and bent, but also suffered from pressure and constriction, the progress of the disorder and of its symptoms was much more marked. The rapid return of sensation in the fingers was remarkable, and far beyond my expectations; the adherent portion of nerve being so thinned and flattened, that I doubted if it could ever resume its functions, and thought it most likely that I should be obliged to operate again, remove the damaged portion, and stitch together the divided ends.

I alluded to the fact of our not being able to find the ulnar artery in the wound. The probability is that it was so crushed by the sharp bone, that it was either divided, or so damaged that it became impervious immediately after the injury.

It may occur to some that an exploratory operation should have been performed earlier. Possessed of the wisdom which comes after the event, it certainly does appear that an earlier operation would have been at all events justifiable; and, with the knowledge gained in this instance, I should feel disposed, should I meet with a similar case, to operate before such a condition of paralysis was reached.

ON THE PRECISE RELATIONS OF MICRO-ORGANISMS TO DISEASE AND THE SCIENCE OF DISINFECTION.

By CHARLES T. KINGZETT, F.I.C., F.C.S.,
Vice-President of the Society of Public Analysts, etc.

WHILE the connection of micro-organisms with the chief contagious fevers is, as yet, a matter of pure inference, it is impossible, in the face of the results of modern investigations, to deny the intimate relations of micro-organisms to certain other diseases, including puerperal fever, pyæmia, septicæmia, and anthrax of cattle; but of the nature of the precise relations, next to nothing is known. The physiological effects produced by inoculation-experiments can be readily observed, but the physiologist cannot lay his hands upon the active principles which cause them. In this connection, I am convinced he can ascertain nothing of a final character without the aid of the chemist; and, because this fact seems to me to have been entirely neglected in all recent investigations, I now beg to direct special attention to this matter, and to indicate how far reliance is to be placed upon the germ-theory of disease, and the use of disinfectants as controlled by that theory. In the first place, then, I shall endeavour to show that the effects which are witnessed in certain diseases are not caused by micro-organisms, but by chemical substances which are elaborated in or by them by way of secretion, excretion, or otherwise; and, secondly, I shall show that the methods now commonly employed by many microscopists and physiologists for testing the action of disinfectants are entirely and radically erroneous.

To demonstrate my views upon the first of these subjects, I will take three well known facts, and consider each very briefly.

In the Report of the Medical Officer of the Privy Council for 1876, there is a description of some carefully conducted and important experiments made by Dr. Burdon Sanderson, in confirmation of the earlier investigations of Panum. In these experiments, a septic solution was prepared by precipitating putrilage with alcohol, redissolving the precipitate in water, evaporating the extract to dryness, and redissolving the dried residue in water. From a series of physiological experiments made with this solution, Panum arrived at the conclusion that "there exists in putrid fluid a specific chemical body which is soluble in water, and is endowed with the property, when introduced into the circulating blood, of calling into existence that peculiar group of symptoms which are recognised as those of septic infection;" and, to use the words of Mr. Simon in reviewing these results, "Dr. Sanderson, though apparently still supposing that the septic ferment is particulate, seems to regard, as proven by Professor Panum's experiments, as well as approximately by his own, that it 'does not consist of living organisms.'" It has been proved then that micro-organisms, in course of putrefactive fermentation, initiated by them, produce one or more chemical products, which act as specific poisons and as infectants in pyæmia, septicæmia, etc.

The attenuation of the virus of chicken-cholera, which has been described by Pasteur, admits only of a chemical explanation. How can it be explained that micro-organisms, freshly cultivated in clear *bouillon de poule*, exhibit a murderous fatality when inoculated under the skin of previously healthy fowl, while the same micro-organisms, in equal number and activity, taken from a cultivation-mixture which has been freely exposed to the air for a long time,

are devoid of this property? To suppose that a morphological change can account for the observed difference in effects is, if not actually absurd, at least entirely unwarranted; and the only explanation is that the micro-organisms in question have nothing to do directly with the poisoning effects we are considering, but that they are due to a specific chemical product which is present in the freshly cultivated mixture, but which is absent in the stale mixture. Possibly it is destroyed by oxidation carried on by atmospheric oxygen.

Again, in the thirteenth annual report of the Local Government Board, Dr. Klein has described experiments which seem at first blush to indicate a variability in the degree of virulence of the *bacillus anthracis*; but further experiments proved that the observed facts were "irreconcilable with the assumptions (1) that the bacillus is in reality capable of undergoing a diminution of its physiological activity, that is, suffering a real attenuation, and (2) that there exist anthrax-bacilli having an intrinsic virulence of various degrees." He then adds, "The facts seem, however, capable of another explanation. Owing to different conditions of growth, for example, high temperature, or other artificial conditions, or owing to different soil on which they grow, for example, the body of a mouse or of a guinea-pig, the bacilli, although themselves the same, embody or appropriate, chemically or otherwise, some new or different substance, which produces the alteration for a particular species of animals. Whether this substance is comparable to a ferment or not, I am not in a position to say; possibly, it is some ferment produced by the new conditions."

It will be at once seen that Dr. Klein almost embraces the chemical theory of disease, which for some years I have persistently advocated; at least, he has himself furnished evidence which gives immense support to my views.

Professor Virchow also, while hesitating to allege the inadmissibility of a mechanical hypothesis of disease caused by micro-organisms, yet clearly thinks the assumption of chemical action remains as the only real explanation, as will be evident to all who are conversant with his writings, and notably with his article on "Infectious Diseases in the Army," which has been translated from the German by Dr. John James.

The chemical theory places us at once upon ground with which we are familiar, and gives us an assurance of security. Just as the yeast-cell decomposes a solution of sugar by the agency of a soluble zymase which it is supposed to produce, and as the *mycoderma aceti* oxidises (by the assistance of the air) alcohol into acetic acid, and as the *bacterium lactis* sours milk and produces lactic acid, so also do the micro-organisms which initiate putrefaction produce definite chemical products, which act as blood-poisons; and the micro-organisms which are known to be intimately associated with certain specific diseases act as the excitants, not in a primary or mere mechanical sense, but in a secondary sense, viz., by the agency of chemical substances elaborated by them under suitable conditions.

These reflections necessarily take us a step further. If there be no sugar present in its soil, the yeast-plant cannot produce alcohol; but it is not to be assumed (at least, in the absence of sufficient evidence) that this micro-organism can live only upon sugar. It is highly probable, indeed, that any one micro-organism can live and thrive under a variety of conditions, and upon a great number of soils; and so the products of fermentative change must necessarily vary accordingly. Many of them may be poisonous in character, while many others may be innocuous. So also it must be with the micro-organisms which are associated with disease; in consequence of which it follows that so-called zymogenic organisms may become pathogenic in character, simultaneously with a change of soil or other conditions, and *vice versa*.

Reviewing all these possibilities and facts, is the science of disinfection to throw overboard all accumulated knowledge, experience, and faith in the action of all disinfectant substances which are not under all conditions germicidal in property? Is the object of mankind henceforth to be the destruction of micro-organisms? If such an object could possibly be regarded as well founded, even then it were idle to attempt its consummation; for micro-organisms are ubiquitous, and constitute a necessary order in creation. By acts of hydrolysis, and oxidation carried on upon all dead organic matter by their agency, such substances are resolved into final innocuous products of change, which are essential to the well-being of the higher orders of creation (plants and animals).

The fact is, that men always outstep the natural limits of a discovery, and jump at conclusions which are not warranted by the results of further investigation. The somewhat sudden discovery of the intimate association of micro-organisms with disease led many to think that, in order to prevent the spread of disease, the micro-organisms must be killed wherever met with; but, now that scientific

investigation has proceeded to a further stage, it is being found that it is not the micro-organisms themselves that are poisonous to man, but the products to which they give rise under certain conditions. Those, therefore, who have the charge of the public health must now trim their sails anew, and henceforth the study of this matter enters upon a new phase, which is chemical in its character. We must now seek to discover under what conditions and from what substances various micro-organisms elaborate poisonous substances, and also to determine the chemical composition of these products.

In the meantime, physiologists and microscopists must abandon their old methods of testing disinfectants. It will no longer serve, in order to ascertain the value of a disinfectant, to take a particular colony of micro-organisms and expose them to the presence of the disinfectant, with the view of ascertaining if they are killed thereby, by means of subsequent attempted isolation and culture; nor will it suffice to expose a colony of micro-organisms to the presence of disinfectants, and, after isolation, to inoculate animals therewith. On the other hand, the infectants must be introduced into the bodies of animals simultaneously with, and in the presence of, the disinfectant; and if the specific disease do not follow upon the inoculation, the disinfectant is a reliable one for that particular set of circumstances.

After all then, we fall back upon old lines of policy, and must have recourse to chemical substances which act on the one hand as antiseptics, thereby preventing micro-organisms from multiplying and producing poisonous substances (real infectants), and substances which by chemical changes, such as oxidation and chlorination, act in a destructive sense to the same chemical poisons if they happen to be already in existence. Indeed, the idea of employing some active chemical poisons, such as carbolic acid, sulphurous anhydride, absolute alcohol, creasote, chlorine, and corrosive sublimate, for the treatment of diseases like cholera, typhoid fever, and dysentery, is, of course, absolutely out of the question; and the only hope is that a non-poisonous antiseptic, such as "sanitas" fluid, which may be administered internally, may be found to supply the means, that is urgently called for, of combating such fearful diseases.

Of the nature of the chemical poisons referred to in the preceding paragraphs as constituting infectants related to specific diseases, I can only suggest that they are derivatives of albumin produced by a series of chemical changes involving hydrolysis; and in connection with this subject, the investigations of O. Nasse and P. Schützenberger have already paved the way for the comprehension of results which may be expected to speedily attend new researches into the chemistry of diseases. I particularly refer to such investigations as those conducted by Selmi with reference to pathological bases formed in the tissues, and to the experiments of the same investigator, Paterno, and others, concerning the formation of ptomaines, and the alkaloids produced in putrefaction. It may be remembered that Selmi, suspecting that in various diseases, poisonous substances are formed in the tissues, and that these determine the death of the patient, analysed the urine of patients affected with progressive paralysis, miliary fever, and rheumatic tetanus, and found in all cases that poisonous bases were present. One of these bases resembled nicotine in its properties, while another had the odour of conine, and a third substance (amongst others) was obtained which was white and crystalline, and was capable of determining the conversion of starch into glucose.

These facts, and the well ascertained formation of poisonous alkaloids amongst the products of putrefied albumin, not to speak of what is known regarding the physiological action of alkaloids generally, including abrin (from jequirity-seeds), may all be regarded as preparatory evidence of the production both in and out of the human body of highly poisonous substances, or infectants, by the agency of micro-organisms.

In conclusion, I wish to add that I am now carrying on a series of investigations concerning the chemical history of some micro-organisms; and I am confident, from the results already obtained, that they will lend strong confirmation to the views I have herein expressed concerning the relations of micro-organisms to disease, and the qualifications of disinfectants.

THE LATE DR. TIBBITS.—The Board of Management of the Bradford Infirmary, at their meeting on the 1st instant, passed the following resolution: "That the Board of Management desires to place upon record its deep regret at the loss it has sustained in the death of the late Dr. Tibbits, who, to his varied professional acquirements, conjoined a deep sympathy with human suffering, and rendered invaluable service to this institution and the community at large. The Board, at the same time, tenders its sincere condolence with Mrs. Tibbits and her family in the irreparable bereavement they have sustained."

A NEW INHALER, WITH REMARKS ON OPEN ANTISEPTIC INHALATION.

By JOHN WARD COUSINS, M.D. Lond., F.R.C.S.,
Surgeon to the Royal Portsmouth Hospital.

THE advocates of antiseptic inhalation are quite unanimous as to the necessity of employing it with great regularity and perseverance over a long period; but there is much diversity of opinion as to the method of application, and the contrivance best adapted for the treatment. The experience of most practitioners is, however, clearly in favour of the direct inhalation of dry vapours, and a great variety of instruments have been constructed for the purpose, for the most part modifications of the original respirator-inhaler suggested by Dr. Sinclair Coghill in 1876. The simplest forms of apparatus are now almost universally preferred, as they are more comfortable to the patient and more readily tolerated during prolonged application. Some inhalers are too heavy, and cause a feeling of oppression, and, sometimes, even difficulty of breathing. Others are objectionable by pressing on the face, and causing irritation of the skin. It is my opinion that all close oro-nasal respirators and complex instruments present no real advantages, and that they must soon fall into disuse, as their employment is seriously irksome to many patients. An inhaler ought to be a very light mechanical contrivance, especially designed to permit the voluntary introduction of medicated vapour by full inspiration; at the same time securing the freest possible access of air, so that the continuous and daily practice may be rendered both endurable and pleasant.

The small instrument represented in the engraving, appears to me to possess all these essential qualifications. It consists of a vulcanite receptacle (Fig. 1) for holding the little pledget of cotton-wool upon which the inhalant is dropped. The wire suspends the inhaler, and serves also as a compressor of the nose. When used for nasal inhalation, one of the balls (Fig. 2) must be selected, and half only of its circumference ought to enter the nostril. During oral inhalation, another ball is used, or the neck of the inhaler can rest against the upper teeth. The Figures 3 and 4 explain the methods of adjusting the instrument. By merely opening and closing the mouth, the patient can regulate the entrance of the antiseptic vapour into the lungs. It is extremely light, and causes no fatigue or oppression, and it does not require to be taken off during coughing and expulsion of the sputa. I am much indebted to Messrs. S. Maw, Son, and Thompson for the care they have bestowed upon the manufacture of my inhaler, and I am glad to add that it can be obtained from that firm at a very moderate price.

The following table exhibits the respective weights of some of the best known inhalers now in general use.

	Drachms.	Grains.
Coghill's metal inhaler...	8	45
" nickelled inhaler ...	7	19
" celluloid " ...	3	27
Mackenzie's metal " ...	15	40
" nickelled " ...	18	52
" celluloid " ...	8	29
Roberts's nickelled " ...	9	3
" metal " ...	7	2
Burney Yeo's perforated zinc inhaler ...	3	40
Ward Cousins's new antiseptic " ...	1	12

The inhaler which I have now described is a very convenient little instrument for the treatment of chest-disorders by inhalation. It is my opinion that the cumbrous instruments which are employed by many, with the intention of filtering the inspired air, are practically useless, and that their persistent use exercises a baneful influence on