

ries, and the largest for hospitals—making due allowance in all cases for space occupied by furniture. And *no deviation should be made on account of children*, whether in regard to the different members of a family or a school-room. With regard to this point, Mr. John Simon well observes: 'It is to be desired that laws and regulations as to overcrowding should not proceed on the assumption that children (to any measurable extent) require less breathing space than adults. Against any such assumption, two facts have been considered—first, that even healthy children, in proportion to their respective bodily weights, are about twice as powerful as adults in deteriorating the air which they breathe; secondly, that the children will almost invariably have certain eruptive and other febrile disorders to pass through, from which adult life is comparatively exempt, and in which the requirement of space is greatly increased. And having regard to these two considerations, I think it best that children and adults should be deemed to require equal allowance of air and ventilation.\*'

"Moreover, it should be observed that the mere space allowance should in no case detract from the absolute necessity of means for renewal, and the smaller the space so much the more certain should be this provision. If 300 cubic feet only be allowed, the air must be changed, at the least, every twenty minutes. *To neutralize the deleterious properties of respired air and to replenish it, every person requires 2,000 cubic feet of fresh air hourly, and with less provision than this contamination is sure to follow.*

"The poisonous effluvia which pervades the atmosphere of close and unventilated rooms is not only re-breathed, it adheres to all the surroundings; it sticks to the walls and furniture, settles into the drinking cups, into the food utensils, food and drink, permeates the clothing, and attaches to the person. It creates a nidus, which is not only in itself poisonous, perpetually lessening the vital force of all who inhabit it, and predisposing to blood poisons of every kind, but it also becomes a hotbed for the planting and propagation of specific poisons, such as small-pox, scarlet fever, measles, whooping cough, diphtheria, and the whole category of epidemic diseases, and a fruitful source of scrofula and consumption. The consideration of these diseases in detail, and their relations to crowded and unventilated places, would comprehend a treatise on the predisposing causes of epidemics. It may be stated in general terms, however, that the specific poisons which perpetuate this class of diseases are kept alive by the conditions common to school-rooms, always exist somewhere, and the history of them all demonstrates alternations of repose and activity, of prevalence in one place and absence in another, of successive invasions of contiguous neighbourhoods and succeeding immunities. But the specific morbid poisons, the *seed*, never die; they remain and live on from generation to generation, ever susceptible to enlivening influences, and liable to transmission from place to place, renewing strength by the way, again to become dormant and lie in ambush, awaiting the return of congenial conditions for renewed activity.

"The epidemic influences or constitution which some authors are wont to describe as conditions precedent to the activity of epidemic diseases, and which are believed to be periods of predisposing receptivity of specific poisons, are due in no small degree to the prevailing condition of school-rooms and their congeners. As a rule, the older these conditions—the longer the period of time in which they have been tolerated—the more depressed the vital powers of their occupants, and the greater their predisposing receptivity. Besides, the depressed state of the organism under such conditions is not only predisposing to epidemic diseases, but the liability to and the danger of all diseases is thereby intensified, and vicissitudes of weather, which, under favourable circumstances may be encountered with impunity, under these depressing influences become dangerous perils; and, doubtless, much that is attributed to the season of the year supposed to be predisposing to scarlet fever, measles, whooping cough, diphtheria, and some other common affections of children, is due to the same cause. It is at any rate very remarkable that the beginning of the autumnal school term should be simultaneous with or speedily followed by the sickly term. There is surely something more than a mere coincidence in these relations; they stand much more like cause and effect. The effect of high temperature, in this regard, may seem to imply an exception to these conclusions. Heat has, indeed, received much consideration lately, as a sort of independent cause of disease, and to its influence especially has been attributed the excess of mortality common to infants in hot weather. There is no question that heat exercises a very important influence, but we are fully persuaded that it is so entirely secondary in its relations, even in the heat of summer, as to be among the most preventable of causes. Its influence is mainly due to its effect on organic matter, unventilated apartments and filthy surroundings, and, above all,

on the food of infants artificially fed. Evidence is almost wholly wanting on the deleterious effect of summer heat on infants nursed by their mothers, or on older children with healthy surroundings. Its specially dangerous effect is, in short, due to conditions such as are usually present in close school-rooms and tenement-houses. Heat intensifies, but it does not cause the excess of summer mortality, and it frequently has the same effect in overheated school-rooms at other seasons.

"Carbonic acid in school-rooms, in some respects, bears similar relations to heat. Dangerous and fatal as it is known to be, when in great excess, its importance, *per se*, is unquestionably very much exaggerated. Naturally it exists in the atmosphere in variable proportions from 2 to 5 volumes in 10,000. But according to Dr. Angus Smith, no discomfort is experienced from the presence of carbonic acid in soda-water manufactories, when the amount is 2 volumes per 1,000, or more than ten times its normal proportion in the atmosphere. And Pettenkofer and Voit, in their experiments with this gas, experienced no discomfort from its presence, even to the extent of five times as much, or ten volumes per 1,000. Notwithstanding, *respired* air, containing only 1.5 volumes of carbonic acid per 1,000, is well known to cause headache, vertigo, and other painful admonitions of danger. And experience abundantly proves that whenever respired air, or the air of occupied apartments, is found to contain of carbonic acid more than 1 volume per 1,000, such an atmosphere is dangerous to health. It is apparent, therefore, that the ill effects of air which contains only a little more than 1 volume per 1,000 of carbonic acid, are due to other and more potent poisons. Such air not only contains, besides the excess of carbonic acid, and not unfrequently the more deadly carbonic oxide, dead and decomposing animal matter, and other mephitic gases and exhalations, but it is deficient in its very first life-sustaining property, oxygen.

"The average amount of oxygen consumed by a healthy person is half a cubic inch every respiration, which in a day amounts to upwards of 25 cubic feet. And as oxygen constitutes but one-fifth of the volume of the air, a single individual renders not less than one hundred and twenty-five cubic feet of air unfit for respiration, every twenty-four hours, by the mere abstraction of oxygen alone. Meanwhile, there is exhaled by the lungs about 15 cubic feet of carbonic acid, 30 ounces of watery vapour, and an indefinite amount of organic matter, which has been variously estimated at from 10 to 240 grains.

"The whole quantity of air actually respired in 24 hours by a healthy person is about 400 cubic feet. This contains, when once passed through the lungs, about five and a-half per cent. of carbonic acid. The proportion of watery vapour depends upon circumstances; as a rule, as much as necessary to saturate it at the temperature of the body: consequently, the amount varies in the inverse proportion of the quantity of moisture the air contained before it was respired. It may be estimated at about 200 cubic feet per hour. 1,000 parts of vapour exhaled from the lungs consists of pure water, 907 parts; carbonic acid, 90 parts, and animal matter, 3 parts. In addition to these, it is well known that other substances introduced into the circulation may be thrown off from the system and increase the danger.

"Besides the danger from active and fatal disease from exposure to the conditions which have now been described, all physiologists recognize the influence of depressing agents on the human organization in blunting the sensibilities, obtunding the intellect, promoting stupidity, idiocy and physical deformity. And in this relation at least, the 'survival of the fittest' often has a painful significance, not alone confined to the present generation, but, recognizing the accepted law of inheritance, well calculated to shock the sensibilities in anticipation of the future. To discuss in detail the collateral dangers of bad construction, bad furniture, disregard of light, the general want of attention to proper school ages, differential management in regard to sex, physical condition, etc., would extend this paper to an inordinate length. For the discussion of these dangers, it will suffice our present purpose to refer to the papers of Dr. Richard Liebrich and Dr. George Ross, of London, recently published in *Public Health*; a paper by Dr. C. R. Agnew, of New York, in *The Sanitarian*; the treatises of Dr. Edward H. Clarke, of Boston, on *Sex in Education* and the *Building of a Brain*; the Report of Dr. Frederick Winsor on *School Hygiene*, in the Report of the State Board of Health of Massachusetts, and other papers recently written on these subjects.

"The following abstract of a Report on the Public Schools of Brooklyn, in March last, by the Sanitary Superintendent of the Board of Health, is submitted as an illustration of the conditions which have now been described. I will read only some of the best and some of the worst examples:

"No. 1. Ten rooms to each floor; average attendance 1,004. In one room there were 70 present in 7,560 cubic feet of space—108 cubic feet for each child. At the time of inspection, the second

\* Eighth Report of the Medical Officer of the Privy Council.