plain moist gauze are laid, and over all a thick layer of cotton-wool, after which the whole is bandaged firmly. A splint is an additional advantage.

If all is going well, as shown by the general condition, the pack is left in for about seven days (about the third day the characteristic odour will develop), when it can be removed and the granulating wound irrigated with warm normal saline or eusol solution, after which a healthy wound only requires treatment, and either by the Carrel-Dakin method or by the use of antiseptic paste it can soon be closed by suture.

SELECTION OF METHOD.

With all these methods of wound treatment to choose from I may be asked which I prefer.

In cases seen at the front the first duty of the surgeon in all shell wounds is to lay the wound fully open, including every pocket, to remove all foreign bodies and bits of clothing as well as loose particles of bone and dead or damaged tissue, to arrest bleeding, and to irrigate the wound thoroughly with some antiseptic such as eusol or Dakin's fluid, or hypertonic saline or alcohol—in fact, to treat the case on the general principles well known as suitable for poisoned wounds; this, followed by free drainage, was the method carried out with more or less success in the early months or first year of the war.

Now, although this led to saving of life and to abolishing violent sepsis and gas gangrene, it left large wounds to heal by a long process of granulation, and led to exhaustion of vital powers and to deformity caused by large scars. Now, however, we have several methods to choose from to shorten the treatment subsequent to the first necessary operation.

(a) The Carrel Dakin treatment, with closure of the wound in from a week to a fortnight, is, if the case can be got shortly to a good hospital and kept there, the ideal method, and it has certainly given excellent results, but it is not good for cases that have to be transferred by sea and rail.

(b) If the patient has to be transferred—as, indeed, have the greater number of cases—after cleansing the wound and drying it with alcohol, the bipp treatment with closure of the wound affords an excellent method; this is especially the case if the wound has been completely excised, when either bipp or the paste recommended by Captain Hey can be used.

(c) The salt-pack treatment used by Colonel Gray is excellent both for transport and subsequent treatment, to be followed in about a week or more by the Carrel-Dakin or bipp methods.

(d) For the care of septic suppurating wounds arriving constantly at the base hospitals both in France and in England, the pathological method followed out at Reading of grafting the purified wound with the Reading bacillus under packs of sphagnum moss is both simple and effective, and the experience there is that secondary hæmorrhage has never occurred under this treatment.

The modern treatment of gunshot wounds gives ample scope for the skill of both surgeon and nurse, and is attaining a state of perfection that could hardly have been expected by those who saw the dreadful prevalence of gas gangrene and its treatment by amputation in the early stages of the war.

Whatever the other services engaged in the war may or may not have done, I think we can without hesitation say that the medical services and the nursing service have both "made good," to use a term coined on the other side of the Atlantic.

When the war started we had a small Army Medical Service to meet the needs of our "contemptible little army," to use the Hun expression. The administrative work that this small service has accomplished under the genius of our present Director-General, Sir Alfred Keogh, has been phenomenal, and can only be appreciated by those who know the difficulties that have had to be met; but I venture to think that it will figure largely in the history of the war.

The way in which the civil branch of the profession has taken up its work as part of the medical service of the army is not the least wonderful record of a great sacrifice. The leading physicians and surgeons giving up their consulting practices have, the former, thrown themselves into the prevention of disease as well as its treatment, and the

latter have undertaken the treatment of the legitimate risks of war—wounds and casualties. From their ranks have also been drawn the army consulting physicians and surgeons to act and advise wherever the British army is on active service.

Not only this, but all the towns and villages of the empire, whether in the colonies or at home, have spared so many of their doctors and surgeons that the civil population has had to make no little sacrifice in order that the numerous war hospitals and hospital ships almost all over the civilized world might be staffed with physicians, surgeons, anaesthetists, and specialists of all kinds, who have performed their many duties with the same skill and care that they previously gave to their private patients.

The work of the nursing service is beyond all praise; they have been the ministering angels ever ready and always present to give help and comfort to the sick and wounded. Wherever they move they carry with them the gleam of the ideal—the symbols of love, mercy, patience, and sacrifice. I have seen many of them in the thick of the work, when the wounded were coming straight from the battlefield and where the sad sights were enough to blanch the stoutest hearts, never flinching, but steadily pursuing their beneficent duties. Not a few of them have given their lives to the cause—some have been killed by the shells of the enemy, others have died from disease contracted when on duty, others have been drowned when serving on hospital ships, and one at least has suffered martyrdom, but still their numbers increase and still more are wanted.

THE TREATMENT OF GONOCOCCAL ARTHRITIS BY SENSITIZED GONOCOCCAL VACCINE.

BY

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SENSITIZED VACCINES were first employed by Besredka in 1902. He prepared vaccines of this type for prophylactic use against cholera, plague, and typhoid fever, sterilizing by heat either before or after sensitizing with the specific serum. He claimed that active immunity was produced almost immediately and with little local reaction or constitutional disturbance.

Later, Broughton-Alcock employed sensitized living vaccines in the treatment of infections of the staphylococcal, gonococcal, and streptococcal types. He obtained his specific serums for the purpose of sensitizing the cultures by first administering to the patient an ordinary vaccine of the infecting micro-organism, and using the serum of the patient thus infected to sensitize the living vaccine.

In 1913 Lieut.-Colonel Gordon, R.A.M.C., published a paper in the *Lancet* on "Sensitized vaccine in acute bacterial infection," in which he gave the results obtained in a series of cases. He showed that in the treatment of all types of infection by *Streptococcus pyogenes* (among these he includes streptococcal septicaemia and post-puerperal streptococcal endometritis), out of nineteen cases treated twelve showed great improvement after administration of the vaccine. He admits disappointment at the results obtained after employing sensitized staphylococcal vaccines. However, the results in the streptococcal infections above mentioned suggested that it might be useful to try the administration of sensitized gonococcal vaccine in the joint infections which, as a rule, improve very slowly or not at all with the ordinary method of treatment.

The sensitized gonococcal vaccine was prepared in the following manner:

The first case treated was a patient whose knee-joint was affected. The swollen joint was aspirated and fluid removed which was markedly purulent.

A pure growth of gonococcus was obtained from this on blood agar. This was subcultivated on blood agar at intervals of two days until a good growth resulted. Then a series of blood agar slopes were inoculated and incubated for twenty-four hours.

An emulsion of the growths on these slopes was made in 15 c.cm. of sterile saline solution (normal saline being used). The growth was removed from each slope by means of a platinum loop, each loopful being washed off into the saline solution by agitation. The tube was then closed by a rubber cap and shaken vigorously by hand for ten minutes.

After this the amount of turbidity was noted and an approximate count made of the total number of gonococci (in millions) contained in the test tube. This was noted. Then 15 c.cm. of antigenococcus serum (B. W. and Co.) were added and the whole vigorously shaken to ensure thorough mixing of serum and bacterial emulsion.

The mixture was then incubated for twenty-four hours at 37° C. The tube was removed from the incubator after this and inserted in a test-tube rack (to retain it in a vertical position); this was then placed in a refrigerator for twenty-four hours. By this time the gonococci had formed a deposit at the bottom of the test tube.

The supernatant fluid was removed by hand pipette and 15 c.cm. of sterile saline solution added to the deposit. The whole was then well shaken, after which the tube was returned to the test-tube rack and replaced in the refrigerator for a further period of twenty-four hours.

After this the same procedure was followed, and the supernatant fluid was again removed and replaced with 15 c.cm. of sterile saline solution and the whole shaken and returned once more to the ice chest for twenty-four hours.

At the end of this time the supernatant fluid was again removed, leaving only the deposit, and 15 c.cm. of sterile saline solution were again added. To this was now added 1 c.cm. of a 10 per cent. solution of carbolic acid. The tube was well shaken and placed in the refrigerator for three or four days, during which period it was well shaken twice daily.

At the end of this time the bacterial emulsion was tested for sterility, and if sterile was ready for use. Having already noted the total number of gonococci present when the emulsion was first made, it only remained to divide this number by the figure 16 to obtain the strength of the vaccine in millions per cubic centimetre.

The first case treated was given this autogenous sensitized vaccine. The improvement in his condition encouraged me to continue the method, because he had previously been treated first with stock vaccine consisting of mixed gonococci and staphylococci, and subsequently with an autogenous gonococcal vaccine without apparent benefit, whereas when the sensitized vaccine was given a decided improvement in his condition was noted. However, the strain died, and as our numbers here are rather large to permit us to prepare an autogenous vaccine for each individual case, it was decided to employ a stock sensitized gonococcal vaccine prepared from several strains of the micro-organism.

Fresh strains of gonococci obtained from various urethral discharges were subcultivated several times, and then forty-eight hours cultures employed.

Four strains of gonococci were used in the preparation of the vaccine, and as a forty-eight hours' growth of gonococcus does not emulsify so readily as a twenty-four hours' growth, the emulsion was made in the tube of sterile saline, the tube closed by a rubber cap, and then placed in a mechanical shaker, where it was kept vigorously shaken for one hour. At the end of this time the tube was taken out of the shaker, and the approximate strength of the emulsion in millions of gonococci noted.

The procedure then continued on the same lines as in the preparation of the autogenous sensitized vaccine just described—namely, addition of antigenococcus serum incubation for twenty-four hours, washing twice with saline, etc.

The advantage of using a sensitized vaccine in contradistinction to an ordinary vaccine is that one can push the dosage and still get practically no local or general reaction. Occasionally the patient will complain of the affected joint or joints being more tender to the touch within a period of several hours after the administration.

In dealing with the question of dosage a routine was tentatively drawn up as follows:

1st day ...	...	25 million of gonococci
2nd day ...	...	50 "
3rd day ...	...	100 "
5th day ...	...	150 "
7th day ...	...	200 "
9th day ...	...	250 "
12th day ...	...	300 "
15th day ...	...	350 "
18th day ...	...	400 "
22nd day ...	...	450 "
26th day ...	...	500 "
30th day ...	...	550 "

Then an increase of 50 million every fifth day.

In the first series of cases this dosage was adopted.

CASE I.

This patient had a watery gleet on admission. There was marked swelling of the left knee, which was acutely painful. Temperature varied from 100° F. to 102° F. The joint was aspirated on three occasions and fluid removed.

He was given a stock mixed vaccine of gonococci and staphylococci without any improvement. This was followed by an autogenous gonococcal vaccine, during the administration of which the patient remained the same. A sensitized gonococcal

vaccine was prepared from this strain and administered according to the above-mentioned routine. He had the course up to the eighteenth day, when the dose was 400 million of gonococci. After the third dose the pain was easier, and the temperature came down to normal, at which, with an occasional rise, it remained practically all the time the patient was in this hospital. He could lie comfortably while at rest, but movement of the affected leg continued painful. He had been emaciated, but began to put on flesh rapidly.

After the administration of the vaccine on the eighteenth day he was transferred to England, where his temperature for six days was between 99° F. and 100° F., after which it remained normal. Pain on movement continued for three weeks, and swelling for four weeks, when the left knee showed half an inch greater circumference than the right.

CASE II.

Admitted February 24th, 1917, with purulent urethral discharge, and pain and marked swelling of the right knee. Vaccine treatment was commenced on the following day. The pain became easier and the swelling began to diminish on February 27th. The pain had disappeared on March 17th and the swelling on March 24th. The result was that the joints became quite freely movable and he was able to walk perfectly. The temperature on admission was 101.6° F. It fell to 100° on the fourth, was normal on the twentieth day, and so remained.

CASE III.

Admitted January 26th, 1917, with purulent urethral discharge and pain and swelling in finger and wrist joints of both hands. The vaccine was commenced on the following day. Swelling began to diminish on February 7th and had completely disappeared on March 18th. Pain became easier on February 16th and had completely gone on February 20th. The result was that the movements of hands and fingers were quite good. The temperature was normal on admission and remained so afterwards.

CASE IV.

Admitted on January 25th, 1917, with gleet and stiff and painful neck. X-ray examination on January 14th showed thickness of spinous process and also of body of second cervical vertebra. The diagnosis of gonococcal infection having been made, the vaccine treatment was begun on February 16th. On February 19th pain was easier, on March 5th movements of the neck were quite good, and on March 17th all trace of pain and limitation of movement had gone. The temperature was normal throughout.

CASE V.

Admitted February 1st, 1917, with purulent urethral discharge and some swelling and pain of the knee-joint. Vaccine treatment was commenced on the following day. The pain became easier on February 12th and had completely gone on March 1st. Swelling began to diminish on February 13th and had disappeared on March 1st. The result was that the joint was perfectly well. There was a slight rise of temperature for the first few days.

CASE VI.

Admitted February 1st, 1917, with swollen and painful right elbow, but no urethral discharge, though he had had gonorrhoea on January 19th, 1917. Vaccine was begun on February 2nd; three days later the pain was easier and the swelling began to go down. On February 10th pain had entirely gone. On February 16th the swelling had disappeared, and a week later extension and flexion of the forearm were almost complete. Temperature was normal throughout.

CASE VII.

Admitted January 1st, 1917, with gleet and some swelling of both knees and both ankles. Patient was much attenuated. Vaccine was begun next day. On January 14th the pain became easier. On January 16th the swelling began to go down, and next day both pain and swelling disappeared. The patient was then evacuated to England, as he was still very much wasted, and his legs were very weak. His temperature was normal throughout.

CASE VIII.

Admitted January 14th, 1917, with purulent urethral discharge. On January 26th some swelling and pain appeared in the left ankle. Vaccine was begun on February 6th. On February 9th the pain became easier, and the swelling began to go down. On February 12th the pain and swelling had gone. The result was complete recovery of the joint. The temperature was normal throughout.

CASE IX.

Admitted January 22nd with right epididymitis and some swelling and pain of the right knee. Vaccine was begun the same day. On January 30th the swelling began to go down. On February 10th the pain became easier, disappearing two days later. The swelling had gone by February 15th. The result was complete recovery of the joint. The temperature was normal throughout.

CASE X.

Admitted February 20th, 1917, with purulent urethral discharge, and some swelling and pain of the left knee. Vaccine was begun on that day. The swelling began to go down on February 28th, and the pain improved on March 11th; by March 26th both pain and swelling had gone. In the result the patient was still weak but able to walk, and the joint was freely movable. The temperature was normal throughout.

As regards local treatment of the joint every patient had rest and application of Scott's dressing.

The above-mentioned cases gave encouragement to continue with the sensitized vaccine, but it was thought desirable to try the administration of bigger doses.

On that account the following routine was adopted in the cases reported below:

1st day	...	...	100 million of gonococci.
5th day	...	...	200 " "
9th day	...	...	400 " "
13th day	...	...	600 " "
17th day	...	...	800 " "
21st day	...	...	1,000 " "
25th day	...	...	1,200 " "

And increasing 200 million every fourth day up to a maximum of 2,000 million.

CASE XI.

Admitted May 16th, 1917, with gleet, some swelling and pain of left wrist, and slight swelling of left shoulder with marked stiffness and restricted movement. Vaccine was begun the same day, and on May 23rd the pain became easier and the swelling began to subside. On June 6th the pain and swelling had gone. The result was that movements at the wrist were quite normal, and only slight restriction of movement remained at the shoulder. The temperature was normal throughout. In this case the local treatment was by ionization.

CASE XII.

Admitted April 14th, 1917, with purulent urethral discharge. On July 3rd some swelling and pain appeared in the left knee. Vaccine was begun next day. The pain became easier on July 13th, and the swelling began to subside on the 14th. The pain and swelling had gone on August 6th. In the result the knee was practically normal, though movement was somewhat restricted. The temperature was normal throughout.

CASE XIII.

Admitted June 11th, 1917, with purulent urethral discharge, and some swelling of the left knee. Vaccine was begun on July 11th, and the pain was easier two days later. The right knee developed slight swelling and pain on July 16th. By July 18th the left knee was greatly improved. On July 28th the right knee was free from pain. Two days later the left knee was better and all other joints were normal. Finally on August 18th all movements were normal.

CASE XIV.

Admitted June 15th, 1917, with purulent urethral discharge, well-marked arthritis of the left elbow with fluid, early arthritis of the right elbow, and pains in the right leg. Temperature 102° F. Vaccine was begun the same day. The pain was less on June 21st, and the swelling less on June 27th. The pain disappeared on July 10th, and the swelling on July 14th. A week later movements in the arms were normal.

CASE XV.

Admitted June 30th, 1917, with purulent urethral discharge, swelling and tenderness of left ankle and knee. Temperature 99.4°. Vaccine was begun at once; on the following day the right ankle was swollen. On July 14th both pain and swelling had diminished, and the ankles and knee were greatly improved on July 16th. By August 1st the pain had left the affected joints, the left knee was practically normal, the right knee normal, but the left ankle still slightly swollen. This patient showed marked reaction to the vaccine when he received a dosage of 1,200 million, after which he had transient pains in all his joints.

CASE XVI.

Admitted July 8th, 1917, with purulent urethral discharge and both knees swollen and painful. Temperature 99.6°. Vaccine was begun the same day, and the pain and swelling abated on July 13th. On July 18th the right knee was greatly improved; the left knee slightly improved. The next day there was slight pain in the right ankle, and on July 23rd the fingers of the left hand swelled. The right ankle was free from pain on July 24th. On August 15th the knee movements were practically normal, and on August 23rd the hand was better and the left ankle almost well.

CASE XVII.

Admitted July 23rd, 1917, with gleet, and swelling and pain of left knee, but no fever. Vaccine was begun the same day. The pain and swelling were less on July 28th. The knee was greatly improved on July 31st, and the pain had gone on August 16th. By August 20th the knee was practically normal in its movements.

The last six cases were all treated locally with Scott's dressing, lead and opium fomentations, and ionization.

From a consideration of these seventeen cases I feel justified in recommending the administration of sensitized gonococcal vaccine as a line of treatment worthy of trial in cases of acute and subacute gonococcal infection of joints.

The first case, as already stated, was given an autogenous sensitized gonococcal vaccine, the micro-organism being grown from the fluid aspirated from the knee. All the other cases were treated with sensitized gonococcal

vaccine prepared from four strains of gonococci, all of which were obtained from urethral discharges. None of these strains was autogenous for any of the cases treated.

I have the impression that recently-obtained strains are best for this purpose, and endeavour has been made to avoid using gonococci which have been subcultivated for more than four months, the strains being discarded at the end of that period and younger ones employed. Four strains of gonococci have always been employed in the preparation of the stock vaccine.

In the matter of dosage the second routine has the advantage of being less troublesome for both patient and medical officer, and the results are quite as good as with the first routine; the second is to be recommended, though probably one might give even bigger doses with safety.

Only a few of the cases treated have shown any reaction after administration. Case xv showed the most marked reaction, and one or two of the others had a slight increase of pain in the affected joint or joints, which generally disappeared after a few hours.

I have to acknowledge my indebtedness to Captain C. Lundie, R.A.M.C., and Captain W. J. Ronan, R.A.M.C., for giving the vaccine an extended trial in their cases and for so kindly supplying me with the clinical notes. I must also thank Captain Billington, R.A.M.C., for his helpful suggestions when I began this work.

A NOTE ON MUSCLE NERVE TESTING DURING OPERATION.

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The following is a brief account of the method adopted for the electrical testing of a peripheral nerve at the time of operation at the Military Orthopaedic Hospital, Shepherd's Bush.

It is necessary, in the first place, to emphasize the extreme importance of testing the excitability of the nerve in many cases, and that it is therefore essential that the surgeon should be prepared to do so in every case. If, on cutting down on the nerve, a complete anatomical division is found, with an end bulb on the proximal end and perhaps an inch or more of separation, there is no need to test the electrical conductivity of the nerve.

But very often this is not the case. The exposed nerve may show a thickened area with no anatomical division, and the question arises whether or no there is physiological conduction through this. It may be thought that a complete investigation of the case beforehand should suffice for diagnosis, but it happens sometimes that the notes of cases are not complete, and that the surgeon may not be fully familiar with the case. In any case, a diagnostic method as easily applied and as valuable as is that under discussion should always be made use of.

It is quite simple to test the conductivity of the nerve, and the result, coupled with a consideration of the history, will give a clear indication whether the lesion is recovering or not.

The relative rapidity of return of voluntary power and of faradic excitability (as ordinarily tested) after injury is not constant; sometimes the one and sometimes the other returns first. If the exposed nerve is stimulated faradic response in the muscles always precedes, in my experience, the return of voluntary power. It occurs so often that it may be regarded as a constant factor.

Illustrative Case.

Pte. H. Gunshot wound through neck, August, 1916.

There was a lesion of the fifth and sixth cervical nerves, with paralysis of the deltoid, biceps, and supinator longus muscles. The scars of entrance and exit were in the root of the neck.

The case was treated with the arm in abduction for five months, in order to relax the deltoid and biceps. As there was no evidence of recovery, exploration was decided upon. The fifth and sixth cervical nerves were explored in the posterior triangle, together with the upper trunk and its anterior and posterior divisions. Some scar tissue was dissected off during this exposure, and the nerves were stimulated. Faradic excitability was evidenced by contraction of the biceps, deltoid,