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FLOATING MINUTE ORGANIC MATTER IN THE AIR AND ITS MANAGEMENT TO PREVENT DISEASE AND TO MITIGATE OR CONTROL IT, WITH A NEW DEVICE FOR ATMOSPHERIC PURIFICATION.

——: WITH AN ORIGINAL ILLUSTRATION. :——

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As to the number of microbes in the air, some reliable information is to be obtained from some recent observations by M. Miguel in a publication reviewed by M. Hache in the *Revue de Chirurgie* for May and June, 1884.

By these observations, what was known before in relation to the influence of the weather is further confirmed.

The spores of the mould and cryptogams are especially variable, being most prevalent in damp weather. On the other hand, the septic microbes are least abundant during the rainy periods and most abundant during the periods of drouth.

The average number of microbes found in the air at M't Souris (near Paris) was 84 to the cubic metre of air. In approaching the centre of the city, the number was found to increase, being ten times that outside of the city.

A series of observations was made at the top of the Pantheon, 250 feet high, which showed that the air was more pure there than at M't Souris, and ten times less charged with microbes than that on the surface in the centre of the city.

In the interior of the well-kept habitations, the microbes increase during cold weather at the same time that they diminish in the free atmosphere.

To give an example of the enormous accumulation in apparently well-kept houses in populous centres, observations were made in the fourth story of a house recently built, in a bed-

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room occupied only twelve hours of the twenty-four, and there was found to be the large number of 526 microbes to the cubic metre of air, while in a room similarly situated at M't Souris there were only 325.

In hospitals, microbes have been found by M. Miguel to the number of 6,300 to the cubic metre. At the Hotel Dieu, 5,123 in the summer and at the Hopital de la Pitie an average, by the year, of 11,100.

The microbes found in surgical wards abound especially in the form of micrococcus. The microbes cultivated and inoculated into animals generally proved harmless, but in some rabbits and guinea pigs, grave affections were produced.

The dust deposited upon objects was found to contain microbes to the number of 750,000 to 1,300,000 to the cubic metre.

The question is discussed by the author and his reviewer, whether the different forms of microbes are originally of different species and varieties, or whether they are capable of developing or degenerating from one form and character into another. M. Miguel, M. Cohn and M. Nœgali are quoted as having investigated the subject, the latter of whom is quoted thus: "I am well convinced that too many species have been distinguished among the schismocetes. It seems to me, on the other hand, somewhat probable that all the schismocetes constitute one natural species. There may exist among them a small number of genera or species now recognized of which each passes through a cycle of forms."

M. Hache goes on to say, that successive cultures can profoundly modify the mode of their physiological activity.

Examples are quoted of the metamorphosis of the comparatively innocent hay bacillus (or bacillus subtilis) into the microbe of anthrax or splenic fever, which is one of the most virulent of the pathogenic forms.

Finally, the cultivations of Pasteur are referred to as a proof of this position. On the other hand, Klein, in a series of articles in recent numbers of the *Practitioner*, which have been published also by McMillan in book form, claims that in those cultures in which septic microbes seem to have been converted into pathogenic microbes, and vice versa, there has not been sufficient care to secure purity of culture; that the kinds have become mixed to such an extent as to destroy the value of the observations.

Many carefully made observations and some diagrams are

presented in the article by M. Miguel to show that, in the main, the amount of disease prevailing among people is proportionate to the number of minute organisms floating in the air; the greater amount of mortality in the centre of large cities corresponding with the greater number of floating microbes.

One reason for this may be that cities furnish in decaying organic substances, the culture media, for the propagation of the dangerous forms of microbes, while in the country the decaying material is chiefly vegetable and fitted for the development of the zymotic and septic varieties, and equally unfitted for the development of those microbes which are known to produce specific diseases, the most common of which is erysipelas.

According to present knowledge, the organic objects floating in the air may be classified as:

1. The spores of objects many of which are to be seen with low powers. These became familiar to the earliest observers with the microscope, as the yeast plant.—*Zymotic Agents.*

2. The spores and sometimes the developed forms of a class requiring higher and sometimes the highest powers to see them, which produce in nitrogenized organic material the phenomena of putrefaction but have no power of attacking living tissue. As, bacterium termo, hay bacillus—*Septic Agents.*

3. The spores and sometimes the developed objects of a class generally requiring high powers for their observation, which produce, when introduced into living tissues, or their fluids, changes characterized by the phenomena of special disorders, as erysipelas, hospital gangrene, anthrax, tuberculosis, etc.—*Pathogenic Microbes.*

In the following named diseases, this contagium has been proved to be *particulate* and vital, capable of mutiplying and perpetuating its kind when temperature and sustenance render it possible.

These are, various septic developments, and erysipelas, hospital gangrene, small-pox, diphtheria, gonorrhœa, Koch's septicæmia of mice, Davaine's septicæmia, chicken cholera, swine cholera, leprosy, Koch's malignant œdema, anthrax, actinomycosis, tuberculosis, relapsing fever and Asiatic cholera. The last lacks the proof of successful inoculations after a series of cultivations.

From this it is probable that all other contagious and infec-

tious diseases are originated and repeated by the action of similar particulate vital agencies.

DIGESTION.

Dr. G. V. Black, in his book on "The Development of Poisons through Micro-Organisms" has helped to generalize the conception of the manner in which living things appropriate nutriment from surrounding food material. The amœba converts a portion of its exterior into a temporary stomach by investing an object sufficiently small and digesting it, so that the nutritive elements of it may be absorbed. In accordance with the same idea, an object smaller than a blood cell comes in contact with the tissues of the body. If the vital condition of the tissue is sufficiently strong, the minute object may be digested. If, on the other hand, the vital force is weak, the cell, with which the invader comes in contact, is digested and the invader by natural increase becomes a spreading colony, appropriating more and more of the adjacent substance. If several individual invaders gain entrance at the same time, the conquest is more rapid. It appears from the researches of Pasteur, Koch and others, that different microbes have different degrees of power in the attack. The septic micrococci, bacteria, and bacilli being only capable of attacking material destitute of present vitality, while they are incapable of invading living substance.

There are minute living objects, most commonly floating in the air, of many species or varieties and capable of living upon albuminoid material. In accordance with this idea, a blood clot exposed to the air and left in the wound may become the seat of septic changes, while the lips of the same wound brought together without any intermediate clot, though exposed to the same germ-bearing atmospheric contact, may digest the invading organisms and heal by the *first intention*. The blood clot, however, having no such vital power of resistance, may go into a state of putrefaction and become a source of irritation and infection to the adjacent living surface. Again, if the supposed blood clot is secluded from air containing organisms, or if the vitality of these invaders is neutralized by some antiseptic agent, as carbolic acid or mercuric bichloride, the clot fails to go into putrefaction and becomes penetrated by a living projecting growth, secreting a soluble ferment, by which the clot is digested and brought into a condition of solution to be absorbed and carried away. In this

view, the question of the innocence of a blood clot turns upon the fact of its exposure to the atmospheric organisms in a condition in which they can appropriate its nutritive material and thrive upon it. If, in a peritoneal cavity, a clot has had such an exposure it will probably go into a condition of putrefaction. If, on the other hand, through the absence of organisms brought by the air, or through their neutralization by antiseptic agents, the seeds of putrefaction are absent or inactive, the clot will become ultimately permeated by leucocytes, digested and absorbed. The same thing happens with catgut ligatures, with sponge, or other substance which the tissues have the power of dissolving by the production of an appropriate digestive fluid. Catgut may be said to be easy of digestion, so that it disappears in a few days. Silk is more difficult of digestion and is, therefore, more liable to result in an abscess for its ultimate expulsion. Linen is more difficult still of digestion and, therefore, more liable than silk to the formation of an abscess. Silver is again absolutely indigestible, while it is unirritating and may innocently remain any length of time in contact with living tissue.

A catgut ligature or a blood clot containing septic germs, is almost certain to proceed to putrefaction, unless from the smallness of volume, the living tissues may be capable of surrounding the germs and infiltrating the clot, catgut or other substance containing them, with a digesting agent capable of destroying the vitality of the microbes; of dissolving and carrying away both them and their store of food.

As these agents, either in their developed or in their germ state, float everywhere in the air without the possibility, by any means hitherto practiced, of completely excluding them, except on a very small scale, their entrance to some extent into every open wound is a matter of course.

This consideration points to the importance of the employment of local antiseptics during the progress of operations attended by incisions and as long afterwards as the wound remains open. The antiseptics are employed in the form of spray or of a continuously flowing stream.

The danger is greater when the invaders are not simply the agents of sepsis, but are the pathogenic microbes of erysipelas, hospital gangrene or other infectious disease.

These are proved to have a capability of attacking living tissues and of producing by the employment of a stronger diges-

tive agent, the destruction and appropriation of live cells and fixed tissue, without any other natural limit than the whole extent of the body attacked.

If the invading agent be very small in amount and the vital condition of the patient be perfect, the invaders, if not repulsed or destroyed in the very entrance, may be limited to the formation of an abscess, while, if the vitality of the patient be feeble, the smallest invasion may end in the complete destruction of the system. This may be the reason why a dissecting wound produces a minute abscess in one person, an abscess with a slight fever in a second, and a fatal blood-poisoning in a third. The difference lies in the power of resistance, and not in the nature of the invaders.

The use of medicinal agents taken by the mouth or injected into the tissues and vessels has for its object the increase of the power of resistance, as when we combat erysipelas by the internal employment of chloride of iron.

The local applications, on the other hand, generally have for their object the destruction of the invading agents.

The local agent applied in anticipation may, however, have a two-fold effect; first to destroy or render inactive the atmospheric living agents, and next to preserve the vitality of the incised or lacerated surfaces, so that the invaders may be destroyed by the defensive fluid secreted by the living surfaces.

A stream of the aqueous solution of carbolic acid of the strength of 1 to 100, of mercuric bichloride of a strength of 1 to 1,000, or 1 to 10,000 does not necessarily destroy the spores of septic and pathogenic microbes, but it destroys the present activity of those which are in a developed and active condition. It at the same time preserves the moisture and the unimpaired condition of the exposed surfaces, so that the invading germs are immediately surrounded by a secretion of a strong character which invests the invading germs and digests them. A stream of pure water would have the same effect upon the incised or lacerated surface, only to be sure of its freedom from organic life it must have been recently boiled for more then thirty minutes. Klein in his little book recently published,* states that distilled water becomes in a few hours full of septic microbes in an active developed state, ready to multiply and flourish when introduced

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* Micro-organisms and Disease. McMillan. 1884.

into any substance furnishing oxygen, nitrogen, and hydrogen, *i. e.* any natural animal or vegetable substance.

There are numerous illustrations of the power of resistance of living tissues against organisms which are simply septic in their character.

It is probably rare that a hypodermic injection of any substance is made without introducing at the same time a bubble of air containing a colony of micro-organisms, either as germs or in a developed condition; yet the formation of an abscess or a more severe general septic poisoning is an exceedingly rare occurrence. These agents must be devoured as they are surrounded by a stronger vitality.

The introduction of air on a very large scale occurs after wounds connecting the respiratory passages with the surrounding connective tissue, and yet the air is generally absorbed without evil consequences.

However, if instead of common air it be loaded with the floating products of erysipelas, puerperal or other septic fever or hospital gangrene, the hypodermic injection might introduce an enemy of greater destructive force, capable of appropriating and living upon the surrounding cells and fixed tissues, the vitality of which it overmasters.

Again, if the patient is in a condition of very feeble vitality, the minute blood clot occasioned by the point of the needle may afford an insufficient resistance to the relatively superior vital force of the invading microbes, though only of the septic class.

In view of these facts and reasons, the most important consideration in relation to surgical (or accidental) wounds is the purity of the atmosphere, or its freedom from microbes, especially those of a *pathogenic* nature. The latter are very apt to be present in houses which have been contaminated by erysipelas and by those septic fevers which are attended by the presence of pus in a putrefactive condition, while the out-door air or the air of an apartment not used for dwelling purposes, is likely to have only those microbes which are capable of starting putrefaction in non-vital animal and vegetable substances.

The second most important consideration is the health of the patient, or his power of resistance to the ordinary septic influences which are almost everywhere present.

The power of medicines to increase the resistance is not here paroper subject to consider; suffice it to say, that a great consid-

eration is the neutralization of the latent malarial poison ready to develop on any occasion of depressed vitality.

The management of diet is of equal importance, but not in the scope of consideration to be entertained here. The diet which for the time secures the best state of health, or the management which secures a demand for nutriment and a capability of digestion and assimilation, are expressive of the end to be secured.

The third consideration is that of the local management of a wound—There are three things; (1.) to protect the surface from drying and the consequent tendency to die and become the seat of septic changes. This is done by a spray or by irrigation, or by the presence of a clot which should not needlessly be wiped off until the time for the final dressing.

(2.) The presence, in the fluid of the spray or irrigation, of some agent which destroys or temporarily neutralizes the floating organic substances in the atmosphere. It is probable that the best agent yet tried for the purpose, is an aqueous solution of mercuric bichloride, and, as the result of experience, a strength of 1 to 10,000 for a prolonged contact.

The agent can be applied without injury to the vitality of the exposed wound surfaces, and while too weak to destroy the vitality of the spores of pathogenic microbes, it is sufficiently strong to nullify their present activity and prevent the immediate production of their digestive soluble ferment. The substances to be applied to wounds to prevent subsequent septic development are boric acid and iodoform. The latter is capable of being introduced into a wound without interfering with union of the surfaces by the first intention.

The iodoform is ultimately disposed of along with the material of the coagulum which envelops it. The investment of the wound with borated cotton affords a material which retards or prevents putrefaction in the effusions and exudations escaping from the wounds by openings or through drainage tubes. The borated cotton receives these products and prevents their putrefaction, thus affording a material for a dry dressing which makes it practicable to subject a wound to dressings at infrequent times. The baking slowly of borated or sublimated cotton until it assumes a light brown color, is found to afford a dressing in which the exudations which have escaped from a wound and become dry do not putrefy.

For a wet dressing, there is nothing yet known superior to a

drip of carbolic acid of one *per cent.* strength, applied constantly or at times not more than 20 minutes apart, in order that the presence of the agent may be perpetual. This is incapable of destroying spores, but is yet strong enough to prevent the activity or vital manifestation of the septic microbes, and is probably capable of suppressing the vital manifestations of those of a pathogenic character, or those having the power of producing specific diseases, as those of erysipelas, hospital gangrene and other diseases, many of which have not yet been carefully studied, while yet the applications are weak enough not to injure the surfaces to which they are applied.

It is not the purpose of this paper to go much into detail, but to indicate in a brief way, the advance of thought upon the subject, based upon the careful investigations which have proved beyond dispute the dependence of many diseased manifestations upon the presence of micro-organisms.

The conception of digestion, as the means by which micro-organisms are enabled to attack and live upon substances that go into decomposition in connection with their growth and multiplication, is further developed by Dr. Black in his book,* pp 50 & 85.

Quoting from Lister,† he states that this observer found that a few germs, of the species of bacterium found in the hydrant water of London, contained in a single drop of water, could not start decomposition, but a larger amount could. At the same time, the smallest amount of putrid material would start decomposition. The explanation approached by Lister and clearly stated by Dr. Black, is that in the detached state, a bacterium is not able to develop a ferment in sufficient amount or intensity to overcome the chemical union of the serum, but when introduced in sufficient number to unite their digestive products, or in a condition in which the individual organisms are already surrounded by their ferment, they are able to attack the serum, living upon it and multiplying in it.

This consideration has an important surgical relation. In this view, it is not necessary that an agent acting as an antiseptic should be capable of destroying the micro-organism. If it is capable of neutralizing the digestive ferment produced by the

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* Formation of Poisons by Micro-Organisms. Presley Blakiston, Son & Co., 1884.

† Transactions of the International Medical Congress, London, 1881.

attacking micro-organism, the development and multiplication of the microbe may be held in check until destroyed by the digestive action of the cells of the surface of the wound invaded.

The fact that spores will live in alcohol, and afterward thrive when planted in a good field, does not militate against the usefulness of alcohol as an antiseptic, however poor a disinfectant it may be. By way of reference to the alphabet of the subject, the facts known of the nature of the poisons evolved by micro-organisms imply that by their nature and their modes of action they may be arranged in three classes.

1. The local effects of a digestive fluid by which the cells attacked are paralyzed and then destroyed. When the invading organisms are circulating in the blood, they infiltrate the white blood corpuscles and destroy them. A period of incubation elapses between the invasion and a sufficient multiplication of the microbes to produce a manifest local disease or to affect the general health.

The superior vital force of the blood or tissues may arrest or destroy the invading agents. When unable to do this, the forces of resistance may yet establish a wall of limitation so that there may be only a local inflammation or a small abscess; and when the localization is less complete, the lymphatics going from the spot affected may become inflamed.

2. The production of a poisonous waste product, which, being taken up into the circulation, poisons in analogy with morphia and strychnia, which alkaloids in this view, may be classed as alkaloid waste products of the poppy and the strychnos.

The inoculation of such a poisonous waste product produces immediate disease without an intervening period of incubation.

Sepsin, the waste product of septic action, when filtered out from the microbes which produce it, immediately produces general disease when inoculated, though there is nothing living in it by which it can be multiplied or reproduced by the processes of cultivation. This impossibility of cultivation shows that the poison has been separated from the vital agents which have produced it.

The entrance of sepsin in sufficient quantity, whether generated in a wound or ulcer, or injected artificially, destroys life, but if insufficient for this, recovery takes place as in the case of other poisons.

3. Pathogenic poisons are those of special diseases which are

supposed to arise from microbes of peculiar species on one theory, or on another theory, such as are profoundly modified by the temperature and the food-media with which their growth and multiplication have been circumstanced.

These microbes are called by Klein pathogenic to distinguish them from microbes which produce only septic effects and which are called septic microbes. All these pathogenic microbes have a period of incubation, some longer and some shorter.

During this period of incubation, the invaders are living upon the tissues at the point of entrance, multiplying and extending, or if floating in the blood, they are attacking the white blood corpuscles in greater and greater number. According to their nature they produce different diseases.

Some cause a gangrene as they travel and are very local, until the system becomes attacked by septic poisoning from the septic decomposition of whatever is destroyed, while others diffuse themselves in the blood. Others, like the bacillus of tuberculosis and of actinomycosis, lodge upon particular spots, multiplying and destroying the tissues.

The mode of poisoning by atmospheric micro-organisms which is most to be feared in surgery, is that of erysipelas, because the agents of this infection are more abundant in dwelling houses and hospitals and most difficult to eradicate. The micrococcus of erysipelas is extremely minute.

As quoted by Klein (*p. 48 of Micro-Organisms*) Feheleisen cultivated the micrococcus of erysipelas through fourteen generations, and with the last generation produced erysipelas on the ears of rabbits, and on some tumors and lupus ulcers of human patients, the application being made for the purpose of curing the local diseases.

Feheleisen found that a three *per cent.* solution of carbolic acid and a one *per cent.* solution of mercuric bichloride destroyed the vitality of this micrococcus.

It thus appears why a spray or irrigation of either of these agents upon a wound during the progress of its formation in the course of a surgical operation. is a protection against an erysipelatous contamination.

The treatment of microbes in order to destroy them or render them inactive is (1) by heat not less than 150° F. (71° C), and some of them require 300° F. (148° C), prolonged and repeated; (2) by disinfectants which destroy the germs of the dangerous

microbes, and by antiseptics which hold their development and activity in check without destroying them. An interesting illustration of this distinction is given by Dr. W. J. Miller, of Dundee, Scotland, in an article on contagium in the London Practitioner for Sept., 1884.

Dr. Dougal suspended the action of vaccine lymph by the incorporation of carbolic acid, but when, by exposure to the open air, the *antiseptic* had evaporated the lymph was found to have been preserved unimpaired. According to this and some other observations "Carbolic acid is not a disinfectant, not a destroyer of organic matter, but rather an antiseptic or preserver of organic matter, arresting and preventing putrescent and fermentive change, and suspending zymotic action for a time, leaving such matter unchanged after the volatilization of the antiseptic."

This distinction may be criticised, by saying that a strength of carbolic acid of sufficient intensity to hold back and paralyze the invaders, may be weak enough not to injure the organisms to be preserved. In the case of vaccine virus, it is not injured by a strength of 2½ *per cent.* though the putrefactive microbes are held in check. These microbes would quickly destroy the special contagium if not opposed by this or some other antiseptic. A stronger preparation of carbolic acid would destroy both invaders and defenders and be a disinfectant. A strength of ½ *per cent.* preserves bread pulp and ⅛ *per cent.* preserves broth and milk. Washing the hands in a 5 *per cent.* solution is thought to be the weakest solution capable of protecting the hands against receiving and imparting contagium, and this is far inferior to a solution of sulphurous acid. In the form of vapor, however, it is doubtful whether carbolic acid has any effect whatever on account of its great dilution.

All the experiments which have been made with carbolic acid vapor are negative.

Among the disinfectants, Dr. Miller (above quoted) considers sulphurous acid (from burning sulphur) the most valuable of all. Its vapor destroys every microbe, whether zymotic, septic or pathogenic.

Its gas permeates every crack in the walls of a room, and its solution is easily applicable to the surfaces of solid bodies. Its only objectionable feature is the difficulty of employing it in rooms while people are in them.

It is not necessary here to enumerate and compare even the

principal antiseptics and disinfectants. Chlorine, hydro-chloric acid, iodine and bromine are powerful but difficult to manage.

Salicylic acid, boric acid, iodoform and mercuric oxides and salts are excellent antiseptics for local application in the solid form, the choice among them being determined by circumstance and convenience.

AIR PURIFICATION.

We come now to another method of managing the subject. Taking a hint from the observations recently made in Paris, and quoted in the beginning of this paper upon the effect of rainy weather upon the number of microbes floating in the atmosphere, it occurs to ask, whether or not it is practicable to subject the air entering an operating room to the influence of artificial showers in order to precipitate to the ground the whole or the greater part of these enemies of surgery.

They are known to be heavier than the air because they entirely disappear from the air within a tight box which has been for several months in one position. This principle of rest is of no use to us, for the purification of the air of an operating room by this means is impracticable.

The dry filtration by means of cotton or other substances to entangle and arrest the particulate substances floating in the air, is not practicable on account of the rapidity necessary in the entrance and exit of the air in order to displace the agents entering from without during the progress of an operation, and those emanating from the occupants of the room. If, however, we can cause the air entering the room to pass though several showers of water, we have an expedient which may entangle these objects and carry them to the ground.

The following is a description of such a device.

1. BASEMENT.—On the right hand is an entrance ventilator, twenty inches in diameter, in which a steam jet is made to play in order to infiltrate the entering air with very fine globules of water. (2) (3)

2. The air thus moistened passes in the direction of the arrows under a curtain or diaphragm reaching within fifteen inches of the floor. Under this curtain lies an iron pipe with numerous small holes drilled in the upper side, furnishing an interrupted spray under the curtain, and making it necessary for all the moving air to pass through this artificial shower near to the floor and into the next room warmed by the stove seen on the left hand of the diaphragm or screen. (5)

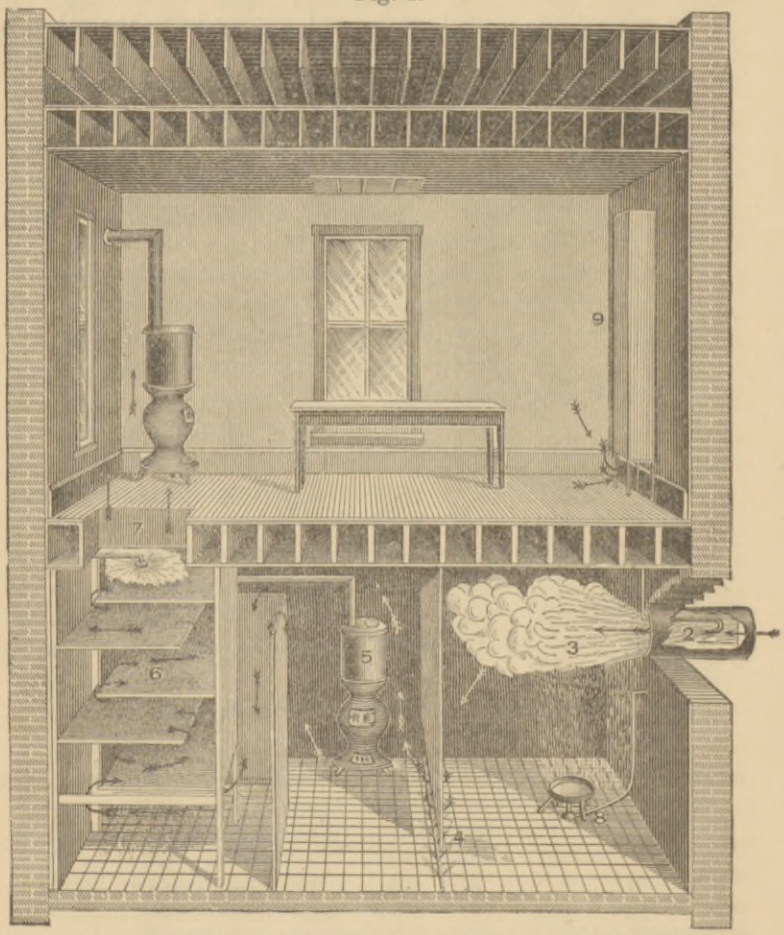
3. The air, thus warmed, passes through a filter, composed of shelves of thin muslin through which water is dripping. The warmed air

first passes over the top of a vertical screen to avoid the entrance of cold air, then under another vertical screen, and then back and forth between horizontal screens fifteen inches apart, dripping with water and finally through the spray which supplies this water. (6)

Thus there are three filtrations of the air, one by steam and two by water.

4. The air thus filtered three times, emerges through an opening in the floor and goes to the top of the operating room above. [7]

Fig. 1.



Basement below and Operating Room above—Scale, one to sixty.

5. Operating Room.—The exit ventilation is seen on the opposite, or right hand side of the room, in the direction of the garrows.) This is effected by a movable shaft or box, made by

tacking muslin upon a frame, so that it can be set up against a window, with the upper sash pulled down to the necessary degree. The shaft can be shifted from one window to another to be free from the pressure of the wind, or on the opposite side, or from the wind. The arrangement thus far, is to get an atmosphere more pure than that outside, and through the frequent change of the air in the operating room, to get rid, to the greatest possible degree, of the contamination of the air (during the progress of an operation) by the emanations from surgeons, assistants, spectators, and the patient himself. This change is secured by the entrance of filtered air from the basement and the exit, from the floor of the operating room, of the air which has been the longest in the room, having descended gradually from the ceiling where the air is hottest, after having entered from the warming chamber below.

6. The floor of the operating room is made of yellow pine, and filled with paraffin to as great a depth as heated smoothing irons can drive it. By this means, all cracks are filled so as to be non-absorbing. Under this, lies a layer of tarred paper upon a common floor upon the joists. Between the joists, lies a layer of tarred paper upon the ceiling, the under side of which ceiling is painted, and lined with muslin while the paint is fresh. The muslin is again painted on the under side. The floor thus has seven layers, including the joists.

7. The operating room is free from closets where anything unclean can be hidden, and all wood work is either paraffined or painted.

8. There is no opening into any other room; about six feet of space intervening between the door of entrance and the nearest wall of the main building.

9. Before the use of the room for an operation involving the opening of a joint or the peritoneal cavity, it is intended that the rooms above and below shall be fumigated by sulphur burning in the basement. An iron pan for this purpose is figured in the cut(8) resting over a Bunsen burner for the combustion of sulphur. This is to be done for the destruction of any floating material of an organic character which may have gained entrance while the room may have been out of use.

It is found by trial that when the different sprays of water are going, one can remain very comfortably in the room above while sulphur is burning in the room below; the fumes being first

absorbed by the steam and having then to pass through the two different showers of water become thoroughly percipitated.

10. This building is the execution of a theory of combining the best known expedients for securing the best possible atmosphere for surgical operations, by excluding noxious agents and by destroying or expelling those which may have stolen in, or which may be introduced by the patients, or by the surgeon and his assistants and guests. It is supposed that enough air will enter and escape to change the whole volume of the air once in fifteen minutes. The exit draft coming from the floor will carry away most of the floating material.

11. The employment of a spray or douche of carbolic acid of the strength of 4 to 100, or of mercuric bichloride of 1 to 10, 000, or other antiseptics, locally applied, though less necessary than in an ordinary room, may yet be resorted to in order not to omit any useful precaution.

12. The employment of solutions of carbolic acid, mercuric bichloride or permanganate of potash with the nail brush for cleaning the hands should be supplemental to the fixed provisions against septic and pathogenic particulate infection.

13. The bathing of the instruments in carbolized water, while this proceeding is incapable of disinfecting or destroying any germs which may adhere to them, may yet be useful in an antiseptic sense *i. e.* by destroying microbes in a developed state or freeing them from the supposed secretion by which they may be surrounded, and which may serve as their weapon of attack by which they digest or destroy the surfaces with which they come directly in contact.

14. A useful precaution on the part of the operator may be a bath and a change of clothing, the hair and head being dampened so that dust will not escape from them; and yet another precaution may be the wearing of gowns which will oblige all dust escaping from the clothing of the operator and his assistants to fall to the floor whence it may escape with the draft which carries out the lowest stratum of the air.

NOTE. The construction of an operating room on the principles here explained in a hospital already built, without erecting a detached building, would require that two rooms should be taken one above the other and if the upper one can have a skylight it will be of great advantage. The lower room might be in the basement with a shaft not less than (3) three feet in diameter extending to the upper room which might be under the roof for the advantage of a skylight. All communications must be closed by brick and mortar and an entrance opening made in the outer wall, the approach being secured by means of a platform on the outside of the building, so that it must be unavoidable to go into the open air for entrance and exit. The lower room should be equally shut off from communiation with other rooms of the building.