I think that those who prefer antiseptic to saline treatment have found, as in all sloughing wounds and cellulitis of civil practice, that nothing is so good as prolonged immersion in an antiseptic fluid; but unfortunately most of the wounds are not so situated that this is possible. When this is the case then the next best thing is to employ constant irrigation, and very many wounds have done exceedingly well under this method, whether saline or antiseptic fluids have been used. But, whatever fluid is employed, every surgeon knows by an experience which is far more valuable than any other source of information that good results in complicated wounds can only be obtained if the treatment of the wound is varied according to its conditions. It could only be inexperience of wounds that would limit a surgeon to a single form of lotion, and it is the merest truism to say that in complicated and septic wounds a change of lotion or other application is as necessary as is a variation in the diet of the patient.

It has seemed to me that the period during which the saline hypertonic treatment is useful is strictly limited to the separation of sloughing and unhealthy tissue, and that once a granulating surface is obtained throughout it had better be abandoned, for it is generally painful, and if it is continued the skin becomes irritated, the granulations often become exuberant and flabby, and the healing process is correspondingly slow. The use of such well-tried applications as silver nitrate and zinc sulphate may then well prove more beneficial than that of the most potent solution of antiseptics or salines, for to treat wounds according to the daily report on their microbic infection to the neglect of all else is as foolish as it would be to treat every symptom of an illness rather than to treat the patient who is ill.

Hypochlorous Acid.

Within the past few months the treatment by solutions of hypochlorous acid has been most extensively tried, and the methods of producing it, advocated by Dakin and Carrel and Lorrain Smith respectively, seem to most observers to be equally good. Personally I may add that, as far as I have seen, there is nothing to choose between the two solutions, and I think I may safely say that almost all surgeons are pleased with the results obtained in the early treatment of recent wounds, and many have given up other methods in its favour. Where wounds of the hands and feet have been immersed in the solution, they have cleared up with great rapidity, and where extensive lacerated wounds and bad compound fractures have been treated by irrigation many patients have done extremely well. I think that wounds of this class have done better under treatment by hypochlorous acid than under any other, but I cannot say that they have become sterilized as rapidly as the cases recently described by Carrel, and I do not think that the good results he obtained were in wounds of the class I specially refer to—namely, extensive lacerations by shells and bad compound fractures. It is, however, my very decided opinion that the hypochlorous acid treatment is an important advance, more especially when used in recent wounds and before suppuration has occurred, and I find that it has to a great extent displaced all other forms of treatment in many of the casualty clearing stations. It is generally believed to have prevented the occurrence of gangrene in many bad lacerated wounds and to have arrested its progress in others; and, although I am well aware that it has not always been successful, I consider that it has already been productive of very much good and to be more useful in this class of wound than any other application we have yet tried. It is also a very remarkable fact that, unlike most antiseptics, it can be used in solutions sufficiently powerful to destroy virulent microbes very quickly without at the same time injuring the tissue cells. It should, however, be only used in solution, for if used as a powder, it, like many other powders, is liable to form hard lumps, which obstruct free drainage and so counteract its good effects.

CONCLUSION.

I have now, Mr. President, completed the task I set myself at the beginning of this lecture, and I have placed before you as well as I am able to do in so brief a space of time the circumstances and conditions of our wounded

soldiers in France and Belgium and the nature and treatment of their wounds.

But there remains yet a duty which I feel I owe both to the army itself and to the medical profession at large, and that duty is to express to you how deeply I feel the whole country is indebted to the medical officers in whose hands are ultimately placed the duties of caring for our sorely tried soldiers.

I do not propose to say one word about the general efficiency of the corps to which I have the honour to belong, for it needs no words of mine. What I do wish to say is that nothing has impressed me so forcibly or so favourably as the qualities of many of the younger surgeons on whom has rested the chief stress of the actual treatment of the wounded. There is not a medical school in Great Britain or Ireland that has not reason to be proud of its pupils, and the work of the surgeons has been equalled and supported by that of their pathological colleagues.

I do not know whether to admire most the energy and keenness which has enabled the staffs to work days and nights without adequate rest, or the technical surgical skill in the complicated and difficult operations on the abdomen and limbs alike, which has been so conspicuous a quality in so many officers. The care, the zeal, and patience displayed in efforts to save limbs and life have been no less praiseworthy than operative dexterity.

The Royal College of Surgeons of England has influenced and guided the teaching of surgery during many years, and all who have shared in this responsibility may feel a legitimate pride in the splendid work now being done by its pupils. "The tree is known by its fruit," and the future of British surgery is in safe keeping, for many of the best brains and hands which guide its course are yet young.

REFERENCE.

¹ *Lancet*, September 18th, 1915.

IODINE AND SODIUM HYPOCHLORITE AS WOUND DISINFECTANTS.

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WHILE the use of iodine and the recently revived hypochlorites as surgical disinfectants is of old standing, very little in the way of laboratory records of their efficacy, particularly with regard to the special difficulties occasioned by the sterilization of wounds, is to be found in the literature, and although the actual lethal effect of a disinfectant on the bacterial flora of a wound to which it is being applied is only one of a number of qualities desired from an antiseptic, it has been thought of interest to carry out a number of comparative tests with phenol, iodine, and Dakin's hypochlorite solution. Noguchi,¹ Turner and Catto,² Kutscher,³ Brünning,⁴ Réclus,⁵ Firth and Macfadyen,⁶ among others, have investigated the sterilizing power of iodine, but in most cases from the point of view of its application to the skin before operation, in the manner advocated by Grossich.⁷ Based for the most part on the older thread and garnet methods, the results are in marked conflict. Firth and Macfadyen employed both the thread and Rideal and Walker's drop method, and used as test bacteria *B. prodigiosus* and *B. typhosus*; with the latter they determined as well the efficiency of iodine in the presence of a certain amount of urine.

In the experiments which are described below the drop method was followed; the organisms used were *Staphylococcus aureus* and *B. oedematis maligni*, as examples of the sporing and non-sporing groups; and, as a test of the efficiency of the disinfectant in the presence of organic matter, in one series disinfection was carried out on bacteria suspended in distilled water; in another series on bacteria suspended in sheep serum.

In the case of the staphylococcus, an emulsion was prepared in distilled water and in serum from a twenty-four hours agar shape culture. These suspensions were then counted in Thoma-Zeiss slides; the predetermined density was effected, and to 4 c.cm. placed in a sterile test tube were added 4 c.cm. of disinfectant. In this way both emulsion and disinfectant were diluted one half, and it is in this ultimate working strength that the disinfectants

and emulsions are reported in the tables below. Each test tube had its own 1 c.cm. pipette bound in with the cotton-wool plug, the two being removed together when it was required either to open the tube or to take out a measured quantity of its contents.

To determine when sterilization was complete a 0.1 c.cm. sample was taken from time to time by means of the pipette and dropped—when iodine was the disinfectant—into 0.2 c.cm. of a 10 per cent. sodium thiosulphate solution placed in a sterile Petri dish—when phenol was the disinfectant into an empty Petri dish; the plates were then poured with agar. An incubation of one to two days revealed whether the sample taken was sterile or not, sterility being roughly taken as meaning the disinfection of all bacteria present in the disinfectant emulsion mixture.

As a control of a possible inhibitory power of the neutralized iodine or of the surplus sodium thiosulphate in the amounts used in the experiments a series of plates was poured as given in Table I. The figures tend to show—and on other occasions similar results have been obtained—that inhibition of growth does not occur at all, but that, on the contrary, in those samples in which iodine and serum are present a somewhat greater number of colonies is obtained, either owing to a stimulating effect of these substances on the growth of the cocci, or more probably as a result of clumps of cocci being broken up by an alteration in surface tension.

TABLE I.

Number of cocci per c.cm. of a *Staphylococcus aureus* emulsion estimated from an average of four agar plates, poured after the addition of 0.1 c.cm. of the emulsion to a Petri dish containing:

0.1 c.cm. (serum and iodine) neutralized with			
0.2 c.cm. sodium thiosulphate:			
Not mixed before plating	...	...	2,412
Mixed before plating	...	...	2,570
0.2 c.cm. sodium thiosulphate:			
Not mixed before plating	...	...	2,155
Mixed before plating	...	...	2,210
0.2 c.cm. distilled water:			
Not mixed before plating	...	...	2,007
Mixed before plating	...	...	2,250

The serum-iodine mixture was one containing equal parts of sheep serum and 2½ per cent. iodine in 5 per cent. potassium iodide. The sodium thiosulphate solution = 10 per cent.

TABLE II.

Disinfectant.	Environment.	14.5 Million <i>Staphylococci</i> per c.cm. at 22° C.	
		Are not all Killed after	Are all Killed after
0.0015 % iodine	Distilled water	—	2 minutes.
0.125 % iodine	50 % serum	16 minutes	32 minutes.
1.0 % phenol	Distilled water	16 minutes	33 minutes.
1.0 % phenol	50 % serum	32 minutes	—
1.5 % phenol	50 % serum	8 minutes	16 minutes.
1.75 % phenol	50 % serum	4 minutes	8 minutes.

In the experiments with malignant oedema spores, the method of procedure had to be slightly varied. To obtain a finely divided emulsion, a seven to nine days' old broth culture of *B. oedematis maligni*, which generally contains about one fully developed spore to three or four rods, was centrifuged and the deposit resuspended, partly in distilled water and partly in serum. After enumeration in Thoma-Zeiss slides and regulation of the number of spores per cubic centimetre according to one's wishes, 4 c.cm. of emulsion were added to 4 c.cm. of disinfectant. When the disinfectant was iodine or hypochlorite, the sample taken as a test of sterility was 0.2 c.cm. in amount, and was dropped into 0.4 c.cm. of 10 per cent. sodium thiosulphate, contained in a sterile test tube; after neutralization 0.15 c.cm. of this, representing 0.05 c.cm. of the original disinfectant-emulsion mixture, was dropped into a test tube of meat medium, and incubated under anaerobic conditions for five to seven days. The meat medium employed consisted of finely minced fat-free meat, preferably heart muscle, autoclaved with a small quantity of water and brought well to the alkaline side of the litmus neutral point: the meat is then ground to a paste in a mortar, and

portioned off into test tubes with sufficient of the liquid extract to cover the fine meat deposit half an inch or so; the tubes receive a final sterilization by steam at atmospheric pressure or by autoclave. The medium has been found by Miss Robertson, working in the institute on the anaërobe group, to be one of the best for the growth of *B. oedematis maligni*.

Where the disinfectant used was phenol, 0.05 c.cm. of the disinfectant-emulsion mixture was dropped directly into the meat tube. The higher concentrations of iodine were obtained by dissolving in a potassium iodide solution double the percentage of the iodine required. The hypochlorite solution was prepared according to Dakin,⁸ and consisted of a mixture of bleaching powder and sodium carbonate solutions neutralized with boric acid. That used in these experiments was very kindly prepared, and its percentage of sodium hypochlorite estimated, by Professor Harden. It will be observed that the amount of sodium hypochlorite in the solution fell from 0.337 per cent. to 0.24 per cent. after an interval of eight days, during which period the solution stood in a corked glass cylinder on a laboratory bench.

TABLE III.

Disinfectant.	Environment.	102 Million Malignant Oedema Spores at 19° C.	
		Are not all Killed after	Are all Killed after
Dakin's solution, diluted one half, containing 0.1685 % NaClO	Distilled water	—	½ hour.
Ditto	50 % serum	5½ hours	—
5 % iodine...	Distilled water	1½ hours	2 hours.
5 % iodine...	50 % serum	2 hours	3½ hours
10 % iodine	Distilled water	½ hour	1 hour.
5 % phenol	Distilled water	8 days	—

Table III shows the failure of 5 per cent. phenol to sterilize malignant oedema spores and the difficulty with which iodine does so, whether serum be present or not. Dakin's solution, even in half the strength at which it is usually employed, is, on the other hand, in the absence of serum, most effective, though, as seen in Table IV, even small quantities of serum can interfere with its action; this would lead one to expect no direct lethal effect of the solution on similar resistant spores embedded in the tissues of a wound unless by irrigation the serous fluid surrounding those spores could be replaced to well above 95 per cent. by the hypochlorite solution.

TABLE IV.

Dakin's Solution (full strength, containing 0.24 % NaClO) and Sheep Serum.		84 Million Malignant Oedema Spores per c.cm. at 15° C.	
Dakin's Solution.	Serum.	Are not all Killed after	Are all Killed after
80 %	20 %	6 hours	—
90 %	10 %	6 hours	—
95 %	5 %	5½ hours	—
99 %	1 %	10 minutes	20 minutes.
100 %	—	8 minutes	16 minutes.

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- ¹ Noguchi, *Arch. f. klin. Chir.*, 1911, No. 96, 2. ² Turner and Catto, *Lancet*, 1911, i, 733. ³ Kutscher, *Berl. klin. Woch.*, 1910, p. 390. ⁴ Brünning, *Arch. f. klin. Chir.*, 1911, No. 94, p. 587. ⁵ Réclus, *Bull. de l'Acad. de Méd.*, 1910, No. 63, p. 375. ⁶ Firth and Macfadyen, *Journal Royal Sanitary Institute*, 27, p. 17. ⁷ Grossich, *Centralbl. f. Chir.*, 1908, No. 44, p. 1289. ⁸ Dakin, *BRITISH MEDICAL JOURNAL*, 1915, ii, 318.

THE Director of the United States Bureau of Mines recently announced that the cost of radium had been reduced from £24,000 to £7,200 a gram. This reduction is the outcome of the work of the research bureau which has been engaged during the past year in studying the problem of the cheaper production of radium.