| City. | Birth Rate. | | Fall in birth rate. Per cent. | Infantile Mortality. | |
|---|---|---|---|---|---|
| | 1876. | 1901. | | 1876. | 1901. |
| Salford | 49.3 | 29.2 | 43.0 | 189 | 204 |
| Manchester | 39.8 | 29.1 | 27.0 | 180 | 159 |
| Birmingham | 42.8 | 32.1 | 25.0 | 160 | 187 |
| England and Wales | 36.3 | 28.5 | 20.5 | 146 | 151 |

*Density of population* has an influence upon the death rate. The death rate of rural districts is lower than that of cities, as a general rule. The urban districts of England in 1899 had a death rate of 19.2 per 1,000, while that of the rural population was only 16.3. In Massachusetts the death rates in 1890 and 1900 in the urban and rural populations were respectively 20 and 18.5 per 1,000 in the urban districts and 17.8 and 17.3 in the rural districts. It is only when the density has reached a certain degree of intensity that it begins to assert an appreciable effect. Even then it is what is implied in or is an attendant upon aggregation, rather than the aggregation itself, that is harmful. Poverty and intemperance are usually greater in densely populated districts than elsewhere, with their accompaniments of deficient food and clothing and bad housing. Hence the excess of phthisis in tenement-houses, and especially in those tenements consisting of two or three rooms only. Newsholme says that "the true density that should be considered is the number of persons to each room, not the number of persons on a given area" ("The Vital Statistics of the Peabody Buildings," Royal Statistical Society, February, 1891).

Dr. Farr had proposed an extremely mathematical rule or formula for the calculation of the death rates of populations of different density, stating at first that the mortality increases in proportion, not to the density of population, but to the sixth root of the density. This formula he afterward changed to the eighth root approximately, or, more exactly, to 0.11998.

By this formula if $d$ and $d'$ = density of population of two places, and $m$ and $m_1$ = mortality of population,

then $\frac{m'}{m} = \sqrt[8]{\frac{d}{d}}$ and

$m' : m :: \sqrt[8]{d'} : \sqrt[8]{d}$

In 345 English districts which had a mortality of 19.2 per 1,000, the density was 186 persons per square mile. What was the mortality in 9 of these districts which had a high density of 4,499 per square mile?

$$\frac{m'}{19.2} = \sqrt[8]{\frac{4,499}{186}} \qquad m' = 28.6$$

So closely was the ratio found to be followed in places whose sanitary conditions were fairly the same, and which differed only in density of population, that Dr. Farr proposed that in any sanitary inquiry the influence of density should first be discovered by means of the foregoing formula, and that the effect of other influences above or below this should then be investigated. But the death rate has declined in recent years, as density has increased. In England the density of population has increased from 307 per square mile in 1851 to 497 in 1891, while the death rate meanwhile has declined from 22.5 to 19.1 per 1,000 in the same time. In New England the density increased from 75.8 in 1890 to 90.2 per square mile in 1900, while the death rate decreased as follows: In 1892, 19.9; in 1893–97, 18.3; in 1898–1900, 17.3.

With Newsholme, therefore, we are led to believe "that either the relationship between density of population and mortality is accidental rather than essential, or that countervailing influences are at work."

While, therefore, this strict mathematical formula may be applicable to the densely crowded portions of large cities when compared with each other, it does not necessarily apply when the condition of one district is compared with its own condition at an earlier period when the density was much less. Nor can it be employed in comparing the populations of cities and districts in the United States, without careful correction for age and sex distribution.

In the three States of Maine, New Hampshire, and Vermont, with an average density of population of 30.2 per square mile, the death rate in the nine years 1892–1900 was 16.90; but in the three States, Massachusetts, Rhode Island, and Connecticut, with an average density of 296.5 per square mile, the death rate in the same period was 18.55 per 1,000.

To a certain degree the number of rooms occupied by a given number of people bears a definite relation to the density of population as well as to its social condition, and hence has a direct effect upon the death rate, as shown in the following table for the city of Glasgow:*

| Size of houses. | Census population (1901). | Deaths from all Causes. | | Infectious Diseases. | | Phthisis. | | Respiratory Diseases including Croup. | |
|---|---|---|---|---|---|---|---|---|---|
| | | Deaths. | Death rate. | Deaths. | Death rate. | Deaths. | Death rate. | Deaths. | Death rate. |
| One room | 104,128 | 3,405 | 32.7 | 771 | 7.4 | 247 | 2.4 | 792 | 7.6 |
| Two rooms | 348,731 | 7,418 | 21.3 | 1,576 | 4.5 | 620 | 1.8 | 1,600 | 4.6 |
| Three rooms | 151,754 | 2,081 | 13.7 | 290 | 1.9 | 178 | 1.2 | 362 | 2.4 |
| Four rooms and more | 136,511 | 1,533 | 11.2 | 139 | 1.0 | 99 | .7 | 272 | 2.0 |
| Whole city | ..... | .... | 20.6 | .... | 3.8 | .... | 1.8 | .... | 4.3 |

*The Effect of Occupation upon Mortality.*—The occupation or calling in which persons are engaged has an influence upon the health and consequent length of life of those who are thus employed, some occupations being more favorable to health than others.

Various methods have been adopted for measuring the comparative healthfulness of occupations. For several years it was customary in some of the older States to give the *mean age at death* of persons engaged in different occupations and thus to compare them with each other. This method, however, is entirely fallacious. For example, the average age at death of judges in Massachusetts was 65.9 years, of clerks 36.4 years, and of students 23.7 years. These figures obviously have no value as determining the comparative length of life or healthfulness of the persons engaged in these employments.

Nor is it a strictly correct method to compare the number dying in any given occupation with the number engaged in such occupation, since the persons entering upon the duties of one occupation may do so at a much earlier or later age than those entering another occupation which may be compared with it.

According to Newsholme,† the only trustworthy method is to compare the mortality of those engaged in one occupation and of a given age, with the mortality of those engaged in another occupation and of a corresponding age.

The circumstances which render certain occupations injurious to the health of persons engaged in them are overcrowding and defective ventilation, extremes of heat and cold, inhalation of noxious vapors, and especially of dust, both organic and inorganic, exposure to lead and other poisons, mental anxiety, and exposure to intemperance.

Observations upon the mortality of occupations in American communities are generally untrustworthy and inaccurate; first, because of wrong methods adopted; and second, because of the shifting and unstable character of persons employed, as compared with those engaged in foreign industries.

The following table, constructed by Dr. Tatham from the registrar-general's returns of England for the years 1890–92, may be deemed accurate for English occupations. It embraces the statistics of death of 61,215 men who were engaged in the occupations named in the table.

| Occupations. | Ages. | | | | Comparative mortality figures. |
|---|---|---|---|---|---|
| | 25-35 years. | 35-45 years. | 45-55 years. | 55-65 years. | |
| Clergyman, priest | 4.86 | 4.23 | 5.18 | 10.52 | 533 |
| Lawyer, solicitor | 5.32 | 10.67 | 17.72 | 34.50 | 821 |
| Physician, surgeon | 6.69 | 14.02 | 21.04 | 34.16 | 966 |
| Commercial traveller | 6.09 | 12.62 | 21.41 | 39.28 | 961 |
| Farmer, grazier | 4.29 | 7.03 | 11.20 | 23.97 | 563 |
| Agricultural laborer | 5.54 | 9.14 | 13.56 | 24.83 | 666 |
| Fisherman | 9.13 | 10.60 | 18.61 | 25.65 | 845 |
| Innkeeper, bartender, etc | 15.21 | 23.32 | 34.84 | 53.18 | 1,642 |
| Innkeeper's servant | 15.06 | 24.52 | 35.24 | 52.68 | 1,650 |
| Grocer | 5.40 | 8.62 | 14.34 | 24.92 | 664 |
| General shopkeeper | 8.89 | 14.03 | 19.92 | 32.59 | 973 |
| Printer | 9.10 | 14.40 | 21.56 | 43.39 | 1,096 |
| Butcher | 7.53 | 15.66 | 22.65 | 43.32 | 1,096 |
| Corn miller | 5.07 | 9.33 | 18.90 | 38.83 | 845 |
| Hatter | 6.96 | 15.35 | 24.75 | 42.90 | 1,109 |
| Baker, confectioner | 6.49 | 11.00 | 22.18 | 35.45 | 920 |
| Tailor | 6.86 | 13.67 | 21.98 | 37.59 | 989 |
| Hairdresser | 9.41 | 15.01 | 23.28 | 39.03 | 1,099 |
| Shoemaker | 7.66 | 11.35 | 19.85 | 35.25 | 920 |
| Tanner | 5.78 | 6.40 | 18.69 | 32.78 | 756 |
| Currier | 6.79 | 12.67 | 22.16 | 40.62 | 968 |
| Tool, scissors, file, saw, needle maker | 8.36 | 18.38 | 32.93 | 57.52 | 1,412 |
| Blacksmith | 5.80 | 10.81 | 20.74 | 39.45 | 914 |
| Copper, lead, tin, zinc worker | 7.43 | 13.98 | 24.55 | 46.02 | 1,123 |
| Bricklayer, mason | 6.55 | 13.45 | 22.04 | 40.23 | 1,001 |
| Carpenter, joiner | 5.78 | 9.36 | 17.19 | 32.15 | 783 |
| Plumber, painter, glazier | 7.04 | 14.79 | 25.13 | 45.58 | 1,120 |
| Woollen operatives | 6.99 | 11.99 | 20.58 | 43.76 | 996 |
| Cotton, flax, linen operatives | 7.13 | 13.38 | 25.11 | 55.06 | 1,176 |
| Wool, silk, cotton dyer and printer | 10.90 | 16.14 | 28.05 | 57.95 | 1,370 |
| Potter, earthenware maker | 8.19 | 19.58 | 42.97 | 75.13 | 1,706 |
| Coal miner | 6.29 | 9.63 | 19.42 | 43.79 | 935 |
| Tin miner | 8.06 | 14.32 | 33.20 | 66.09 | 1,409 |
| Glass maker | 11.32 | 17.88 | 32.14 | 60.79 | 904 |

In the foregoing table, the first four columns of figures present the death rates at four different ages of persons engaged in the specified occupations. For example, the death rate of clergymen, twenty-five to thirty-five years of age, is 4.86 per 1,000; of innkeepers of the same age, 15.21 per 1,000. The figures in the last column should be read as follows: The same number of men (aged twenty-five to sixty-five years) that would give 1,000 deaths among all males (as a standard of comparison) would give 533 among the clergy, 563 among farmers, 1,642 among innkeepers and bartenders, 1,412 among steel grinders, etc.

When the mortality of persons in different occupations is distributed according to the causes of death, we find more specific results of the effect of such industries on the health of the employed. The highest mortality from cancer among occupied males is found among chimney-sweeps. For phthisis the lowest mortality is found among clergymen, railway engineers and stokers, farmers and coal miners; and the highest among steel grinders, lead miners, costermongers, and hotel servants. Pneumonia causes a low mortality among teachers and the clergy, and a high mortality among hotel servants, dock laborers, iron workers, and coal heavers. Diseases of the liver cause low mortality among the clergy and railway porters, and high mortality among lawyers, brewers, physicians, and publicans.

The following table* is interesting as showing the effects of dust-laden air in different occupations:

| Occupation. | Phthisis and diseases of the respiratory system. | Occupation. | Phthisis and diseases of the respiratory system. |
|---|---|---|---|
| Agriculturist | 100 | Agriculturist | 100 |
| Iron miner | 133 | Quarryman | 261 |
| Carpenter | 148 | Zinc worker | 266 |
| Coal miner | 166 | Iron and steel worker | 282 |
| Corn miller | 166 | Gunsmith | 294 |
| Baker | 177 | Copper miner | 307 |
| Blacksmith | 177 | Copper worker | 317 |
| Wool worker | 202 | Lead miner | 319 |
| Tin worker | 204 | Glass worker | 335 |
| Carpet and rug maker | 213 | File maker | 373 |
| Bricklayer, mason | 215 | Tin miner | 400 |
| Cotton worker | 244 | Cutler, scissors maker | 407 |
| Lead worker | 247 | Potter, earthenware maker | 453 |
| Chimney-sweep | 249 | | |

This table is to be read as follows: In each 100 deaths of agriculturists out of a given number employed in such occupations, there would be 133 deaths of iron-miners employed in that occupation, etc. Dr. Ogle points out that the dust of coal and wood is least injurious, that of metals and stone most injurious, while flour dust and that of textile factories occupy an intermediate position in their effects upon health.

*Lead Poisoning.*—The mortality of all males from lead poisoning being taken as 1, that of printers is 3, lead miners 5, gasfitters 6, coachmakers 7, copperworkers 8, glassmakers 12, potters 17, painters and glaziers 18, plumbers 21, file-makers 75, and lead workers 211.

*Alcoholism.*—The returns under this head are usually imperfect, but since the intemperate use of alcoholic drinks damages most of the viscera, the excess of deaths from nervous diseases, phthisis, kidney diseases, gout, and suicide in different occupations forms an index of the effect of alcoholism upon health.

In the following table the mortality of occupied males between twenty-five and sixty-five years of age from each cause of death is taken as 100, and the mortality in each industry is reduced to a figure proportional to that standard:†

| | Alcoholism and diseases of the liver. | Alcoholism. | Diseases of the liver. | Gout. | Diseases of the nervous system. | Suicide. | Phthisis. | Diseases of urinary organs. |
|---|---|---|---|---|---|---|---|---|
| Occupied males | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Coachman, cabman | 153 | 215 | 122 | 300 | 100 | 143 | 124 | 132 |
| Costermonger | 163 | 377 | 107 | 150 | 170 | 100 | 239 | 171 |
| Coal heaver | 165 | 223 | 137 | .... | 120 | 50 | 116 | 122 |
| Fishmonger | 168 | 215 | 144 | 150 | 100 | 150 | 86 | 120 |
| Musician | 168 | 223 | 141 | 450 | 135 | 164 | 174 | 141 |
| Hairdresser | 175 | 269 | 130 | 400 | 109 | 250 | 149 | 78 |
| Dock laborer | 195 | 400 | 96 | 150 | 139 | 157 | 176 | 166 |
| Chimney-sweep | 200 | 454 | 78 | .... | 100 | 221 | 141 | 144 |
| Butcher | 228 | 269 | 207 | 300 | 128 | 164 | 105 | 117 |
| Brewer | 250 | 315 | 219 | 500 | 132 | 124 | 148 | 190 |
| Innservant | 420 | 815 | 230 | 550 | 132 | 179 | 257 | 188 |
| Innkeeper | 733 | 708 | 744 | 600 | 195 | 229 | 140 | 220 |

The Causes of Death.—These are usually stated either in proportion to the number of deaths from all causes or as a ratio of the living population. The latter is the preferable method.

The first plan may be adopted when it is desired to ascertain the proportional share of any given cause of death in the total mortality, but for general purposes the population should be the standard of comparison.

For a half century or more diseases have been classified in most English-speaking countries in accordance with

* "The Death Rate in One-Apartment Houses," by A. K. Chalmers, M.D., Medical Officer of Health of Glasgow, 1903.
† "Vital Statistics," third edition, page 172.

* Newsholme's "Vital Statistics," third edition, p. 183.
† Newsholme's "Vital Statistics," third edition, p. 184.

the plan proposed by Dr. William Farr, about the middle of the last century. The principal groups of this system were termed the zymotic, constitutional, local, developmental, and violent classes of disease or causes of death. The progress of medical science, however, has demanded a change, and the Bertillon system of classification has in many countries superseded the system of Dr. Farr. According to this new system, the groups of causes of death are as follows: (1) General diseases; (2) diseases of the nervous system; (3) diseases of the circulatory system; (4) diseases of the respiratory system; (5) diseases of the digestive system; (6) diseases of the genito-urinary system; (7) childbirth; (8) diseases of the skin; (9) diseases of the locomotor system; (10) malformations; (11) early infancy; (12) old age; (13) violence; (14) ill-defined diseases.

These changes in classification do not in the least interfere with the study of separate causes of death, when it is desirable to compare their present and past incidence upon the population.

A general consideration of the principal infectious diseases shows, in nearly all nations or communities in which registration records are kept, a remarkable decrease, while the diseases of special organs, or local diseases as they have usually been termed, together with cancer, have shown a decided increase. In Massachusetts, for example, the group of diseases embracing smallpox, measles, scarlet fever, diphtheria, typhoid fever, cholera infantum, consumption, whooping-cough, dysentery, and the diseases incident to childbirth had decreased from a mean of 81.7 per 10,000 living in the five-year period 1856–60 to 50.5 per 10,000 in the five-year period 1891–95; while, on the other hand, the group embracing pneumonia, kidney diseases, heart diseases, brain diseases, and cancer had also increased from a mean of 27.7 per 10,000 in the five-year period 1856–60 to 68.8 in the period 1891–95.

Longstaff, in his "Studies of Statistics," shows that similar changes have taken place in England.

*Tuberculosis.*—This disease, which until a quite recent period has been for at least a half-century and probably much longer the most destructive disease of the human race, has shown a steady decline in mortality in those countries where records have been kept. In England this decrease has been from a mortality of 2,579 per million living among males in the period 1851–60 to 1,487 per million in 1901, and from 2,774 among females to 1,054 in the same time. This shows a greater fall among females than among males, and the same is true of Massachusetts, where the phthisis death rate fell among males from 3,166 per million in 1851 to 1,690 in 1902, and among females from 4,600 per million in 1851 to 1,504 in 1902. The death rate for both sexes from this cause declined still further to 1,595 per million in 1902.

Newsholme says, in treating of this remarkable decrease: "It is possible that, owing to more accurate statement of causes of death, there has been considerable transference from phthisis to diseases (other than phthisis) of the respiratory organs. The term phthisis is now not so loosely used as formerly, when any chronic chest affection received this name. But that this is by no means a complete explanation of the decrease in phthisis is evidenced by the fact that while the mortality from phthisis has decreased at all age groups, the mortality from respiratory diseases has only increased under five and over seventy-five years of age. Furthermore, the mortality from phthisis chiefly takes place between the ages of fifteen and fifty-five years, while that from respiratory diseases is very low during these years and greatest at the extremes of life."

A circular of the imperial board of health of Germany published in 1896 states that out of each thousand deaths during the wage-earning period of life (fifteen to sixty years) there were from tuberculous diseases in Vienna 459 deaths, in Paris 400, in Belgium 371, in Bavaria 359, in the German empire 322, in Denmark 297, and in England 223.

*Typhoid Fever.*—As an index of the sanitary condition of a community, the death rate from typhoid fever holds high rank, and especially as a proof of the purity of the public water supply. Since the general introduction of public water supplies in cities and towns, the death rate from this disease has steadily fallen.

*Ages.* The highest relative mortality from this disease is at the ages fifteen to thirty years in both sexes.

*Seasons.* Typhoid fever proves most destructive in the months of September, October, and November, the number of deaths from this cause in New England occurring after September 1st in each year being usually about as many as those which precede that date.

In those cities in which public water supplies have been introduced, the typhoid death rate has fallen from 21 per 10,000 in Munich to 6.3, in Dantzic from 9.9 to 2.4, in Berlin from 9.2 to 2.9, in Vienna from 12 to 2.1, in London from 10.2 to 4.5, and in Lawrence, Mass., from 13.4 to 1.6, the periods which elapsed varying from five to forty years. In Lawrence the death rate from this cause fell within a few weeks after the introduction of filtered water from 10.5 in 1892 to 4.8 in 1894, the filter being introduced in 1893.

The general decline in this death rate in Massachusetts is illustrated by the following diagram and table, in which the typhoid death rate is compared with the *percentage of the population not supplied with public water*, since it is among this portion of the population that typhoid fever largely occurs. Many people even in large cities still derive their water supply from polluted sources, wells, springs, and canals in manufacturing cities.

TYPHOID FEVER IN MASSACHUSETTS.

| Period. | Death Rate from Typhoid Fever, per 100,000. | Percentage of Population Not Supplied with Public Water. |
|---|---|---|
| 1856–65 | 92.9 | 75.4 |
| 1866–75 | 80.8 | 58.9 |
| 1876–85 | 47.4 | 31.7 |
| 1886–95 | 26.4 | 13.9 |
| 1901 | 19.5 | 8.5 |

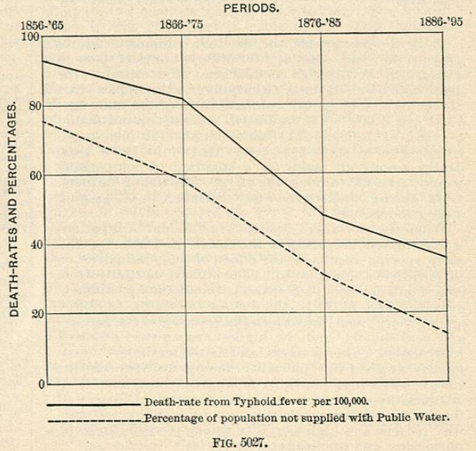


FIG. 5027.





*Scarlet Fever.*—This disease proves most destructive in the second, third, fourth, and fifth years of life. Three times as many die of it in the first five years of life as in the second five years, and about fifteen times as many as in the period ten to fifteen years.

The death rate of the two sexes is nearly equal, and the number dying in the first half of the year is considerably greater than those who die in the second half.

The death rate from this cause declined in England from over 9 per 10,000 in 1866–70 to 2 in 1891–95. It also declined still further to 117 per million in 1899, which was the lowest death rate in that country from this cause on record. A similar decline has been observed in many other countries, and may undoubtedly be attributed to the introduction of more efficient methods of isolation and control of infectious diseases.

*Measles.*—The deaths from this disease are also greatest in number in infancy and childhood, the mortality in the first five years of life being eight or ten times as great as in the second five years. The deaths of the two sexes from this cause are nearly equal. (In Massachusetts in twenty years there were 4,015 deaths of males and 3,934 of females from measles.) The deaths from this cause in the first six months are usually greater in number than those which occur in the last six months of the year. The death rate from this cause has declined in most countries, but not so decidedly as in scarlet fever.

In England it was 315 per million in 1899, or the lowest rate recorded since 1881.

In Massachusetts it was 159 per million in the twenty years 1856–75, and only 90 per million in the twenty years 1876–95.

*Whooping-Cough.*—This disease is more fatal in the first year of life than in any succeeding year. More females die of it than males, and the death rate from this cause has diminished, the rate in England in 1899 having been 319 per million, or the lowest yet recorded except that for 1895, which was 316. That of Massachusetts had declined from 220 per million in the twenty years 1856–75, to 140 in the twenty years 1876–95.

*Diphtheria.*—The figures for diphtheria are now usually considered together with those of membranous croup. The mortality is greatest in the second, third, fourth, and fifth years of life, that of the third and fourth years combined being slightly greater than those of the second and fifth years. The death rates of the sexes are nearly the same in diphtheria, but of the deaths registered as from croup those of males are slightly in excess.

The effect of seasons upon the prevalence of this disease is quite uniform and well marked, the lowest death rate usually occurring in midsummer (June to August), after which the rate rapidly rises to November, and continues at a high rate until January or February, after which the decline is more gradual than the rise in the autumn. There is reason to believe that the rapid rise in autumn as related to the opening of the schools is more than a mere coincidence.

Its prevalence from one period to another for a long series of years has been quite irregular as shown by the following figures for Massachusetts, embracing the statistics of 64,281 deaths from this cause:

| Five-year periods. | Deaths from diphtheria. | Death rate per 10,000 living. | Five-year periods. | Deaths from diphtheria. | Death rate per 100,000 living. |
|---|---|---|---|---|---|
| 1866–1860 | 2,949 | 4.9 | 1881–1885 | 8,944 | 9.5 |
| 1861–1865 | 7,710 | 12.3 | 1886–1890 | 8,857 | 8.4 |
| 1866–1870 | 3,664 | 5.3 | 1891–1895 | 7,652 | 6.4 |
| 1871–1875 | 5,038 | 6.4 | 1896–1900 | 6,331 | 4.7 |
| 1876–1880 | 13,676 | 15.8 | | | |

With reference to the fatality of this disease (ratio of deaths to cases) a marked change has taken place since the general introduction of antitoxin treatment in 1894–95. Previous to its introduction the fatality of diphtheria ranged from 25 to 40 per cent. in different localities. In Massachusetts it was 28.3 per cent. for the four years 1891–94, but this percentage has been cut down to 13.1 per cent. for the seven years 1895–1901, and in 1901 it was only 10.5 per cent. The meaning of these figures, according to the Thirty-third Annual Report of the State Board of Health of Massachusetts is a saving, in the seven years, of 10,697 lives, and even if all sources of error were to cut down this figure by one-half "the result would be the saving of more than 5,000 lives by the use of antitoxin in the seven years 1895–1901."

There has also been a decided reduction in the death rate from dysentery and from puerperal fever and the diseases incident to childbirth, these latter being coincident with the introduction of antiseptic methods in the management of the lying-in chamber.

In Prussia the death rate of women in childbirth has been diminished from 81.8 per ten thousand births in the five years 1856–60 to 43.3 in the three years 1891–93, or nearly one-half. These figures are the results of observations upon over 44,000,000 cases of labor, and 296,867 deaths in childbirth.*

*Smallpox.*—The statistics relating to this disease and its relation to the practice of vaccination may be found fully stated in the article on *Vaccination*.

*Other causes of death* from which the death rate has increased. The foregoing causes of death in which the death rate has fallen during the past half-century are of the infectious class, and are mainly the diseases of children and young adults. Had the death rate from all other causes remained stationary this decided fall in that of infectious diseases would have caused a material reduction in the general death rate, an observation which applies to most countries where vital statistics are carefully recorded. But the death rate from most of the diseases, usually known as local diseases, has increased in a ratio nearly equal to the decline in infectious diseases. For example, Longstaff in his "Studies of Statistics," p. 230, presents the following table, which may be termed the balance of mortality:

ENGLAND.

| The death rate from each of the following diseases per million inhabitants has fallen from the five years 1850–54 to the five years 1875–79, as follows: | | The death rate from each of the following diseases per million living has risen, 1850–54 to 1875–79, as follows: | |
|---|---|---|---|
| Phthisis | 694 | Lung diseases | 1,213 |
| Developmental diseases | 617 | Heart diseases | 696 |
| Fever (mostly typhoid) | 569 | Brain diseases | 378 |
| Dropsy | 405 | Kidney diseases | 229 |
| Convulsions | 342 | Liver diseases | 32 |
| Cholera | 287 | Cancer | 191 |
| Smallpox | 197 | Diphtheria | 69 |
| Scarlet fever | 173 | Tabes mesenterica | 65 |
| Tuberculous meningitis | 111 | Whooping-cough | 45 |
| Sudden death (cause unknown) | 101 | Rheumatism | 45 |
| Diarrhœa | 85 | | 2,963 |
| Disease of stomach and intestines | 68 | Balance, a fall per million of | 1,049 |
| Measles | 64 | | |
| All other causes | 269 | | |
| | 4,012 | | |

There are several points of interest in the foregoing table:

1. Most of the destructive infectious diseases are found in the column of those in which the death rate has fallen, while the local diseases, or diseases of special organs, are found in the other column of causes in which the death rate has risen.

2. The former class, including phthisis, are chiefly diseases of children and young adults, while the latter, the local diseases and causes, are diseases of advanced life.

3. The decided fall in some instances may be taken as an evidence of more exact diagnosis of disease, as in the case of "dropsy," a symptom only which is now more commonly certified under its correct title of heart, kidney, or liver disease, hence the lessened number of cases atttributed to this indefinite cause.

*Dr. H. B. Brennecke. in Vierteljahrsschrift f. öff. Gesundheitspflege, 1897, p. 81, vol. xxix.

4. The fall in the death rate from typhoid fever "is without doubt," as Longstaff states, "the great triumph of the sanitary reformers." Undoubtedly, a large share of the fall in phthisis, smallpox, scarlet fever, and measles may reasonably be attributed to the same cause.

5. The steady rise in the death rate from cancer has given occasion for comment and investigation in all countries where registration of deaths is made.

The following figures show the increase of cancer in the countries and cities named:*

*Various Countries.*

In Germany, while the population increased from 1890 to 1900 14.18 per cent, cancer increased in 10 states in a shorter period (1892–93 to 1898–99) 24.56 per cent.
In Ireland cancer increased with a diminishing population from 5.8 per 10,000 in 1897 to 6.5 in 1901, or in absolute numbers, 2,635 to 2,893 deaths.
In Austria from 5.4 per 10,000 in 1891 to 7.0 in 1900.
" Bavaria from 8.9 per 10,000 in 1891 to 9.9 in 1900.
" Holland from 7.9 per 10,000 in 1891 to 9.3 in 1900.
" Italy from 4.3 per 10,000 in 1891 to 5.2 in 1900.
" Norway from 6.1 per 10,000 in 1891 to 9.2 in 1900.
" England from 5.1 per 10,000 in 1880 to 8.3 in 1899.
" Switzerland from 11.4 per 10,000 in 1889 to 13.2 in 1898.
" 250 cities of France from 8.4 per 10,000 in 1887–90 to 11.0 in 1900.

*New England States.*

" Maine from 6.1 per 10,000 in 1891 to 7.6 in 1900.
" New Hampshire from 5.6 per 10,000 in 1891 to 7.1 in 1900.
" Vermont from 5.5 per 10,000 in 1891 to 8.5 in 1900.
" Massachusetts from 6.1 per 10,000 in 1891 to 7.1 in 1900.
" Rhode Island from 5.1 per 10,000 in 1891 to 6.8 in 1900.
" Connecticut from 5.2 per 10,000 in 1891 to 6.6 in 1900.

*Various Cities.*

" Boston from 6.9 per 10,000 in 1891 to 8.1 in 1900.
" Brussels from 3.4 per 10,000 in 1891 to 4.4 in 1900.
" Breslau from 8.6 per 10,000 in 1891 to 10.8 in 1900.
" Copenhagen from 13.6 per 10,000 in 1891 to 13.9 in 1900.
" Munich from 12.7 per 10,000 in 1891 to 11.9 in 1900 (14.8 in 1897).
" New York from 5.4 per 10,000 in 1891 to 6.7 in 1900.
" Paris from 10.0 per 10,000 in 1891 to 10.5 in 1900.
" St. Petersburg from 9.9 per 10,000 in 1891 to 10.0 in 1900.
" Vienna from 10.4 per 10,000 in 1891 to 12.1 in 1900.

*The Relation of Seasons to the Death Rate.*—Seasons have an influence upon the mortality of populations. In temperate climates, having a wide difference between the temperature of summer and winter, a very cold winter usually increases the mortality of aged people, while an unusually hot summer increases the infant mortality. The effect of seasons may be shown by dividing the year into four quarters and stating the death rate in each. For this purpose the Registrar-General of England re-estimates the population for each quarter, allowing for increase. Dr. Böckh, of Berlin, makes a new estimate for each month in stating a monthly death rate.

MONTHLY DEATHS IN NINETY CITIES AND LARGE TOWNS IN MASSACHUSETTS IN 1901.

| | Deaths in each month. | Deaths per day. | Monthly ratio. | | Deaths in each month. | Deaths per day. | Monthly ratio. |
|---|---|---|---|---|---|---|---|
| January | 3,742 | 120.7 | 108.8 | August | 3,683 | 118.8 | 107.1 |
| February | 3,517 | 125.6 | 113.2 | September | 3,514 | 117.1 | 105.6 |
| March | 3,832 | 123.6 | 111.4 | October | 3,178 | 102.5 | 92.4 |
| April | 3,406 | 113.5 | 102.3 | November | 3,127 | 104.2 | 94.0 |
| May | 3,063 | 98.8 | 89.1 | December | 3,296 | 106.3 | 95.9 |
| June | 2,886 | 96.2 | 86.7 | | | | |
| July | 3,250 | 104.8 | 94.5 | | 40,494 | 110.9 | 100.0 |

In order to show the relative incidence of disease in each month, the writer has adopted the following method, which corrects the effect of the varying length of the months.

Divide the whole number of deaths in the year by 365, to obtain a daily standard (in leap year 366).

Also divide the number of deaths in each month by the number of days in the month.

Divide the daily number of deaths in each month by the daily number for the whole year and multiply by 100.

By this method the intensity of the death rate in each month may be compared with that of the year, and with that of each of the other months.

By quarters of the year the highest mortality in the German Empire, Austria, Switzerland, and France was in the first quarter, but in Italy the highest mortality was in the third quarter. In Massachusetts during the forty years (1856–95) the highest mortality was in the third quarter.

With reference to the different diseases or causes of death considerable variations are found when these causes are compared with each other.

The following table presents the relative monthly incidence in the mortality from eight different diseases in Massachusetts for the twenty years 1876–95. These observations are made from 291,222 deaths from the specified diseases which occurred during the period named (1876–95).

TABLE SHOWING THE COMPARATIVE MORTALITY BY MONTHS OF EACH OF EIGHT DISEASES IN MASSACHUSETTS (1876–95).

| | Measles. | Scarlet fever. | Diphtheria. | Typhoid fever. | Dysentery. | Cholera infantum. | Consumption. | Pneumonia. |
|---|---|---|---|---|---|---|---|---|
| January | 94.8 | 143.2 | 124.0 | 79.2 | 17.9 | 5.2 | 104.9 | 171.4 |
| February | 103.4 | 121.0 | 106.1 | 67.3 | 19.4 | 4.7 | 104.2 | 153.8 |
| March | 116.1 | 129.1 | 89.4 | 64.6 | 19.7 | 5.3 | 109.5 | 158.8 |
| April | 166.7 | 121.5 | 90.4 | 67.7 | 19.8 | 6.0 | 110.4 | 154.5 |
| May | 182.9 | 120.1 | 92.4 | 62.8 | 23.7 | 9.4 | 105.6 | 115.1 |
| June | 169.0 | 91.9 | 83.7 | 56.8 | 35.2 | 39.5 | 94.6 | 60.7 |
| July | 128.7 | 63.9 | 68.3 | 64.7 | 187.9 | 382.8 | 93.7 | 39.0 |
| August | 55.2 | 56.0 | 65.8 | 125.0 | 416.5 | 443.8 | 94.2 | 32.1 |
| September | 33.7 | 55.7 | 86.3 | 190.8 | 282.5 | 216.2 | 95.8 | 39.5 |
| October | 30.3 | 78.8 | 125.1 | 181.3 | 115.5 | 56.2 | 95.8 | 61.8 |
| November | 49.7 | 105.3 | 134.7 | 136.4 | 35.0 | 12.9 | 93.8 | 88.0 |
| December | 70.6 | 114.7 | 134.1 | 102.3 | 18.8 | 5.5 | 97.5 | 128.2 |
| Mean | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

These figures are to be read as follows: Assuming a monthly standard mean of 100 throughout the year, there were 94.8 deaths from measles in January, 103.4 in February, 116.1 in March, etc.

*Vital Statistics as Tests of the Comparative Healthfulness of Communities.*—1. The general death rate is the test most commonly applied for determining the comparative health of different communities. It, however, has certain limitations. It may be trusted for comparing the health of a city, town, or district for any given year with that of the same community for a preceding year or period. But when comparison with other districts, cities, or towns is to be made, erroneous conclusions may be drawn.

(*a*) Because of differences in the age and sex distribution of the population of the places compared with each other (see page 250).

(*b*) There may be public or private institutions in the city or town in which deaths of persons other than residents occur. Correction for these should be made. For example, in a small town in Massachusetts in 1900 having a population of 3,683, the deaths were 453, giving the enormous death rate of 123 per thousand of the population; 402 of these deaths occurred in a state institution, leaving for the town a death rate of about 19 only.

(*c*) Occupation and social conditions have a decided effect upon the death rate. In the manufacturing communities in which different industries are conducted, one in which the wages are high and the other in which they are low, the death rate of the well-paid population is usually comparatively low.

2. The death rate from the principal infectious diseases is often quoted as an index of sanitary condition, the diseases embraced in such a general statement being measles, diphtheria, scarlet fever, whooping-cough, typhoid fever, cholera infantum, and tuberculosis. In consequence of the different methods by which such diseases are spread the methods of prevention also differ, and are more susceptible of application in some diseases than they are in others.

For example, a high death rate from typhoid fever in a town would indicate a greater neglect of sanitary precautions than a high death rate from influenza. In presenting the death rates from preventable or communicable diseases it is better to state the death rate of each one separately than to give an average of several, since the latter method is apt to conceal the effects of epidemics from special causes.

3. The infant mortality constitutes a delicate test of sanitary conditions, but should not be quoted as the only test or index. It should always be based upon the number of births, and not upon the census enumeration (see page 251).

4. A more exact method when all the data are complete is to construct a life-table by which the expectation of life may be compared in different districts, as well as among different classes of population. Those of insurance companies may be compared with each other, or with a general average of several companies; but these are obtained from a large number of lives selected by individual examination, and should theoretically give more favorable results than those constructed from the general population. The difference, however, between the expectation of insured lives and that of the general population at the same ages is less than might at first thought have been expected.

These tests of the health of a community, and especially the general death rate, are most trustworthy when the experience of a given community or district for a certain year is compared with its experience in a previous year or number of years, and least trustworthy when comparing its experience with that of other communities or districts.

*Effect of Sanitary Improvements upon the Death Rate.*—The most convincing proof of the effect of sanitary measures in lowering the death rate is shown in the Reports of the Registrar-General of England, as well as in the Ninth Report of the Privy Council of the same country. In the Registrar's Report for 1881 he says: "There is nothing in the series of reports issued by this office that comes out more distinctly and unmistakably than the wonderful effect which the sanitary operations of the last decade have had in saving life. The Public Health Act came into operation in 1872. The average annual death rate for the immediately preceding ten years (1862–71) had been 22.6, and there were no indications whatsoever of any tendency of the rate to fall lower. Indeed, in 1871, the final year of this period, the rate was exactly the average, viz., 22.6. The act came into force, and at once the rate began to fall, and continued to fall year by year with almost unbroken regularity, until in 1881 it was no more than 18.9. Once only in the ten years that had elapsed since the act came into operation was the rate as high as the average of the previous decades. . . .

"Had the fall in the death rate been limited to a single year or to two years, or even to three, it might have been argued by sceptical persons that the improvement was due to a succession of seasons favorable to health, or to other causes unconnected with sanitary administration, and that the setting in of the fall, coincidently with the coming into operation of public health measures was no more than casual; but, in face of a fall, lasting for ten years in succession and increasing each year in amount, no one can seriously maintain such a position. There can be no real doubt that the saving effected in life was the direct product of the money and labor expended in sanitary improvements."

A similar effect has been observed in many large cities following the introduction of purer water supplies and other sanitary improvements, notably in Hamburg, Paris, Munich, Vienna, Berlin, Chicago, and in Lawrence.

*Fallacies in Vital Statistics.*—For the purpose of avoiding serious errors in the use and interpretation of vital statistics Quetelet has proposed the following excellent rules:

1. Never have preconceived ideas as to what the figures are to prove.

2. Never reject a number that seems contrary to what you might expect, merely because it departs to a great extent from the apparent average. (Any unusual departure from an apparent average, however, should lead the statistician to make a careful revision of his figures with the object of correcting possible errors.)

3. Be careful to weigh and record *all* the possible causes of an event, and do not attribute to one what is really the result of the combination of several.

4. Never compare data which have nothing in common.

Errors from paucity of data often occur in medical writings where statistics are employed. A small number of observations is not sufficient to establish a conclusion. The degree of approximation to the truth may be estimated by means of Poisson's formula:

$\mu$ = the total number of cases recorded in two groups.
$m$ = the number in one group.
$n$ = the number in the other group.
Hence $\mu = m + n$.

The extent of variation in the proportion of each group to the whole will vary within the proportions represented by $\frac{m}{\mu} + 2\sqrt{\frac{2mn}{\mu^3}}$, and $\frac{n}{\mu} - 2\sqrt{\frac{2mn}{\mu^3}}$.

The larger the number of the total observations ($\mu$) the less will be the value of $2\sqrt{\frac{2mn}{\mu^3}}$, and the less will be the limits of error in the simple proportion $\frac{m}{\mu}$.

Thus, out of 150 cases of diphtheria 18 died, a fatality of 12 per cent. The possible error is determined by the second half of the above formula,

$$= 2\sqrt{\frac{2 \times 18 \times 132}{150^3}} = 2\sqrt{\frac{4{,}752}{3{,}375{,}000}} = 0.0756,$$

*i.e.*, the possibility of error = 0.0756 of unity or 7.56 per cent. In other words, in a second series of cases of diphtheria under the same conditions as the foregoing, the fatality may vary from 4.44 to 19.65 per cent., an indefinite result which indicates that the first series cannot be depended upon as establishing more than a *prima-facie* case in favor of any special method of treatment that may have been adopted. If 15,000 cases and 1,800 deaths are taken the limits of error are comparatively small.

The steady decrease in the limits of possible error as the number of recorded facts increases is shown in the following table, where in the first line there are 7 recoveries (70 per cent.) out of 10 cases, and in the last line 700,000 out of a million cases. In the first instance the absurdity of drawing conclusions from a small number is shown, since the possible recoveries are actually greater than the whole number of cases:

| Total number of cases. | Number of recoveries. | Possible number recovering out of 100,000 cases according to Poisson's formula. |
|---|---|---|
| 10 | 7 | 29,020 or 110,980. |
| 100 | 70 | 57,000 or 73,000. |
| 1,000 | 700 | 66,000 or 74,000. |
| 10,000 | 7,000 | 68,700 or 71,300. |
| 100,000 | 70,000 | 69,600 or 70,400. |
| 1,000,000 | 700,000 | 69,870 or 70,130. |

An instance illustrating this fallacy occurs in a recent work upon vaccination, in which the author makes the following statement:

A certain Society for the Relief of the Blind publishes the names of fifty people seeking relief, and states the causes of their blindness: "One of these people was blind from having had smallpox. Smallpox hence appears to occasion two per cent. of the blindness at the present time."

The fallacy of this statement appears upon the application of the foregoing rule, since the limits of error

* The figures are from the Mittheilungen aus Kaiserlichen Gesundheitsamte, vii., p. 120, and "Uebersicht über Verbreitung der Krebskrankheit am Ende des 19. Jahrhunderts in einigen ausserdeutschen Gebieten," by Dr. Rahts, and from the Registrar-General's Report upon Cancer in Ireland, Dublin, 1903.