under consideration; this is in marked contrast to the arc spectrum of copper, which is seen to consist of groups of very bright lines, with considerable intervals between them. The carbon arc (5) is seen to have a somewhat restricted range of ultra-violet radiation.

THE PENETRATING POWER OF ULTRA-VIOLET LIGHT.

When any of the various sources of ultra-violet light are used therapeutically the question arises as to how far the rays are able to penetrate through the tissues. It has long been known that blood pigments are strongly absorbent of such radiation, and means were accordingly taken to prevent, as far as possible, direct access of the blood to the part receiving the rays.

It seemed desirable, however, to make some measurements of the extent to which the ultra-violet rays penetrate the skin. For this purpose skin removed from the human abdomen was used; it was cut parallel to the external surface in layers $\frac{1}{10}$ mm., $\frac{1}{2}$ mm., and $1\frac{1}{2}$ mm. thick by means of a large-sized microtome; these different thicknesses of skin were then placed in front of the slit of the spectrograph, to ensure that any radiation entering the instrument and affecting the photographic plate placed in position, would first have penetrated the particular thickness of skin.

The source of ultra-violet radiation selected was the Simpson arc. When this was placed about 20 cm. distant from the slit of the spectrograph an exposure of a few seconds was sufficient for a photograph of this radiation as far as wave length 3,000. In order to bring out the very short wave lengths the plate has to be rather over-exposed in the violet region (see Fig. 3, No. 1). The exposure in this case was 5 seconds.

It was soon found that skin was very absorbent for the ultra-violet radiation, and consequently the time of exposure had to be much increased in order to obtain any record on the photographic plate. Fig. 3, No. 2, shows the result of interposing $\frac{1}{10}$ mm. of skin in front of the slit of the instrument; the exposure was increased from five seconds to two minutes. No. 3 and No. 4 show the results for a thickness of $\frac{1}{2}$ mm. and $1\frac{1}{2}$ mm. respectively; the exposures were in each case eight minutes—that is, nearly one hundred times that of the unscreened radiation. In spite of this, however, a large portion of the spectrum is cut out.

It will be seen, therefore, that ultra-violet rays of wave lengths 2,100 to 3,000 A.U., the approximate positions of which are indicated in Fig. 2, are very easily absorbed by human skin; certainly less than one part in a thousand of this radiation penetrates to a depth of half a millimetre.

As we proceed to the region of wave lengths 3,000 to 3,800 A.U., which latter marks the onset of visible radiation, the rays become rather more penetrating, but it is doubtful whether as much as 1 per cent. of the radiation penetrates as deep as 1 mm. Fig. 3, No. 4, shows, however, that a small percentage of ultra-violet radiation penetrates $1\frac{1}{2}$ mm. of human skin.

THE SPECTRUM OF THE SIMPSON ARC.

The poles of the Simpson arc are said to consist of wolframite, a prominent constituent of which is tungsten. In order to see to what extent tungsten contributes to the ultra-violet radiation from the Simpson arc, two electrodes of pure tungsten were obtained, and the arc spectrum photographed in the same way as indicated above for the Simpson arc.

In Fig. 4, No. 1 is a photograph of the spectrum of the Simpson arc, between wave-lengths 5,800 and 2,100 A.U. No. 2 is a photograph of the spectrum of a pure tungsten arc over the same region; the exposures were for five and ten seconds respectively.

Inspection shows that the two spectra are apparently identical. Whether there are differences in the relative intensities of the emission lines cannot be said without a more extensive examination.

THE last report of the librarian of the Harvard Medical School states that 3,100 volumes have been added to the collection during the past year. The library now contains 27,000 volumes and 46,067 pamphlets. The College of Physicians of Philadelphia has 105,540 volumes; the New York Academy of Medicine, 100,320; the Boston Medical Library, 83,107; and the Johns Hopkins Hospital, 17,000.

SODIUM HYPOCHLORITE IN THE TREATMENT OF SEPTIC WOUNDS.

BY

FLEET SURGEON FREDERICK J. A. DALTON, R.N.

IN September, 1915, a committee was sent to the Gallipoli peninsula in the naval hospital ship *Rewa*, by order of the Medical Director-General of the Navy, to report on the efficacy of hypochlorites in the treatment of infected wounds. The committee made two trips to the beaches in this ship—one to Anzac and one to Cape Helles. Unfortunately for their purpose, there was at this time very little attacking going on at the peninsula, and although 1,176 patients were carried in the two trips, the majority were cases of dysentery, enteric, and epidemic jaundice, and the proportion of wounded to sick was very small. The committee returned to England on October 18th.

Before leaving, Dr. H. D. Dakin, who was working in connexion with the Medical Research Committee, asked me to continue the investigation of the value of hypochlorites as opportunity offered on this ship, and this has been done.

In the past two months we have carried an additional 2,753 cases to Alexandria and Malta, but of this large number only a very small percentage have been wounded.

Every wounded patient received on board during this period, whose wound or wounds were clinically septic on arrival, has been treated with the special sodium hypochlorite solution prepared according to Dakin's formula. No other form of antiseptic was employed. Although this report is based on the small total of 57 cases, the results have been so uniformly and consistently good that I think it may be useful to publish it now, in order that the hypochlorite solution may be more generally used in the treatment of wounds than is the case at present.

Wounds that were clinically clean on arrival on board were also irrigated with the sodium hypochlorite solution and dressed with gauze soaked in the antiseptic. But these cases are not considered in connexion with this report since they would probably have remained clean and healed with any other form of customary dressing, and therefore cannot be counted as evidence in favour of hypochlorites being far superior to any other form of antiseptic that we have so far used on board this ship; that being the point I wish particularly to bring out.

Before employing the sodium hypochlorite antiseptic, my colleagues and I in this ship used various weak antiseptic lotions for the thorough irrigation of these large septic wounds, each fancying his own pet solution—be it carbolic acid, perchloride of mercury, etc.—gave the best results. My own predilection was for passing pints of ordinary sterile salt solution through the wound. Since making trials of the hypochlorite solution there has been absolute unanimity among us as to the preference for it, and we all now use it as our routine lotion.

Preparation of Hypochlorite Solution.

The antiseptic solution is made on board from dry carbonate of soda (United Alkali Co.'s best soda ash), bleaching powder of good quality, and boric acid, according to Dakin's directions given in the *BRITISH MEDICAL JOURNAL*, August 28th, 1915. The solution was made in large carboys holding about 40 litres.

Five hundred and fifty grams of the carbonate of soda were dissolved in a carboy half filled with fresh water; 800 grams of bleaching powder were then added, and the mixture thoroughly shaken for five minutes. The carboy was then filled up with fresh water, and, shaking the mixture once more, it was allowed to settle for half an hour. The clear fluid over the precipitate of calcium carbonate was siphoned off as completely as possible, and filtered into a second carboy by passing through a plug of cotton in the neck of a large funnel; 150 grams of boric acid were added to the filtrate, and the mixture was then ready for use. It was drawn off from the carboy as needed by means of a siphon.

The solution was never kept longer than a week, and any unused solution that had been made longer than a week was thrown overboard. This waste is a matter of no moment since the cost of the preparation is so extremely small.

Method of Use.

The usual surgical procedures were adopted for enlarging the wound, making counter openings, removing portions of detached bone, foreign bodies, including bits of clothing, fragments of shell, bullets, gravel, etc. Every portion of the wound was then thoroughly irrigated with large quantities of the hypochlorite solution. One or several rubber tubes, according to the nature of the wound, serving for the introduction of the hypochlorite solution, were then inserted, and strips of gauze arranged around the tubes and lightly packed into every portion of the wound. It is essential that this should be properly done, the idea being that the gauze strips function simply as wicks to convey fresh hypochlorite during subsequent treatment to every surface of the wound.

The outer surface of the wound is then dressed with gauze lightly wrung out in the hypochlorite solution. The ends of the rubber tube or tubes are brought out through the gauze dressings, a bandage lightly applied over all to keep tubes and dressing in position, and the ends of the tubes brought out through the bandage, to serve for the subsequent renewal of the hypochlorite.

In profoundly septic cases the hypochlorite solution is injected into the tubes, by means of a glass syringe, every two hours for the first twenty-four to forty-eight hours, and subsequently less frequently as the wound begins to clean up. In less severe cases we find by experience that syringing with hypochlorite at four-hourly intervals suffices. Each case should be treated, so far as frequency and quantity of hypochlorite administration is concerned, with regard to the size, nature, and septicity of the wound. The object aimed at is to supply every surface of the wound with a sufficiency of fresh hypochlorite solution as often as required.

In bad cases the gauze strips are renewed after the first twenty-four hours. With slighter wounds they may be left in for three to four days, and then usually do not need to be replaced by fresh strips, as the wound generally cleans up with simply occasional squirting of fresh solution into the tubes.*

NOTES OF CASES, ETC.

The cases were under the personal care of Staff Surgeon Fisher, R.N., temporary Surgeons Smith and Beaton, R.N., and Surgeons Gilbertson and Chitty, R.N.V.R. They comprise a great variety of bullet, shell, shrapnel, and bomb wounds, and a number of cases of gangrene following frost-bite. In addition, several stinking appendix abscess cavities were successfully treated with careful irrigation and swabbing with the hypochlorite solution.

It does not seem worth while to reproduce the case notes in full, since this would involve much needless repetition. A few typical cases are selected, to which are added the notes of the surgeons in whose care the patients were.

The use of hypochlorite in cases of frost-bite with broken skin, or where gangrene and sloughing have supervened, appears to be distinctly valuable. Sloughs are rapidly removed, and it accelerates the production of healthy granulation tissue. In gangrenous cases its deodorant action is very marked, but it is important that severe cases should be treated not less frequently than four-hourly. A single typical case is briefly noted at the end.

CASE I.

H. R. D. Gunshot wound of lip, neck and vertebrae, piercing first rib with exit over sixth dorsal spine. A haematoma of the neck was cleaned out and hypochlorite injected into the cavity at frequent intervals. After four days there was no sign of pus, and the hypochlorite dressings were applied only twice daily.

CASE II.

A. H. G. Septic wound of left buttock with cellulitis. Operation November 29th. Wound was opened up, leaving very dirty sloughy surface, 6 in. long, with foreign bodies in it. Hypochlorite was applied four-hourly. The cellulitis rapidly cleared up, and in four days the wound was covered with clean granulations.

CASE III.

M. R. Compound fracture of left upper humerus. The patient was admitted December 15th, after treatment on shore for one week. The wound was septic, with much pus and oedema of arm. The hypochlorite was given three-hourly.

* Information relative to the use of sodium hypochlorite for the early treatment of wounds before sepsis has developed will be found in the BRITISH MEDICAL JOURNAL, October 23rd, 1915, p. 609, and November 27th, 1915, p. 790.

December 16th, temperature 98.6° to 99.4°. December 17th, necrosed bone removed; much less pus. December 19th, temperature 99.2° to 99.4°. December 21st, almost all trace of pus disappeared, with wound surfaces clean. The counter opening was healing, and granulations were felt to be covering the bone surfaces.

CASE IV.

M. M. Rifle bullet wound of left leg. Very septic when received, October 29th, with iodine vesication and much inflammation. Hypochlorite was used twice daily. On November 2nd the wounds were clinically clean, and all inflammation and swelling had subsided.

CASE V.

A. W. O. Compound comminuted fracture of right ulna in upper third. When received on board, the wound had been thoroughly opened up, but was extremely septic, with much inflammatory oedema of the part. The superficial areas were dirty, and thick yellow malodorous pus drained out in large quantities. A large rubber tube was inserted, and surrounded with light gauze packing. Hypochlorite solution, 20 c.cm., was injected every two hours. Within a week the clinical appearance of the wound was absolutely healthy. The pus was replaced by a clear mucoid secretion, and the surfaces were covered with red healthy granulations. The swelling and oedema entirely disappeared, and the wound progress was most satisfactory.

CASE VI.

G. J. Rifle bullet wound of left arm above elbow-joint, involving the ulnar nerve and the external condyle of the humerus. An operation had been performed on shore before the patient was received. The bullet and fragments of bone had been removed, but the wound had been closed. Within a day of admission the arm was much swollen, and inflammatory oedema extended from the joint upwards. The forearm was much swollen also.

The wound was opened up, and a rubber tube inserted, passing to the site of the fracture. Hypochlorite, 20 c.cm., was given every two hours. The pus, which drained at first rapidly, changed to a mucoid secretion, and the inflammation and oedema rapidly diminished, and had disappeared at the end of five days. The tube was then removed and a simple dressing applied. The wound granulated perfectly, and at the end of ten days there remained only an area the size of a threepenny piece to be covered.

CASE VII.

A. B. Bomb wound of right leg. Received on board October 29th, three days after injury. Perforating wounds of calf, entry and exit 2½ in. apart; much pus present; temperature 104°. The wounds were incised; a pocket extending upwards was opened, and the whole freely irrigated with hypochlorite. The following day the temperature fell to 98° and did not subsequently rise above 99°. Three days later the wound was clean, with no discharge, and all swelling and inflammation had gone.

CASE VIII.

A. W. Bomb wounds of left leg received October 26th. Treated on board October 29th. Several severe wounds, all septic; one over external malleolus, penetrating the bone; a second on dorsum of foot, midway between two malleoli; a third in the middle of the leg, between the tibia and tibialis anticus muscle; and a fourth below and behind the head of the fibula.

The wounds were very dirty, but when opened up fragments of bomb were only found in the fourth wound. Hypochlorite dressings and injections by tube were used freely. After three days all the wounds appeared clean with the exception of the wound in the dorsum of the foot, where there was some cellulitis. It was explored, and a small pocket opened and emptied of pus. A tube introducing hypochlorite was inserted, after which marked improvement took place until the patient was discharged.

CASE IX.

A. H. Shrapnel wound of left leg received October 26th. Compound comminuted fracture of tibia in the lower third. The patient had been operated on ashore, and was received on board October 30th. The dressings were stinking, and the surface of the wound extremely dirty. Free irrigation with hypochlorite and subsequent injections were employed. The wound was far from being in a satisfactory condition when this case was discharged three days later, but, considering the state of the wound on admission, the improvement was really wonderful.

CASE X.

D. M. Perforating bullet wound entering right malar bone and emerging just below the angle of the jaw, causing a large neck wound, and ploughing up the surface of the trapezius muscle for 3 in. at a depth of 1 in. Temperature on admission 104°. The wounds were cleaned, dressed with gauze soaked with hypochlorite, and carrying tubes for its renewal. On discharge, five days later, the temperature was normal and the wounds in the cheek and trapezius muscle were clean. The wound in the neck was suppurating slightly with some inflammation of the submaxillary gland.

CASE XI.

T. B. Compound comminuted fracture of right femur caused by shrapnel bullet. The wounds on the front and back of the thigh were freely incised, but no bone was removed. Rubber tubes were inserted to carry hypochlorite to the bottom of the wounds and the cavities lightly packed with gauze. The hypochlorite was renewed every two hours at first. The wound remained clean and did well.

CASE XII.

A. J. H. Shrapnel bullet wound over right frontal bone. Depressed fracture; trephine necessary when depressed bone removed with piece of bullet. Dura uninjured. Temperature on admission 102°. On discharge, five days later, temperature was normal and the wound almost healed.

CASE XIII.

G. A. N. Compound fracture of left humerus, received October 26th. Musculo-spiral nerve exposed and partly divided. The whole track and wounds of entry and exit were very foul and stinking, with redness and oedema of the whole upper arm, when the case was received on board on the 29th. The wounds were enlarged, drained, and irrigated four-hourly with hypochlorite. No spread of sepsis occurred and redness and oedema rapidly subsided, as did the offensive odour. When discharged, four days later, the wound was lined with healthy granulations and there was only a trifling discharge of pus.

CASE XIV.

G. T. Compound fracture of jaw and shell wound of right arm. The fragment of shell had entered at the tip of the right shoulder and emerged above, the external condyle of the humerus. All the wounds were horribly offensive. They were irrigated with hypochlorite under anaesthesia, and many loose fragments of jaw and detached teeth were removed. Four-hourly irrigation with hypochlorite was adopted, and the patient was given a chloramine mouth wash. On discharge, four days later, the patient's mouth was remarkably clean, but the external jaw wound was still discharging though relatively clean in appearance. Sloughs had all separated. The arm wounds were clean and lined by healthy granulations.

CASE XV.

W. C. When received on board the right foot was gangrenous as regards the soft tissues up to the base of the metatarsals; its appearance was black with an intense zone of inflammation of the higher part of the foot. The left foot was gangrenous to the base of the proximal phalanges, with similar signs of intense inflammation. The odour was appalling. Hypochlorite baths were used and at once removed the odour. In two or three days the dead soft tissues had softened and could be quite easily removed. The wounds took on a healthy aspect, and the granulations were red and clean.

CONCLUSIONS.

The advantages we have observed in the employment of the sodium hypochlorite solution in the treatment of septic wounds may be briefly stated as follows:

1. The simplicity and cheapness of preparation of the antiseptic.
2. Being non-toxic and non-irritating to the tissues when properly prepared according to Dakin's formula, the hypochlorite solution may be safely used in large quantities over long periods of time without ill effects.
3. The deodorant action of the solution is remarkable. The fetor from gangrenous tissues usually disappears in twenty-four hours.
4. The rapidity with which sloughs separate and clean granulation tissue is formed in a wound under its influence.
5. The infrequency of redressing required by cases treated as described with hypochlorite, compared with the constant change of dressings required in large wounds with other forms of antiseptic.
6. The fact that injections of the hypochlorite solution into the rubber tubes used in the dressings may with safety be entrusted to very imperfectly trained orderlies without fear of ill results, once the case has been adequately dealt with by the surgeon.

The facts referred to under (5) and (6) are very important considerations in war surgery, as cases frequently arrive in large numbers at varying intervals.

Memoranda:

MEDICAL, SURGICAL, OBSTETRICAL.

TYPHOID PERFORATION: OPERATION: RECOVERY.

THE following case of perforation in a man suffering from unsuspected typhoid (no doubt modified by inoculation) is, I think, of interest as emphasizing the importance at the present time of a strict investigation into all cases of pyrexia, even when unaccompanied by other marked symptoms. It is also worth recording from a surgical point of view, since recovery took place in spite of the fact that operative measures were unfortunately not taken until some eighteen hours after the accident.

Pte. C. was admitted to the Reading War Hospital on

September 17th, 1915, having been wounded in Gallipoli on August 24th. On admission he had a small healed entrance wound in the buttock and an irregular open wound, about an inch in diameter, on the inner aspect of the thigh, where the bullet had emerged. He appeared in good health. He stated that he had been inoculated against typhoid in November and December of the previous year (two inoculations).

On September 28th it was noted that there had been some pyrexia since he had been in hospital, the temperature ranging from 100° to rather over 101°, though frequently down in the morning to normal. The man said that he felt perfectly well except that now and again he suffered from headache. His bowels had on several occasions been somewhat relaxed. No abnormal physical signs could be detected in chest or abdomen, and the tongue was clean. The pulse had varied with the temperature from 90 to 112. The wound had nearly healed.

On arrival at the hospital on the morning of October 1st I was informed that the patient had complained the previous afternoon of sudden severe pain in his stomach, and now appeared to have serious abdominal mischief. I found him with a temperature of 103.4°, a pulse of 136, and all the signs of an acute abdomen.

He was at once taken to the theatre and laparotomy performed. There was general peritonitis, with a quantity of free pus; the lower part of the ileum was covered with masses of lymph, and a perforation a quarter of an inch across, evidently the result of typhoid ulceration, was present in this portion of the bowel. I closed the hole with some difficulty, on account of the condition of the gut, and drained by means of a large tube passed down into the pelvis. The usual after-treatment for general peritonitis was adopted, and the patient made an excellent recovery, the only trouble being some suppuration in each breast where he had received subcutaneous saline infusion. He had fairly typical typhoid stools for about ten days after the operation, but by October 19th the temperature was normal. There was a short relapse from October 31st to November 11th. The patient is now (December) nearly well.

Bacteriological examination of the stools shortly after the operation showed the presence of a non-lactose fermenting bacillus, typhoid or paratyphoid (the exact identity not determined). On November 7th it was found that the blood agglutinated *B. typhosus* up to 1 in 500 dilution, but had no effect on *B. paratyphosus* A or B.

Reading.

W. BERNARD SECRETAN, M.B., F.R.C.S.

A SECOND CASE OF COMPLETE INVERSION OF UTERUS.

MRS. R., aged 30, was confined early in September. She looked very delicate and fragile, and the pains were weak from inertia of the uterus. A little chloroform was given, and the delivery was very easily effected by forceps. The placenta caused no trouble, and the uterus contracted normally. All went on well for fourteen days. The nurse then assisted the patient to stool, when on pressure a pain was felt, and "something seemed to come down." On my arrival I found the fundus uteri well outside the vulva and still being extruded; there was no bleeding. An hour later Dr. MacLagan gave chloroform, and reduction was accomplished after some patient work in ten minutes or less. As in my previous case (*BRITISH MEDICAL JOURNAL*, 1910, vol. i, p. 260), the method by direct pressure on the fundus was not successful and was not long persevered with, whereas the other method was very readily effective. I reduced the bulk of the tumour into the vagina followed by the right hand, grasped the neck of the mass with the finger tips surrounding, and worked at it exactly as one would reduce a hernia. The patient made a good recovery. I venture to record this case on account of its very great rarity, and, after my experience, would suggest to any one who may be unfortunate enough to encounter this formidable accident that the method I have attempted to describe will most readily be successful.

C. L. FRASER, F.R.C.P., F.R.C.S. Ed.

Berwick-upon-Tweed.

DR. CHARLES RICHET, professor of physiology in the University of Paris, who is now serving in Russia, has been elected an honorary member of the University of Moscow.