claim to be free from mistakes. They dog the steps of the best of us. He will do well who recognises this early and tries to learn the important truths they teach—that we must not rely upon any inspiration to help us to a diagnosis, but that it must be reached, if at all, by means which are open to everyone—the diligent seeking out and the just weighing of facts.

ON THE DISINFECTING ACTION OF SODIUM HYPOCHLORITE.

BY E. KLEIN, M.D., F.R.S.
LECTURER ON PHYSIOLOGY AT ST. BARTHOLOMEW'S HOSPITAL.

IN the *Journal of the Society of Chemical Industry*, vol. XV., No. 5, Dr. Clayton draws attention to the disinfecting action of solutions of sodium hypochlorite, and describes experiments conducted by himself and Professor Boyce of University College, Liverpool, which show that sodium hypochlorite even in weak solutions—e g , containing only 0·2 or even 0·1 per cent. of available chlorine—has a decided disinfecting action on non-sporing microbes. The sodium hypochlorite which was used in the experiments of Dr. Clayton and Professor Boyce, and with which I have also made a series of experiments confirming their results, is a fluid of strong bleaching power and is described as containing 10 per cent. available chlorine. It was used in my experiments as solutions in distilled water—1 in 10, 1 in 100, and 1 in 200—and was tested on the following microbes: (1) proteus vulgaris; (2) bacillus coli communis (these two representing typical putrefactive microbes); (3) bacillus typhosus; (4) bacillus diphtheriæ; (5) bacillus of swine fever; (6) vibrio of cholera Asiatica; (7) staphylococcus aureus of ordinary pus; (8) spores of bacillus anthracis; and (9) spores of the anaerobic bacillus enteritidis.

In the case of the first seven microbes cultures on the surface of nutrient agar were made and kept at 37° C. for forty-eight hours; there was by this time copious typical growth in a very active state. The spores of anthrax were derived from an agar surface culture; when transplanted to gelatin or agar they produced typical growth and when injected into the guinea-pig caused fatal anthrax within thirty-six hours. The spores of bacillus enteritidis were derived from an anaerobic culture in grape sugar gelatin that had been established about ten days; the culture was by this time full of spores which, when transplanted into fresh sugar gelatin, yielded normal active growth. The disinfectant fluid—i.e., the hypochlorite of soda—was used in solution; a definite quantity of the fluid is dissolved—i.e., poured into a definite quantity of sterile distilled water kept in a sterile glass-stoppered bottle. Immediately, after a small quantity, generally 5 c.c., of this solution is poured into a sterile test tube, and then a particle of the microbic culture above mentioned is taken up with a sterile platinum loop, introduced into the 5 c.c. of the disinfectant solution, and well shaken so as to form a uniform distribution or emulsion. In all instances the emulsion contained the microbes in very great numbers, being distinctly turbid. By making a similarly turbid emulsion in sterile distilled water, and then making plates to ascertain approximately the number of microbes present in the emulsion, it was found that one platinum loop of the emulsion yielded colonies far too numerous to be counted.

After exposing the microbes in the above emulsion to the disinfectant fluid for a definite time, cultures are made so as to see whether, and to what extent, the microbes have been affected. Of the first eight microbes—viz.: (1) proteus vulgaris; (2) bacillus coli; (3) bacillus typhosus; (4) bacillus diphtheriæ; (5) bacillus of swine fever; (6) vibrio of cholera; (7) staphylococcus aureus; and (8) spores of bacillus anthracis—the inoculation of the sub-culture was made from the emulsion into nutrient broth and on to nutrient agar and then incubated at 37° C. for four days. By this time any living microbes introduced into the sub-culture would have had ample time and opportunity of producing easily visible growth. In the case of the anaerobic spores of bacillus enteritidis the sub-culture was made anaerobically in deep sugar gelatin and incubated at 20·5° C. for six days. In every instance the sub-culture was made by introducing into the culture medium three platinum loops of the emulsion so as to transfer as many microbes as possible from the disinfectant emulsion. As stated above, each loop would hold an uncountable number of microbes.

An important comparative experiment was made at the outset. It was this. By introducing from the disinfectant emulsion three loops of the fluid into the culture medium it might be said that this culture medium received a comparatively large addition of disinfectant which might interfere with—i.e., inhibit—the subsequent growth of the microbes transplanted into the new culture from the disinfectant emulsion, and therefore if no growth occurred in the sub-culture this absence of growth might not be due to the fact that the microbes had been previously killed, but rather that although still living they were incapable of growing owing to the addition to the culture medium of three loops of disinfectant fluid. In order to ascertain whether the addition of three loops of disinfectant emulsion to the new culture medium had any such inhibitory action on the subsequent growth of microbes a series of cultures were made in the following manner. Of disinfecting mixtures (1 in 10, 1 in 100, and 1 in 200—that is, in the strength in which they were used for disinfecting purposes, as will presently be shown), five loops were transferred to each broth and agar in test tubes, then these test tubes were inoculated separately with the above microbes 1 to 8, and incubated. The result was that in all tubes normal and active growth took place, thus showing that the addition of five loops of the disinfectant mixture per culture tube, even of the strength of 1 in 10, had no inhibitory effect on the subsequent growth of the microbes. The experiments on disinfection made with the above nine species of microbes were as follows.

Series 1.—The hypochlorite of soda was used as mixture of 1 in 10—i.e., containing 1 per cent. of available chlorine. The following microbes were used: proteus vulgaris, bacillus coli, bacillus typhosus, bacillus diphtheriæ, bacillus of swine fever, vibrio of cholera, staphylococcus aureus, spores of bacillus anthracis, and spores of anaerobic bacillus enteritidis. 1. After exposure for twenty minutes the result was that in no sub-culture was there any growth; the microbes had been devitalised by the mixture 1 in 10 in twenty minutes. 2. After an exposure for ten minutes the result with the same nine species of microbes was that there was no growth in the case of the first seven species; also in the case of the spores of the anaerobic bacillus enteritidis there was no growth; but in the case of the spores of the bacillus anthracis there was a limited growth in the broth culture, and in the agar culture there was one single colony. On sub-culture this yielded normal growth, which produced typical anthrax in a guinea-pig. While, then, 1 in 10 completely devitalised the spores of anthrax in twenty minutes it did not quite succeed in doing this with all the spores, although it did so with the great bulk of them. 3. The above seven microbes were also killed by an exposure for five minutes, no sub-culture yielding growth. The spores of bacillus anthracis and of the anaerobic bacillus enteritidis were seemingly unaffected, since copious normal growth was obtained in sub-culture.

Series 2.—Hypochlorite of soda used as a watery solution, 1 in 100—i e., 0 1 per cent. of available chlorine. 1. The following bacilli—the proteus, coli, typhosus, diphtheria, swine fever, cholera, and staphylococcus—were devitalised after an exposure for twenty minutes, there being no growth in the sub-culture. The spores of anthrax and of enteritidis yielded normal and abundant growth. 2. After an exposure for ten minutes the same result was obtained as above. 3. Also after an exposure for five minutes the same result was obtained. It follows, therefore, from this series that hypochlorite of soda in solution of 1 in 100 disinfects the non-sporing microbes above mentioned in five minutes, but does not do this with the spores of anthrax and enteritidis in twenty minutes. 4. For the spores of these two microbes the time of exposure was then prolonged to (*a*) thirty minutes, (*b*) one hour, (*c*) one and a half hours, and (*d*) two hours. The result was that the anthrax spores exposed for thirty minutes to the disinfectant (1 in 100) yielded in sub-culture normal and copious growth both on agar and in broth. The same spores for one hour yielded no growth in broth and a limited number of colonies on agar. After exposure for one and a half and two hours no growth took place. Spores of bacillus enteritidis exposed for thirty minutes yielded good growth. The same spores exposed for one hour yielded a very limited number of colonies. When exposed for one and a half to two hours no

growth was yielded. From these experiments it follows that the hypochlorite of soda used as solution of 1 in 100 had a complete disinfecting power on both anthrax spores and enteritidis spores when acting for one and a half hours; its disinfecting power was limited when acting for one hour, but it had no effect in thirty minutes. This result of the solution of 1 in 100 on spores of anthrax (complete disinfection in one and a half hours) compares most favourably with all disinfectants that I am acquainted with exclusive, of course, of mercuric bichloride.

Series 3.—Hypochlorite of soda used as a watery solution, 1 in 200—i.e., 0·05 per cent. of available chlorine. In this series, also, the time of exposure was (1) for twenty minutes, (2) for ten minutes, and (3) for five minutes. The microbes used were: proteus vulgaris, bacillus coli, bacillus typhosus, bacillus diphtheriæ, bacillus of swine fever, vibrio of Asiatic cholera, and staphylococcus aureus. All these succumbed to the action of the solution after a five minutes' exposure, so that no sub-cultures were obtained in any of the culture tubes. Of course, exposure for ten and twenty minutes respectively had *a fortiori* the same result. On the spores of bacillus anthracis and those of bacillus enteritidis this solution 1 in 200 had practically no effect, as even after exposure for four hours good and copious sub-cultures were obtained.

It follows, then, that on non-sporing microbes the solution of hypochlorite of soda (1 in 200) acts as disinfectant in five minutes. Weaker solutions that I have tried—e.g., 1 in 300 and 1 in 350—required an exposure so long that for practical purposes it must be considered as not applicable, the bacillus coli, and particularly the staphylococcus aureus, exposed to the solution 1 in 300 for three hours yielding in sub-culture good and normal growth. An indication of the positive disinfecting action of the solution of hypochlorite of soda on the microbes in the above experiments is noticeable already by simple inspection of the microbic emulsion. It is this: the emulsion becomes changed from the original turbid into a clear solution; this clarifying action is in proportion, in point of time, to the strength of the hypochlorite of soda solution. Using it in the strength of 1 in 10 its clarifying action is already noticed in from two to three minutes on the emulsion of non-sporing microbes; an emulsion of spores of anthrax is transparent already in ten minutes.

Series 4.—In this series sewage as passed out of St. Bartholomew's Hospital was mixed with hypochlorite of soda. A measured quantity of the sewage (99 c.c.) was put in a glass-stoppered sterile bottle and to it was added 1 c.c. of the disinfectant. Consequently we had here a solution of 1 hypochlorite of soda in 100. The untreated sewage was tested for the number of living microbes contained in it, which was found to be a little under three millions per 1 c.c. After shaking up the 99 c.c. of sewage with 1 c.c. of hypochlorite of soda sub-cultures with three platinum loops per tube were made in broth, on agar, and for anaerobes in deep grape sugar gelatin. The first two were kept at 37° C. for four days and the sugar gelatin culture at 20·5° C. for six days. 1. After thirty minutes all the culture tubes remained free of growth. 2. After twenty minutes there was no growth in the aerobic cultures, but there was one colony in the anaerobic culture; this proved to be a colony of bacillus butyricus. 3. After ten minutes there was copious growth on the agar surface, which proved to be a pure culture of the sporing bacillus mesentericus, but no growth in the broth culture. It follows from this that all non-sporing microbes of the sewage were killed in ten minutes by the addition of 1 c.c. of hypochlorite of soda to 99 c.c. of sewage. Spores, however, both of the aerobic bacteria (bacillus mesentericus) as well as the anaerobic (bacillus butyricus) were not disinfected in ten minutes, but appeared to have been destroyed in thirty minutes. This last result does not quite coincide with the results obtained with the spores directly experimented with in the former series (Series 2), in which 1 in 100 of disinfectant did not harm the spores of anthrax and of enteritidis. The spores of bacillus mesentericus having a greater resisting power to inimical influences (heat and chemical disinfectants) than those of bacillus anthracis, and the latter withstanding the action of hypochlorite of soda, 1 in 100, for thirty minutes, the above result of the apparently successful disinfection of the spores of the bacillus mesentericus in twenty minutes seems at first sight unintelligible. It is, however, explained if we remember that in the experiments with the spores of anthrax (Series 2) three loops of the emulsion would contain an enormous number of spores, while three loops of the sewage may fail to contain a spore of the bacillus mesentericus, this microbe, or its spores, being present far less numerously in the sewage than in our emulsion crowded with the spores of bacillus anthracis.

The addition of 1 hypochlorite of soda to 100 of the fluid is sufficient to devitalise non-sporing microbes in sewage or any similar fluid in ten minutes.

THE ANÆMIA OF RHEUMATOID ARTHRITIS.

BY GILBERT A. BANNATYNE, M.D. GLASG., M.R.C.P. EDIN.,

HONORARY PHYSICIAN TO THE ROYAL MINERAL WATER HOSPITAL, AND TO THE ROYAL UNITED HOSPITAL, BATH.

ALTHOUGH resembling most other anæmias in being secondary and symptomatic rather than primary or idiopathic, that of rheumatoid arthritis is none the less interesting. It differs from that of acute rheumatism, the form to which one would probably consider it should most fitly be allied; but in essentials it may be classed with those anæmias seen in other infective diseases.

Turning to the general characters of the anæmia we seldom find it very marked except in advanced and acute cases, but in almost all, even the slightest, there is as a rule a certain amount of blood deficiency. Roughly speaking, I have found it to exist in about 95 per cent. of the cases coming under my care. We rarely find extreme pallor of the skin, the patients rather, as a rule, presenting a sallow or brownish-yellow appearance, with moderate blanching of the mucous membranes. This sallowness is apt by degrees to pass into a deeper shade until it insensibly merges into a distinct discolouration. Not infrequently we find cardiac bruits and venous hum associated with it. Hæmorrhages, so common in other forms of anæmia, are rare but not unknown. They are very rare from the mucous membranes, being most commonly seen as small purpuric spots on the lower limbs. At the present moment I have under my care a woman aged twenty-two years with marked and advanced rheumatoid disease and anæmia, and in whom there has been very considerable hæmatemesis, there being no obvious gastric condition to account for it. On the whole hæmorrhages are rare, and this we understand when it is remembered that they are most often seen in anæmias of more than 50 per cent. blood deficiency, which depend more on a corpuscular deficiency than on that of the hæmoglobin. With regard to observations of others on the anæmia of rheumatoid arthritis we find that Forsbrooke[1] states that in all cases he found anæmia either in an early or in a late stage. He found a diminution in the number of the red corpuscles as well as of their hæmoglobin value, the decrease in the numbers averaging between 77 and 52 per cent., and in their hæmoglobin value between 55 and 25 per cent. Lane,[2] without entering into details of the anæmia, mentions that it is one of the most constant symptoms, but that it has not the appearance of an idiopathic anæmia and that it never assumes a chlorotic form.

On microscopic examination I have found the blood in rheumatoid anæmia to have the following characters: there is a slight but well-marked diminution in the numbers of the red blood corpuscles (4,300,000 to 3,000,000); a marked and greater diminution in the hæmoglobin (from 80 to 40 per cent.), and a slight increase in the number of the white corpuscles. It is thus evident that the hæmoglobin value of each individual corpuscule is lessened, and as a consequence the functional value of the blood as a whole. The percentage increase of the white corpuscles is slight, and seems to have no definite relationship to the percentage of the other constituents of the blood, nor yet, as far as I could ascertain, to the severity of the joint disease. This point, however, I have not yet been able to thoroughly work out. The blood shows red corpuscles of varying size and varying shapes, but does not present any microcytes (Eichhorst's corpuscles), or yet any nucleated corpuscles. The hæmoglobin would not only appear to be less in quantity in each cell, but to be

[1] Forsbrooke: Dissertation on Osteo-arthritis.
[2] Lane, H.: Rheumatic Diseases—so-called.