AN ADDRESS

ON

A NEW ANTISEPTIC DRESSING.

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MR. PRESIDENT AND GENTLEMEN,—When I last had the honour, five years ago, of addressing this Society at the request of its President, I brought before you an attempt I had made to utilise the powerful antiseptic properties of corrosive sublimate without the great disadvantages attendant upon its highly irritating qualities. I had ascertained that when corrosive sublimate precipitates albumen, the precipitate is not, as had been generally supposed, an albuminate of mercury, that is to say, a combination of albumen as an acid with mercury as a base; in other words, that the albumen does not displace the chloride from its combination, but that the bichloride of mercury retains its properties intact, the albumen being loosely associated with it, in a species of solid solution, if I may so speak.

Further, I had found that this precipitate, even after drying, is capable of being dissolved in the serum of the blood, and that the solution in blood serum is powerfully antiseptic, while not irritating. I proposed and brought before you a new dressing in the shape of what was termed the sero-sublimate gauze, charged with a solution of corrosive sublimate in the serum of the blood. This gauze gave very satisfactory results, both in my own hands and in those of surgeons in places so far distant as Poland and Spain. Nevertheless, it was not all that could be desired by any means; it was somewhat harsh mechanically; it was not very absorbent, a serious defect, and one of the materials of which it was made, the serum of horse's blood, was not always easily obtainable. I was, therefore, well disposed to look for something superior.

A few weeks after that communication was made to the Society, a firm of manufacturing chemists, Messrs. Gibbs, Cuxson and Co. wrote to me saying that they had found that if chloride of ammonium or sal-ammoniac in quantity equal to one-fifth part of the weight of the bichloride of mercury was added to the mixture of bichloride of mercury and blood serum, the result was a much more fluid preparation than I had obtained. If I used a preparation of 1 part of bichloride of mercury to 100 of blood serum, I got a thick liquid somewhat difficult to diffuse in gauze. They therefore suggested that by adding sal-ammoniac in that proportion, I should get a much more workable arrangement. On consulting chemical works, I found that one-fifth of sal-ammoniac was exactly sufficient to produce with bichloride of mercury the salt long known to chemists as sal-alembroth, a double salt of bichloride of mercury and chloride of ammonium. I naturally wished to ascertain whether this addition of sal-ammoniac would impair or even destroy the antiseptic properties of the bichloride of mercury. I therefore made experiments on the point, and I found that the sal-ammoniac associated in the form of a double salt with the bichloride of mercury did not by any means impair its antiseptic properties; on the contrary, it improved them, so far, at least, as concerned that which we have to deal with as surgeons, an albuminous fluid like the serum of the blood. Sal-alembroth and bichloride of mercury proved to be exactly equivalent weight for weight as antiseptics in such a fluid. Each had to be used in normal serum of specific gravity of about 1025 in the proportion of nearly 1000, in order to prevent altogether the development of micro-organisms. Those who are acquainted with Koch's researches will consider this a very high proportion. Koch has shown that in a solution destitute of albumen 1000000 part of bichloride of mercury is sufficient to prevent the development of organisms; but when we have albumen present in the solution the case becomes altogether altered. Albumen interferes with the antiseptic action of corrosive sublimate, and thus in serum of the blood of specific gravity 1025 we require, as I have already said, as large a proportion as about 1000 instead of 1000000.

When the albumen is small in amount, less corrosive sublimate

proves efficient. Thus in a case of spermatocoele, where the specific gravity of the fluid was exceedingly low—only 1007—I found that 100000, just intermediate between the proportions required for blood serum and water was efficacious. On the other hand, when blood-corpuscles are mixed with the serum in the same amount as in the circulating blood, making the albuminoid substances much more abundant than in serum, we require proportionately more of the corrosive sublimate; at least 1 to 500 is required for the purpose of preventing development. This is a most important consideration after an operation. In the first twenty-four hours the discharge contains a large amount of blood-corpuscles as well as serum, whilst, at the same time, it is the most copious, more copious than it will be in any subsequent day, provided all goes well aseptically. It is, therefore, an exceedingly serious consideration that in the first twenty-four hours we have a discharge which in both these respects tests our antiseptic more severely than it will ever be tested again, both from its abundance and from its quality. Still the sal-alembroth, whether used with blood serum or with a normal mixture of serum and corpuscles such as that obtained by whipping the blood of the ox so as to get rid of the fibrin, proved equivalent antiseptically to bichloride of mercury.

I may, perhaps, say in a few words how the experiments were conducted. For the purpose of ascertaining whether a given antiseptic can or cannot prevent development of organisms, a very simple mode of experimentation suffices. What we have to do is to ascertain whether it is *inhibitory*; not whether it is *germicidal*. The only special apparatus required for such experiments is a warm chamber, which can be kept pretty constantly about the temperature of the human blood. Beyond this a few stoppered bottles, with well-fitting stoppers—perhaps half-ounce stoppered bottles—are really all that is required. Into a series of such bottles serum of the blood, to the amount, say, of 150 grains, containing solutions of the antiseptic of different strengths is introduced. These are all inoculated by means of a small syringe pipette with the same quantity, say 1-10th of a minim, of some potently septic liquid such as blood serum in a state of advancing putrefaction. The bottles are placed in the incubator, and then, if development takes place, that is evidence that in the bottle in which it occurs such proportion of the antiseptic as that bottle contains is inadequate; if no development occurs we have proof of antiseptic efficacy. The transparency of the serum permits a recognition of the development of the organisms, which invariably causes opacity. If we have no change in this respect, if the serum maintains its transparency, at the same time keeping its odour unimpaired, and, further, if microscopic examination of any little sediment there may be shows that it contains no organisms, we have clear evidence that the antiseptic in the proportion concerned has proved efficacious.

Now, if the sal-alembroth was equivalent to the bichloride of mercury weight for weight, that shows that the sal-alembroth was really more efficacious as regards the quantity of bichloride of mercury it contained. The bichloride of mercury having the sal ammoniac added to it, and also water in the double salt that is formed, is increased in atomic weight very considerably; and therefore if an equal weight of alembroth is equal in antiseptic action to bichloride of mercury, that shows that the bichloride of mercury is made more efficacious in the blood serum by the addition of the chloride of ammonium. The chloride of ammonium in combination protects the bichloride of mercury, so to speak, to a certain extent, from the interfering influence of the albumen.

At the same time, the sal-alembroth proved much less irritating than bichloride of mercury. Experimenting on my own skin, I ascertained that it has certainly not half the irritating property of corrosive sublimate. The chloride of ammonium attached to the bichloride of mercury, while it protects the bichloride in some degree from the influence of albumen interfering with its antiseptic operation, prevents it also from acting so powerfully on the human skin. And thus the union of sal-ammoniac with corrosive sublimate had the double advantage of rendering it both more efficacious antiseptically and much less irritating.

Hence I was at first much pleased with sal-alembroth. But it soon appeared that there were certain disadvantages attending it. These depend very much upon its excessive solubility. It is essential for a satisfactory antiseptic dressing that the antiseptic should not be readily washed out of it by the discharge. Sal-alembroth is so exceedingly soluble that it is washed out with the greatest ease; thus we were always, even if we used large masses of sal-alembroth gauze, in fear that when the discharge was copious the antiseptic would disappear,

say within the first twenty-four hours, and then the septic mischief would have an opportunity to enter. There was another disadvantage from this great solubility. When the discharge entered a mass of the sal-alembroth dressing it dissolved out the alembroth from it, passed into another part of the dressing, and there took up another portion of the sal-alembroth, and so went on from part to part of the dressing, until if the discharge was copious and the dressing large, as it must be when the discharge is copious, before the discharge got to the edge of such a dressing it became so concentrated a solution of the sal-alembroth as to be highly irritating. We have seen, for instance, after the removal of the mamma, when the first dressing is changed on the following day that there has been over the scapula and the neighbourhood a huge blister. No doubt that was only a temporary inconvenience. We never had the discharge again so great as in the first twenty-four hours; but still it was a great inconvenience.

Such being the disadvantages of sal-alembroth dressing, I was disposed to seek for something better. I may say that I myself have never published anything in favour of sal-alembroth dressings; I have never been satisfied with them. It has leaked out that I have used them, and they have come into extensive employment, but never with my published sanction.

In the course of the following year I made various experiments in the hope of rendering sal-alembroth more useful in different ways, with which I need not trouble you, but without much success. In February, 1886, my attention was drawn by Mr. Martindale, of New Cavendish Street, to cyanide of mercury as possibly a valuable antiseptic, and, if so, having this advantage, that it did not coagulate albumen. I therefore proceeded to make experiments with cyanide of mercury, and I found indeed that in inhibitory power it was remarkably efficacious. I have said that with blood serum sal-alembroth or bichloride of mercury is required in about 1/1000th part. I found that the cyanide of mercury kept blood serum, with only 1/1000th part, perfectly free from organic development, in spite of inoculation with potent septic fluid, for a month, when the experiment ended. I may remark that we have in cyanide of mercury a striking instance of the discordance that there may be between inhibitory power and germicidal power in an antiseptic. In inhibitory power the cyanide of mercury is, as we have seen, exceedingly high; but in germicidal power it turns out to be very low. Mr. Cheyne has made experiments for me, which have shown that even 1/1000th part in water is incapable of destroying the germs of bacteria. Still the inhibitory property of cyanide of mercury was a most important point if in other respects the salt were not disadvantageous; but, unfortunately, it proved to be so highly irritating that the greater irritating property of the cyanide of mercury more than counterbalanced its superior inhibitory power. It naturally occurred to me that the cyanide of mercury might perhaps combine with some other cyanide and form a double salt, having advantages corresponding with those presented by sal-alembroth as compared with bichloride of mercury. I tried the soluble double cyanide of mercury and potassium, but found it quite too irritating. I here again consulted Mr. Martindale, and he mentioned to me that in Watts's *Dictionary of Chemistry* it is stated that a double cyanide of mercury and zinc of very slight solubility may be formed by mixing together a solution of the double cyanide of mercury and potassium with a soluble salt of zinc, the zinc taking the place of the potassium. I therefore obtained some of this material, and proceeded to make experiments on it. I ascertained, in the first place, that it was quite insoluble in water. This seemed at first extremely unpromising. It was soluble in about 150 parts of glycerine, but insoluble in water. I found, however, that it was soluble in about 3,000 parts of blood serum, and therefore it was possible that it might work antiseptically. I made experiments to ascertain whether such was the case or not, and I found that this zinco-cyanide of mercury, as we may call it, had really most important antiseptic properties; that in the proportion of 1/1000th part it kept blood serum perfectly free from the development of organisms for eighteen days, in spite of potent septic inoculation.

I then tried experiments with serum and blood corpuscles as presented in the whipped blood of the ox. On instituting comparative experiments between sal-alembroth, cyanide of mercury, and this double cyanide, I found that with the alembroth all proportions lower than 1/100th putrefied within twenty-four hours after septic inoculation, while with the cyanide of mercury 1/100th part sufficed to preserve the serum and cor-

puscles from putrefaction. At the same time with the double cyanide I was much surprised and much pleased to find that 1/1000th, half as little again, was sufficient to keep the mixture of serum and corpuscles permanently free from putrefaction. It may be said that the absence of putrefactive odour is but a rude test. There may be organisms developed without any putrefactive odour being present; that is perfectly true. At the same time, if in a given experiment we find that with one agent putrefaction occurs within twenty-four hours with 1/100th part, while with another salt there is no putrefactive odour after the lapse of weeks with 1/1000th part, we have pretty conclusive evidence that, so far as the mixture of corpuscles and serum is concerned, we have a more efficacious antiseptic in the latter. I therefore proceeded to prepare dressings of this new substance, diffusing it—for it is an exceedingly fine powder—in water with a little glycerine added to fix it, to prevent it from dusting out. If you simply diffuse it in water and pass gauze through it, with nothing more than the water, the result is that you have gauze which, with the slightest touch, gives out the double cyanide in a cloud of dust, which produces not only inefficacy of your dressing by loss of the proper proportion of the substance, but becomes in the highest degree irritating to the nostrils of those who are near. A little glycerine, however, prevented the double cyanide from thus dusting out. I proceeded to try it in practice. I confess I did not dare to use it—considering its very slight solubility in serum—unmixed, and I associated with it some of the very soluble cyanide of mercury; and with this cyanide gauze we tried various experiments in the way of dressing and got some admirable results. But then, on the other hand, there were disappointments. We found, for one thing, now and then very troublesome pustules as the result of a peculiar kind of irritation. Another disadvantage was that occasionally we got suppurations, coming on at a late period in the case, such as we had never been accustomed to with our carbolic dressings. A case might go on perfectly well for, say, ten days, and then suppuration might occur about a stitch track and spread perhaps further; and sometimes the healing of cases was greatly protracted by this late suppuration. In consequence of these two circumstances I gave up the use for the time being of this material.

I then directed my attention to biniodide of mercury, which has been highly spoken of for its antiseptic powers, and which has the advantage over alembroth of being comparatively little soluble either in water or in serum. I found that the iodide of mercury gauze answered our purpose very well so far as its antiseptic properties were concerned, but that it had the great disadvantage of producing irritation, which it was extremely difficult to control. In order to control it we interposed between the iodide of mercury gauze and the skin unprepared gauze, except in so far as it was steeped in a weak solution of bichloride of mercury (1 to 4,000). But we found that different skins differed greatly in liability to this irritation. The iodide of mercury, which is so very slightly soluble, as you know, in water, is much more soluble in serum, and the solution in blood serum becomes irritating. In consequence of this we had the same disadvantages from irritation as we had with the alembroth; and although, as in the case of the alembroth, this was only a transient inconvenience, I became dissatisfied with the iodide of mercury gauze. There was, however, one point of considerable interest, both theoretically and (as it turned out afterwards) practically, which we found in this investigation with the iodide of mercury. If we simply charged with iodide of mercury, say from a solution in spirit of wine, and then applied the gauze so prepared, we found that the particles of iodide of mercury tended to gravitate down towards the skin, and there produce the most fearful irritation. It was absolutely necessary that it should be fixed. I tried various means, and among the rest a solution of starch, and then there came out this remarkable fact, that if a solution of starch is used with one of the ingredients employed for forming the biniodide of mercury by mixing a solution of iodide of potassium with solution of bichloride of mercury—if you dissolve the iodide of potassium in a weak solution of starch—the iodide of mercury thus formed in the nascent state associates itself with the starch particles in the most intimate manner and becomes entirely precipitated along with the iodide of mercury. If you take a drop of the red fluid formed by mixing these two solutions, and place it on a piece of calico, the watery material is absorbed by the calico and passes into the surrounding parts without colouring them, while the red spot with its insoluble

iodide remains. If now you take a little iodine water, and apply it to the part of the calico moistened by the fluid that has exuded, you find that the iodine water produces no blue colour of iodide of starch, showing that there is no starch in the fluid that thus oozes out and leaves the iodide of mercury behind; whereas, if you take a simple solution of starch and apply it as such to a piece of fabric, as far as the fabric becomes moistened so far do you get a blue colour with the iodine. Here we have, as it seems to me, a somewhat analogous case to the so-called albuminate of mercury. We have the starch particles associated with the particles of iodide of mercury: the starch remains as such, the iodide of mercury remains as such; still they are attached to each other. And so the result was that when such a red solution produced by mixing these two liquids was used for charging gauze, the iodide of mercury was stuck to the gauze by means of the starch, and we had a most satisfactory arrangement in that respect. The iodide of mercury could not be washed out by water, nor did it in the least dust out. The value of this observation with reference to our present subject will appear shortly.

Being dissatisfied with the iodide of mercury, I turned my attention again to the double cyanide of mercury and zinc. Looking back to my notes, I found such evidence of its superior antiseptic properties that I felt that we had deserted this material too readily. In the interval we had had other experience of importance with the alembroth gauze. Occasional late suppurations had at first occurred under its use, just as was the case with the double cyanide gauze. These, however, had ceased to trouble us after my attention had been directed to the expediency of always using mercurial dressings in a moist condition. If they are used dry, the mercurial salt having no volatility, and having no power therefore of destroying any micro-organism in contact with it, whether derived from the manufactory or elsewhere, there could be no security that the dressing when applied was free from living organisms. This important object could, however, be infallibly attained if the dressing were used moist with an efficient germicidal solution. I put this idea into practice, and during the two years that have since elapsed, we have never on any single occasion had to complain of these late suppurations. Might not the same immunity attend our cyanide gauze if we adopted with it the same expedient?

The other objection to this double cyanide gauze had been the irritation which it occasioned. Might not this have been due to the simple cyanide, which, as I have said, I used along with the double cyanide? The simple cyanide is highly irritating, and, just as with the sal-alembroth, being freely soluble, it can be taken up by successive portions of discharge, and, when the discharge is free, may come to be in so strong a solution as to irritate. On the other hand, experiments on my own person had shown that the powder of the double cyanide might be kept applied to the skin for an indefinite time, whether moistened with water or with blood, without occasioning any irritation whatever. If this was the explanation, and if, as our experiments indicated, the double cyanide could be trusted, we might get rid of irritation by using a double cyanide dressing moistened with a weak solution of bichloride, say 1 to 4,000, which, while it is securely germicidal, can never irritate. But here arose a new difficulty. I have told you that when we tried this double cyanide in a gauze at first, in order to prevent the dusting out, with its great inconveniences, we used glycerine; but if we moistened the gauze with 1 to 4,000 solution of corrosive sublimate, we should run great risk of washing out the glycerine, and then the double cyanide would be free to dust out on drying. And, besides that, it must be admitted that the glycerine arrangement was not a good one, independently of that consideration, inasmuch as when the discharges flowed into the gauze they would wash away the glycerine, and then the double cyanide might be washed out also, and so fail in one of the most important requisites of an efficient antiseptic dressing—the storage of the antiseptic in the dressing in spite of the discharge. How was this difficulty to be overcome?

Now came to our aid our experience with the iodide of mercury and the starch. Might it be that the particles of the double cyanide might attract starch as those of the iodide had done? It did not seem very likely, seeing that cyanogen is not known to have the special affinity for starch that iodine has. Still, I thought I would try the experiment. I prepared the double cyanide by mixing a solution of the double cyanide of mercury and potassium with a solution of sulphate of zinc. I tried this with one of the ingredients dissolved in a starchy solution; and, to my great satisfaction, I found that the precipitated double cyanide

left a supernatant liquor almost absolutely free from starch, and that the particles which thus fell, the double cyanide with the starch associated, fixed themselves to a gauze in such a way that it did not in the least dust when dry. Not only so, but immediately after being charged with the precipitate diffused in water, it might be washed in the wet state without the double cyanide being washed out of it, so closely did the starchy particles stick the double cyanide to the fabric. It is of great importance that in some way or other the double cyanide should be washed, because at the same time that an insoluble double cyanide is formed, there are produced other double cyanides which are soluble, and which are in the highest degree irritating; they must be washed out.

Well, I thought I had thus attained my object, and that by mixing starch with one of the two solutions necessary for forming this double cyanide and allowing the precipitate to fall, then decanting, pouring in more water, and, after precipitation, decanting and repeating the process another time, so as to get rid of all the irritating soluble salts, and then diffusing the precipitate through a gauze I should have all that I desired. But when I tried to get this done commercially I found that I got such blundering as to make the thing practically hopeless. There was nothing for it but in some way or other to get the double cyanide from the chemist as a definite product, and then in some way devise a means of fixing that powder of the double cyanide to the fabric. I therefore naturally tried whether a solution of starch would answer this purpose; whether the starchy particles would associate themselves with the double cyanide particles, not only in the nascent state, which we had before tried, but also when the already formed double cyanide was mixed with the starchy solution. I found that it did so; that when a starchy solution was stirred up with the double cyanide in the proportion of one part of starch to two of cyanide, the starch was almost all precipitated, and the precipitate so formed adhered to the gauze in the most satisfactory manner.

But though its adhesion was satisfactory enough, it turned out that the precipitate thus formed aggregated into a tenacious mass, which could not be diffused uniformly through the gauze, and here I was again at fault. This difficulty was overcome by first charging the gauze with the double cyanide powder diffused in water, and then transferring it to a starchy bath. This at once fixed the cyanide in the gauze; and whereas, before it was placed in the starchy bath, the slightest squeeze made a milky fluid exude, no sooner had it been well penetrated by the starchy liquid than you might squeeze it as you pleased, and nothing came out but a clear fluid. I was much pleased with this, and it is in this way that I have prepared the gauze that I have used for the last twelve months, both in the hospital and in private practice. Still, this method had its disadvantages. When the gauze had been passed through the fluid in which the double cyanide had been diffused without any starch, it required very tender handling. If you gave it a squeeze, out came a quantity of double cyanide; and it was plain that, although one might do it oneself satisfactorily, if we trusted to the manufacturers, there would be an utter uncertainty as to what quantity of material might ultimately remain in the gauze.

Only lately has this difficulty been surmounted. It occurred to me that perhaps if the starch were first blended with the double cyanide, and then dried and reduced to powder, if water were afterwards added to this dried dissolved starch associated with the cyanide, there might not be the same tendency to lumpiness and difficulty of diffusion. I found that the process did not answer quite as I hoped in the first instance, in this respect, that the dried starch and double cyanide were extremely difficult to scrape off from any plate on which they were put to dry, and also very difficult to pound up and to diffuse for charging the gauze. I got rid of these inconveniences by means of sulphate of potash, used for the same reason as Dover's powder—that is, that it is an inert substance, with sharp, gritty particles. Mixing a pretty strong solution of starch with the double cyanide powder and adding to this a quantity of pounded sulphate of potash, the result is that you get a material which, after drying, is easily scraped off by the manufacturer and easily reduced by him to an impalpable powder, which is then readily diffused in water, and makes a perfectly uniform gauze. Being mixed in large quantity with water in order to charge the gauze, the sulphate of potash is practically got rid of, and if any of it remains it does no harm, because it is inert. Thus we have the means of easily charging fabrics with this double cyanide.

I have spoken of diffusing this preparation in water, but in reality we employ for this purpose the 1 to 4,000 solution of bi-chloride of mercury, which fortunately does not in any way interfere with the process. I may remark that the double cyanide, like the simple cyanide of mercury, though very efficient as an inhibitor, cannot be trusted as a germicide. There are different ways in which absorbent gauze such as this may be charged. One is to pass it folded in about sixteen layers through a trough, such as the one before me, which I have myself used, having a bar near the bottom to ensure the gauze being kept well under the liquid. It is then, as soon as you please, squeezed, to press out superfluous liquid, and then, if wanted for immediate use, a simple way is to place the masses of gauze—say, six-yard pieces—in a folded sheet, turn the folded sheet over them and roll it up. The folded sheet then absorbs the still redundant liquid, and you have moist gauze ready for use in five minutes. For the use of the ordinary surgeon it will probably be best to have the gauze dried, on the understanding that it is again moistened with 1 to 4,000 sublimate solution before being used. Here is a sample of the gauze in the dry state, which you see does not give off dust even when freely handled.

Other articles may be charged as well as gauze with this substance. The double cyanide being perfectly unirritating, there is no objection to having an excess of it. If you take therefore some of the preparation and stir it up with water, so as to produce an opaque liquid, and put linen rags into it, and then place them in a folded towel to take out the excess of liquid, you have your dressing ready prepared then and there. It can thus be very easily worked on an emergency.

We have seen that the double cyanide requires about 3,000 parts of blood serum to dissolve it. If therefore it is present in a gauze in the proportion of about 3 per cent., you will easily understand that blood serum may soak through such a gauze time after time without washing the ingredient all out; so that it is a material which is admirably stored up in the dressing. That is one of its three great advantages, the others being that, while trustworthy as an antiseptic, it is completely unirritating. In actual practice the few layers placed next to the wound are washed in a solution of carbolic acid, 1 to 20; this washes out the corrosive sublimate, which, though present in small amount, might irritate the wound to some extent. The carbolic acid soon flies off, and there is left in the application next the wound merely the unirritating double cyanide, and under this we find that not only do wounds, the edges of which are brought accurately together, unite beautifully by first intention, but even granulating sores heal by the gradual process of cicatrization from the edges—*heal by scabbing in a way that we have never seen so satisfactorily under any other dressing.*

Having satisfied myself that this was really a useful material, I proceeded to request a manufacturing chemist to provide it for me on a large scale. Messrs. Morson and Son, of Southampton Row, kindly undertook to do this, and I have to thank them for the great pains they have taken in carrying out experiments on this subject at my suggestion. Their manager, Mr. Taubman, soon informed me that in his opinion there was exceedingly little mercury in this so-called double cyanide of mercury and zinc. Very little mercury could be got from it on testing, in comparison with what would be obtained if it were a true double salt. He asked if I was sure that the cyanide of zinc was not after all the thing that was efficacious! Was the idea of the double cyanide altogether a delusion? I need not say how much pleased I should have been if such had been the case—if we could have had the cyanide of zinc without any poisonous mercury in it as an antiseptic. The cyanide of zinc was a perfectly definite compound, there could be no mistake about it. I proceeded to make experiments, and I found, indeed, that cyanide of zinc has antiseptic properties. I made, for instance, experiments of this kind—I took a piece of glass tube and packed it in two inches of its length with gauze charged with cyanide of zinc only, and then, holding it vertically, poured serum of horse's blood into it till the gauze was fully moistened; and then poured more in, till a quantity dropped out from the lower end equal to that which had produced saturation, the upper part of the gauze being thus thoroughly washed with the serum.

I then inoculated the top of the gauze with a potent septic drop. I had another similar tube with gauze that had no cyanide of zinc in it, and after pouring serum through it I inoculated that. I put each into stoppered bottle, so as to prevent any evaporation, and placed them in the incubator. At the end of four days I opened the two bottles. That which contained the gauze without

the cyanide of zinc stank, and, on taking portions of the gauze from either one end or the other, squeezing them and examining under the microscope the fluid that escaped, there were seen teeming multitudes of bacteria of various sorts. The bottle with the cyanide of zinc, on the other hand, had a pure odour of hydrocyanic acid, which this gauze always has when moist. I then examined drops squeezed from both ends, and I found no bacteria in the clear serum that was pressed out, not only from the lower end, but even from the upper end in the immediate vicinity of the inoculating drop, and where the gauze had been drenched repeatedly with the serum.

Now that, so far, is a result such as no other antiseptic had ever given me. Take iodide of mercury, for example. Comparatively insoluble as it is, if you pour blood serum upon it in such profusion you wash the iodide of mercury out, and if you inoculate septically the part so washed you induce bacteric development. The test applied was, of course, an extremely severe one. In actual surgical practice the discharge which pours into the dressing is pure to begin with, supposing the wound to be aseptic at the outset. The septic agency acts from without upon unwashed parts of the dressing, and in a far milder form than here, where a potent septic drop was used. Thus we had clear evidence that the cyanide of zinc is an antiseptic. On the other hand, it turned out to be not so powerful antiseptically as our double cyanide so-called. In order to compare the two salts I made another experiment similar to that last described. I packed three pieces of glass tube with gauze in two inches of their length, one of the gauzes being charged with cyanide of zinc, and another with the so-called double cyanide (neither of these gauzes having been treated with solution of bichloride of mercury), while the third gauze was unprepared. Serum of horse's blood was poured into the upper end of each vertically-held tube till it thoroughly soaked the mass of gauze, after which each gauze was inoculated septicly at the centre of its upper end. The tubes were then placed vertically in stoppered bottles in the incubator. It happened that in the septic liquid used for the inoculation that I used there was, among other organisms, a species of streptococcus which had a remarkable power of producing an acid fermentation in blood serum. After four days I proceeded to examine the contents of the three tubes. In the unprepared gauze there was utter putrefaction. In the gauze prepared with cyanide of zinc only, no putrefaction had taken place, but acid fermentation had occurred; both at the upper and lower end of the gauze litmus paper was reddened on application to the serum. In the putrid gauze turmeric paper was most intensely reddened, much more so than by normal blood serum, an alkaline fermentation having occurred there. On the other hand, with the gauze that contained the double cyanide, with mercury as well as zinc, both at the upper and at the lower end the turmeric paper was reddened exactly as it was by the normal blood serum. This state of things continued the next day; but on the following day, six days after the commencement of the experiment, I found that at the upper end, in the vicinity of the inoculated spot, this gauze purpled litmus, while at the lower end it still reddened turmeric. At the end of seven days the same condition persisted. After eight days, however, both the upper and lower end of the gauze purpled litmus. This peculiar septic organism, with the power of producing acid fermentation in serum, had gradually worked its way down, in spite even of the cyanide of zinc and mercury; but the cyanide of zinc and mercury, you observe, had been much more efficacious than the cyanide of zinc alone. The cyanide of zinc had prevented the development of organisms that produced putrefaction, and only permitted the growth of the coccus that produced acid fermentation. Cyanide of zinc and mercury had for several days prevented all development. This was proof, therefore, that the mercurial element in our compound was valuable, and that we could not dispense with it.

It may be thought an unsatisfactory thing that there should have been any organism able to work its way thus through a gauze charged with our antiseptic. But I may remark, in the first place, that, as above stated, we tested the material exceedingly severely; in the second place, that it was a long while before the organism penetrated the gauze even for a short distance; and, in the third place, that penetration of micro-organisms through such a dressing into wounds does not seem to occur in practice, seeing that in the year during which I have used this antiseptic in my surgical work at King's College Hospital we have had no single instance in which we have had any reason to suspect septic change in the deeper parts of our dress-

ing; we have had no instance in which deep-seated suppuration has occurred in an operation wound made through unbroken integument. If we have had any pus at all in such cases it has been from the surfaces exposed between stitches or at situations where drainage tubes have been inserted, where what I have termed antiseptic suppuration has shown itself occasionally, and even this in very slight degree. Such being the case, I feel not only permitted but bound to bring this material under the notice of my professional brethren.

As to the composition of this so-called double salt, it is for the present uncertain. This much is already established: that the cyanide of mercury is in very much smaller proportion to the cyanide of zinc than Watts's *Chemistry* would lead us to expect the double salt would give. But what the precise composition of the salt is we do not yet know. I am having it investigated by the Pharmaceutical Society, who have kindly undertaken the work.

There is another use for this material besides the charging of dressings. The powder moistened with a weak solution of corrosive sublimate may be rubbed into hairy parts, when it will convert the hairs into an antiseptic dressing. Not long ago a medical friend of mine brought his wife to me with no less than seven sebaceous cysts in the scalp, requesting me to remove them. Having washed the hair with 1 to 20 carbolic acid solution, I simply passed a comb over each tumour in the line where I was about to transfix, without shaving at all; and after taking out the cysts, rubbed some of the moistened powder into the hair in the vicinity. I then applied a dressing of cyanide gauze, and I was glad to learn that all the seven wounds had healed without disturbance.

We have now in the hospital a case of psoas abscess, shown to be of spinal origin, not only by the history of the case and the symptoms, but by the discharge of a portion of bone with the pus. That case is pursuing a course which, allow me to say, psoas abscesses will pursue in the great majority of cases, if the surgeon uses a trustworthy antiseptic, and takes the same pains with dressing to the last as at the outset; that is, he will find his trouble rewarded by the complete cure of these formerly incurable cases. I say this because I grieve to think that psoas and lumbar abscesses still seem to be regarded as hopeless affairs by many surgeons. In this man's case the temperature has never been affected in the least; he has put on flesh rapidly; the discharge, after the purulent and curdy matter that existed originally in the abscess was got rid of, has been of serous character, and is in small and diminishing quantity. But the opening made for the discharge is in the vicinity of the pubes, and the pubic hairs used, under such circumstances, to be a constant source of anxiety to us unless frequently shaved away. Here we rub in at each dressing a little of the moistened cyanide, and convert the hairs into an antiseptic application.

I will not at present enter into the details of the preparation of this material; these will be supplied in a note on a future occasion.¹

The sketch which I have given you of this investigation, though it has, I fear, wearied you, conveys but a small idea of the toil it has involved. There are those who still believe that the use of antiseptic substances in surgical practice is always useless, if not injurious. The germ theory of septic diseases is indeed now happily established incontrovertibly. All now admit that septic mischief in our wounds depends upon the development of micro-organisms in them derived from without. But the gentlemen to whom I refer are, more or less logically, disposed to trust everything to the antiseptic powers of the human tissues.

I believe I happened to be the first to direct attention to the antiseptic agency of living structures, and there is perhaps no one who attaches greater importance to it than I do. Without it surgery in former days would have been absolutely impossible. Still I know too well from experience that it cannot always be trusted, and that the use of antiseptic adjuncts is in the highest degree important. And I have the satisfaction of knowing that there is among you a constantly increasing number who, when they have operated on an unbroken skin, with a fair field around for the application of their dressings, if they see septic inflammation occurring in the wound with its attendant dangers, know that it is their fault or the fault of the antiseptic appliances at their disposal. To those among you who are impressed with this conviction I offer the dressing which I have described as the most satisfactory that I have hitherto met with; and I venture to hope that you will regard it as a not unwelcome addition to your resources.

¹ This note will appear in our next issue.

AMPUTATION AT THE HIP-JOINT.

By THOMAS MYLES, F.R.C.S.I.,

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I HAVE recently been practising on the dead body a new operation for amputation at the hip-joint, though I have not yet had an opportunity of trying it on the living.

The dangers of this operation are three—shock, hæmorrhage, and infection of the wound from its proximity to the anus. The first-named will exist probably in spite of every improvement; the two latter I think are obviated by this new method of operating, which I will now briefly describe.

The femoral artery is carefully felt for below Poupart's ligament; one inch below Poupart's ligament and half an inch outside the artery a stout nickel or steel skewer is thrust straight through from before backwards, and emerges on the posterior aspect a little above the gluteal fold. This skewer passes just inside the neck of the bone in the angle between neck and shaft of femur. A piece of india-rubber like that used in boy's catapult is passed on the inside of the thigh, and twisted in a figure

FIG. 1.—A, artery; F, femur; X, space between bone and artery into which pin is thrust from before backwards; T, elastic or india-rubber band passed around limb and ends of pin on inner side.

of 8 over the projecting ends of the skewer. It can be tied or, preferably, clamped with a bit of soft metal. By this means the femoral artery is completely controlled above the origin of the profunda. A long straight transfixion knife is now passed in the same direction as the skewer, but entering the skin at a slightly lower level, and emerging at a slightly lower level behind. A straight vertical incision, about two inches long, is now made with the knife, which is finally carried inwards, making a tapering flap from the tissues on the inner side of the limb.

During this part of the operation very little hæmorrhage is likely to occur, as the femoral in front and the sciatic artery behind are compressed by the elastic band. The limb is now forcibly abducted, and the capsule, stretched over the protruding head, comes into view, a nick with the knife allows the head to escape, and the blade is now carried first above and then outside the great trochanter, keeping close to the bone; and, finally, a second flap, similar to the first, is cut from the tissues on the outside of the limb.

This operation can, of course, be modified by tying the femoral and other visible vessels after the first incision; or, when the head is freed, a second pin, an elastic ligature, may be made to encircle the outer flap before it is completely divided. The accompanying rough diagram explains the method. The advantages of this are:—(1) extreme rapidity; (2) complete control of hæmorrhage; (3) the wound is vertical, therefore allows for drainage; cleanly cut, therefore ensures apposition and prompt union; away from the anus, and, therefore, not liable to infection. I trust that other surgeons will at least try the method, which, I believe, will be found most satisfactory.