

had apparently greatly decreased. Radiographs taken at regular intervals showed gradual absorption of the paraffin and replacement by bone. Radiographs showing this absorption were submitted for publication, but were not capable of reproduction.

Here, then, are two cases varying greatly in their clinical character, one due apparently to a very attenuated staphylococcus and the other probably tuberculous, both of which reacted well to this form of treatment, the active disease being cut short and the convalescent period being greatly shortened from that of even the most satisfactory cases where methods of opening, scraping, and draining are employed, being in these cases two weeks as compared with from two to four months by the other method, and the final results seem to be remarkably good. Apparently not only is the paraffin slowly absorbed and replaced by new bone, but a large amount of the inflammatory new bone deposited around the shaft is also absorbed as soon as the irritant material has been removed.

To secure good results the following points seem to be necessary. First, the wound should be carefully protected by gauze from contamination with the material in the abscess cavity or the irritant substances used to sterilise and to dry the cavity. Secondly, the operation should be completed in one stage so that good apposition of the edges of the periosteum and skin may be insured. This does not in any way seem to prevent the sterilisation of the cavity, the only argument in favour of doing it in two stages. Thirdly, paraffin of a melting point of 120° F. should be used to fill the cavity. Many cases have now been recorded by Stephen Paget where its use subcutaneously has been followed by success and one case where it was used to fill up a frontal sinus, the cavity in the bone being packed with it.² It sets more firmly than Moorhof's mixture and can be sterilised more readily and has no local or general toxic characters, whilst the argument used against it that it is not absorbed does not from these cases seem to be correct.

For permission to publish these cases I am much indebted to Mr. C. W. Mansell Moullin, under whose care the patients were.

London Hospital, E.

ELECTROLYTICALLY PRODUCED FLUIDS CONTAINING HYPOCHLORITES, THEIR MANUFACTURE, AND THE RATIONALE AND CHEMISTRY OF THE PROCESS FOR SECURING STABILITY.

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IN the metropolitan borough of Poplar the Hermite process of making an electrolytic disinfecting fluid has been in operation for a period of nearly two years. The fluid has been made throughout at an average strength of from 4.2 to 4.8 grammes or more of available chlorine per litre and by appropriate treatment has been rendered exceedingly stable, thereby enabling it practically to maintain an undiminished strength for months, and even extending to years, as samples taken and kept since the installation of the plant prove. Owing to the evanescence of the chlorine great difficulty was experienced at first in rendering the fluid stable. I was occasioned much anxiety, as the process that I had recommended and which had been adopted by my council was not giving the satisfactory results that I had anticipated and had been led to hope for. I had been assured, and in turn had assured my council, before adopting the process, that the fluid could be rendered quite stable by the addition of certain chemicals. In September, 1905, I had given to me a note relative to the bases formerly used to render stable the fluid made by the Hermite process—namely, lime and caustic soda. Neither of the processes was adopted. I had ascertained that by merely adding a solution of caustic soda to the fluid it would produce stability, but such I found on experiment would not bring about the desired effect, for fluid made at 4.8 grammes

of available chlorine per litre began to degenerate immediately it left the electrolyzers and in a very few hours only gave a test of 2.0 grammes of available chlorine per litre and continued to diminish in strength. Then, after the addition of caustic soda, the carboy was necessarily shaken for some minutes, but shaking a carboy of 150 pounds weight by hand was, of course, a most difficult operation. Better results, however, were certainly obtained by half filling the carboy. It was observed that upon the addition of caustic soda to the electrolytic fluid a white precipitate was formed which immediately fell to the bottom of the carboy. The precipitate was, of course, hydroxide of magnesium and the shaking of the carboy caused this insoluble and not easily diffusible compound to be distributed throughout the fluid and to give it a milky appearance, and it was found that the more milky in appearance the fluid became the more stable was the fluid rendered. The white precipitate ultimately settled at the bottom of the carboy and the fluid became quite clear. Having arrived at this point, and in order to secure the desired full amount of chlorine in the fluid from the moment it leaves the electrolyzers, arrangements were made to drop the solution of caustic soda into the carboys and to stir whilst they were being filled, and by another simple mechanical arrangement the hydroxide of magnesium and the electrolytic fluid were mixed well together by stirring the mixture in the carboys immediately after the process of filling. For my present purpose I need not further describe this arrangement and the apparatus for mixing. Careful thought and experiments have explained to me the rationale of this process and my explanation will possibly throw some light upon the whole process of the electrolytic production of hypochlorites.

To understand the process of making the fluid stable one must first comprehend what is common knowledge respecting the electrical action within the electrolyzers and to find out if there be any point which has been previously overlooked. I venture to say that my observations and experiments have demonstrated there is a point and this the crucial one, the discovery of which has been most gratifying and which I consider well worth all the trouble I have taken in this direction. The Hermite process adopted at Poplar, which no doubt will give a key to all other processes, has been described as follows:—

(a) When a solution of a mixture of magnesium chloride and sodium chloride is submitted to the action of an electric current of the proper strength in a special apparatus called an electrolyzer, the magnesium chloride is decomposed by the electric current, as also is the water. Nascent chlorine and nascent oxygen or ozone are formed at the positive pole. These two bodies immediately combine and form an oxygenated compound of chlorine, unstable, but of great oxidising power. This chlorine compound is soluble in the liquid in which it is formed. The hydrogen produced by the decomposition of the water and the magnesium are set free at the negative pole, the latter decomposing the water and producing magnesium hydrate, of which part combines with the chlorine compound set free, and the rest remains in suspension in the tank.

The sodium chloride acts as a conductor for the electric current. The solution of the chlorine compound obtained by this method has only a slight smell of chlorine, it is nearly neutral. Its strength can be easily tested by the usual arsenious acid test.—Extract from a pamphlet upon Sanitation by Electricity—Hermite System.

Or again:—

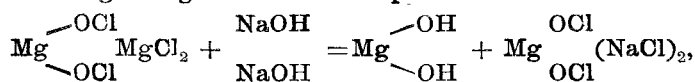
(b) The principle of this process is passing a current of electricity through sea water, or if sea water is not handy, a solution of magnesium and sodium chlorides; a portion of these chlorides is converted into hypochlorite, a substance which disinfects, deodorises, and bleaches similarly to the active ingredient of bleaching powder—calcium hypochlorite. The change from chloride to hypochlorite takes place almost entirely with the magnesium salt—yielding magnesium hypochlorite $Mg(ClO)_2$. It is found, however, that in the electrolyzers and tanks a white deposit takes place, consisting of magnesium oxide combined with water, viz., magnesium hydrate, showing that the magnesium hypochlorite has decomposed, forming magnesium hydrate, which precipitates, leaving hypochlorous acid in solution. The action may take place as follows: $Mg(ClO)_2 + 2H_2O = Mg(HO)_2 + 2HClO$. The amount of oxidising power is expressed by the quantity of available chlorine in grammes per litre, the usual working strengths being from 0.5 to 1.0 gramme per litre of solution.—From a paper read before the British Association by J. Napier, F.C.S., F.I.C., borough and county analyst, Ipswich.

Now is this chemical expression right? I venture to suggest that it is not, for the reason that the major portion of the white deposit in the electrolyzers is an oxychloride of magnesium ($MgCl(OCu)$) and the formation and accumulation of this deposit is the *bête noire* of the process. I have explained in another place how difficulties of working the electrolyzers on account of this formation of oxychloride of magnesium are at present surmounted. No doubt there is a limited quantity of hydroxide of magnesium in the deposit but not much. I have caused an analysis to be made of the

deposit. NaCl is not acted upon to any extent, if any at all, but carries the current to the $MgCl_2$, and there is formed, according to the above description (a), magnesium hypochlorite in solution and magnesium hydrate in suspension; and, according to description (b), hypochlorous acid in solution and magnesium hydroxide in suspension; but nothing is said in either instance about the deposit of oxychloride of magnesium.

Now I venture to suggest, and I think it can be proved, that there are in the electrolyzers in solution both hypochlorite of magnesium and hypochlorous acid. What really must occur during the electrolytic process is that hydroxide of magnesium is certainly formed at the negative pole and unstable compounds of oxygen and chlorine at the positive pole and the hydroxide of magnesium endeavours to combine with these unstable compounds of oxygen and chlorine. Some of it no doubt does so, but a large portion, possibly half, for reasons which will be given further on, is prevented from doing so by the formation of the oxychloride of magnesium or there may not be sufficient hydroxide of magnesium formed to combine with all the unstable compounds of oxygen and chlorine, so that clearly what one has to do to render the fluid stable is either to assist the process by the addition of hydroxide of magnesium whilst the electrolysis is taking place or to complete the process afterwards by the addition of hydroxide of magnesium after the fluid has left the electrolyzers or to combine both methods. It must be remembered that hypochlorite of magnesium is stable for practical purposes when kept in non-actinic bottles and stoppered with paraffined corks or kept away from the light, but hypochlorous acid is very unstable even in the dark.

In Poplar there is added and kept stirred within the fluid to be electrolysed a small quantity of hydroxide of magnesium the object of which is obvious—namely, to assist in picking up the unstable compounds of oxygen and chlorine formed at the positive pole. Now, if the heaped-up deposit in the electrolyzers and which deposit lies closely against the positive pole were hydroxide of magnesium, where would be the necessity to add this compound? It speaks for itself that the deposit is not hydroxide of magnesium but magnesium oxychloride. Now for a step further. When sodium hydroxide is added to the electrolysed solution the following change is said to take place:—



the magnesium sodium double salt being considerably more stable than the corresponding magnesium one.

This may be so, but I venture to say that the double magnesium sodium salt is not formed and here I would call attention to the fact that the hydroxide of magnesium falls to the bottom as mentioned in the first part of this paper and the fluid will not remain stable unless it be rendered milky throughout, either by shaking or stirring, which in other words means that the hydroxide of magnesium, which is extremely insoluble and not diffusible, must, in order to fix the unstable and evanescent compounds of oxygen and chlorine—that is to say, to preserve the strength of the fluid—be brought into immediate and absolute contact with such compounds by making the fluid milky throughout, then the hydroxide of magnesium having done its work, the surplus sinks to the bottom of the carboy. In order to make hydroxide of magnesium soluble it requires 5000 parts of water at 15.5° and 36,000 parts at 100° . Will the addition and stirring of hydroxide of magnesium in the electrolytic fluid answer the same purpose? Yes, certainly it will, and I find it will answer much better than the addition of sodium hydroxide for a reason I will presently state; therefore, it cannot be that a magnesium sodium double salt is formed when magnesium hydroxide is added instead of the sodium hydroxide. Hydroxide of magnesium has no action upon the already formed hypochlorite of magnesium, hence it must be the unstable compounds of chlorine and oxygen present in conjunction with the hydroxide of magnesium which effect the result aforementioned. To pursue the case further I have added and stirred into a filling carboy oxide of magnesium in place of hydroxide of magnesium and have rendered the fluid quite stable and obtained the same results, and in this instance no double magnesium sodium salt could have been formed, and oxide of magnesium will not act upon hypochlorite of magnesium. Carbonate of magnesium I have found up to the present not satisfactory as the unstable compounds of

oxygen and chlorine in the strength of solution manufactured will not displace carbonic acid.

The following experiment which I have carried out is, no doubt, interesting and assists my contention. Electrolytic fluid was being made at 4.818 grammes of available chlorine per litre, $\frac{1}{2}$ lb. carbonate of magnesium was placed into the specially constructed 15 gallon carboy, and the electrolytic fluid as it came direct from the electrolyzers was allowed to run into the carboy and during the time of filling kept well stirred with the carbonate of magnesium, of course making a very milky fluid, and when this carboy was filled a final stir was given by means of the geared stirrer. Into another 15-gallon carboy $\frac{1}{2}$ lb. of oxide of magnesium was placed and a similar process as mentioned above in the case of the carbonate was carried out. In due course the fluids cleared themselves and sediment formed. The electrolytic fluid, as mentioned above, was being made at 4.818 grammes of available chlorine per litre and within 24 hours the fluid with the carbonate of magnesium gave a test result of 2.741 grammes of available chlorine per litre, but the one containing the oxide of magnesium remained at 4.818 grammes per litre.

Fluid made at 4.818 grammes per litre and mixed with carbonate of magnesium—

At expiration of 24 hours gave 2.741 grammes per litre.

"	48	"	"	2.064	"	"
"	72	"	"	1.870	"	"
"	96	"	"	1.691	"	"
"	120	"	"	1.590	"	"
"	168	"	"	1.500	"	"
"	192	"	"	1.472	"	"
"	216	"	"	1.394	"	"
"	37 days	"	"	0.963	"	"*

* After continued testings and exposures.

And fluid made with oxide of magnesium and made at 4.818 grammes per litre—

At expiration of 24 hours gave 4.818 grammes per litre.

"	48	"	"	4.818	"	"
"	72	"	"	4.818	"	"
"	96	"	"	4.818	"	"
"	120	"	"	4.818	"	"
"	168	"	"	4.676	"	"
"	192	"	"	4.676	"	"
"	216	"	"	4.676	"	"
"	37 days	"	"	4.416	"	"*

* After continued testings and exposures.

This no doubt shows that there were 2.741 grammes of available chlorine per litre due to hypochlorite of magnesium and 2.077 grammes of available chlorine were due to hypochlorous acid or other unstable compounds of oxygen and chlorine. The fluid upon standing in the carboy in which the oxide of magnesium was stirred gave an alkaline reaction and the fluid upon standing in the carboy with carbonate of magnesium added gave a faintly acid reaction. This clearly proves that hypochlorous acid or the other unstable compounds of oxygen and chlorine are not strong enough in the strength of the manufactured solution to displace the carbonic acid from the carbonate of magnesium but readily combine with the oxide of magnesium and the fluid becomes also alkaline. The continued dropping in strength of the available chlorine in the carboy with the insoluble carbonate of magnesium is undoubtedly due to the exceedingly unstable hypochlorous acid or other unstable compounds of oxygen and chlorine which lose some chlorine in the first state, the remainder being converted into hydrochloric acid which then slowly but steadily acts upon the hypochlorite of magnesium.

It is obvious that the stable solutions of electrolytically made hypochlorite of magnesium are preferable to those of sodium and potassium or even calcium, because for fixing purposes there would have to be used hydroxide of the metals of the alkalies which are extremely caustic, alkaline, and very soluble, and where varying strengths of electrolytic fluid containing the hypochlorites of sodium and potassium are produced one may add too much or too little of the hydroxides of the alkalies. The hydroxide of the alkaline earth calcium may also be used as stated in the first portion of this article, but when the extremely insoluble hydroxide or oxide of magnesium is added and stirred in the manner described one can add and stir in any quantity but only the necessary amount will be absorbed. Besides, the alkalinity of the hydroxide of magnesium can only be observed by placing

a small portion in the moist state upon test paper which clearly shows as well as its insolubility that it is not a strong alkali. By very simple means the hydroxide or the oxide of magnesium can be added to the fluid in the electrolyser and kept stirred in it immediately it has passed over the last weir, thereby securing the full amount of chlorine. I think it is common knowledge that metallic hypochlorites of the alkali metals and alkaline earths may be obtained in the pure state by neutralising hypochlorous acid with certain metallic hydroxides of the alkali metals and alkaline earth groups, but to obtain hypochlorite of magnesium by means of the hydroxide or oxide of magnesium even upon a small scale, to say nothing of the large quantity manufactured in Poplar, is not common experience and knowledge.

I particularly desire, in conclusion, to state that throughout my experience in the production and improvement of the electrolytic disinfecting fluid I have had no desire to pose as a chemist. I have been much interested in the Hermite process since the publication of the report of "THE LANCET Commission" in the year 1894, and since the plant has been working in Poplar for the last two years I have given close observation and continued attention to the process, in the course of which I have not hesitated to avail myself of the valued knowledge and experience in these matters of M. Hermite, the chemical knowledge of Dr. W. R. Hodgkinson of the Military Academy, Woolwich, Dr. J. Gordon Parker of the Herald's Institute, Bermondsey, and Mr. Albert E. Parkes, analyst for Stepney, to all of whom I am much indebted for the success achieved in the undertaking.

Public Health Office, Bow-road, E.

Medical Societies.

ROYAL SOCIETY OF MEDICINE.

SURGICAL SECTION.

Subphrenic Abscess.

A MEETING of this section was held on Jan. 14th, Mr. J. WARRINGTON HAWARD, the President, being in the chair.

Mr H. L. BARNARD read a paper on Some Surgical Aspects of Subphrenic Abscess. He discussed a series of 76 cases. After dealing fully with the anatomical subdivisions of subphrenic abscesses, he said that a right anterior intraperitoneal subphrenic abscess was situated between the upper surface of the right lobe of the liver below and the dome of the diaphragm above. In regard to the treatment of right anterior intraperitoneal subphrenic abscesses he said that in appendicitis when the infection was recent and the abscess was diffuse the right loin incision should be employed. In cases due to perforated gastric and duodenal ulcers which presented in the epigastrium an anterior incision should first be made and when the perforation had been closed a counter-opening might be made in the loin. When the abscess had become well localised after ten or 14 days it was better to drain it by the posterior transpleural or subpleural method, whether it presented in the epigastrium or not, if the exploring needle could find pus in the lower intercostal spaces behind. The liver should be pressed up by an assistant so as to close the pleural space whilst the pleura was incised. Where the exploring needle failed to find pus behind and an epigastric swelling was present the anterior epigastric incision should be employed and the peritoneum opened as high up as possible in the subcostal angle. A right posterior intraperitoneal subphrenic abscess formed in the subhepatic pouch or the right renal fossa. It was a pyramidal space transversely disposed beneath the overhanging margin of the liver. The abscess was best drained by a loin incision as far back and high up as possible below the last rib. The index finger guided the drainage-tube transversely below the liver. Should the signs at the right base indicate the presence of pus under the dome of the diaphragm, the index finger should be inserted between the liver and the diaphragm, and a long tube passed up into the right anterior intraperitoneal subphrenic space. A left anterior intraperitoneal subphrenic abscess was also known as an anterior perigastric abscess or a perisplenic

abscess. That fossa was bounded by the diaphragm above. In the acute and diffuse stage soon after perforation it was usual to open the abdomen in the middle line and to close the perforation. Practice then differed. The abdomen was sometimes sponged out and closed altogether. In other instances a drainage-tube was passed into the pelvic fossa through a puncture above the pubes and the patient was sat up in Fowler's position. Others drained from the anterior incision. He preferred to make a counter-opening in the left loin and to pass a tube up to the spleen and then adopted the Fowler position and the pelvic drain. When the abscess had become localised and pointed in the epigastrium it should be opened by a left epigastric incision as high up as possible in the costal angle. A large tube, irrigation, suction, and position were then usually enough to insure efficient drainage. Otherwise the abscess might be counter-opened by the posterior transpleural method, guided by a finger in the cavity. When the abscess had not extended forward to the front it was nevertheless well to explore it from the epigastrium and then to open it by the posterior transpleural method above the adhesions. The lateral subpleural method was suitable to some of these cases or a posterior or a loin incision might be made and a finger passed up through the adhesions to the spleen, after the general peritoneal cavity had been packed off. A left posterior intraperitoneal subphrenic abscess occurred in the small sac of the peritoneum. When the abscess pointed in front it should be cut into and drained. Posterior perigastric abscesses should be explored from the front and drained from behind by a loin incision or the posterior transpleural route. The pouch between the Spigelian lobe and the spine was nearly inaccessible. A right extraperitoneal subphrenic abscess formed in the cellular space between the layers of the coronary and other peritoneal ligaments of the liver. When the abscess pointed in the epigastrium it should be opened there by an incision strictly in the middle line. In two of his cases he was able to reach the abscess without opening the peritoneum. With a large drainage-tube, irrigation, suction, and position counter-drainage was seldom necessary. If the abscess did not point in front it would probably be disposed of by puncture between the ribs behind over the area of dullness. The rule was then to use an exploring needle and to adopt the posterior transpleural method. Should the pus point in the right loin the abscess should be opened there and a tube be passed up into the subphrenic space. The left extraperitoneal subphrenic abscess formed in the cellular tissue in the left loin. A left loin incision over the swelling would sufficiently drain the pus away. He declared that it was clear that a promiscuous search for pus with an ineffective syringe was dangerous and deceptive, but the proper use of a good aspirating needle upon the operating table and under a full anaesthetic was the most certain means of diagnosis and it had never failed him. The only safe rule in thoracic operations was to follow the needle, and it was useless to make a large opening and admit air to the pleura, where the needle could demonstrate that no pus was present. Needling should never be abandoned until it was certain that no pus was present, and it might be added that although the method was so free from risk when practised through the thoracic wall it was never safe to puncture abdominal swellings across the peritoneum and through the abdominal wall because they afterwards leaked into the peritoneum. Of the 76 consecutive cases which made up the series 40 lived and 36 died, a mortality of 47·4 per cent. 64 cases were operated upon of the series of 76 consecutive cases, and of these 24 died, making a mortality of 37·5 per cent. These operations were divided up as follows: 26 posterior operations with seven deaths and four lateral operations with three deaths. Posterior operations were therefore more favourable. Of his own series of 21 consecutive cases submitted to operation, four died (19 per cent.); 15 of these operations were posterior with two deaths (13·3 per cent.), and nine were anterior with two deaths (22·2 per cent.).

The PRESIDENT said that it would be interesting to know in what proportion of these cases of subphrenic abscess the base of the lungs was involved.

Dr. F. DE HAVILLAND HALL said that physicians were sometimes asked in cases where subphrenic abscess was suspected and there was a resonant area giving an amphoric sound whether the disease was above or below the diaphragm.