Tuberculosis: A Disease of Insanitary Living

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Commission of Conservation
Canada

TUBERCULOSIS: A DISEASE OF INSANITARY LIVING*

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PEOPLE who live in temperate climates necessarily inhabit houses requiring to be closed in inclement weather, and have had to establish a harmony with an air environment which may truly be called an artificial climate. It is in relation to this house climate that the people of civilized communities have especially to study how they may best establish a complete harmony.

CONSTITUENTS OF AIR

Normal air everywhere contains the same constituents, which are nitrogen and oxygen in the proportions of nearly four of the former to one of the latter, with incidentally a minute amount of carbonic acid of three parts in ten thousand of air. Such is found everywhere, over great expanses of water, of forest and of mountain where there are few residents, to contain almost nothing else than gases; but where population increases and human industries are carried on, many particles of dust from cultivated fields, streets and yards, stables and factories, and the bodies of men and animals are to be found, these reaching, on a windy day, as many as a million particles in a cubic foot of air, while living particles or microbes in the air of a hospital may reach 40,000 per cubic metre. In addition to such dust particles are the seeds of many plants and the spores of moulds and fungi, some of which live upon dead organic matter, while others live and multiply in the air passages and tissues of men and may become the exciting causes of disease.

When it is remembered that air at five miles an hour causes a change of the atmosphere around a person standing still of some 25,000 times, while with warm air moving at the rate of more than six feet a second a draft is felt, it must be plain that, as persons breathe seventeen times a minute, and even while sitting exhale at least 30 cubic inches of air, they not only will inhale a cubic foot of air every three minutes, but will also exhale the same amount, giving off not only carbonic acid to the extent of 25 per cent of the air exhaled, but also any dried particles from the mucous surfaces of the respiratory passages. In addition to this, particles of epidermis and whatever clings to it are constantly given off from the hands and exposed parts of the body, and these often contain living particles, either vegetating on the skin or picked up from the objects which are everywhere handled. It is under such conditions of life, especially in the houses of our cities and crowded work-rooms and stores, that such particles, being the direct cause of some disease such as smallpox, scarlet fever or tuberculosis, may become, by contact, as they pass into the air and by touch, immediately dangerous to individuals of all ages.

CONTAMINATION OF AIR

In addition to this direct source of disease, we have special cases where the dangers are greatly multiplied, as where individuals known to be suffering from open cases of tuberculosis contaminate the air enormously, both by particles of moisture from the throat while speaking and

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coughing, and by expectorations which contain millions of the bacteria or direct agents of the disease.

Other special sources, such as the milk supply from tuberculous cattle, do increase the danger of infection from this disease, especially in children; but if the problem of living in houses in harmony with the environment is to be adequately solved, it must be especially realized that it is the particles discharged into house atmospheres and on to walls and floors of rooms which must be dealt with if tuberculosis is to be eliminated from any population.

The problems of dealing with and of preventing tuberculosis will, therefore, it is apparent, mean the removal, so far as in practice is possible, of the dangers directly attaching to the tuberculous person, such as a consumptive who expectorates enormous numbers of the germs of the disease, and thereafter of cleansing the air, the person's clothing, the furniture, the floors, and walls of rooms which he has occupied, and of providing in all such places the largest amount of fresh air that is possible. Education of the individual stands in the first place in the measures for the prevention of tuberculosis, and all persons, whether physicians or members of families where the sick are, should teach and be taught the principles of personal hygiene. In practice, it is found that nowhere do individuals suffering from the disease receive such education so well as in sanatoria, where expert physicians and nurses establish a routine of daily hygiene, which those who have spent a few months under it will practise after they have returned to their homes or gone elsewhere.

Education Needed as to Meaning of Fresh Air

But even greater good will result from the education of the community at large as to the real meaning of fresh air in living houses and living apartments. The weekly sweeping and still more the half-yearly house-cleaning illustrate, as when a carpet is beaten, the infinite number of particles which, unseen, are constantly accumulating in houses. It is further only necessary to leave a room closed in which a carpet is present to appreciate strong odours and the effects of moisture in the decomposition of the organic materials present in it, through the action of microbes which cause decomposition. We thus realize how one of the first steps we must take to keep a house clean is to allow nothing to be on the floors, which will retain particles of organic matter and the microbes which settle upon it, which cannot be readily and frequently removed and cleaned in the fresh air. Thus polished hardwood floors with rugs fulfil best both sanitary and æsthetic household conditions; while in many instances, as in hospitals and places of public resort, nothing serves the purpose so well as well-made modern linoleum, which can be cleaned with a moist cloth, or, still better, frequently rubbed with a weighted felt block, which has been treated with paraffine dissolved in turpentine or with some other wax preparation. What has been said with regard to carpets on floors is similarly true with regard to heavy wool hangings, such as curtains.

Standards of Air Space in Rooms

Inasmuch, however, as we have persons always present in rooms, whose boots and clothing, as well as their persons, carry particles of all

kinds of matter, and similarly exhale others by mouth and nose, we must provide some systematic means whereby these persons may not only be prevented from polluting the air unduly, but may also be prevented from suffering from the lack of fresh air. Of course, it is apparent that there must be some limit to the number of persons living in any given space, and a standard has been adopted, under Public School Acts, in most progressive countries, whereby each child must be provided with 2,000 cubic feet of fresh air per hour. In an ordinary schoolroom, the space per child is commonly measured by the floor area of 4 x 5 feet in a room 12 feet high, thereby allowing each about 250 cubic feet. It is apparent that this air will require eight changes per hour to supply the required amount. Heating appliances are now available, whereby fresh air is warmed over steam pipes in the basement of schools and other buildings, and delivered by fans through ducts, which will supply the requisite amount by what is known as mechanical ventilation. The ordinary household, however, is not, on the one hand, subjected usually to the limited amount of air space just indicated; but, on the other, it is not commonly supplied with facilities for changing the air, such as that just described. Some have asserted that enough fresh air comes in around windows and under doors, etc., in northern cold climates to provide the requisite amount of fresh air. This, as a matter of fact, is not true; but

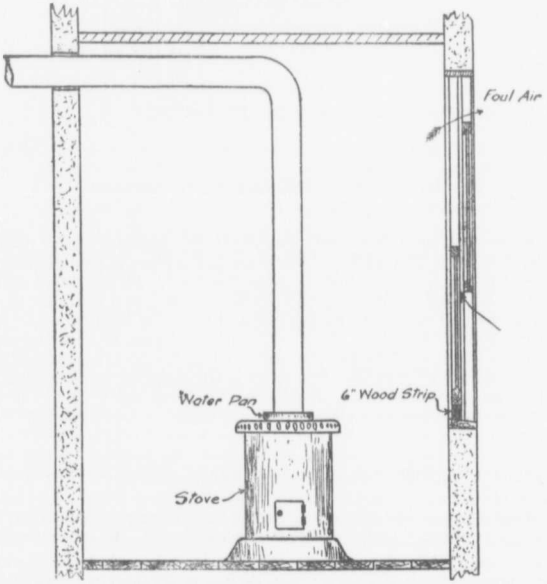

DIAGRAM NO. 1—Window Ventilation

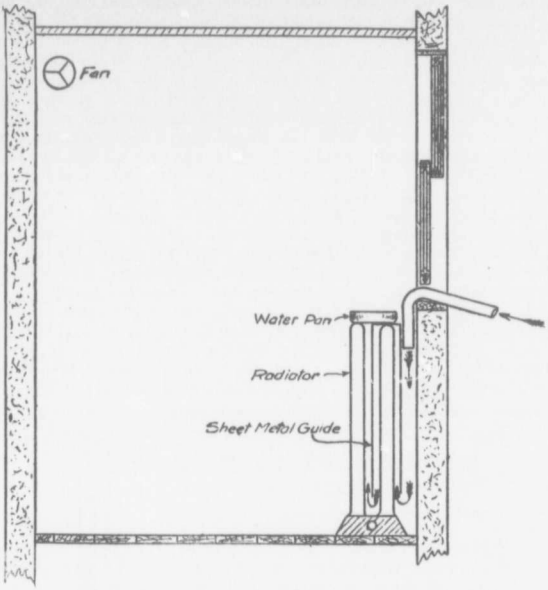

DIAGRAM No. 2—Radiator and Fan Ventilation

even when such air inlets exist, they have the constant defect that it means an uneven distribution of warm air and a sense of draughts about the feet and legs, due to cold air near the floor. Hence, some means should be adopted for insuring the entrance of warmed fresh air to our living rooms. Of course, in houses ordinarily heated with furnaces, it is often possible to minimize the evils due to the lack of ventilation by having the windows of bed-rooms open at night, when the body is protected by sufficient covering; but there is the need for some scheme by which house air can be kept practically at a temperature of 65° to 68° F. and yet be sufficiently changed to maintain its freshness and even distribution.

PROPOSED SCHEMES FOR SUPPLYING FRESH, WARM AIR IN ROOMS

Many more or less effective schemes have been attempted, but the following, applicable under different circumstances, are recommended:

In diagram No. I, it will be seen that a simple stove heater, which may be a base-burner or of any similar type, is utilized, while the room is ventilated by placing a screen made of a well-stretched piece of cotton on a frame above the upper window sash,

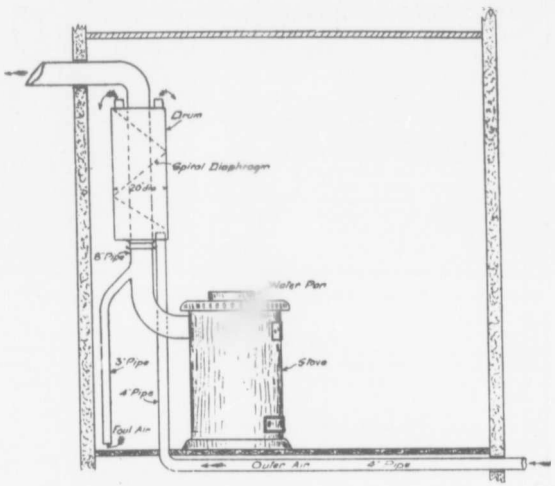

DIAGRAM No. 3—Drum Ventilator, with Foul Air Outlet

which has been drawn down, and so supplying a steady interchange of outer and inner air through a substance which transfers much less heat from the room than a glass surface does. The space below the two sashes provides the inlet for fresh air. This, of course, will operate with double windows having movable panes fitted for the purpose.

Another means of introducing fresh air, which has been adopted with advantage, is that seen in diagram (2) where steam or hot water heating is utilized. Provision is made in this method whereby an inlet duct of tin the width of the window delivers fresh air behind a radiator placed in front of the window. The air is so distributed through the coil by a metal diaphragm between the two rows of coils that it passes into the room, warmed up to the point required and in proportion to the size of the radiator. The system is completed by a small exit pipe leading to the adjoining hall with an electric fan removing the foul air to the extent desired. Several similar openings may supply the requisite outlets for the warm room air even without the use of a fan.

Diagram No. 3 probably represents the most effective and satisfactory scheme for changing the air in the rooms of ordinary houses where a room heater is used. The diagram almost explains itself. An inlet duct for fresh air delivers it into a drum surrounding the stove pipe within which drum the air by a spiral diaphragm is warmed and passes into the room at the top of the drum. An outlet for foul air, which serves extremely well also for drawing the warm air toward the floor, conducts the room air into the draught of the stove-pipe and so maintains a pleasant even room temperature with a constant change of air.

Diagram No 4 serves very well large rooms, such as country school rooms and lumber camps, etc., where a large wood stove is used for heating.

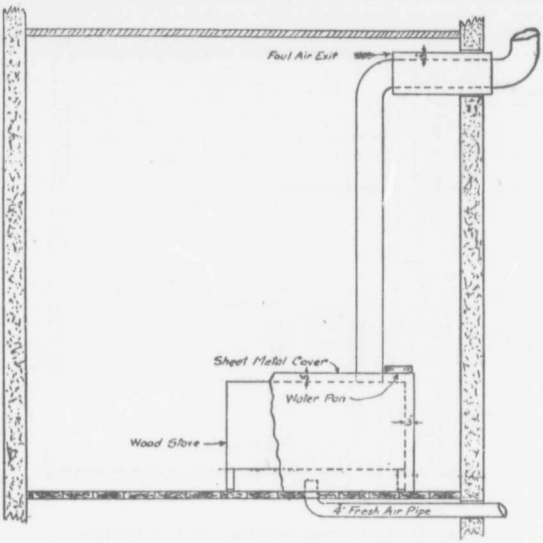

DIAGRAM NO. 4—Rural School and Camp Ventilation

Fresh air is brought in beneath the stove, which has a sheet-iron outer cover which enables the air to be warmed well around the stove before being delivered into the room. The foul air is extracted by an outer pipe around the upper portion of the stove pipe. The distribution of the warmed air in such a large room is thoroughly effected by connecting ducts leading from near the floor in each of the four corners of the room up to the exit duct around the stove-pipe. These pipes serve the double purpose of extracting the cold air from the corners of the room and so having warm air pass toward the outlets, while at the same time drawing the air off next the floor, thereby maintaining the lower air at a proper temperature.

MAINTAINING HUMIDITY OF INDOOR AIR

In each of the cases illustrated, nothing has been said about the necessity for maintaining the humidity of indoor air at normal. When it is remembered, however, that air at zero can only hold at saturation point 0.48 of a grain of water in a cubic foot and when it is realized that this outer air warmed up to 70°F. would hold approximately seven grains of water, the result of warming outer air without supplying it with some means of moisture is evident. In practice it is found that such indoor air in an ordinary dwelling does not have more than 25 per cent of relative humidity, with the consequence that it abstracts moisture from furniture, walls and the bodies of inmates, creating in such a sense of cold due to the insensible loss of body moisture through evaporation and so requiring a temperature of 70° to 75° F. in order to maintain comfort. To obviate such serious defects in house air, it is possible,

wherever hot air, hot water or steam is used in a house, to supply a constant amount of steam from a metal heater placed over the fire of the furnace, water being supplied to the evaporator at the same time automatically from the city water supply.

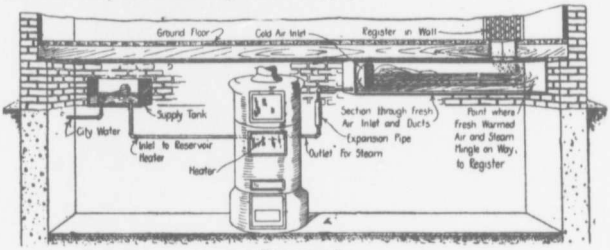

DIAGRAM 5

The apparatus consists of (*a*) a hollow casting or a series of pipes coupled together and placed over the fire beneath the sections of the boiler with the inlet pipe attached to the public water supply through an ordinary closet tank, set in the cellar at such a level as to just keep the heating reservoir filled. (*b*) The exit pipe leads directly to the flower room or other convenient place in the house, where it delivers steam directly and through the *law of expansion of gases* diffuses itself throughout the house, so that everywhere the degree of humidity is in practice the same. The automatic character of the water supply regulates nicely the moisture in the house, because, if the weather outdoors is cold and dry, the amount of heat required is greater, the fire burns brighter and the evaporation is more; while, if the outer atmosphere be mild and consequently holds more moisture, the fire will be burning less brightly and the amount of water evaporated will be proportionately lessened. It is desirable in order to make such a system effective that means be provided for introducing fresh air constantly into the house along with the moisture to maintain the sensation of freshness associated with moving air. It is found possible to warm outer air by passing it through a chamber in tubes which are surrounded by the steam as it moves toward the flower room, since as the air is warmed its capacity for moisture increases, and when the two are mingled they pass into the house atmosphere without any precipitation of moisture whatever.

The proper application of this sytem will maintain house air at a pleasant humidity of 50 to 55 per cent, while by a method shown in the diagram, the steam may be utilized to warm fresh air as it is introduced into the hall or living room of the house. The law of diffusion of gases operates so completely that hygroscopic tests will show air in all parts of the house to maintain practically the same relative humidity.

Realizing the defects and cost of methods adopted in schools and other places of assembly in supplying enough fresh air with an even distribution, recent experiments have been made tending to prove that the amount of carbonic acid in the air of a room given off from the lungs of persons is not in itself deleterious; but that the essential thing is to have the air which surrounds the individual, whose body temperature is 98.4° F., constantly replaced; or, in other words, that practically all the requirements of ventilation are met so long as the air of a room is kept in motion. While it is true that movement of the air in rooms is most desirable and necessary, the facts as herein set forth seem to supply ample evidence of the necessity of bringing to persons who have to live much indoors a steady supply of warmed fresh air, if they are to maintain themselves in good health and minimize the dangers from those who suffer from tuberculosis to those living with them.