Antiseptics
Disinfectants &
Disinfection

Since Lister reasoned and proved to his own satisfaction, that the Faculty, and more especially the Surgeon, was not wholly free from responsibility in the communication of disease, by neglecting to take the ordinary precaution of cleanliness in all details, regarding the practice of their profession, many, when he went further and boldly enunciated and proved by demonstration, that diseases of an infectious or contagious nature could be prevented

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from spreading and infecting others, by adopting measures which would either prevent the virus from gaining access to the system, or, by so acting on the system as to render it proof against the action of the virus, or, by acting chemically on the virus so as to render it innocuous, the attention of the profession has been directed more to the prevention of disease than formerly. The routine practice of medical men in treating an infectious case, is first of all, to find out the source or channel by which the disease has been acquired, (suitable medical attention being given to the patient at the same time) and then, to adopt such measures as will prevent, or reduce to a minimum, the chances of the disease being communicated to others. Thus, say in a case of Scarlet fever, we know that the desquammated particles from the most fruitful source of infection in that

disease, yet the exhalations also, communicate the disease, and while the former source has more attention paid to it and probably justly so, yet we ought if possible do more than is usually done towards rendering the latter source abortive. This can only be done by first of all ascertaining the real nature of the virus contained in the exhalations, and as this is the fundamental principle involved in all infectious diseases, until our knowledge of the nature, including the chemical properties, mode of action, vitality, life history of a microorganism, and lastly the channel or channels of communication of each specific poison, is more complete, we will require to continue our more or less crude and imperfect methods of sterilising, or otherwise rendering abortive the elements, which communicate disease. Each separate virus will require to be studied in all its various phases,

on a strictly scientific basis, before that time comes which I do not believe to be millennial in its remoteness, when medical men will be able to meet infection, or contagion, either in a sporadic or epidemic form with complacency, arising from the knowledge, that they possess the power of preventing the spread of the disease.

What happier position could be desired by any Doctor than is illustrated by the following paragraph, which appeared in a recent edition of a local newspaper; "The ship Blank on a voyage from New York to the Clyde, arrived at the Sail of the Bank to day, with two of the crew suffering from Typhoid Fever. The ship was visited by the Medical Officer, who ordered the removal of the men to the Hospital. The ship was afterwards disinfected and proceeded." The simplicity, and assumed completeness of the

whole proceeding is charming. I only hope the disinfection was as effective. And why should it not be so? We know that germs or organic particles, when exposed sufficiently to certain chemical influences, loose their infective properties, and it will be my aim in this paper, after treating of the various kinds of infective matter or poisons and what knowledge we possess regarding them and their mode of action in propagating disease, to indicate what will be the most suitable disinfectant, to select, and to compare the relative effecency of different disinfectants, all of which, might be suitable, and the best form of applying them not only in sporadic cases but also in disease of an epidemic form. Let me begin with the aphorism, that the nearer the source of infection, you

are able to apply the disinfectant, the greater will be its efficiency. The failure to accomplish their object, of some reliable, and well known disinfectants, is due to an imperfect understanding, or want of appreciation, of the chemical action which is expected to take place between the disinfectant and the virus, but it may be assumed that oxidation represents the desired action, in all cases.

Nature of the virus

On this will depend entirely, the choice of a suitable disinfectant. Broadly, infective material, may be divided into two classes.

1st. Those complete organisms, endowed with vitality, and capable of individual existence, apart from the human system, of a parasitic nature, and to which the general name of Germ, or Microorganism,

is applied. These again may be divided into classes, as Bacteria, Bacilli, or Spores, which in their turn, may be further distinguished, by being coupled with the name of the disease with which they are more intimately associated, as the Tubercular, Typhoid, or Cholera Bacillus. Germs, like all other low forms of life are difficult to classify so far as their animal, or vegetable origin, is concerned; though they have been classified by Flugge, from their physiological effects on the system, as.

1st Septic or putrefactive
2nd Zymogenic or fermentive
3rd Chromogenic or pigment forming
4th Pathogenic or those giving rise to specific infectious disease

Again there seems to be no limit to

the number of these microorganisms, and their distribution is universal, whether we breathe the air on the mountain top, in midocean, or in the crowded rooms of cities, their presence only differs in degree. They are found wherever dead organic substances exist, in all waters, stagnant, or flowing, in all liquids, that can ferment or putrefy, and even in some liquids, which have hitherto been supposed to be free from any changes of such a nature, such as, a solution of Corrosive Sublimate, where fungi have been found luxuriating, even organisms of a very much higher position in the scale of life have been found, as witness the presence of insects, in Cupric-sulphate solutions, at Swansea.

We are compelled to theorize, in order to explain satisfactorily, these seeming anomalies; but the fungi being of a vegetable nature may play some part in explaining it. To describe the Life History

of any specific germ seems almost a hopeless task, yet, when we compare our knowledge of germs today, with what it was but a few years since, we have reason to hope that even that, will be accomplished in the near future. I had the pleasure of listening, some years ago, when I was sufficiently far advanced in my professional studies, to follow with practical interest, the opening address in the Medical Faculty, when the speaker, in the course of his address (an address pregnant with subject-matter suitable for theses) declined to accept

the doctrine, that a particular bacillus was the cause of a specific disease; in answer to that, let me quote the words of Sir William Aitken on "Animal Alkaloids" who also, was an honest doubter regarding the germ theory of disease. "In the first edition of this book, I too strongly expressed myself as an unbeliever, in any micro-organism being the sole cause of disease, But there are exceptions; and I have had the advantage of practically studying and appreciating the evidence now at our disposal; and of coming to certain definite conclusions from personal observations, and to the exclusion of mere theory. That it is a fact that in at least two infective diseases, Anthrax, and Relapsing Fever, the constant presence of definite and characteristic organisms, have been positively demonstrated; and

to these might be added, Tuberculosis, Lupus, Leprosy, and Malta Fever; these conclusions have been arrived at, after having satisfied all the rigorous tests, of the canons laid down by Doctor Koch, and which I need not here enumerate. One of the most important of the above canons, is, that a specific germ, when introduced into the system irrespective of the manner of introduction, must always "breed true".

Physical appearances.

This link in the chain of their life history, has been to a certain extent supplied; we are able to distinguish by means of the microscope, the characteristic form of many such organisms; some are spheroidal in form, as micrococci, and may occur either singly, or in masses; others as the

bacillus of tuberculosis, are rodshaped, or they may assume a spiral form, as spirilla, all germs, are more or less recognizable by their behaviour on treatment with staining matter or reagents.

Mode of Action

of germs, in producing disease, has never yet been clearly demonstrated, but certain definite results of more than a mere negative character, have been obtained, and here I would like to state, that the human system when infected by any specific germ, acts as a factory, for their reproduction, as long as the disease they give rise to lasts, and the duration of the illness, when not fatal, will vary with the rapidity of their reproduction; the system only being freed from their presence, as it becomes exhausted of those elements from which they

derive

their sustenance. Other cases no doubt exist, where reproduction does not take place within the system, and in such, it will be difficult to account for their manner of reproduction or propagation. Germs, are understood to reproduce themselves, by a process of transverse subdivision, or, by the formation of spores: in either case they are autogenetic, and while we could scarcely conceive, of sexual differences among germs, yet, it is quite possible, that one germ may possess the quality of rendering the surrounding tissue suitable for the existence and development of another, thus necessitating a definite relationship between certain germs, before either could be effective in producing disease. In support of the above theory, let me cite an experiment made by Bocklisch, with vibrio proteus, better known as Finkler's Bacillus. He found

that it did not seem to produce any poisonous substances; although it occurs in the dejecta of patients suffering from sporadic cholera, and is supposed to cause the disease; but he remembered that it never occurs in the human intestine, as a pure cultivation, and that possibly, the presence of another bacillus along with it, might cause the formation of poisonous products in sporadic cholera. He therefore mixed it with some other bacteria, and found that the mixed bacilli formed the highly poisonous substance, Methyl Guanidine.

Germs, may develope or produce disease in two ways. First, directly by their presence causing changes in the tissues of the organisms, which induce disturbances in their functions; they are unable to settle in a perfectly healthy body, thus differing from Leucomaines, or poisons belonging to a

class I have not yet spoken of. Germs can only develope, when the physico-chemical constitution of the tissues, is morbidly altered, so as to correspond with their requirements; being passive agents they are unable to select a suitable residence for themselves, but when they are conveyed to such parts of the organism, they possess the power of adapting themselves more or less, to the condition of the soil in which they find themselves, and of manufacturing a ferment, suitable for their wants. This has been demonstrated, from experiments made by Doctors Lauder Brunton, and McFadyen, who found that the same bacilli, produced a different ferment when grown in starch paste, from what it did when grown in gelatine or beef tea, that ferment would convert starch into sugar but would not act on gelatine.

Secondly, germs produce disease indirectly, by generating poisons of definite chemical composition, these being of an alkaloidal nature, are separable material, and possess all their poisonous and infective qualities, after treatment which no germ could undergo and retain its vitality, or infective power. The other class into which I have divided infective material, is poison also of organic origin, destitute of vitality, non parasitic in nature, and is derived from the system either as a natural result of its vital functions as Leucomaines, or the product of morbid processes; in both cases they are produced by the fermentation, decomposition, or putrefaction, of proteid or albumenoid matter. It is not within the scope of my subject to attempt to explain the effects of such poisons on the system, why, when they gain access to the circulating medium,

certain organs are more affected than others as the lungs in Phthisis, or the intestines in Typhoid Fever; but whatever their origin may be, they not only resemble one another in the symptoms they produce, and in their ultimate issue, but they also resemble, in most particulars certain vegetable alkaloids, of well known poisonous qualities, as Digitaline and Nuxvomine.

Such poisons are found in the exhalations of patients, in the saliva, dengueamniae, the urine, the excreta, in fact the secretions normal and abnormal of the system generally. Having now noticed the more prominent features of the morbid or infective materials, which communicate disease, I will now treat of the channels by which these poisons are introduced to the system.

Channels of introduction.

1st Through the medium of the air

2nd By ingesta, Foods of all kinds, Solids & liquids

3rd By direct innoculation, purposely or accidental

1st As this channel must be the most common, as also do I regard it as the most fruitful, and easiest way of entrance to the system. The poison when acquired by this channel must necessarily exist in very minute particles, so small, as to be of a less specific gravity than the air, and is probably distitute of any protective covering, except in the case of germs, and is in fact a naked poison which, coming into immediate contact with a very fine, sensitive, membrane is rapidly absorbed and transmitted at once to the circulation, reaching all parts of the system readily. The poison in such cases, not being subjected to the influences of the gastric and other juices,

which do possess the power of modifying, and in some cases altogether destroying, the activity of certain poisons.

(2nd) Ingesta, foods of all kinds may convey poisons to the system, either as vehicles, or, being of an unsound or unwholesome nature, possibly undergoing putrefaction, be the origin of disease, as in the case of game, in a high or tainted condition, putrid fish, and other foods in like condition; but it is in the form of a vehicle, that food is most active in propagating disease. I need only refer to the numerous outbreaks of Scarlet and Typhoid Fevers, where milk, or water, has been clearly shown to have been the agent in disseminating disease, in an epidemic form. Tins of preserved foods, are every now and again credited with being the cause of acute, and often fatal illness, limited to those who have

partaken of them.

3rd Innoculation, as this is the method used in the majority of cases, when experimenting on the lower animals, with organic poisons, for the purpose of ascertaining their action and therapeutical value, and comparing their effects on different animals I need only mention it, but we have unfortunately to admit, that Syphilis has been conveyed in vaccination, Urethral Fever and Cystitis in Catheterisation, and Puerperal Fever from the use of Forceps. Again, in the wards of Hospitals, we find it occurring accidentally as in the case of Erysipelas or Diphtheria, attacking stumps of amputated limbs, or other open wounds.

Having now finished my remarks Regarding the various Poisons of an infective nature, and referred to their

varied characters and properties. I will before proceeding to treat of disinfectants and antiseptics, and their application as such, define the real meaning of these terms. In popular language the word disinfectant, is understood to mean an agent which not only destroys germs, but also acts as an antiseptic and deodourant, some of them do act in these capacities, but the term disinfectant, really means an agent, capable of destroying the germs which cause disease, while an antiseptic, is simply an agent which prevents putrefaction, by destroying the germs producing disease; a deodorant may possess neither of these qualities.

As the infective microorganisms already spoken of, are in some cases sporebearing, and as spores have been found to be most resistant to the destructive action of disinfectants, and the spores of the Anthrax bacillus more so than any others, this fact has been taken advantage

of, for testing or forming a standard, by which a disinfectant can be recognised, the test being that a disinfectant shall possess the power of destroying the most resistant microorganisms, and their spores, the destruction being determined by the complete failure of subsequent attempts at cultivation.

One of the first things which attract the attention of anyone studying the subject, is the number of disinfectants, and we seem to be adding to them if not daily at least annually. They are all admitted to be more or less effective, and may be classified in various ways. A chemical classification however, seems most convenient, such as a division of the salts of the metals into Chlorides, Nitrates, and Sulphates the comparative antiseptic values of which, have been tested by Kingzett in the following manner. An extract made from fresh lean beef, carefully digested and repeatedly strained when cold, to

remove undissolved portions and solidified fat, was used as the standard solution. In each observation 95 CC. of this extract was taken, and to it was added 5 CC. of the particular antiseptic solution to be tested; but in cases where the substances were not perfectly soluable, the solutions containing the undissolved particles in suspension were used, with the following results.

Beginning with Chlorides. On the 4th day the mixtures containing the following chlorides had become putrid: Chlorides of potassium, sodium, ammonium, barium, strontium, calcium and magnesium, as also the standard extract. On the 9th day, the chlorides of iron, lead, zinc, and tin.

On the 15th day chloride of aluminum.

The mixtures containing the chlorides of

copper, and mercury, remained intact.

Nitrates

On the fourth day, the nitrates of potassium, sodium, ammonium, barium, strontium, calcium, magnesium, and iron.

On the 6th day nitrate of zinc.

On the 9th day nitrate of lead.

The mixtures containing the nitrates of copper, and mercury, alone remaining intact.

Sulphates

On the 4th day the sulphates of potassium, sodium, ammonium, iron, and manganese.

On the 5th day sulphate of zinc.

On the 11th day sulphate of aluminium.

The mixtures containing the sulphates of copper and mercury alone, remained intact during the whole period of observation viz 16 days. It may be said by way of summary that the chlorides, nitrates and sulphates of the alkalis, have slight antiseptic effects,

and those of the alkaline earths, are not much better. The compounds of manganese, tyme, tin, iron, lead and aluminium, are all of value. As a rule the chlorides are to be preferred. The compounds of mercury and copper are comparatively most effective; the nitrate of mercury is not so reliable as the perchloride, which is the most effective of all disinfectants or antiseptics.
Koch says, regarding it, that a solution of 1 in 5,000. can be relied on for perfect disinfection, since it suffices to annihilate all life in microorganisms and their spores, within a few minutes. Klein, however thinks this an exaggeration of its powers, but otherwise, confirms its effectiveness. In whatever way it acts, it is deficient in the power of oxidation; and though able to kill germs and their spores, is destitute of any power of oxidation of the toxic product

of germs, which is probably the real infectant.
All the mineral acids Sulphuric, hydrochloric, nitric and also some organic acids, such as carbolic, possess strong disinfectant properties; but, the corrosive nature of acids in general, militate against their use as disinfectants.
Another class or group of disinfectants, or antiseptics, are derived from an organic source; the principal members of this group are, carbolic acid, salicylic, creosote, thymol, oils of eucalyptus and pinus sylvestris, and terebene. I purpose speaking of each in detail, and will begin with Carbolic acid

This extensively used, and well known antiseptic and disinfectant, was brought into prominent notice, by Professor Lister, in his famous method of antiseptic surgery; it would be superfluous on my part, to prove its being an effective

antiseptic, or, to enter into details of its application as such, in the form of medicated dressings. As a disinfectant, it may be regarded as a typical member of the group I am speaking of; it is an accepted fact that it arrests fermentation, and destroys minute animal and vegetable forms of life; it can be disseminated through the atmosphere as a vapour, or atomised spray, but as an aerial disinfectant, it could not be used in the sick room, on account of its objectional odour and poisonous qualities when absorbed. The various powders containing Carbolic acid, and sprinkled about sick rooms, act as deodourants, rather than disinfectants; the limited portion of the air coming into contact with the powder being too small to be effectively disinfected.

Creosote, may be regarded as similar in all respects to carbolic acid.

Oleum Pini sylvestris

This valuable oil, which is obtained from the pine leaf, possesses many qualities, which approach more nearly the fulfilment of the conditions necessary in a perfect aerial disinfectant, than any other member of this group; it is easily volatilised, has a fragrant, agreeable odour, and contains an organic peroxide, which it readily yields; it is non-poisonous, and it forms the basis of various systematic forms of treatment in pulmonary disease. The numerous winter resorts, in the South of England, and on the Continent, have for one of their attractions, the presence of large pine forests, that phthisical patients, residing in such places, are usually much benefited, if not in some cases actually cured, will not be denied, and while all the other elements of residence do contribute toward recovery, yet, I am

disposed to give a large amount of the credit of the cure, to the oxidising agency of this oil. Such resorts would loose their virtue, and popularity, were these forests done away with.

Terebene.

This fluid, obtained by distillation from spirits of turpentine, is a more powerful disinfectant than the oil of Pinus sylvestris; it has the same rich, fragrant odour, and forms the basis of the well known Sanitas disinfectants; from experiments made with it at the Royal Victoria Hospital, Netley, where it was used with excellent effects, in correcting the offensive evacuations of dysentery, the odor of purulent collections, such as occur in liver abscess and empyema, and at the same time it was found to sweeten the air of the wards, by diffusing

through them its own peculiar pine-like fragrance. It is specially recommended as a deodorant for water-closets and commodes, and as a disinfectant, for the bowel-discharges of infectious diseases. Both the oil of pine and terebene, can be used as aerial disinfectants with good results; small quantities placed in shallow vessels will be slowly volatilised at the ordinary temperature of a sick room: if necessary, a slight application of heat will volatilise them more rapidly and in sufficient quantity, to have a powerful oxidising, and true disinfectant action on all micro-organisms, and organic particles, with which it comes into contact.

Thymol

is a powerful antiseptic and germicide. A solution of it, containing 1 in 2000 has rendered sterile a cultivating fluid; it is

used like carbolic acid for medicating dressings for surgical purposes.

Salicylic acid

I simply mention this acid, as a type of a class which, while they do undoubtedly possess strong antifermentive and antiputrefactive powers, as well as being good deodourants, in certain diseases, yet, except in the form of medicated dressings, are not used as antiseptics or disinfectants.

Eucalyptus oil

This valuable oil, which can be readily volatilised is a powerful antiseptic, being very destructive to low organic growths, it is more than three times as strong as carbolic acid, in preventing the development of bacteria, and is not as poisonous. Air, impregnated with the vapour of this oil, has been recommended as a substitute for the carbolic spray; it is to this oil, as well as the acidity which the growing tree

has for water, that its antimalarial influence is due to. The sib also possesses an oyonising influence on the atmosphere. Dressings impregnated with it, will, when applied to wounds, keep them sweet for a longer period than similar carbolic dressings. It has been found of special value, as an antiseptic and disinfectant, in Scarlet Fever, where its administration internally as well as its injection during the whole course of the disease, has been beneficial in many respects; the severity of the symptoms has been lessened, and the duration of the illness shortened, while it seems to rob the disease of its infective power. Instances could be adduced, where the isolation of the patient was not as complete as could be desired, and yet the fact of attendants, and members of the family, coming more or less in contact with the vitiated atmosphere, and escaping the disease could only be accounted for, by the efficacy of

its disinfectant power. This again, opens up the question of the mode of application of volatile disinfectants, to which the most of the members of the group I am now speaking of, belong. If the efficacy of medicated dressings have been proved to be of service in surgical cases, why not carry their usefullness further, and medicate the bed, and bed clothes, on which a patient suffering from an infectious disease lies; the bed clothes could without being disagreeable or objectionable to the patient, be impregnated with such disinfectants as Terebene, Pini Sylvestris, or Eucalyptus, which I make bold enough to say, would act in an antiseptic or disinfectant manner, on the desquammae of Scarlet Fever patients, and the gaseous discharges, loaded with organic particles, from the bowels of a Typhoid case. Another disinfectant more powerful than any of those I have mentioned, is Heat. Again

Cold, while it undoubtedly delays putrefactive changes, and thus acts as a preservative, as is evidenced in the usefulness of refrigerating chambers, for the preservation of foods, has on investigation been found to be destitute of any antiseptic or disinfectant property; microorganisms exposed for various periods of time to low temperatures, have failed to develope, but on their afterwards being placed under favourable conditions for their growth, have been found to be possessed of all their infective and reproductive qualities, apparently unimpaired.

While the disinfectants in common daily use, are mostly solutions of the salts of those metals I have already spoken of, as zinc. mercury, iron, copper, calcium, and gaseous ones as nitrous acid, sulphurous acid, and chlorine, yet the number is considerably increased by the addition of patent disinfectants

such as Sanitas fluid, Saliyer, Cresline, Condy's fluid, Burnett's solution, Knyzett's bactericides, St Bees disinfectant, Calvalum, Crosfurs salts, McDougalls powders, and others. These disinfectants owe for their active agent, one or other of the above salts, in combination with other chemical compounds, the combination being a more powerful disinfectant, than either of the component disinfectants. I will conclude my observations on disinfectants, by giving another table of results, of the comparative value of some disinfectants obtained both from organic and inorganic sources.

Anthrax spores were the organisms selected for the following tests.

Corrosive Sublimate solution of 1 in 5000, destroyed the spores, in 10 minutes.

Carbolic Acid, solution of 1 in 20, destroyed the spores, in 24 hours.

Thymol. solution of 1 in 80.000 prevented growth.

Zinc Chloride, solution of 1 in 20,
had no effect, at the end of a month.
Ferrous Sulphate, solution of 1 in 20,
had no effect, in 6 days.
Chloride of lime, solution of 1 in 20,
retarded development in one day, and
destroyed the spores in 5 days.
Potassic Permanganate, solution 1 in 20,
destroyed in one day.

Practical Disinfection.

The mode of application
of disinfectants, naturally falls into 3 divisions.
1st Chemicals in solution.
2nd Chemicals in the form of vapour.
3rd Heat in a dry or moist form.
It will be convenient in the first place,
to treat of the application of disinfectants
in the sick room, during illness, separately,
from their application to empty rooms, and

in a public manner. A patient suffering from an infectious disease, should first of all be isolated; the apartment should be selected where ventilation will be most easily maintained by means of windows and fireplaces, thus affording light and warmth when required; unnecessary furniture and drapery should be removed at once, these not only reduce the air capacity of the room, but act as receptacles for the retention of the virus; attention should also be paid to the situation of the room, to the usual household conveniences, and the sleeping apartments of the attendants, as the carrying through the house of excreta, even when disinfected, is undesirable, and anything which tends to the exhaustion of the attendants, (who have often to add the nursing to their usual household duties) thus predisposing them to acquire the disease,

ought to be avoided. All this is simply applying the natural and ultimate disinfectan of all organic material, namely, a copious supply of pure fresh air, oxidation in the true sense of the term.

Aerial disinfection, is the form best suited for the sick room, and although it has never been considered satisfactory, yet I believe a considerable advance on our present efforts, in that direction, can be made, disinfectants to be of use in such cases would require to be easily volatilised, and while effective for the purpose intended, would not act injurious ly on those who have to respire the atmosphere containing them, for a lengthened period of time; for anything approaching the fulfilment of these conditions, it will require to look to the organic group I have spoken of, the following members of which could be used in the manner desired.

Terebene and the oils of Pinus Sylvestris and Eucalyptus any of these placed in shallow vessels in the room will readily volatilise with but a slight application of heat. Of course other non-aerial methods of disinfection should be carried out at the same time such as the inunction of the patients body with the above mentioned oils especially in cases of exanthematous diseases and the medicating of the bed and bedclothes with the same, all infectious excretions and discharges should at once be received into and well mixed with and covered by chemical solutions of sufficient strength to thoroughly disinfect them. Chemicals in solution

are essential for the effective disinfection of uninhabited rooms and their contents, commodes, water-closets cesspools and all house drains, especially after recent cases of infectious disease

The disinfection of rooms and uninhabited places, should take place as soon after the patient has been removed, as possible; clothing, bedding, carpets and drapery, should be removed, and dealt with in a special manner, which I will refer to when treating of heat as a disinfectant. The furniture should be washed with a strong solution of some disinfectant, as corrosive sublimate, carbolic acid, terebene, or any of the numerous patent disinfectants; afterwards the floor, and all woodwork, in the room, should be similarly treated; paper on walls should be stript off and burned. Then after closing doors, windows, and other openings, chlorine, sulphurous acid, or nitrous acid gas should be generated in large quantities and allowed to remain in the room for some hours. Afterwards, the doors and windows should be thrown open for a few days, when the

ceiling and walls, could be washed with quicklime, and afterwards whitened or tempered as desired.

Waterclosets, and all house drains, ought to be flushed at regular and stated times, irrespective of illness in the household, with water, either cold or hot, or better still, with hot solutions of some disinfectant; there being none more suitable for this purpose, than perchloride of mercury; my reason for recommending flushing with hot solutions being, that the the ordinary waste water discharges from dwelling houses, being frequently warm, and often contain a large quantity of fat, or grease, in a liquid condition, and as the discharges in passing through the drains become lowered in temperature, the fat, or grease, becomes solidified, and adheres to the sides of the drains, or cesspools; this takes place to a certain extent, in spite of

those modern inventions known as grease-bosses. We have here conditions most favourable to the growth of germs; the presence of faecal matter, possibly containing germs; warmth, moisture, and organic matter, suitable for food. The hot disinfectant solution, would dissolve the adhering fats or grease, and carry them beyond the house drains into the common sewer, where they would not constitute so great a danger, while the disinfectant itself being volatile, might reach all parts that did not come into contact with the solution itself. Could steam be forced under pressure into drains, it would act as a perfect disinfectant. Cesspools should be cleaned frequently, and disinfected, but are better absent altogether. Public drains or common sewers, should be as frequently flushed with pure water or a disinfectant solution, all public urinals, necessaries, water closets, should be treated in

the same manner; manure heaps, or collections of filth of any kind, should either be removed from the vicinity of dwellings, or if that be impracticable, ought to be thoroughly saturated with some disinfectant solution.

Chemicals in the form of vapour

are only used

(with the exceptions of those, viz eucalyptus, terebene, and pini sylvestris, which I stated might be used advantageously in the sick room,) for the purpose of disinfecting infected chambers, and their contents, furniture, clothing, bedding etc. the most commonly used are sulphurous acid, nitrous acid, and chlorine gas.

Sulphurous acid gas is obtained by burning lump sulphur, allowing about 1 lb of sulphur to every 1000 cubic feet of space, and in large rooms, it is advisable to burn the sulphur in several places, to secure thorough disinfection.

Nitrous acid fumes, are obtained by adding

nitric acid, slightly diluted, with water, to copper filings. Its power of oxidation of organic matter, is very great, and it is a splendid deodourant, though the fumes are exceedingly irritating and dangerous. Chlorine gas, can be rapidly obtained in the following ways. To 3 parts of bleaching powder, add one part of strong sulphuric acid or To one part of powdered binoxide of manganese, add 4 parts by weight, of strong hydrochloric acid. or To equal parts of common salt, and binoxide of manganese add 2 parts of water and about the same quantity of strong sulphuric acid.

"Fumigation, appears from the following experiments to be unreliable for the disinfection of infected articles of clothing or bedding, sulphurous acid gas, failed to affect dry anthrax spores even in great excess, though well soaked spores were destroyed

and in the absence of moisture in ordinary rooms, the effect on comparatively sensitive microorganisms, was nil. Anthrax bacilli, exposed directly to the action of the gas, were destroyed, but the spores placed in crevices or pockets of garments, were untouched after 24 hours.; with chlorine when the air was saturated with moisture, the results were more satisfactory, but not in dry air.

Heat, as a disinfectant may be used in two ways, 1st Dry heat: 2nd Moist heat or steam, in either way heat is without doubt the most powerful disinfectant known, and its use is specially applicable to all articles which cannot be boiled in water, as blankets, bedding, carpets and cloth clothes generally. The relative disinfecting power of dry, as compared with moist heat, has been tested

in the following manner, The time required to insure complete destruction, as proved by failure of subsequent cultivation experiments, of the spores of the anthrax bacillus.

1st Dry heat at 220° F. 4 hours, 245° F 1 hour.
2nd Steam or boiling water at 212° F 5 minutes.

Steam is therefore incomparably more expeditious and reliable, it is also free from all danger of scorching. In large communities where it is necessary to deal quickly with large quantities of such infected materials, it has been found necessary to resort to machinery for the purpose. Machines for using dry, as well as moist heat, each having their own advantages, have been invented, Of dry air machines the self-regulating Nottingham stove seems to be the best, but all forms of dry heat apparatus, are inferior to the

steam machines, in securing the required penetration of heat, into badly conducting articles, such as thick mattresses.

To ensure efficiency in any heat disinfector, it is necessary, That the temperature shall be equally distributed, That it shall be maintained constant during the whole process and shall be accurately indicated by some heat guage, so as to avoid any possibility of scorching or ineffectual disinfection. Steam apparatus such as the "Washington Lyon steam disinfector," possess these qualities, namely equal distribution, rapid penetration, and accurate registration, as indicated on the steam pressure guage. For the purposes of large cities, some form of steam apparatus is necessary, on account of its rapidity of action. For the less pressing work of small districts, a self-regulating dry air machine, will do good service.

Having now mentioned in detail, if not in as exhaustive a manner as the subject deserved, the better known poisons of an infectious nature, and the various artificial compounds used as disinfectants, and indicated the various ways in which they could be applied, I can only say in conclusion, that no artificial methods of preventing disease are anything like as valuable prophylactics, or can take the place of, cleanliness, not only personal, but also in our dwellings; free ventilation, an abundant supply of pure water, and perfect drainage; the former ought, and the latter can, be obtained, by every individual and community in the Kingdom. Surely the better education of the masses, will bear good fruit, in the near future, by causing them to take an intelligent interest, in the natural laws which govern health, and assist

the legislature, in its efforts to see, that none of these laws can be violated with impunity.

In addition to personal observation, as Medical Officer of Health, regarding effective drainage and disinfection of drains, resulting in absolute immunity, from zymotic diseases, in what had formerly been an almost continuously infected locality, the following works have been studied by me in preparing this thesis.

Wilson's Handbook of Hygiene.
Sir W. Aitken on Animal Alkaloids.
British Medical Journal.
Provincial Medical Journal.
Medical Annuals, and general literature bearing on the subject, any quotations are distinctly indicated as such.

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