be very successfully done even by those with a very low grade of intelligence and among the poor; but artificial feeding is not successful unless carried on with much intelligence and experience and at the same time with a certain amount of money to secure reliable materials, especially pure milk.

The child's nutrition, dependent largely on the manner of feeding, affects profoundly the mortality from every form of acute disease. Deaths attributed to convulsions are almost all of them in children artificially fed. It is easy to see, therefore, why it is that the kind of feeding is so important a factor in mortality figures.

Turning now to the acute respiratory diseases, especially bronchitis and pneumonia, we note that deaths from these causes form 18.5 per cent. of our infant mortality in the four cities considered. The percentage is considerably higher in New York and Chicago than in Philadelphia and Boston. That the percentage of New York is higher than other cities is, I think, to be explained in part by the greater congestion of our population. Overcrowding affects to some degree all diseases, but much more those of the respiratory tract—bronchitis, pneumonia and tuberculosis.

Recently an infant was admitted to my wards in the Babies' Hospital suffering from his third attack of pneumonia within a few months. It was learned that he was one of a family of ten, all living in a single room. Such overcrowding inevitably leads to a great increase in acute respiratory diseases in the winter. Fuel is scarce and expensive and doors and windows are kept tightly closed to keep out the cold. No such thing as ventilation exists. Then it is that all the evil effects of

overcrowding are intensified. The spread of common colds and influenza is certain. When neglected or when proper care or treatment is impossible, these quickly lead to severe bronchitis and pneumonia. It is the infants who feel most keenly the effects of such unfavorable conditions, since they are continually subjected to them, besides being the most susceptible members of the household.

The subject of influenza is one which deserves something more than passing mention. Ever since the general epidemic of 1891, it has prevailed regularly every winter season. Although it appears as an insignificant factor in mortality tables, it is one of major importance. In the Babies' Hospital during the past winter cultures were taken from throats of nearly all cases of severe bronchitis and pneumonia during life and from the lungs after death, and it was exceptional to find a protracted case of either of these diseases which was not complicated by influenza infection. Aside from its association with diseases of the lungs, influenza plays an important part in the production of diseases of the upper respiratory tract, the nasopharynx, ears, mastoid, etc.

The importance of acute respiratory diseases as a factor in infant mortality has greatly increased during recent years. Chart 7 gives a comparison between the mortality in New York City from bronchitis and pneumonia and that from diarheal diseases since 1880. The curve for diarrheal diseases shows a steady decline, that for acute respiratory diseases quite as regular a rise. For this increase the prevalence of influenza is, I believe, largely responsible. For the first three years of this period the deaths from diarheal diseases for Manhattan and Bronx were more than twice as many as the deaths from bronchitis and pneumonia. A gradual approximation of these curves is seen until in 1902 the deaths from acute respiratory diseases exceeded those from acute gastrointestinal diseases in 1903. If this tendency had continued, in a short time acute respiratory diseases would have taken first place in the infant mortality figures. During the years 1907 and 1908, however, the curve for intestinal diseases again rises, while the curve for respiratory diseases declines. The reason for this is not quite apparent unless it is that the gospel of fresh air which has been so vigorously preached is beginning to bear fruit.

It is my belief that the figures for tuberculosis given in the mortality tables of the different cities do not represent the part which that disease plays in infant mortality. The mortality figures of the Babies' Hospital for ten years show that in that institution 5.6 per cent. of the deaths under one year were from tuberculosis, or nearly three times as many as the proportion in New York or in the four cities combined. This difference I believe to be only a consequence of more accurate diagnosis in the hospital. There is no doubt that much infantile tuberculosis is overlooked in general practice. The city figures show a very considerable number of cases diagnosticated "simple meningitis," nearly all of

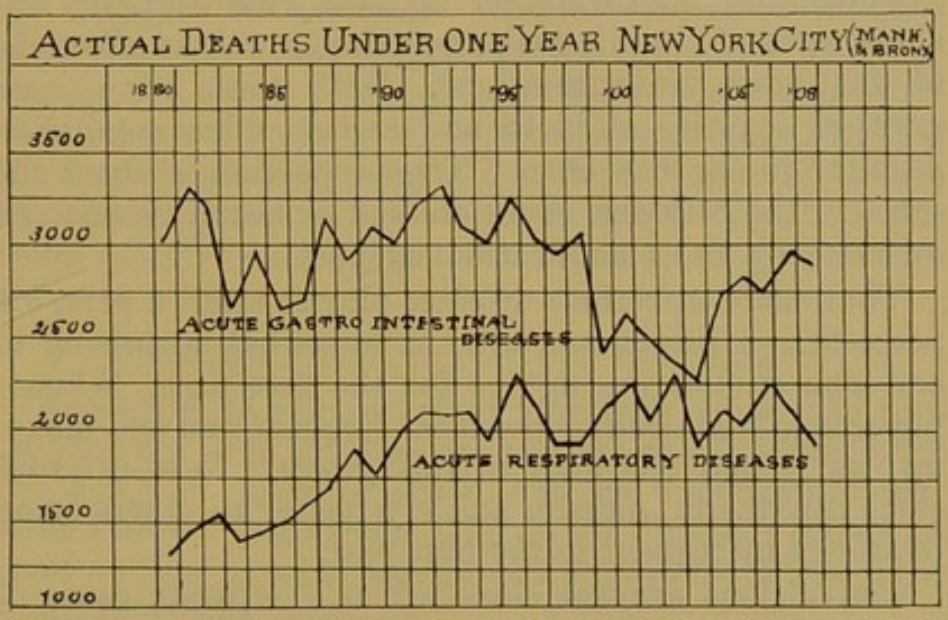

Chart 7.

which are surely tuberculous. Again, the tuberculin tests employed in the hospital and the careful search for tubercle bacilli show many pulmonary cases to be tuberculous, which in outside practice are regarded as cases of simple bronchopneumonia. These facts have operated to reduce the percentage of hospital deaths from non-tuberculous acute respiratory diseases to 15.3 per cent., while in the cities generally it stands at 18.5 per cent. The hospital figures I believe to be fairly representative of the frequency of tuberculosis in infancy, since in most respects other than those mentioned they are in substantial agreement with mortality figures of the city as a whole.

The prevalence of tuberculosis is closely associated with overcrowding and insanitary dwellings. The exciting cause in infants is usually exposure to adult cases of pulmonary tuberculosis. It is to the sick father, mother or other member of the household that the care of the baby usually falls when the healthy members of the family are away at their work. Such close contact usually leads to infection of the infant. To such exposure we have been able to trace definitely nearly one-half of the cases of tuberculosis in infants admitted to the Babies' Hospital in recent years, and it certainly existed in a very much larger number than we were able to demonstrate it.

Congenital malformation in most vital statistics include cases of chronic hydrocephalus as well as affections of the heart, intestines, etc. With these have been grouped injuries at birth and certain other conditions peculiar to the new-born. The proportion is about the same in the different cities studied as nearly as one can estimate by the classification adopted.

That acute infectious diseases play so small a part, 5.4 per cent., in infant mortality is somewhat surprising to one who studies the figures for the first time. Whooping-cough is altogether the most frequent one and makes up nearly half the total in this group. Next in order come diphtheria, measles and erysipelas, all others being relatively infrequent in the first year.

Convulsions are not classified as a separate cause of death in some of our cities, e. g., in Boston. They should not be in any. Many of the cases so classed belong in the acute diseases of the gastrointestinal tract, others are doubtless instances of status lymphaticus, tetany or tuberculous meningitis.

Syphilis is put down as causing 1.2 per cent. of the deaths. The figure is so nearly the same in all the cities that it ought perhaps possibly to be accepted. But syphilis is responsible for many deaths which go down in records as due to prematurity. Besides there are deaths ascribed to marasmus which are due to syphilis.

The group "all others" include all nervous diseases except tuberculous and cerebrospinal meningitis and convulsions, diseases of the heart, liver and kidney, deaths by violence or accident and a large variety of others that scarcely deserve mention.

While in the four American cities studied there is a general agreement regarding the importance of the various factors, there are some interesting differences. The figures for acute gastrointestinal diseases are highest for Chicago, 32.9 per cent.; almost the same, 32 per cent., for Philadelphia; considerably lower for New York, 26.8 per cent.; lowest of all, 19.5 per cent., for Boston. Acute respiratory diseases cause the greatest number of infant deaths, 20.9 per cent., in New York; almost as many, 19.8 per cent., in Chicago; while in Philadelphia the percentage is only 15.6 and in Boston only 15.1.

Greater differences are seen between our American cities and London. In that city the percentage of acute gastrointestinal diseases is only 12.9, as compared with our average, 28 per cent. Acute respiratory diseases cause 21.3 per cent. of the deaths, compared with our average, 18.5 per cent. Deaths from acute infectious diseases are 9.5 per cent., against our average, 5.4 per cent.; while more striking still is the fact that tuberculosis is more than twice as common, the deaths from this being 4.3 per cent., against our 2 per cent. in American cities.

THE REDUCTION OF INFANT MORTALITY.

Any effort to reduce infant mortality must take into account not only the final or terminal diseases which are put down as causes of death, but the important underlying causes. Let us now take up the different groups of cases and see by what measures it is possible to lessen the death-rate from them.

To affect prematurity, its underlying causes must be discovered and removed. Syphilitic women should, of course, receive treatment during pregnancy. But even for other cases something can be done. Pinard in 1895 made observations on 1,500 women in France. In the first group of 500 who worked up to the time of their confinement, the average weight of the infant at birth was 3,010 gm. (6½ pounds); in 23.9 per cent. the children were born more than ten days before term. In a second group of 500 who spent ten days in retreat before confinement, the average weight of the infants at birth was 3,290 gm. (7¼ pounds); where they were in such a place for a longer period than ten days the average birth-weight was 3,366 gm. (nearly 7½ pounds). In the last two groups only 12.6 per cent. of the infants were born more than ten days before full term.

A period of rest to the mother before confinement has then a very direct and important influence on the completion of pregnancy and hence on the weight of the child at birth, both of which factors are important in relation to the child's vitality. This is a strong argument for prematernity hospitals or retreats. It also points to the necessity of some law which shall prevent women from working in factories for a certain period, from two to four weeks before delivery. But it is not in factories alone that women are obliged to work hard, sometimes up to the very hour of their confinement, and again within a few days after it, and this class also needs to be protected and relieved.

Again, there is urgently needed proper hospital provision for the care of premature infants. They are exceedingly difficult patients to deal with, requiring the most skilled nursing and medical care. Almost no provision is made for their care in existing institutions. In the homes of the poor nearly all die. This factor in infant mortality is one which has too long been ignored. In cases of true congenital debility the conditions and the needs are essentially the same as in premature infants.

To reduce the mortality from marasmus and acute intestinal diseases, the important causative factors, food, methods of feeding, summer heat and surroundings, must be kept in mind.

Among the poor and ignorant, breast-feeding is by far the most effective measure that we possess in preventing intestinal diseases in summer. Little or nothing has been done systematically in this country to encourage maternal nursing. France has taken the lead in this as well as in other organizations for the protection of infancy. As long ago as 1876 the importance of this subject was recognized and the *Société pour la propagation de l'allaitement maternel* was organized. Another society, called *Oeuvres des mères de famille* exists, whose object is to furnish employment at home to nursing mothers to relieve them from the necessity of leaving their infants to work in shops and factories.

While desirable for the greater part of the first year, maternal nursing is of special importance during the early weeks of life to enable the infant to make a start. England, Germany and Switzerland have had for many years laws forbidding the employment of women in fac-

tories for a certain number of weeks after and in some countries also before confinement. But such prohibitory laws are not effective unless they are supplemented by some adequate provision, public or private, for the relief of mothers whose necesssities compel them to work under such circumstances. Such measures have been officially taken in Germany and Austria. Assistance by finding proper work at home, furnishing special food—milk, eggs, etc.—to nursing mothers among the poor would in our own city bring a large return. As yet this important subject, so far as I can ascertain, has received little or no attention in this country. In New York we have been so much engaged in the furtherance of the best methods of artificial feeding that means of promoting maternal nursing have not received due consideration. We must be on our guard lest with our day-nurseries and milk depots and other means we do not encourage artificial feeding and discourage maternal nursing.

The encouragement of maternal nursing among the well-to-do is a subject that should not be entirely passed over. While it is my belief that the great decline in maternal nursing among the intelligent classes of the community is due not to their unwillingness, but rather to their inability to nurse their children successfully, still if more encouragement were given by physicians and trained nurses and greater efforts put forth by the mothers themselves, much more might be accomplished than at present.

In this connection a word should be said against wet-nursing as a regular practice where maternal nursing is impossible. While this method of feeding is sometimes necessary, it should not be employed when artificial feeding can be successfully conducted, as with the great majority of children of the well-to-do it can be. The general employment of wet-nurses tends, on the whole, to increase infant mortality rather than reduce it, owing to the excessively high mortality of wet-nurses' infants. An interesting instance illustrative of this, related by Comby, occurred in France during the time of the seige of Paris. In a district near the city from which many women went as wet-nurses to the capital, the infant mortality had been 35 per cent. The war shut off all communication with Paris so that, their former occupation gone, women remained at home and nursed their own

infants, with a result that the infant mortality fell to 17 per cent.

Next to maternal nursing should be placed good artificial feeding when breast-feeding is impossible, and this not only as a means of preventing acute gastrointestinal disease, but also that other group of cases quite as great, classed as marasmus, general debility, etc.

For good artificial feeding several things are necessary. The first is intelligence, which is more important even than the best materials. The next is a pure milk-supply, which must be carefully safeguarded until it reaches the home. The value of what has been done by the Department of Health in New York City and in other municipalities can hardly be overstated. But it is a question whether along these lines very much more can be accomplished in the reduction of infant mortality than is now being done.

General pasteurization of a city's milk is a procedure of doubtful utility, but there can be no question regarding the advantage of the home pasteurization of milk in summer, especially among the poor. So much evidence has already been adduced in its favor that it need not be discussed here. When no ice is available sterilization by boiling is safer than pasteurization. The heating of the milk fed to infants in summer by one or other methods is now very general among the tenement population of New York and has been a factor of no inconsiderable importance in the reduction of infant mortality in the hot months.

What has been accomplished in the last eighteen years in the reduction of the number of deaths from diarrheal diseases is shown in Chart 8, from Freeman. In this are shown for comparison the infant mortality for the differenent years, for the summer months from all causes, and for the summer months from diarrheal diseases only, all per thousand of population.

In a general way these curves are parallel, indicating as has been pointed out, that the deaths from diarrheal diseases in summer determine not only the mortality curve for the summer months, but that for the entire year. It is rather surprising, but should not be overlooked, that the infant mortality from other causes shows, even in the summer months, a reduction quite as great as that from diarrheal diseases. Thus at the beginning of the period in 1891 the deaths from diarrheal

diseases were exactly half the total summer mortality. Precisely the same thing is true of 1908. Many other causes besides improved milk-supply and the sterilization of milk have contributed to this result. Better infant hygiene is a factor. Much has been due to cleaner streets, improved sanitation in dwellings due to tenement-house inspection, the increase in the number of small parks in congested districts, recreation piers, summer outings and day excursions on the water. Something has been done in diffusing knowledge regarding

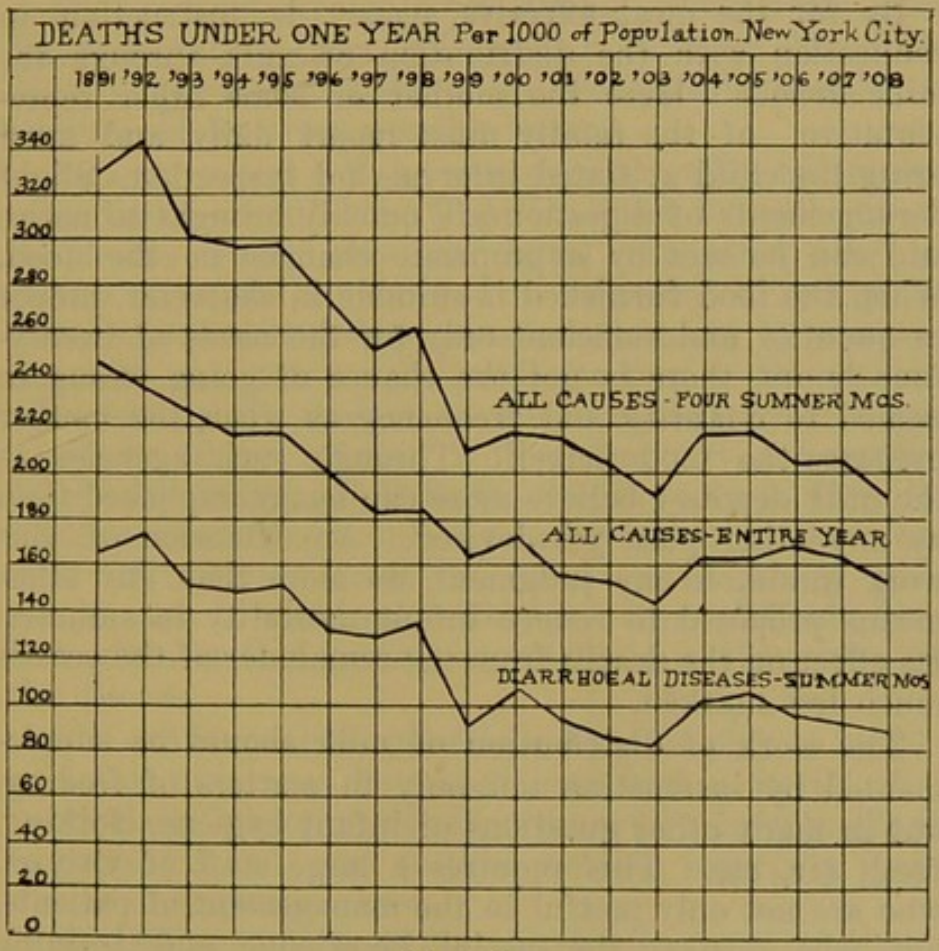

Chart 8.

the care of infants and how they can be kept well, but more particularly regarding how they are to be fed.

Further improvement must come through better artificial feeding, especially among the poor. Ignorance and neglect are more difficult to reach even than a general milk-supply. But as long as it remains true that over four-fifths of the deaths in the first year are in-children who are artificially fed, the direction which effort must take to bring about a change is clear. Hav-

ing done everything possible to encourage and promote maternal nursing, the next step is to teach ignorant mothers and others who attempt artificial feeding how it may best be done. Visiting nurses of hospitals, settlement houses and boards of health can do and are doing great good by instructing mothers in their homes. Much instruction is also given by dispensary physicians to whom these patients apply for treatment, but there it is often too late, after serious disease has already developed.

By far the most effective agency is instruction in connection with the distribution of milk through the milk depots. Here the mother or some other representative of the family must report daily and must bring the child at stated intervals for inspection. Slight derangements of digestion are quickly brought to notice and can be met by appropriate changes in the food. When the food furnished is suitable in character, proper in quantity and sufficient only for the needs of twenty-four hours, there is not the chance of going wrong in regard to quantity and frequency as when the mother prepares the food herself. Through such agencies as the milk depots I believe more can be accomplished than by any other plan yet devised. An extension of this work would, in my judgment, do more than any other means proposed to reduce infant mortality in summer. Its effect on the deaths from the remainder of the year is much less marked.

The work of distribution of milk should be supplemented by instruction not only in matters of feeding, but in many other questions of infant hygiene, clothing, fresh air, etc. This requires a large staff of visitors, who are not only tactful in the management of patients, but who possess the special knowledge and training which qualifies them for this work. These teachers must themselves be properly instructed if results are to follow. Proper knowledge and experience are difficult to obtain except in connection with special hospitals or hospital wards for infants. The important part which these institutions play in the solution of this problem should not be overlooked.

The outlook for a reduction in the mortality from acute respiratory diseases and tuberculosis is not so hopeful as for the groups just mentioned. Both tuberculosis and acute respiratory diseases are greatly in-

creased by overcrowding and bad housing, two conditions very difficult to reach in all large cities, but especially so in New York. But much has already been done to improve them. Something can also be accomplished by teaching the importance of fresh air and removing the traditional fear of taking cold as a causative factor in these diseases. The radical remedy is the abolition of the old insanitary tenement and the erection of more sanitary dwellings. Thanks to the energy and efficiency of the Tenement House Commission, very much has been accomplished already along these lines. The removal of those with young children from the densely populated districts to the suburbs should be encouraged by every possible means.

Tuberculosis is not, as was once thought, an uncommon disease in infants. That it causes 5.6 per cent, of the deaths under one year in an institution like the Babies' Hospital is conclusive evidence on this point. Tuberculosis will not be materially reduced by sterilizaing milk, for it is a very small fraction of the patients who acquire the disease in this way, but by removing adults or others affected with pulmonary tuberculosis from association with infants—certainly from their immediate care. It is only by the removal of these carriers of infection from the household that any great results can be obtained. This is a very difficult question when it is a parent, especially a mother, who has the disease.

The ordinary acute infectious diseases play so small a part that they may be passed over with a word. It is particularly whooping-cough from which infants should be protected and, next to this, measles, especially in the winter and spring season.

General hygiene is of the greatest importance, since it affects nearly all the foregoing diseases, but particularly the acute intestinal diseases of summer and the acute respiratory diseases in winter. Everything which touches the general healthfulness of a city influences infant mortality. It is these most susceptible members of the community who show most quickly the effects of adverse conditions and reflect most markedly improved conditions of living.

The most important causes of infant mortality may be divided into three groups, according to the degree to which they may be reduced:

1. Those but little influenced by treatment:
   Malformations.
   Extreme feebleness or prematurity (before the seventh month).
   Certain accidents during birth.
2. Those capable of considerable reduction, chiefly through proper housing, isolation and medical treatment:
   Tuberculosis.
   Acute respiratory diseases—influenza.
   Contagious diseases—whooping-cough, measles and diphtheria.
3. Those capable of very great reduction through proper feeding and care:
   Acute gastrointestinal diseases.
   Marasmus and inanition.
   Prematurity, after seventh month.

For this last group, which is much the largest, there is needed the fullest and most exact scientific knowledge of the subject of infant-feeding and hygiene. It is in the medical schools that the work of instruction in these subjects should begin. We cannot expect to have well-taught mothers and nurses unless we have well-instructed physicians. What results could be looked for when the subject was so lightly regarded by even so representative a body as the Committee on Curriculum of the American Medical Association in 1905, which, in an "ideal medical course," considered ninety hours sufficient for the study of the diseases of children, exactly the same as the time allotted to electrotherapeutics?

At present there are hardly half a dozen medical schools in the country that possess an independent department of diseases of children. From most colleges a man may graduate without even passing an examination in this subject. It is only a few years since, even in the best institutions, any thing like adequate instruction has been given. The older members of the profession who received their education before this time have been wont to regard matters of infant-feeding and hygiene as subjects which may be safely left to maternal instinct or the wisdom of the trained nurse.

The recognition of the claims of this department of medicine have been tardy, but there are signs that it is coming at last. It is encouraging to note that the Committee on Curriculum of the American Medical Association in 1909 allotted twice as many hours to the diseases of children as were given four years ago. In the whole range of preventive medicine I believe that there

is no field which opens up wider possibilities than the means which may be employed to reduce infant mortality. To accomplish this there is needed an educated profession, well-instructed nurses and an aroused public.

14 West Fifty-fifth Street.

NOTE.—Other important articles in relation to the subject of infant mortality are the following:

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