SOME NOTES ON SURGICAL TECHNIQUE.

By Captain F. E. GUNTER.
Royal Army Medical Corps.

For some time past I have been making notes as to the result of operations I have done at the Curragh from the point of view of asepsis, and I think a description of the methods used, and their success or otherwise, may be of some general interest, though I have little new to bring to light.

Preparation of the Operation Area.—This I always do myself the night before performing the operation. Thus one has only oneself to blame if it be not done properly. Having washed my hands thoroughly, I put on rubber gloves. This may seem an unnecessary precaution, but one has probably infected one's hands in some outdoor pursuit during the afternoon. It is certainly a cleanly practice from the operator's point of view. The operation area having been shaved is thoroughly scrubbed with ordinary soap and water and a nail brush, and then rubbed with a sterilised towel. After this, methylated spirit is well rubbed in (at one time I used turpentine, as recommended by Messrs. Cheyne and Burghard, but this ruins the gloves). After the methylated spirit, Cheyne and Burghard's "strong mixture" (corrosive sublimate 1—500, carbolic 1—20) is thoroughly applied, and finally a poultice of 1—1,000 corrosive is applied for the night. When the patient is under the anæsthetic, I give a scrubbing down with ether soap, methylated spirit, and 1 in 1,000 corrosive sublimate.

Preparation of the Hands.—I wash my hands very thoroughly with soap and water and a nail brush, and polish the nails most carefully. Haegler lays the greatest stress on this washing, which, he says, is by far the most important item in the disinfection of the hands. He recommends that in order to learn the capacity of one's hands for taking up dirt, one should smear them well with Indian ink and let it dry, and then scrub the ink off with soap and water. I have tried this, and certainly find that it is much more difficult to remove all traces of ink than one would imagine. After washing the hands with soap and water, Haegler recommends that they should be dried thoroughly by rubbing with a rough towel, as this helps to remove the *débris* of epithelium. He tested his hands by rubbing them with a sterilised thread, with which he afterwards inoculated gelatine plates, before and after

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rubbing with a towel. The thread cultures from the rubbed hand showed many fewer colonies than from the unrubbed hand. I tested my hands by means of this thread test, and obtained the following results, using agar, which, though less delicate than gelatine, is simpler to work with :—

THREE DAYS' GROWTH ON AGAR AT 37° C.

(1) Unwashed hands..	Countless colonies.
(2) Washed for five minutes in soap and water without using nail-brush	34 colonies.
(3) Ditto, as above, but using nail brush	12 ,,
(4) As above, but in addition scrubbed with a sterilised towel	No growth.

Consequently, since making the above experiments (March, 1906), I have always rubbed my hands with a sterilised towel. After scrubbing with the towel, I dip my hands consecutively in methylated spirit, "strong mixture," and corrosive sublimate (1—1000).

Gloves.—Throughout the operation I wear rubber gloves. To test the efficiency of gloves the following thread and agar plate tests were tried.

	After 24 hours	After 3 days
(*a*) My own hands after washing and drying with a towel	No colonies ..	Numerous colonies (probably *subtilis*).
(*b*) Lieut. W.'s (my assistant at operations) treated as in (*a*)	,, ,, ..	Some colonies.
(*c*) My gloves on hands *before* operation	,, ,, ..	2 colonies.
(*d*) Lieut. W.'s gloves on hands *before* operation	Five colonies ..	29 ,,
(*e*) My gloves on hands *after* operation	No colonies ..	4 ,,
(*f*) Lieut. W.'s gloves on hands *after* operation	Eight colonies..	32 ,,

Conclusion from the above Experiments.—That the wearing of gloves in my case was fairly efficient. Haegler seems to conclude that the infection of the gloves is by one's own hand. Were this so in my case, I think there would have been more growths from the gloved hand after the operation than was the case. Moreover, from experiments (*a*) and (*b*), it will be seen that Lieutenant W. was more successful in disinfecting his hands than I was; but from experiments (*c*) and (*d*), it is evident that his "gloved hand" results were much less satisfactory than mine. He was wearing a pair of new gloves, whereas I was wearing a pair that had been used several times. Why his gloves should have been infected

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previous to operation I do not understand, unless he inadvertently infected them in putting them on, as both his pair and mine were sterilised by boiling in the same saucepan. I may state, however, that I am always particularly careful, in putting on gloves, to handle them as little as possible with the ungloved hand. Of course it is unjustifiable to draw conclusions from one set of experiments, but I give them for what they are worth.

Air of Operating Room.—This was tested on one occasion, before and after an operation, by means of gelatine plates exposed for five minutes. After three days the plates were examined with the following results:—

The plate exposed before operation was sterile.

The plate exposed after operating (eight people in the room) for half an hour showed thirty-four colonies. On microscopic examination rod-shaped bacilli, retaining stain by Gram's method, were detected.

The obvious conclusion is to have the room as empty as possible, and to avoid conversation and movement. I never wear a cap or a mouthguard, nor shall I do so, especially the latter, until every other possible source of infection has been eliminated. A mouth guard is most uncomfortable, and I cannot believe that a cap, unless it thoroughly covers the head, is of the slightest use. To keep one's hair short and not to breathe into the wound are obvious surgical first principles.

Guarding the Operation Area.—For all operations about the abdomen I use a sterilised sheet which covers the patient completely. It has a slit in the middle. The edges of the slit, which are arranged to correspond roughly with the proposed incision, are then stitched lightly to the skin to fix the sheet. The skin incision having been made, the interval between the incision and the sheeting is filled up with gauze which is lightly tacked to the patient's skin. The knife used for making the skin incision is not again used during the operation.

Instruments.—These are, of course, always boiled, except cutting instruments, which are kept in 1 to 20 carbolic. Before using an instrument I invariably dip it in sterilised water to get rid of the excess of carbolic lotion. For swabs, sterilised gauze wrung out in distilled water is used. No one handles either swabs or instruments except myself and the officer who is assisting me. I never use any lotions except sterilised water, though I frequently dip my hands in 1—1000 perchloride.

Ligatures and Sutures.—For ligatures silk is invariably used,

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TABLE.

Serial Number	Disease	Operation and date	Date of dressing	Result of cultures
1	Onychia ..	Removal of nail matrix, 2.1.06	9.1.06	10.1.06, broth sterile; 13.1.06, growth. Sub-culture on agar, a few non-motile cocci.
2	Varix ..	Excision of veins, 2.1.06	9.1.06	10.1.06, broth sterile; 13.1.06, sterile.
3	Appendicitis	Removal, 3.1.06	10.1.06	11.1.06, broth sterile; 13.1.06, growth. Sub-culture on agar, actively motile diplococci.
4	Ventral hernia following old appendical abscess	Repair of abdominal wall, 4.1.06	10.1.06	11.1.06, broth sterile; 13.1.06, growth. Sub-culture on agar, a few non-motile cocci decolourised by Gram.
5	Varicocele ..	Excision of veins, 4.1.06	10.1.06. A small sinus leading down to ligature; no purulent discharge	13.1.06, growth. Sub-culture on agar, numerous organisms, some in heaps, some in chains; a few diplococci. The chief organisms were apparently staphylococci.
6	Omental hernia	Radical cure, 5.1.06	11.1.06	14.1.06, growth on broth. Sub-culture on agar, a few cocci, decolourised by Gram.
7	Hernia ..	Radical cure, 28.1.06	3.2.06	4.2.06, growth on broth. No sub-culture made.
8	Onychia ..	Removal of nail matrix, 28.1.06	3.2.06. A drop of pus in each nail matrix	Examination showed Staphylococcus.
9	Varicocele ..	Excision of veins, 28.1.06	3.2.06	4.2.06, growth on broth. Sub-culture on gelatine, numerous non-motile cocci stain by Gram, probably staphylococci.
10	Varix ..	Excision of veins, 28.1.06	3.2.06	5.2.06, broth sterile.
11	Hernia ..	Radical cure, 11.2.06	20.2.06	21.2.06, growth on broth. Staphylococci subsequently recovered.
12	,, ..	Radical cure, 13.2.06	22.2.06	24.2.06, growth on broth. Sub-culture gelatine liquefied in 48 hours; rod-shaped bacilli, no streptococci or staphylococci detected.
13	Fracture of patella	Wiring of fragments, 21.2.06	3.3.06	5.3.06, growth from subculture on gelatine, staphylococci and streptococci isolated.
14	Strangulated hernia	Radical cure, 22.2.06	3.3.06	Growth on broth in 12 hours; *B. subtilis* isolated, no staphylococci or streptococci detected.
15	Hernia ..	Radical cure, 27.2.06	7.3.06	8.3.06, growth on broth, staphylococci isolated.
16	Varicocele ..	Excision of veins, 2.3.06	11.3.06	13.3.06, growth on broth, staphylococci isolated.
17	Hallux rigidus	Excision of base of proximal phalanx, 27.2.06	7.3.06	9.3.06, broth sterile.
18	Hernia ..	Radical cure, 20.3.06	29.3.06	Growth on broth after 24 hours, staphylococci detected.

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TABLE.—*Continued.*

Serial Number	Disease	Operation and date	Date of dressing	Result of cultures
19	Varicocele ..	Excision of veins, 20.3.06	29.3.06	Growth on broth after 24 hours. Agar plate made on 29.3.06 direct from wound showed one colony; on 31.3.06 cocci, with Brownian movement, encapsuled. One Streptococcus detected.
20	,, ..	Excision of veins, 20.3.06	29.3.06	Broth, growth after 24 hours; agar plate made as in No. 19, 48 hours, numerous colonies.
21	Fracture of patella	Wiring fragments of bone, 22.3.06	31.3.06	No growth on broth after 48 hours; agar plate as in No. 19, 48 hours' growth, one colony, probably staphylococci.
22	Varicocele ..	Excision of veins, 3.4.06	13.4.06	Broth turbid after 48 hours; agar plate as in No. 19, 48 hours, 100 colonies. Cocci stained by Gram, probably staphylococci, also rod-shaped bacilli stained by Gram.
23	Hernia ..	Radical cure, 3.4.06	13.4.06	Broth turbid after 48 hours. Agar plate, 100 colonies after 48 hours, numerous cocci, probably staphylococci, also rod-shaped bacilli stained by Gram.
24	Foreign body (needle) in thigh	Removal, 6.4.06	17.4.06	Broth turbid after 48 hours, non-motile cocci; agar plates sterile after 48 hours.
25	Varix ..	Excision of veins, 6.4.06	17.4.06	Broth turbid after 48 hours. Agar after 48 hours, three colonies proved to be streptococci.
26	,, ..	Excision of veins, 12.4.06	22.4.06	Growth in broth after 48 hours. No growth on agar.
27	Hernia ..	Radical cure, 12.4.06. There was a small sinus leading to deep ligature, but no pus	24.4.06	There was growth on broth and agar, organisms not determined.
28	,, ..	Radical cure, 1.5.06	10.5.06	48 hours, growth on broth; numerous colonies on agar; Staphylococcus isolated.
29	Varicocele ..	Excision of veins, 1.5.06	10.5.06	48 hours, broth sterile, on agar numerous colonies; rod-shaped bacilli stained by Gram; staphylococci not detected.
30	,, ..	Excision of veins, 5.5.06	13.5.06	48 hours, growth on agar, numerous colonies; non-motile bacilli, short rods with rounded ends; staphylococci not detected.
31	,, ..	Excision of veins, 5.5.06	13.5.06 Slight redness about stitches, but no pus	After 48 hours, growth on agar, numerous colonies, same organism as in No. 30; no staphylococci detected.
32	Hernia ..	Radical cure, 5.5.06	13.5.06	After 48 hours, growth on agar, numerous colonies; non-motile cocci, probably staphylococci.

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except for septic cases. I tested the effect of boiling silks to ascertain the minimum time they could be boiled with safety, with the following results :—

No. 12 silk boiled for one hour, two hours, three hours, and four hours respectively. Broth cultures were made. After five days every tube was found to be infected, except that containing the silk boiled for four hours. (The boiling was done in an ordinary saucepan with a cover.)

No. 12 silk placed in a test-tube and autoclaved under a pressure of 10 lbs. for half an hour proved to be sterile after five days.

No. 12 silk boiled in a test-tube for a quarter of an hour on three successive days was sterile after five days.

The conclusion from the above experiments is that you can use silk No. 12 with safety if you boil it for not less than four hours, autoclave it for half an hour, or boil it for a quarter of an hour on three successive days. Boiling for four hours, however, rots silk and renders it most brittle. This is well shown by the following experiments I made to ascertain the breaking strain of the different sizes of silks.

BREAKING STRAIN IN POUNDS.

No. of silk	Before boiling	After 10 mins. boiling	After 1 hour	After 2 hours	After 3 hours	After 4 hours
2	4	4	6	3	2½	½
7	11½	12	14	14½	12	11
10	16	16	20	19½	17	10
11	17	19	23	..	17	10
12	18	21	28	..	12	11
12	After ¼ hour boiling on three successive days breaking strain was 26½ pounds.					
12	After ½ hour in autoclave breaking strain was 25½ pounds.					

In every case, with the exception of No. 7 silk, which bore the greatest weight after two hours, the breaking strain was greatest after one hour ; after this it rapidly diminished.

Boiling on three successive days is inconvenient, so I am now using autoclaved silk. I put up a few strands, such as may be required for a single operation, in test-tubes according to sizes and then autoclave them. If one end of a skein be cut the strands will be found of a suitable length for most operations.

Sutures.—Throughout the series of operations referred to in the table silkworm gut has been used.

Lotions.—These are always made up fresh by the sister-in-charge of the theatre before each operation. As is well known, antiseptics lose their power by keeping, especially carbolic.

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Whilst dressing the cases I wear gloves and observe the strictest aseptic precautions. Great care is of course necessary, otherwise one may infect the broth and agar and thus get fallacious results. On removing the dressings, I cut the sutures with scissors sterilised by heat, and place the sutures in broth or agar media and incubate and examine them in the usual manner.

Over thirty consecutive cases have been treated in this way, and although the results have been satisfactory from a surgical point of view, that is to say, primary union has been obtained without a sign of suppuration, it has only been occasionally that the wound could be pronounced to be bacteriologically sterile.

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