Thoms (W. F.)

With complements of the Author

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TENANT HOUSES.

BY

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TENANT HOUSES:

THEIR

GROUND AREA, CUBIC FEET OF AIR SPACE, AND VENTILATION.

Box 39

presented by J. Shrady, M. D.

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TENANT HOUSES.

In the preparation of this paper, the most practical works on hygiene have been consulted, consisting of Dr. Parke's Manuel on Practical Hygiene, the sanitary condition of New York, etc., etc.

I am greatly indebted to Dr. Hampton Harriot, of the New York Dispensary, for valuable suggestions in relation to the subject of ventilation.

According to the most accurate statistics collected in 1863 by Capt. Lord of the sanitary squad of the metropolitan police, there were 15,369 tenant houses in the city of New York (the number is rapidly increasing), containing a population of about 500,000. Most of the houses are overcrowded, their ground-area and cubic feet of air space much too small, and the ventilation very imperfect, the sleeping rooms in many instances have not the slightest circulation of air in them, thus increasing the number and severity of the zymotic (or foul air) disease.*

The most marked feature of the tenant houses is the small size of their apartments, whereby ensues overcrowding in each family.

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* Death-rate from zymotic diseases (foul air diseases) in England, London and New York, extracted from my paper on health in country and cities, published in the Transactions of the American Medical Association:

	In England.		In London.		In New York.	
	Death.	Pop.	Death.	Pop.	Death.	Pop.
Small pox	1 in	3,413	1 in	1,384	1 in	1,303
Measles	1 in	1,790	1 in	1,772	1 in	4,186
Scarlatina	1 in	669	1 in	585	1 in	996
Diphtheria	1 in	3,125	1 in	3,755	1 in	918
Quinsey	1 in	62,500	1 in	35,802	1 in	81,818
Croup	1 in	2,024	1 in	3,111	1 in	901
Whooping cough	1 in	1,805	1 in	1,333	1 in	7,087
Typhus and typhoid fever	1 in	1,129	1 in	1,032	1 in	854
Erysipelas	1 in	10,034	1 in	6,561	1 in	7,258
Metritis (puerperal fever)	1 in	17,561	1 in	13,181	1 in	10,742
Carbuncle	1 in	83,333	1 in	51,786	1 in	250,000
Influenza	1 in	22,223	1 in	70,732	1 in	81,818
Dysentery	1 in	19,281	1 in	26,851	1 in	3,146
Diarrhœa	1 in	1,361	1 in	1,212	1 in	380
Cholera	1 in	25,000	1 in	18,230	1 in	7,429
Ague	1 in	142,830	1 in	152,681	1 in	56,250
Remittent fever	1 in	100,000	1 in	32,954	1 in	34,615
Rheumatism	1 in	9,346	1 in	6,666	1 in	18,544
Other zymotic diseases	1 in	166,666	1 in	116,000	1 in	150,000

The common mode of arranging them is as follows: (See drawings No. 1 and 2.)

On a lot of ordinary size, twenty-five by 100 feet, will be erected a front house twenty-five by fifty, and a rear house twenty-five by twenty-five, with a court twenty-five by twenty-five, and frequently less, in which are located hydrant, cesspool and privy. These houses are commonly five and frequently six stories in height above the basement, the principal rooms of which there are four to each floor, occupy the width of the building front and rear, with small bed-rooms between, one to each main room. This arrangement gives accommodation to four families on each floor, making in a six story building twenty-four families, each family averages five members, and frequently more, as it is common for the occupants of these houses to take lodgers.

In this arrangement each person has a little over fifteen square feet in ground area, and 480 cubic feet of air space in the whole house. In the apartments the allowance of air space is 317 cubic feet, and in the dormitories but 89 feet to each person. This is the average, but there are many exceptions where the over-crowding far exceeds this. In addition the facilities for ventilating these small apartments are wholly confined to doors and windows, hall. ways and passages are dark and narrow, and the house is often surrounded by others of greater height, shutting out the cheerful and health-giving influences of sunlight and air.

The arrangement of tenant houses from street to street is as fol. lows (see drawing No. 3): Front house, court, rear house, small space between the rear houses, in which filth of all kinds accumulate, rear house, court and front house.

GROUND AREA.

Each person should have at least 50 superficial or square feet. (See drawing No. 4.)* This would allow 50 persons to each lot 25 by 100 feet. This arrangement would be the most practicable means of preventing over-crowding. The present average ground area is 15 square feet. (See drawing No. 5.)

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* In the metropolitan lodging houses 30 superficial and 240 cubic feet are allowed; in the section houses of the metropolitan police 50 feet superficial and 450 cubic feet are given. The poor-law board allow 300 cubic feet for every healthy person in dormitories, and 500 cubic feet for sick persons. In Dublin an allowance of 300 cubic feet is required in the registered lodging houses.—*From an excellent Pamphlet entitled "Essentia's of a Healthy Dwelling."*

Rule.

Each person should have 50 superficial or square feet of ground-area.

Cubic Feet of Air Space.

The following drawings illustrate the amount of air space which should be allowed to each person, compared with the average air space at present in tenant houses.

The standard amount of air space which practical hygienists say is necessary, is 1,000 cubic feet to each individual (see drawing No. 6); but this is too large an amount to be made practical in our tenant houses, therefore, I have placed the amount at 700 cubic feet of air space to each person—(see drawing No. 7)—it should never be less. This amount, with proper ventilation, will be sufficient to enable the human system to perform its functions properly.

The average amount at present in tenant houses is about 480 cubic feet (see drawing No. 8), but in many of them it is much less.*

The standard air space for the apartments should be 500 cubic feet. (See drawing No. 9.)

The present average in the apartments in tenant houses is about 300 cubic feet. (See drawing No. 10.)

The standard air space for dormitories (sleeping rooms) should be 300 cubic feet. (See drawing No. 11.)

The present average in sleeping rooms is about 89 cubic feet. (See drawing No. 12.)

Rule.

Every tenant house should have 700 cubic feet of air space to each person. The apartments 500 cubic feet, and the dormitories 300 cubic feet.

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* The following is an extract from Capt. Lord's report, illustrating this point:

Tenant Houses.	Cubic feet to each person.	No. of houses.	Population.
Having from	100 to 300	289	9,642
do	300 to 400	1,198	44,989
do	400 to 500	2,125	77,894
do	500 to 600	2,742	96,828
do	600 to 700	2,465	79,237
do	700 to 800	2,028	60,215
do	800 to 1,000	2,221	60,682
Having over	1,000	2,241	50,845
Total		15,309	480,368
Cellar population			15,224
Grand total			495,592

Quantity of Air.

What quantity of air must be supplied per head per hour, so as to dilute the products of respiration and transpiration from the healthy body, so as to keep the air always pure and fresh?

For healthy adult men, the question may be answered both by calculation and experiment. Taking the carbonic acid of respiration as a convenient measure of impurity, the following table will show the mode of calculation:

1. An adult man inspires and expires, on an average, 30 cubic inches at every respiration, and he breathes 16 times per minute. 30 by 16=480 cubic inches.

2. In an hour he therefore expires—480 by 60=28,800 cubic inches, or 16.66 cubic feet.

3. The air he breathes in (if pure) contains 0.4 per 1,000 volumes of carbonic acid, while the air he breathes out contains 40 volumes per 1,000 of carbonic acid, in addition to fœtid organic matter undetermined in amount, and watery vapor to saturation; or in other words, about 0.5 or 0.6 cubic feet of carbonic acid, and 136 grains of watery vapour, are eliminated per hour, or from 12 to 16 cubic feet of carbonic acid in 24 hours.

4. To dilute the expired air, so that the amount of carbonic acid shall be reduced to 0.4 per 1,000, more than 100 times the volume of expired air must be supplied per hour. 16.66 by 100=1,666 cubic feet.

5. But as the added air contains some carbonic acid, and as the exhalations from the skin require to be also diluted, at least one-fourth more must be added, which brings up the amount to 2,082 cubic feet per hour.

Pettenkofer,* by a similar calculation, has fixed the amount as 200 times the volume of the expired air, which he puts at 300 litre (=10.6 cubic feet per hour). Veerodit's calculation of the expired air is 12.75 cubic feet, and Valentin's 16.6 cubic feet per hour. Practical experience confirms this result.

The successive experiments made by Grassi and others have shown, first, that allowances successively given of 10 cubic metres (=353 cubic feet), of 20 cubic metres (706 cubic feet), of 30 cubic metres (1,059 cubic feet), were quite insufficient for one man, and the quantity was gradually increased till 60 cubic metres (2,118 cubic feet) were given. The air in the cell of a prisoner who received that ration of air seemed pure to the senses.

* Meber den Luftwechsel von Dr. Von Max Pettenkofer, 1858, p. 85.

From a number of experiments in which the outflow of air was measured and the carbonic acid simultaneously determined, it has been found by Dr. Parkes that at least 2,000 cubic feet per hour must be given to keep the carbonic acid at 0.5 or 0.6 per 1,000 volumes, and to entirely remove the fœtid smell of organic matter. When 1,200 or 1,400 feet only were given, the carbonic acid amounted to 0.7, 0.8, or 0.9 per 1,000 volumes, and the organic matter was in sufficient amount to destroy .00002 grammes of permanganate of potash, when 12 cubic feet of air were drawn through.

Air Vitiated by Respiration.

The carbonic acid of respiration is equally diffused through the air of the room; it is very rapidly got rid of by opening windows, and in this respect differs from the organic matter, and probably from the watery vapor; neither appear to diffuse rapidly or equally through a room. By the skin and lungs, pass off from 25 to 40 ounces of water in 24 hours, to maintain which, in a state of vapor 211 cubic feet of air per hour is necessary on an average. Of course, however, temperature and the hygrometric condition of the air greatly modify this.

Organic matter is also given off, the amount of which has never been precisely determined, and has been variously estimated at from 10 to 240 grains. Perhaps at present it may be approximately stated at 30 grains per diem for each adult. This organic matter must be partly suspended, and is made up of small particles of epithelium and fatty matters, detached from the skin, and partly of an organic vapor, given off from the lungs and mouth. The organic matter from the lungs when drawn through sulphuric acid, darkens it; through permanganate of potash, decolorizes it, and through pure water, renders it very offensive. Collected from the air by condensing the watery vapor on the sides of a globe containing ice, it is found to be precepitated by nitrate of silver, to blacken on platinum, and to yield ammonia; it is, therefore, nitrogenous. It has a fœtid smell, and this is retained in a room for so long a time, sometimes for four hours, even when there is free ventilation, as to show it is oxydized slowly. It is probably in combination with water, for the most hygroscopic substances absorb most of it. It is absorbed most by wool, feathers, damp walls and moist paper, and least by straw and horse hair. The color of the substance, influences its absorption in the following order;—black most, then blue, yellow and white. It is probably not a gas, but is molecular, and floats in clouds in the air, as the odor is evidently not always equally diffused through a room. This quantity is in no very close relation to the carbonic acid, though a large quantity of carbonic acid derived from respiration always indicates a large quantity of organic matter. In a room, the air of which is at first perfectly pure, but is vitiated by respiration, the smell of organic matter is generally perceptible when the carbonic acid reaches 0.7 per 1,000 volumes, and is very strong when the carbonic acid amounts to 1 per 1,000. Various experiments have shown that the amount of potassium destroyed by air drawn through its solution, is generally in proportion to the amount of carbonic acid of respiration.

Assuming that the organic matter has an effect on the permanganate of potash equal to that which sugar has, DeAngus Smith has calculated the amount of organic matter to be,

	Cubic feet of air.
In a bed-room one grain in	64,000
In a bed-room one grain in	56,000
Inside a house	16,000
In a closely packed railway carriage	8,000
When the air of a sewer entered a house	8,000
Ash of midden or cesspool	62
Pure air on high ground	170,000
Pure air on high ground	209 000

Besides the gaseous products strictly derived from the lungs, the air of most dwelling houses, when examined by the æroscope is found to contain many epithelium cells; many of them are evidently derived from the skin; they are rubbed off, and then float through the air. Some of the cells are smaller and rounded, and are either nuclei, or are from some parts of the air-tubes. Fragments of cotton fibre, wool, etc., etc., are also found. The plates show some of these objects found by Messrs. Hawlett, Stanley and Reed in the barracks at Gravesend. (See drawing No. 13.)

In all tainted atmosphere of this kind, it would appear that the germ of infusoria abound to a much greater extent than in pure air. It seems probable that the discovery of suspended matters of this kind will lead to most important results. The possibility of a direct transferrence from body to body of cells undergoing special changes is thus placed beyond doubt, and the doctrine of contagion receives an additional elucidation. It remains to be seen whether pus and epithelium cells becoming dried in the atmosphere can again on exposure to warmth and moisture, undergo the chemical changes which have been interrupted, or whether they would not rather break down into impalpable particles, and be then totally oxydized and destroyed. It is now generally admitted that protophytes like the prolococcus pluvialis, may be dried and yet retain their vitality even for years, and may be blown about in atmospheric currents, but it would not be right to infer a similar power on the part of epithelium or pus cells.

Effects of Impure Air.

The effect of the fœtid air containing organic matter, excess of water and carbonic acid, produced by respiration, is very marked upon many people; heaviness, headache, inertness, and in some cases nausea, is produced. From experiments on animals in an atmosphere from which carbonic acid and watery vapor were removed, and organic matter alone left, Cavarret and Hammond have found that the organic matter is highly poisonous.

Hammond found that a mouse died in 45 minutes, and Dr. Parkes has known cases in which the inhalation of such an atmosphere for three or four hours produced in men decided febrile symptoms (increased temperature, quickened pulse, furred tongue, loss of appetite and thirst), for even 24 or 48 hours subsequently.

When the air is rendered still more impure than this, it is rapidly fatal, as in the case of the Black Hole of Calcutta, of the prison in which 300 Austrians were placed after the battle of Austerlitz (when 200 died very rapidly). The poisonous agencies are probably the organic matter and the deficient oxygen, as the symptoms are not those of pure asphyxia. If persons survive, a febrile condition is left behind which lasts them three or four days, or there are other evidences of affected nutrition, such as boils, &c.

When air more moderately vitiated by respiration is breathed for a longer period, and more continuously, its effects become complicated with those of other conditions. Usually a person who is compelled to breathe such an atmosphere is at the same time sedentary, and perhaps remains in a constrained position for several hours, or possibly, is also under-fed or intemperate.* But

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* The following table shows the well known fact that the liquor stores are more numerous in those parts of the city of New York where the tenant-house population is the greatest.

The people being deprived of the natural stimulus of pure air, and having to live in foul allowing the fullest effect to all other agencies, there is no doubt that breathing the vitiated atmosphere of respired air has a most injurious effect on health. Persons soon become pale, and partially lose their appetite, and after a time decline in muscular strength and spirits.

The aeration and nutrition of the blood seems to be interfered with, and the general tone of the system falls below par, so that there appears to be less resistance to the action of morbific causes. Of special diseases it appears pretty clear that pulmonary affections are more common. *

Those persons who live in confined quarters do certainly appear to furnish a most undue percentage of phthisical cases. The production of phthisis from impure air (aided most potently, as it often is, by co-incident conditions of want of exercise, want of good food and excessive work), is no new doctrine. Baudelocque

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air, are compelled to resort to artificial stimulation to maintain their drooping spirits, until the powers of life are exhausted. Can happiness or comfort be obtained under such circumstances ?

Wards.	Total population.	Tenant house population.	Liquor stores.	Proportion to total population.
1	18,120	9,062	276	1 to 75
2	2,507	......		
3	3,757	1,305	476	1 to 55
5	22,341	11,206		
4	21,994	17,957	465	1 to 47
6	26,694	22,897	462	1 to 57
7	40,000	20,526	266	1 to 150
8	39,722	16,888	500	1 to 80
9	44,386	15,172	350	1 to 126
10	29,051	18,583	510	1 to 57
11	59,963	65,620	475	1 to 126
12	30,647	......	176	1 to 174
13	32,914	15,936	350	1 to 94
14	28,087	20,425	437	1 to 64
15	27,588	5,205	210	1 to 131
16	45,182	33,650	309	1 to 146
17	72,775	66,207	438	1 to 166
18	57,464	36,099	401	1 to 143
19	32,841	16,272	350	1 to 93
20	67,354	33,218	458	1 to 163
21	40,025	36,870	300	1 to 163
22	61,749	32,644	375	1 to 164

* The following extract from my paper on health in country and cities (Prize Essay), published in the Transactions of the American Medical Association, show the comparative prevalence of pulmonary affections in England, London and New York:

	England.		London.		New York.	
	Death.	Pop.	Death.	Pop.	Death.	Pop.
Phthisis	1 in	398	1 in	369	1 in	253
Bronchitis	1 in	635	1 in	483	in	1,968
Pleurisy	1 in	22,222	1 in	18,954	1 in	7,085
Pneumonia	1 in	840	1 in	788	1 in	519

As might have been expected, the death-rate is much greater in New York than in England or London, from the want of pure air in the tenant houses.

long ago asserted that impure air is the great cause of scrofula (phthisis), and that hereditary predisposition, syphilis, uncleanness, want of clothing, bad food and humid air, are by themselves non-effective. Carmichael, in his work on scrofula (1810), gives some most striking instances, where impure air, bad diet, and deficient exercise concurred to produce a most formidable mortality from phthisis. In one instance, in the Dublin house of industry, where phthisis was formerly so common as to be thought contagious, there were in one ward 60 feet long and 18 feet broad (height not given), 38 beds, each one containing four children; the atmosphere was so bad that in the morning the air in the ward was unendurable. In some of the schools examined by Carmichael the diet was excellent, and the only causes for the excessive prevalence of phthisis were the foul air, and want of exercise. This was also the case in the house and school examined by Neil Arnott in 1832.

In the prison of Leopoldstadt at Vienna, which was very badly ventilated, there died in the year (1834–1847) 378 out of 4,280 prisoners, or one in twelve, and of these no less than 220, or one in nineteen died from phthisis. There were no less than 42 cases of acute miliary tuberculosis. In the well ventilated house of corrections in the same city there were in five years (1850–1854) 3,037 prisoners, of whom 43 died, or one in seventy-one, and of these 24, or one in 126 died of phthisis.

The most important class of diseases produced by impurities in the atmosphere are certainly caused by the presence of organic matter floating in the air, since under this heading come all the specific diseases. The exact condition of the organic matter is unknown; whether it is in the form of impalpable particles, or moist or dried epithelium and pus cells, is a point for future inquiry; and whether it is always contained in the substances discharged or thrown off from the body, (as is certainly the case in small-pox,) or is produced by putrefactive changes in those discharges, as is supposed to be the case in cholera and dysentery is also a matter of doubt. But from the way in which, in many cases, organic substances are absorbed by hygroscopic substances, it would appear that it is often combined with, or is at any rate, condensed with the water of the atmosphere.

The specific poisons manifestly differ in the case in which they are oxydized and destroyed. The poison of typhus exanthematicus is very readily got rid of by free ventilation, by means of which it must be at once diluted and oxydized, so that a few feet give, under such circumstances sufficient protection. This is the case also with the poison of oriental plague; while on the other hand, the poisons of small-pox and scarlet fever will spread in spite of very free ventilation, and retain their power of causing the same disease for a long time, even it may be for weeks, or in the case of scarlet fever, for months.

Is it that in the one case the poison is a mere cloud of molecules; that in the other it is contained in epithelium and pus cells thrown off from the skin in both cases; and from the throat also in one, and which adhering to walls, clothing, &c., partially dry, and then can be rendered again active by warmth and moisture?

The same evidence of the effect of pure and impure air on health and mortality is still more strikingly shown by horses; for in that case the question is more simple on account of the absolute similarity in different periods or places of food, water, exercise and treatment. Formerly in the French army, the mortality among the horses was enormous. Rossignol states that previous to 1836, the mortality of the French cavalry horses varied from one in six to one in five per annum. The enlargement of the stables and the increased quantity of the ration of air, reduced the loss in the next ten years to one in fifteen.

In the English cavalry (and in English racing stables) the same facts are well known. Wilkinson informs us that the annual mortality of cavalry (which was formerly great) is now reduced to 1 in 50, of which one-half is from accidents and incurable diseases. Glanders and Farcy have almost disappeared, and if a case occurs, it is considered evidence of neglect.

The food, exercise and general treatment being the same, this result has been obtained by cleanliness, dryness and the freest ventilation. The ventilation is threefold—general ventilation, for drying the floors, ceiling ventilation, for discharge of foul air, and supply of air beneath the horses' noses, to dilute at once the products of respiration. In cow houses and kennels, similar facts are well known; disease and health are in the direct proportion of foul and pure air. That the breathing of air rendered impure from any cause is hurtful, and the highest degree of health is only possible, when to other favorable conditions is added that of a proper supply of pure air, might be inferred from the physiological evidence of the paramount importance of proper æration of the blood. Experience strengthens this inference. Statistical inquiries on mortality prove beyond a doubt that of the causes of death which usually are in action, impurity of the air is the most important. Individual observation confirms this. No one who has paid any attention to the condition of health, and the recovery from disease of those persons who fall under his observation, can doubt that impurity of the air marvellously affects the first, and influences and sometimes even regulates the second. The average mortality in England increases tolerably regularly with density of population. Density of population usually implies poverty and insufficient food, and unhealthy work, but its concomitant condition is impurity of air from overcrowding,* deficiency of cleanliness, and imperfect removal of excreta, and when this condition is removed, a very dense and poor population may be perfectly healthy.

Ventilation.

In order to keep air in its necessary purity, it must be continually changing.

We have already seen that the change must amount to at least 2,000 cubic feet per hour per head for persons in health, and double that quantity for sick persons.

In whatever way this air is supplied, certain conditions must be laid down.

The entering air: First. The air which enters must itself be pure.

Second. Its movement should be imperceptible, otherwise it will cause the sensation of draught, and will chill.

The rate at which the movement becomes imperceptible is much influenced by the temperature of the air. If this is above 70°

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* See Dr. Duncan's evidence in the Health of Towns Report, vol. 1, p. 131. On this point Dr. Gairdner has also brought together some good evidence in his work on "Public Health in relation to Air and Water," p. 52, *et seq*.

The following part of his table may be quoted:

Population to one square mile in districts taken in England.	Death per 1,000 per annum.	Death-rate. Death. Pop.
56	15	1 in 67
106	16	1 in 63
144	17	1 in 60
149	18	1 in 56
182	19	1 in 53
202	20	1 in 50
220	21	1 in 48
324	22	1 in 46
485	23	1 in 44
1,216	24	1 in 42
1,262	25	1 in 40
2,064	26	1 in 39
2,900	27	1 in 67

a very considerable velocity is not perceived. But taking the temperature of 55° or 60°, a rate of 1½ per second (one mile per hour) is not perceived; a rate of two or 2½ feet per second (1¼ and 1½ miles per hour) is imperceptible to some persons; three feet per second (two miles per hour nearly) is perceptable to most; a rate of 3½ feet is perceived by all persons. Any greater speed than this will give the sensation of draught, especially if the entering air be of a different temperature or moist.

Third. It must be well diffused through the room, so that in every part movement shall be going on; in other words, the distribution must be perfect.

The out going air: Fourth. The air must be removed so immediately that their shall be no risk of a person breathing again his own expired air, or that of another person.

There is a difference of opinion in regard to the comparative value of the upward and downward system of ventilation. Both have their advantages and disadvantages, and their comparative merits can only be decided by practical observation made by numerous observers.

In the ventilation of the rooms in tenant houses, it is my opinion that the downward system is the most practical. (See drawings Nos. 14, 15 and 16.)

First. On account of the diffusion of air being more uniform and there being less danger of a draught.

Second. The saving of heat, which is an important item to the inhabitants of these houses.

Third. Less danger of their being interfered with, the cold air entering by the grating at the roof of the room being brought in contact with the warm air before it descends, becomes warm, and not imparting the sensation of chilliness. The attention of the inmates is not directed to the source of fresh air, and there is less danger of the openings being obstructed. The foul air openings being near the floor are connected with the chimney, or a shaft adjoining the flues. The heat from the stove and chimney draws the foul air out of the apartments. The stoves in these houses are used constantly both summer and winter. The air passing through the outlet being warm does not call the attention of the inmates to it, therefore it is not interfered with.

In the halls and stairways the upward system of ventilation is the best, (see drawings No. 17), the air entering by the street door, passes through the halls and stairways to the roof, and escapes through the ventilators or skylight; thus keeping a constant circulation of air through the center of the house.

Size of the Openings, whether intended for Inlets or Outlets.

As the movements of air increases with temperature, the size of the aperture can only be fixed for a certain given temperature; and as the efflux of hot air increases with the column (supposing the temperature is equal) throughout, a different size has also to be arranged for different heights.

Supposing that the height of the heated column be fifteen feet, a difference of ten degrees between the external and internal air produces an efflux (allowance being made for friction), of about 12,000 linear feet per hour. For an opening of one square foot 12,000 cubic feet would, therefore, be discharged; and if the discharge per man is to be 2,000 cubic feet per hour, the share of outlet space per man will be, of course, the sixth part of a square foot, or 24 square inches. This is nearly equivalent to a square opening five inches (49 inches) to the side. There must be, of course, an equal amount of inlet, so that the inlet and outlet together would be 48 square inches per head. This, therefore, would be the total open area necessary for each person, independent of all openings by windows and doors.

Rule.

The apartments occupied by each family should have an inlet for fresh air consisting of a tube one foot square, (which will allow 1,200 cubic feet of air to pass through it every hour), extending from the front of the house to the sleeping rooms, also an outlet for the foul air, one foot square, in the chimney near the floor. The top of the chimney to be supplied with a cowl (ventilator), turning away from the wind, in order to have the full effect of the aspiratory power of the wind, and prevent down draughts.

The roof over the stairway and halls should be furnished with a skylight the whole length and breadth of the upper hall; the top of the skylight should be provided with two large cowls (ventilators), one at each end.

Explanation of Drawings Illustrating the Proposed System of Ventilation in Tenant Houses.

The first three drawings illustrates the downward system of ventilation, the air enters the ventilator between the two windows and passes through the tube, up to the roof of the room; it is then carried through the living room into the sleeping room (the curve in the tube preventing the warm air from escaping through this opening.) The sleeping rooms are in many instances without windows or ventilators of any kind ; it is here that the noxious gases from respiration and transpiration accumulate, causing so much sickness and death among the inhabitants of these houses.

The air, after circulating through these rooms, passes into the living room, then through the foul air opening up the chimney, thereby keeping up the circulation through the rooms without the loss of much heat. The air entering by the roof becoming warm before it comes in contact with the inmates of the room, does not give that sense of chilliness which is felt when the upward system of ventilation is employed.

The last drawing represents the upward system of ventilation, which is the best one for the ventilation of halls and stairways ; the air entering by the street door passes up the stairway and through the halls to the roof, and escapes through the ventilator or skylight.

The following is a plan for collecting information in regard to the population, ground-area, cubic feet of air space, ventilation, condition of the atmosphere, etc., in tenant houses.

The practical consideration of this subject is of great importance, and should enlist the active energies of this society, and of all who have the welfare of the human race at heart.

The observations and remarks in this paper are merely preliminary to a more extended study of this subject.

Hoping this paper will be the means of calling your attention to this great field of research, so that by united efforts we may be able to collect accurate information, which, properly arranged and systematised, will be the means of making practical sanitary science the greatest boon which Medical men have given to the world during this century.

Plan for the examination of tenant houses in regard to their population, ground area, cubic feet of air-space and ventilation.

WARD.	STREET.				Number of families.	Number of persons.	DIMENSIONS OF LOT.			DIMENSIONS OF HOUSE.				
	No.	Name.	F.	R.			Length.	Breadth.	Square feet.	Length.	Breadth.	Number of stories.	Heighth of floors.	Cubic feet.

WARD.	DIMENSIONS OF LIVING ROOM.					DIMENSIONS OF SLEEPING ROOMS.					Ground area in sq. feet.	CUBIC FT. OF AIR SPACE.		
	Length.	Breadth.	Heighth.	Cubic feet.	Number of inmates.	Length.	Breadth.	Heighth.	Cubic feet.	Number of inmates.		In house.	In living rooms.	In sleeping rooms.

Plan for the examination of tenant houses, etc.—Continued.

WARD.	VENTILATION.							
					MOVEMENT OF AIR IN THE ROOM.			
						RATE OF MOVEMENT.		
	By doors.	By windows.	By chimney.	By special openings.	Direction of	By the anemometer.	By the manometer.	By calculation.

WARDS.	EXAMINATION OF THE AIR.						REMARKS.
		MICROSCOPICAL AND CHEMICAL.					
	By the senses.	The existence and nature of suspended matters.	The amount of organic matters, as estimated by permanganate of potash.	The amount of carbonic acid.	The amount of watery vapor.	The presence of ammonia and sulphuretted hydrogen.	