Original Articles.

CONSUMPTION: AN INDOOR DISEASE.¹

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"How the people live is one of the most important questions that can be considered, and how — of what causes and at what ages — they die is scarcely of less account; for it is the complement of the primary question, teaching men how to live a longer, healthier and happier life."

These words were written nearly a half-century ago, by one of the foremost medical men of his day, Dr. William Farr, and have lost none of their meaning as applied to our own times.

A careful study of the different classes and species of infections reveals their true character as widely diverse, as much so in fact as the different classes of plants which make up the flora of a country, or the different forms of animal life which constitute its fauna. The active agents of infection appear to be only lower forms of life. The infections of animals, the infections of plants, the infections of mankind, have their natural habitats or soils for growth, and are also capable, in many instances, of culture or growth upon other soils.

There is much yet to be learned in regard to the habits or life of the different infections — much that will aid us in the future in successfully combating them.

No form of infection has been studied with greater interest, during the past quarter of a century, than that of tuberculosis. Prominent among the characteristics of this disease, which have been shown by years of observation, by experiment and careful study, are the following:

I. WITHIN THE BODY.

- (a) A slow and indefinite period of incubation.
- (b) In the majority of cases it appears as a disease of the lungs.
- (c) Selection of the youthful or early adult period of life (fifteen to thirty years).
- (d) It exists as a disease of certain other mammals as well as of man.
- (e) Mode of entrance into the body: (1) by the lungs; (2) by the alimentary canal; (3) by inoculation through the skin, in the foregoing order of frequency.

II. OUTSIDE THE BODY.

The infection leaves the body mainly in sputum coughed up from the lungs, but may occur in secretions or excretions from other diseased organs.

The infectious sputum is mainly that of the lungs, and not that which is simply discharged from the mouth as saliva; nor does it usually exist in vomitus.

The tuberculous sputum specially dangerous is dry.

The tuberculous sputum of enclosed air-spaces constitutes a far greater danger than that which remains out-of-doors.

The foregoing conditions may be considered as mainly accounting for the fact that consumption bears the characteristics of an indoor infection. It may be stated, however, almost as an axiom, that this characteristic also applies to nearly all the infectious diseases in a measure, but in a more limited sense to whooping-cough and still more to influenza. Given a definite number of healthy persons, say 1,000, having identical conditions as to age, sex and race, and let them be divided equally, 500 to lead an indoor life, and the other half an outdoor life (for example, like fisher-

men); let an equal quantity of infectious material, for example, that of diphtheria, scarlet fever, or the dried sputum of consumptives, be distributed equally among the two groups, and it may be laid down almost as an axiom, that the indoor group will become infected in far greater numbers than the outdoor group.

The reasons are plain: The persons composing the indoor group are aggregated more closely together and the air-supply is limited in proportion to the efficiency of the ventilation, and these two conditions, the density of aggregation (as shown by Dr. Farr's early reports) and the limitation of the air-supply, or, in other words, the ventilation, favor the spread of infection.

The preservation of the vitality of infectious material is also secured by the protection afforded by enclosed areas, either in rooms, workshops, railway cars, staterooms, cabins, or other enclosed spaces. Hence the usefulness of measures adopted by boards of health, in the shape of ordinances forbidding the practice of spitting upon the floors of such places.

On the other hand, the outdoor group is subjected to similar influences only in an infinitesimal degree. Ventilation is not needed, since the outdoor air affords the necessary protection by its enormous diluting power. The density of aggregation is greatly diminished and disease germs lose their vitality under the destructive influences of the wind, the sun and the rain. The chief danger here arises from the conveyance of such material indoors upon boots, shoes and dress skirts.²

Two persons standing or working at a distance from each other of five or ten feet are far more liable to transmit and to receive infection from each other when indoors than in the outdoor air.

In consequence of the peculiar methods under which tuberculosis is spread from one person to another, from the sick to the well, it is, therefore, desirable that the most careful attention should be bestowed upon the condition of those persons who are compelled either to live or to work indoors, and that a due measure of the work of boards of health with reference to the restriction of the spread of this disease should be expended in this direction. The danger from the consumption of milk and meat of tuberculous animals has been investigated, and thus far, while the danger to be feared from this cause may be said to have passed from the region of possibility to that of probability, that which may be feared from the diffusion of sputum in enclosed areas or spaces may be said to amount to a certainty.

Very much of the investigations now being conducted in other countries in regard to industrial hygiene depends upon this principle of indoor infection. Unfortunately very little has yet been done in this direction in America. (The few papers in the *Transactions* of this Association, especially the prize essay of Mr. Ireland, should be supplemented by some active operations upon our part as an organized association working for the public welfare and having the good of all classes in view.)

The conditions to which I have alluded being known and recognized, we are prepared for the statement of Cornet that open-air infection from tuberculosis may practically be disregarded, since no positive evidence has ever been presented to the effect that human

¹ Read at meeting of American Public Health Association, Philadelphia, Pa., October 27, 1897.

² See Cornet's experiments and those of W. Kruse (*Über die hygienische Bedeutung des Lichtes*), in Koch's *Zeitschrift f. Hygiene*; v, xviil and xlx, p. 313.

beings ever contract tuberculosis in the open air. The results of observation and experiment both tend to show that the far greater danger lies in the direction of indoor infection.

Unfortunately, when the term "infectious" or "contagious" is applied to a disease, there is no discrimination in the minds of the laity, and such disease is at once classed with small-pox, measles and scarlet fever; but infection has its limitations and degrees and those of tubercular infection are well defined and are bounded by narrow limits. Dr. Russell in his excellent pamphlet on the "Prevention of Tuberculosis" quotes the following statement of the French League for the Prevention of Pulmonary Phthisis:

"We know further that the consumptive is not in the least dangerous by contact or proximity, that it is neither his body nor his breath which is hurtful, and that we can chat with him for hours, live with him for years, and even sleep in his room and give him the most constant care, without running any serious risk, *provided we take certain precautions*, the chief of which is to collect his expectoration, and not to delay the destruction of his spittle until it becomes dry, and is disseminated as dust into the atmosphere."

And very wisely adds—

"This position is logical and unassailable. If you accept the doctrine as sound, the practice must be conceded as sufficient. Let there be spittoons handy for everybody; don't put your spit in the way of drying and becoming dust; don't anywhere stir up the dust in inclosed places. The remedy is so commonplace that, after reading all that has been written and spoken, and proclaimed and enjoined, when we look at our notes and find nothing but sputum, spittoons and dust, we are apt to show a little temper, like Naaman when he expected the prophet to hold a solemn function over his leprosy, and he merely told him to go and wash himself. No doubt, the very simplicity of the prescription will constitute the greatest difficulty in the way of its acceptance and observance. . . . Only a clear apprehension of, and firm belief in, the doctrine that practically consumption is communicable through dried expectoration, and nothing else, will save the practice from ridicule."

To say, then, that consumption is not infectious is to contradict the highest authorities, who appear to have settled this question both by experiments upon the lower animals and by observation, both with reference to men and the lower animals.

I shall now call your attention to some of the proofs of the proposition which forms the title of this paper, that consumption is an indoor disease:

(1) The evidence shown by occupations.

(2) That which is presented by the conditions of age and sex.

I. AS TO THE EVIDENCE PRESENTED BY OBSERVATIONS UPON THE MORTALITY IN DIFFERENT OCCUPATIONS.

The best information upon this point is that which has been presented by Dr. W. Ogle, chief medical officer in charge of the English Registration Returns.

In a paper upon the mortality in different occupations presented at the International Congress of Hygiene in 1891, Dr. Ogle presented the following statement and figures concerning them so far as consumption is concerned:

"The difference between an outdoor life in fresh

country air and an indoor life in a town is readily shown by comparing the mortality of farmers, gardeners and fishermen with that of shopkeepers; or, going a step further in the scale of vitiated air, with that of tailors, printers, book-binders and hatters, all of whom habitually work in overheated and under-ventilated rooms."

In this table the author confines the figures to phthisis and diseases of the organs of respiration, although the danger is not limited entirely to these organs. Fishermen appear at the top of the list with the lowest mortality from phthisis and diseases of the respiratory organs.

TABLE I.

COMPARATIVE MORTALITY FROM PHTHISIS AND LUNG DISEASES OF MEN (FORTY-FIVE TO SIXTY-FIVE YEARS OF AGE) WORKING IN PURE AND IN VITIATED AIR.

Air.	Occupation.	Phthisis.	Diseases of respiratory organs.	Phthisis and diseases of respiratory organs.
Pure air	Fishermen	55	45	100
	Farmers	52	50	102
	Gardeners	61	56	117
	Agricultural labor-	62	79	141
Confined air	Grocers	84	59	143
	Drapers	152	65	217
Highly vitiated air.	Tailors	144	94	238
	Printers.	233	84	317

In the foregoing table, Dr. Ogle has presented a few occupations as illustrations of his proposition, to show the difference between the mortality of persons of different occupations working in pure and in vitiated air, or what amounts to the same, outdoor air and indoor air.

In order to present the results of observation as clearly as possible, the usual figures representing the death-rates of the living population at certain ages and of certain occupations are reduced to a standard of 100 for that occupation which presents the lowest mortality from phthisis and diseases of the respiratory organs, and that is the occupation of the fisherman—a typical out-of-door mode of life. Next in order come farmers, gardeners and agricultural laborers; and then a group of indoor occupations in which the indoor space is not seriously limited; and, finally, a group of occupations in which persons work in small and poorly ventilated spaces. That the careless distribution of sputum upon the floors of workshops has had much influence upon the phthisis mortality of such workmen is shown by careful observation.³

Added to the harmful effect of overcrowding in small apartments and workshops, and of inadequate ventilation, is the presence of the dust arising from the methods of conducting certain occupations, and especially of such forms of dust as are sharp and irritating. That such occupations are especially attended by high phthisis mortality is abundantly shown by further tables presented by Dr. Ogle in the paper already alluded to, as well as by other observers.⁴

³ See statement by Dr. Marfan in Rev. d'Hygiene, 1890, vol. xii, p. 66.

⁴ See also the recent monograph of Dr. Sommerfeld, entitled Die Schwindsucht der Arbeiter, Berlin, 1895.

II. THE PROOFS AFFORDED BY THE RECORDS OF MORTALITY BY SEX AND AGE-PERIODS.

Accurate records of occupation mortality extending over long periods of time are not to be had in this country; but there are some quite good statistics of age and sex for different diseases, and there are certain peculiarities of these figures to which I desire to call your attention. The figures which I have selected for examination are those of my own State (Massachusetts) for the nine years, 1887-95. They comprise over 50,000 deaths registered as from pulmonary phthisis in this period, and may be considered as fairly accurate.

TABLE II.

DEATHS AND DEATH-RATES FROM PHTHISIS AT DIFFERENT AGES, MASSACHUSETTS, NINE YEARS, 1887-95.

(Compiled from a total of 50,583 deaths from phthisis in Massachusetts.)

Age Periods.	Deaths from Phthisis.		Death-rates per 10,000 living.		Deaths of females to each 100 males in equal numbers living.
	Males.	Females.	Males.	Females.	
0-2	868	806	26.8*	25.2*	93
2-3	129	127	6.1	6.1	100
3-5	118	150	3.0	3.9	130
5-10	197	266	2.2	3.0	136
10-15	248	737	2.8	8.6	301
15-20	1,804	2,969	19.3	29.8	154
20-30	7,067	8,701	35.4	39.7	112
30-40	5,466	5,611	36.1	35.9	99
40-50	3,363	3,143	30.4	26.8	88
50-60	2,333	1,787	30.9	20.7	67
60-70	1,512	1,295	31.4	23.7	76
Over 70	915	1,001	31.3	26.9	86
	24,020	26,563	24.5	25.6	105

* Corrected figures for ages 0-2 years: Males, 21.0; females, 19.5.

The correction for the first two years of life is made necessary in consequence of the defective character of the census enumeration of children at that age of life.

An examination of this table reveals some remarkable facts upon careful analysis. It will be noticed that the age-periods are presented in a peculiar manner. First, the first years of life (0-2) are presented as one group; secondly, the third year is presented by itself; then come the fourth and fifth years in another two-year group; then the usual five-year groups from five years up to twenty; and then the remainder of life in ten-year groups.

The object in presenting the figures in this manner is to show that at the third year of life the death-rate of boys and girls from phthisis is equal.

In the first ten years of life, the phthisis death-rate of boys is slightly higher than that of girls of the same age, the ratio being 93 deaths of girls to 100 of boys.

In the third year of life, the phthisis death-rate has become equal in the two sexes (100 females to 100 males in equal numbers living). In the next two years, the female death-rate from phthisis has passed that of males, and then is equivalent to 130 deaths of females to 100 of males in equal numbers living. At the period of childhood (5-10 years) the increase of the female over the male death-rate has continued, and

equals 136 females to 100 males. In the next period (10-15) it has reached the very great difference of 301 females to 100 males. In the period 15-20 years, the female death-rate bears the relation to the male of 154 to 100; and in the next period (20-30) it is as 112 to 100. This rapid decline in the female death-rate continues from a death-rate of 39.7 per 10,000 living females, in the period 20-30 years, down to that of 20.7 per 10,000 in the period 50-60 years, at which period it bears the relation to the male death-rate of 67 females to 100 males.

The male death-rate, which has reached a climax of 36.1 per 10,000 in the age-period 30-40 years, declined to 30.4 in the next period, and remained nearly constant from that time throughout the remainder of life.

The points in this table to which I desire to call attention are the following:

In the first two years of life, the death-rate of boys from phthisis is slightly greater than that of girls; but in the third year of life the death-rate is equal. In the fourth year of life the difference in the phthisis death-rate of the sexes is reversed, and that of girls is the greater; and for the two years, 3-5, this excess among girls amounts to 30 per cent. In the five-year period (5-10 years) this excess has increased slightly to 36 per cent.; but in the next period (10-15 years) it suddenly makes a bound and rises to triple the male death-rate. So far as can be learned, the greatest relative difference in the phthisis death-rate of the sexes occurs between the twelfth and thirteenth years of life. The phthisis death-rate of each sex then increases rapidly to its maximum in males in the age-period (30-40), and in females in the period (20-30). The highest death-rate of males from this cause probably occurs at a little over thirty years, and that of females at a little less than thirty years.

A careful examination of English figures for phthisis reveals a general coincidence in almost every particular except that the difference in the death-rates of the sexes at early ages is not so great as in the Massachusetts figures, the female rate at ages 10-15 amounting to double that of the male instead of treble. Again, the period at which the female death-rate begins to exceed that of the male is not until the fifth year of life instead of the fourth, as in Massachusetts. What is the true explanation of these differences in the death-rates of the sexes from phthisis? I shall only offer a hypothetical explanation.

The lessened death-rate of females, as compared with males in the later age-periods (forty years and onward), may be explained (provided the doctrine of immunity or that of insusceptibility applies to phthisis) upon the supposition that the majority of susceptible females have been removed from the population by death in the early age-periods, leaving an excess of susceptible males. But this does not explain the excess of the female death-rate from phthisis in the early ages, after the second year of life. I venture, therefore, to offer the following:

Upon the theory that the infection of tuberculosis is mainly an indoor infection. At birth and from that time, throughout the first three years of life, the death-rate of the sexes from phthisis is very nearly equal. During these three years the relative amount of time spent within doors is about the same for both sexes, but in the fourth year of life, as an average, boys begin to spend more time out of doors than girls,

and the relative amount of difference in time so spent continues to increase from that time onward. It cannot be urged that the period of puberty in girls has an effect in causing this difference, since the difference begins at a much earlier time of life and reaches its climax before that age in females. The delay in the onset of this increase in females in England and the lessened difference at the age 10-15 years may, perhaps, be accounted for by climatic differences, that is, a generally milder climate in the British islands.

A singular instance of the hold which popular fallacy in regard to infection gains upon the laity is presented in the results of a legislative inquiry which occurred in Massachusetts last winter, but which, fortunately, proved a failure.⁶

The underlying principle which could have any possible weight in this investigation was the possible danger of the spread of tuberculosis infection from a hospital inhabited by consumptives to the surrounding neighborhood, or from its inmates while walking about the grounds or the neighboring streets; or, in other words, the danger of outdoor infection. Since such danger was neither proven, nor was even a strong probability thereof shown to exist, the proposed measure utterly failed.

Once let the idea of infection gain a foothold in the popular mind, and the belief spreads rapidly and often to such an extent as to cause harm instead of good. The method and degree of infection are all of no account so long as these words "infectious or contagious" have become impressed upon the mind of the community.

Modern medicine has received no greater impetus than that which has been derived from the rapid advances afforded by bacteriological research. So great, and so valuable have these results proved, that the death-rate from some of the worst forms of infection has begun to lessen with greater rapidity than before, under the influence of methods which had their origin in the laboratory of the scientist.

Notwithstanding this fact, however, it cannot be denied that the most reliable conclusions in regard to the true characteristics of infectious diseases must be derived not only from the laboratory but from the observations of the physician in his daily rounds of practice, together with a study of mankind in his relation to all outward circumstances which influence his condition in life, such as those of sex, age and occupation. In other words, the results of laboratory investigation, clinical observation, and the broad and general study of the natural history of disease taken together constitute a better means of deciding doubtful questions in regard to infection than either of these methods taken separately.

In conclusion, then, it must be admitted, that tuberculosis is an infectious disease. Its character is too well defined, both by observation and by experiment, to admit a reasonable doubt. The active principle of infection, the bacillus of tuberculosis is recognizable; it is capable of isolation from the body, of cultivation, and of inoculation into the lower animals. But, practically, the exact mode of infection, when applied to the daily intercourse of human beings, is extremely limited, and no evidence has ever been presented which tends to show that such infection ever occurs by exposure in the open air, either by the breath of con-

sumptives or by the distribution of sputum upon the surface of the soil. On the other hand, abundant evidence shows that such infection is of very common occurrence from indoor exposure to the distribution of sputum deposited upon floors and dried under favorable circumstances.

By this I do not mean to infer that the outdoor free distribution of the sputum of consumptives should be encouraged or allowed, but should be prevented, on the general principle that all infectious material constitutes a greater or less danger, and not because any serious danger from such outdoor distribution has actually been shown to exist when compared with indoor distribution of sputum.

SOME CONSIDERATIONS OF TUBERCULOSIS.¹

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FREQUENCY.

TWO-SEVENTHS, or nearly 80 per cent., of civilized people are said to have tuberculosis. If this is true, then Lowell has 26,000 people afflicted with tuberculosis. The figures seem appalling. What is the evidence? In 1,000 autopsies by Biggs of New York, 275 or 27.5 per cent. had lesions of tuberculosis. If we consult our city mortality tables we find that for the last thirty years between 15 per cent. and 20 per cent. of all deaths are from the tuberculoses, and if we consider the cases of tuberculosis not only of the lungs, but of bones, skin, glands and other organs that we see maintaining a degree of health consistent with life, these figures do not seem extravagant. But if we look at the mortality charts we notice a curious fact. In 1884, the curve representing the per cent. of deaths from tuberculosis to the total deaths went for the first time below 15 per cent. and has steadily declined since, until it has reached 10 per cent. In the same year the curve representing a corresponding per cent. of deaths of children under five years began steadily to rise from 36 per cent. and has gradually reached a level of 43 per cent. In general this curve is influenced by the deaths from zymotic and diarrheal diseases (the causes of death in most children), but if we take the year 1892, when there were few deaths from all zymotic diseases and when the deaths from diarrheal diseases were the average for ten years, that is when we should expect a low death-rate among children, we find that 42 per cent., nearly the highest for ten years, of deaths were under five years. The deaths from diarrheal diseases was 12 per cent., and from zymotics 21 per cent., making a total of 33 per cent. So that we have 9 per cent. of the total deaths among children under five years to account for. What are the causes given for these deaths?

If we look at the last bulletin, we find that of 83 deaths under five years, 19 are classified as infantile debility and inanition. (Of course the responsibility for this does not rest upon the Board of Health.) In other words, a great many deaths among children really have no pathological cause of death given. Yet we know that during the first two years of life there is a constant increase in tuberculous disease, which then falls only to rise again at puberty.

To recapitulate: When we consider that the death-

⁶ The circumstances attending this investigation, having been already presented in the Journal, it is unnecessary to repeat them here.

¹ Read before North Middlesex District Medical Society, October 27, 1897.