PRESENTATION OF A PREOPERATIVE SKIN DISINFECTANT—AN ALCOHOL-ACETONE-AQEOUS SOLUTION OF MERCURICHROME

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The over increasing tendency on the part of progressive surgeons of today to save their patients as much as possible by the use of local anesthesia, from the discomforts and complications that sometimes follow even the most skilful administration of a general anesthetic, is apparent to all that keep abreast with the march of surgical accomplishments. As a result of this trend towards the more frequent use of local anesthesia, the need of a rapid, efficient preoperative skin disinfectant that will neither cause the patient discomfort at the time of its application nor afterwards, has become increasingly evident. To the genito-urological surgeon, dealing as he does, with the exquisitely tender and highly irritable epidermis of the external male genitalia, the choice of such a disinfectant is of great importance. This need was soon apparent to Dr. Hugh H. Young, to whom we are greatly indebted for his constant cooperation and many helpful suggestions. The choice of such a preparation has become especially necessary since the epidural and the combined epidural and parasacral types of anesthesia have proven to be so satisfactory in that field.

The ideal preoperative skin disinfectant, in addition to being painless when applied and causing no postoperative dermatitis, must possess certain other well known prerequisites before it can be recommended to the surgical profession. High germicidal action and deep penetrability are undoubtedly among the most essential properties a preparation of this kind should have.
The method of application is most important, so much so, in fact that a number of preoperative disinfectants, seemingly satisfactory from the standpoint of sterilization, have been discarded because they were too involved and time-consuming. The drying time must be so controlled that the drug is able to penetrate definitely the tissues and kill the bacteria present without too greatly delaying the other operative procedures. The property of dissolving the skin debris, consisting of glandular secretions and excretions, degenerating cellular substances and dirt, within which bacteria so maliciously lurk is a most essential requisite, without which no disinfectant can hope to approach the ideal. It is a well known fact that many times the microscopic crevices of the skin contain air bubbles which must be decomposed and removed before satisfactory sterilization is obtained. In addition, the ideal disinfectant must be of very low toxicity to normal tissue, thus retarding as little as possible the postoperative healing of wounds. Lastly, it must possess a sufficiently high color index and durability of staining characteristics so that at no time can there be any question as to the preparation and extent of the operative field.

Of the various methods of preoperative skin disinfection in general use today, there is little doubt but that the iodin-alcohol technique is the most popular. This combination, although quite satisfactory from the standpoint of superficial skin sterilization, is far from being ideal. It is generally assumed by all who use iodin in preparing the skin before operation that it has great properties of penetration. McKenna and Fisher (1) in a comparative study of the relative penetration power of iodin and "Kalmerid" (a 1 per cent solution of potassium mercuric iodide in 80 per cent acetone) found that the latter had penetrated the tissues to a considerably greater depth than the former. Some individuals, especially those suffering from hyperthyroidism, have a marked idiosyncrasy to iodin, resulting in most annoying skin irritation following its application. The tendency to spread to the periphery results in a blotchy looking field with a high marginal concentration. Unless special care is exercised in removing these marginal accumulations, blistering of the skin is
important, so much so, in fact, that the use of antiseptics, seemingly satisfactory, have been discarded because of their time-consuming nature. The dry-heat drug is able to penetrate the bacteria present without too much difficulty. The property of glandular secretions of substances and dirt, within the microscopic crevices of the skin, must be decomposed and removed to approach the ideal. In addition, very low toxicity to normal skin is a most essential requisite. The postoperative healing is almost inevitable. In many clinics all the iodin is removed with alcohol before the patient is draped and the incision is made. The mere mechanical cleansing resulting from the application of alcohol undoubtedly aids markedly the process of skin sterilization, but there are two distinct disadvantages connected with such a procedure. In the first place, the method is quite time consuming and, secondly, if unforeseen operative exigencies make necessary the enlargement of the first incision or the presence of one or two more, the operator is frequently at a loss to determine the exact extent of the operative field. Numerous writers, among them O'Conor (2) and Maylard (3) have objected to the use of iodin in cases requiring peritoneal incisions on the grounds that it causes very serious postoperative adhesions.

Genito-urological surgeons have long since learned that the delicate epidermal coverings of the external male genitalia were not adapted to the irritative action of such a drug as iodin. Consequently, they looked anxiously about for less irritating preparations.

As a result of these investigations potassium mercuric iodide and picric acid solutions have become popular in a number of clinics. For several years "Kalmerid," a 1 per cent solution of potassium mercuric iodide in 80 per cent acetone, has been used in the Brady Urological Institute. Although less irritating than iodin, occasional cases of quite marked dermatitis occurred and not uncommonly the superficial layers of scrotal skin peeled off in a day or so after the operation. Also, unless our patients were under the influence of a general anesthetic, they always complained most bitterly of smarting and burning of the skin at the time of its application and for a few moments afterward. In fact, not uncommonly the patients registered more discomfort from the application of "Kalmerid" than they did from the rest of the operative manoeuvres. Consequently, with the increased popularity of all forms of local anesthesia, such as terminal infiltration, field block, epidural infiltration, etc., there was a corresponding decrease in the popularity of this particular preparation. Furthermore the solution is so pale in color that it is frequently quite difficult to determine the extent of the operative
field and the thoroughness with which the drug has been applied to this area. This is especially true when "Kalmerid" is used on negroes.

A 5 per cent solution of picric acid dissolved in alcohol is used as a pre-operative skin disinfectant in a number of clinics. This preparation undoubtedly produces good superficial and deep sterilization of the skin, but is not quite satisfactory for a number of reasons. Conversations with a large number of surgeons have led the writers to believe that skin irritation following the application of picric acid occurs more commonly than a perusal of the literature would lead one to suspect. Also the tendency to crystallize and the slow drying process of the preparation have been mentioned as objectionable features. Perhaps the most common complaint against picric acid is that it not only stains the operating room towels and sheets, but that the patient's bedding, clothing, etc. continue to be stained for several days after the operation. Dressings, towels, etc., which have been saturated in picric acid and allowed to dry are considered quite inflammable. This should always be remembered when the use of the cautery is indicated in the presence of such conditions.

Because of its high bactericidal index, splendid penetrating qualities and practically non-toxic effect on normal tissue, it occurred to us that mercuriochrome would make a satisfactory skin disinfectant providing it could be dissolved in a vehicle capable of disintegrating the various forms of skin debris and possessing moderately rapid drying properties. A survey of the literature on the subject as well as our own experimental work suggested the advisability of using an alcohol acetone solution of this drug, if possible. In such a combination alcohol forms an admirable vehicle because of its bactericidal and drying properties. The acetone, although of little value from the bactericidal standpoint, possesses important solvent and drying properties and in addition markedly reduces surface tension resulting in quicker and deeper penetration of tissues and bacteria.

The pathway leading from the theoretical to the actual combination of the above-mentioned drugs was blocked by an obstacle which caused us no little concern for a considerable period of
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dissolved in alcohol is used in a number of clinics. This
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for a considerable period of
time. All attempts to dissolve mercurochrome in absolute and
95 per cent alcohol resulted in precipitation of the drug before a
concentration of sufficient strength to be of bactericidal value was
obtained. While meditating over this particular phase of the
problem, we studied water solutions of mercurochrome, varying
in strength from 1 to 10 per cent. These were all found to be
lacking in a number of the real essential properties of an ideal
skin disinfectant. Finally the extreme solubility of mercuro-
chrome in water suggested a way out of our difficulties. We
found, for example, if we first dissolved 2 grams of mercurochrome
in 35 cc. of distilled water, we could then add, while stirring, 55
cc. of a 95 per cent solution of alcohol and 10 cc. of acetone with-
out the formation of any precipitate whatsoever. Utilizing the
method just described, numerous combinations of mercuro-
chrome, alcohol and acetone were prepared and tested for bac-
tericidal and other properties before the formula given above was
found to be the most acceptable.

In our attempts to find a satisfactory combination of mercuro-
chrome, alcohol and acetone for skin disinfection, some rather
interesting observations were made. Although aqueous solu-
tions of mercurochrome, varying in strength from 1 to 10 per cent,
have high bactericidal value against Staphylococcus aureus, and
other bacteria found in the skin, when studied in vitro, they are
much less efficient when the cultures are made from skin surfaces
harboring these organisms. Water solutions of mercurochrome
were uniformly less efficient in disinfecting skin surfaces than
iodin solutions. These findings emphasize the importance of a
vehicle possessing definite solvent and penetrating properties.
It is well known that all germicides are much more efficient when
acting in the presence of moisture. We discovered that any
attempts to markedly increase the drying time of mercurochrome
preparations, by increasing the amount of acetone at the expense
of the alcohol content, resulted in decreased bactericidal efficiency.
The presence of a high percentage of acetone results in too rapid
drying and penetrating properties. It is conceivable that the
acetone when present in high concentration penetrates the tissues
so quickly that it is unable to carry the mercurochrome with it,
thus resulting in a more superficial sterilization. A preparation of mercurochrome, made according to the formula previously given, not only destroys the bacteria on the skin but dries in less than two minutes. The drying process is indicated by a slight fluorescent glow over the entire area of application.

When applied to the skin the preparation goes on very evenly and does not have a tendency to concentrate along the margins of the field. However, marginal concentration would be of no significance whatsoever, as the preparation is not at all irritating at the time of its application or afterwards. The color of this mercurochrome solution is such that there can never be any doubt as to the extent of the operative field and the thoroughness of its application even when it is used on negroes.

The solution was subjected to the following laboratory and clinical tests before it was considered acceptable from the standpoint of pre-operative skin sterilization.

A. IN VITRO TESTS

Method

Five cubic centimeters of the drug to be tested were placed in a sterile tube and 1 cc. of an eighteen-hour 1 per cent dextrose broth culture of the test organism added. The mixture was thoroughly shaken. After exposure periods of one, five, ten and fifteen minutes, 0.1 cc. amounts of the drug-organism mixture were removed by means of sterile capillary pipettes, attached to a syringe and transferred to pH 7.6 1 per cent dextrose broth. To avoid the possibility of inhibition of growth by any drug so carried over, a second transfer of 1 cc. of the first was done. Careful controls were made.

Summary

It will be seen from table 1 that this preparation of mercurochrome, even when old, is powerfully germicidal in vitro, killing Staphylococcus aureus, Bact. coli and Proteus in one minute. The concentration of mercurochrome in these tests is weaker than that of the original, on account of the dilution made by adding the culture.
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B. ACTION OF DRUGS ON THE INOCULATED SKIN OF RABBITS

Method

The abdominal and thoracic skin of rabbits was closely shaven, washed and dried. By means of sterile cotton swabs, separated areas about 2 cm. in diameter were then smeared with eighteen-hour 1 per cent dextrose broth cultures of the test organism, Staphylococcus aureus, Bac. coli or Proteus. These applications were allowed to dry. By means of sterile swabs, moistened in sterile physiological salt solution, controls of the inoculated areas were obtained and streaked across the surface of 2 pH 7.6 beef infusion agar plates. The drugs to be tested were then applied by means of sterile cotton swabs to the inoculated areas. At the end of the desired exposure time, cultures were made by means of sterile cotton swabs, moistened in sterile physiological salt solution, 2 agar plates being streaked as in the case of the controls. A control was always taken from an untreated area at the end of the experiment. The plates were incubated for forty-eight hours at 37.5°C and readings were then made. Rarely marginal colonies would be found not in the line of inoculation, which would be disregarded, readings being made of growth along the line of inoculation. Controls of swabs and salt solution were also made.

The findings of these tests are recorded in table 2.

Results

It will be seen that the inoculated, untreated areas invariably gave massive growth, not only when cultured at once after application, but also at the end of the experiment. Using the mercurochrome preparation, sterilization was complete in 100 per cent of the tests, that is 12 tests against Staphylococcus aureus, 8 against Bacterium coli and 6 against Proteus. Iodin and alcohol sterilized completely in all of the 8 tests against Bacterium coli and the 4 against Proteus, the tests with this drug against Staphylococcus aureus showing sterilization in 1 case, very scant growth in 5 cases, usually only 1 colony.

"Kalmerid" also sterilized both Bact. coli and Proteus in every
### TABLE 3

Skin sterilization. Alcohol-acetone aqueous solution of mercuric chromate. Bacteria after the application of (1) mercuric chromate and (2) an aqueous solution of acetone to rabbit skin.

Transfers made to agar plates by moist sterile swabs.

<table>
<thead>
<tr>
<th>Drug Used</th>
<th>Number of Test</th>
<th>Staphylococcus Aureus</th>
<th>Bacillus coli</th>
<th>Proteus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercurochrome (2 per cent)</td>
<td>1</td>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
</tr>
<tr>
<td>Alcohol (52.2 per cent)</td>
<td>2</td>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
</tr>
<tr>
<td>Acetone (10 per cent)</td>
<td>3</td>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
</tr>
<tr>
<td>Distilled Water, 35 cc.</td>
<td>4</td>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
</tr>
<tr>
<td>Iodin alcohol</td>
<td>1</td>
<td>Sterile</td>
<td>3 colonies</td>
<td>Sterile</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Sterile</td>
<td>1 colony</td>
<td>Sterile</td>
</tr>
<tr>
<td>Kalmerid</td>
<td>3</td>
<td>Sterile</td>
<td>2 colonies</td>
<td>Sterile</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Sterile</td>
<td>1 colony</td>
<td>Sterile</td>
</tr>
<tr>
<td>Picric acid</td>
<td>1</td>
<td>Sterile</td>
<td>6 colonies</td>
<td>Sterile</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Sterile</td>
<td>1 colony</td>
<td>Sterile</td>
</tr>
<tr>
<td>Alcohol (52.2 per cent)</td>
<td>1</td>
<td>62 colonies</td>
<td>72 colonies</td>
<td>Massive</td>
</tr>
<tr>
<td>Acetone (10 per cent)</td>
<td>2</td>
<td>55 colonies</td>
<td>8 colonies</td>
<td>Massive</td>
</tr>
<tr>
<td>Drug free culture controls</td>
<td></td>
<td>Massive growth</td>
<td>Massive growth</td>
<td>Massive growth</td>
</tr>
</tbody>
</table>
test, that is, 8 against the former, 4 against the latter, and in the 6 tests against Staphylococcus aureus, sterilized in 3, and showed scant growth in 3. Picric acid sterilized in 1 out of 3 tests against Staphylococcus aureus, in all of the 4 tests against Bact. coli, and in 3 out of the 4 tests against Proteus. The control, consisting of water, alcohol and acetone in the proportions used in making the mercurochrome preparation, failed to sterilize Staphylococcus aureus, showed good growth in 3 out of the 4 tests against Bacterium coli and massive growth in the 4 tests against Proteus.

Conclusion

These tests indicate that on rabbit skin, heavily inoculated with cultures of Staphylococcus aureus, Bact. coli and Proteus, the sterilizing action of the alcohol-acetone aqueous solution of mercurochrome was fully as good, or better, than that of the other drugs tested, namely, iodin and alcohol, “Kalmerid,” and picric acid and that the germicidal action was due in large part to the presence of the mercurochrome, not to the alcohol and acetone in the solution.

C. THE ACTION OF DRUGS ON NORMAL HUMAN SKIN, (ABDOMINAL SURFACE AND SCROTUM)

Method

By means of sterile cotton swabs, moistened in sterile physiological salt solution, the surface of the skin was thoroughly rubbed, an area of approximately 3 cm. in diameter being used for each test. The swabs were then streaked across the surfaces of two pH 7.6 beef infusion agar plates, the growth on which gave a control of the normal flora of the abdominal skin. By means of sterile cotton swabs similar areas of skin were then coated with the different drugs to be tested. After they had been allowed to remain for the desired exposure time, sterile swabs, moistened in sterile physiological salt solution, were rubbed briskly over the treated areas and then over the surfaces of two agar plates. Controls of salt solution and swabs were also made. Plates were always incubated for forty-eight hours at 37.5 °C,
against the latter, and in the sterilized in 3, and showed in 1 out of 3 tests against 4 tests against Bact. coli, theus. The control, consist in the proportions used in malk-failed to sterilize Staphylo. 3 out of the 4 tests against the 4 tests against Proteus. it skin, heavily inoculated lreaus, Bact. coli and Pro- alcohol-acetone aqueous is good, or better, than that n and alcohol, “Kalmerid,” action was due in large part, not to the alcohol and ace-

**HUMAN SKIN, (ABDOMINAL ROTUM)**

moistened in sterile physi-of the skin was thoroughly cm. in diameter being used streaked across the surfaces lates, the growth on which of the abdominal skin. By ar areas of skin were then tested. After they had been exposure time, sterile swabs, salt solution, were rubbed ten over the surfaces of two n and swabs were also made. fifty-eight hours at 37.5 °C, after which readings were made. In this way it was possible to determine the reduction in bacteria due to drug action. In rare cases plates would show one or two marginal colonies, not in the line of inoculation and these were disregarded, only colonies growing in the line of inoculation being counted.

**TABLE 3**

**Action of drugs on bacteria on normal skin.**

Transfers to agar plates by moist sterile swabs after three minutes exposure to drug.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Patient 1</th>
<th>Patient 2</th>
<th>Patient 3</th>
<th>Patient 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercurochrome (2 per cent)</td>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
</tr>
<tr>
<td>alcohol (52.2 per cent)</td>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
</tr>
<tr>
<td>acetone (10 per cent)</td>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
</tr>
<tr>
<td>Iodin (3.5 per cent)</td>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
</tr>
<tr>
<td>alcohol (95 per cent)</td>
<td>Sterile</td>
<td>Growth</td>
<td>1 colony</td>
<td>Sterile</td>
</tr>
<tr>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
</tr>
<tr>
<td>Sterile</td>
<td>Growth</td>
<td>5 colonies</td>
<td>Sterile</td>
<td>Sterile</td>
</tr>
<tr>
<td>Sterile</td>
<td>Growth</td>
<td>1 colony</td>
<td>Sterile</td>
<td>Sterile</td>
</tr>
<tr>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
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<tr>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
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<td>Sterile</td>
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<td>Sterile</td>
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<tr>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
</tr>
</tbody>
</table>

**Results**

The findings of these tests are shown in table 3. They show that, with massive growth from the untreated skin areas, all of the drugs tested caused a very marked reduction in the number of bacteria. The best results were obtained with the mercurochrome-alcohol-acetone solution, which caused complete sterilization in every case, 12 tests. With picric acid, sterilization was
obtained in 7 tests, 1 showing a growth of 2 colonies. With iodin and alcohol, 9 tests showed sterilization, 3 scant growth. "Kalmerid" caused sterilization in 7 cases, 5 showing slight growth.

Conclusion

These figures indicate that all of the drugs used are powerful skin disinfectants, the new preparation, mercurochrome with alcohol and acetone being fully as good and even slightly better than the older drugs, iodin and alcohol, picric acid and "Kalmerid."

D. THE STERILIZING ACTION OF ALCOHOL-ACETONE AQUEOUS SOLUTIONS OF MERCUCROMOE OF DIFFERENT AGES

Method

Three solutions were used in these tests.

Solution 1 had been prepared forty-six days before the final test and, when fresh, had been found to be completely germicidal in two-minute tests on rabbit skin heavily inoculated with Staphylococcus aureus. Since then the solution had remained in a glass-stoppered bottle, exposed for several hours daily to bright sun-light. There had been a slight settling out of metallic mercury and some lightening of the original dark red color.

Solution 2 had been prepared twenty-eight days before the final test, kept stoppered and exposed to light.

Solution 3 was a freshly prepared solution, used the day of its making.

Tests were made by the method previously used (see table 2) that is, on rabbit skin, heavily inoculated with Staphylococcus aureus. The exposure time was two minutes. The results are expressed in table 4.

Results

It will be seen from this table that even the oldest solution, which had been kept under unfavorable conditions, but stoppered, retained its germicidal action, so that all of the organisms were killed in two minutes. It may be concluded, therefore, that, from
growth of 2 colonies. With sterilization, 3 scant growth. 7 cases, 5 showing slight

The drugs used are powerful agents, mercurochrome with iod and even slightly better alcohol, picric acid and

**COHOL-ACETONE AQUEOUS OF DIFFERENT AGES**

tests.

six days before the final test completely germicidal in two-octiled with Staphylococcus aureus remained in a glass-stoppered bright sun-light. There had mercury and some lightening of by-eight days before the final

ion, used the day of its making.

tively used (see table 2) inoculated with Staphylococcus aureus 3 minutes. The results are

at even the oldest solution, in conditions, but stoppered, at all of the organisms were cluded, therefore, that, from

the point of view of germicidal action, the preparation may be used with safety even if not freshly prepared, although, on account of the very slight precipitation, we should advise that it be renewed once a week.

**TABLE 4**

*The action of the alcohol-acetone aqueous mercurochrome preparation in solutions of different ages, using a two-minute test period on rabbit skin, heavily inoculated with Staphylococcus aureus*

<table>
<thead>
<tr>
<th>SOLUTION</th>
<th>AGE</th>
<th>TEST 1</th>
<th>TEST 2</th>
<th>TEST 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solution 1</td>
<td>46 days</td>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
</tr>
<tr>
<td>Solution 2</td>
<td>28 days</td>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
</tr>
<tr>
<td>Solution 3</td>
<td>30 minutes</td>
<td>Sterile</td>
<td>Sterile</td>
<td>Sterile</td>
</tr>
<tr>
<td>Untreated skin control</td>
<td>Massive growth</td>
<td>Massive growth</td>
<td>Massive growth</td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 5**

*Action of drugs in deep skin sterilization*

<table>
<thead>
<tr>
<th></th>
<th>TEST 1</th>
<th>TEST 2</th>
<th>TEST 3</th>
<th>TEST 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercurochrome preparation</td>
<td>No growth</td>
<td>No growth</td>
<td>No growth</td>
<td>No growth</td>
</tr>
<tr>
<td>5 per cent picric acid</td>
<td>No growth</td>
<td>No growth</td>
<td>No growth</td>
<td>No growth</td>
</tr>
<tr>
<td>3.5 per cent iodin</td>
<td>No growth</td>
<td>Moderate growth</td>
<td>No growth</td>
<td>No growth</td>
</tr>
<tr>
<td>&quot;Kalmerid&quot;</td>
<td>No growth</td>
<td>No growth</td>
<td>Heavy growth</td>
<td>Moderate growth</td>
</tr>
<tr>
<td>Untreated control</td>
<td>Heavy growth</td>
<td>Heavy growth</td>
<td>Heavy growth</td>
<td>Heavy growth</td>
</tr>
</tbody>
</table>

**E. ACTION OF DRUGS IN DEEP SKIN STERILIZATION**

*Method*

Rabbit skin was closely shaven, areas about 2 cm. in diameter were swabbed with eighteen-hour 1 per cent dextrose broth cultures of Staphylococcus aureus, which were allowed to dry. The areas were then painted with the drugs to be tested. After these applications had dried, a small piece of the skin was excised with a sterile knife and dropped into pH 7.6 dextrose broth, incubated for forty-eight hours at 37.5°C. and observations made. The results are expressed in table 5.
Summary

In these tests merurochrome and picric acid were found to be effective deep skin sterilizing agents, "Kalmerid" and iodin at times allowing growth, iodin in 1 of 4 tests, "Kalmerid" in 2 of 4 tests.

F. RELATIVE PENETRATING POWER OF IODIN, "KALMERID," PICRIC ACID AND MERUROCHROME SOLUTIONS

The efficiency of any pre-operative skin disinfectant depends not only upon its bactericidal index but upon its power of penetration as well. McKenna and Fisher (1) in a study of the relative penetrating properties of "Kalmerid" and iodin solutions found that the former penetrated considerably deeper than the latter. These findings were substantiated by us. In addition to iodin and "Kalmerid" we studied the penetrating power of picric acid and merurochrome solutions.

The skin over the thorax and abdomen of a rabbit was carefully shaved and dried. Then the solutions mentioned above were applied over areas about 1 cm. in diameter and prepared for microscopic study by the methods described below.

Area 1. To this 3.5 per cent iodin solution was applied and allowed to dry. It was then excised with a wide margin, fixed in formalin and frozen sections were cut.

Area 2. Same as No. 1 only after excision of the tissue it was dropped in a very thin starch solution resulting in the formation of a dark blue precipitate. The tissue was then fixed in formalin and frozen sections were cut.

Area 3. Over the area 1 per cent potassium mercuric iodide in 80 per cent acetone was applied and allowed to dry. Then following the technique of McKenna and Fisher (1) a 30 per cent solution of ammonium sulphide was applied to precipitate the mercury. The area was excised with a wide margin, fixed in formalin and frozen sections made.

Area 4. Same as No. 3 with the exception that paraffin sections were made.

Area 5. To this area a 5 per cent solution of picric acid in alcohol
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IODIN, "KALMERID," PICRIC
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was applied, allowed to dry and excised with a good margin. It was
then fixed in formalin and frozen sections were cut.
\* Area 6. The alcohol-acetone-aqueous solution of mercurochrome
was applied, allowed to dry and area excised with a wide margin.
The tissue was fixed in formalin and frozen sections were made.
Area 7. Same as No. 6 with the exception that paraffin sections
were made.
Area 8. Same as No. 6 with the exception that the excised tissue
was cleared by the Spalteholtz method for clearing tissue as described
by Sabin (4). The tissue was then cut and studied.

Observations

Iodin penetrated the skin very superficially. "Kalmerid,"
while it penetrated more deeply than iodin was not very evenly
distributed and did not uniformly reach the lower layer of the
corneum. Picric acid penetrated the corneum more uniformly
than "Kalmerid" and in many areas the rete mucosum was
invaded. Also picric acid followed along the course of the hair
follicles very well and not infrequently was found about their
papillae. The mercurochrome penetrated as deeply as the picric
acid and seemingly was considerably more uniformly distributed.

Dr. Herbert Traut (5) in his experimental studies on tissue
culture and tissue transplantation, work that requires absolute
skin sterilization for satisfactory results, has confirmed these
studies on penetration. He finds that skin transplants from
areas prepared with iodin almost uniformly become infected.
Similar transplants after picric acid preparation became infected
in about 50 per cent of the cases. In a recent series of six trans-
plants from areas prepared with the mercurochrome preparation
not a single infection occurred.

G. CONCERNING THE TOXICITY OF MERCUROCROME

Observations and experimental work with mercurochrome dur-
ing the past six years have definitely proven that the drug pos-
sesses relatively low toxic properties. It does not precipitate
body proteins. Smith and Hill (6) have shown that mercuro-
chrome is less toxic in its action on the white blood cells than
many of the commonly used germicides. Numerous white blood counts following the intravenous injections of this drug fully substantiate these findings. The very fact that large doses of the drug can be given intravenously with only slight transitory albuminuria and occasional hematuria and a few casts shows its relatively low toxic action on the kidneys. This has been demonstrated by Hill and Bidgood (7) in their pathological studies of kidneys of rabbits after large injections of the drug. A study of a series of clinical cases followed in the Brady Urological Institute and reported by Young, Hill and Scott (8) has convinced the writers that the kidneys are not permanently damaged by the intravenous injections of the drug. Furthermore it has been used locally in the treatment of empyema and wounds in many other parts of the body without any apparent chemical damage. One of the writers injected a 2 per cent solution into the pericardial sac of a rabbit and the animal was seemingly perfectly healthy several weeks later.

The fact that Dr. Traut's (4) tissue transplants grew so vigorously proves quite conclusively that the new mercurochrome preparation has little or no toxic action on the tissues. The writers injected 20 minims each of the iodin, Kalmerid, picro acid and mercurochrome solutions into the skin of a number of rabbits and found that the areas injected with the last named solution always healed as soon and in many instances sooner than those injected with the other preparations.

H. CLINICAL RESULTS

The alcohol-acetone-aqueous solution of mercurochrome has been used in the operating room of the Brady Urological Institute for at least two months. During that time but one clean wound became infected after operation. In this case a large hematoma developed and was opened two days after the operation. At that time the cultures taken were sterile. It was necessary to drain the wound and subsequently it became slightly infected. The trouble in this case, of course, can not be blamed to an unsatisfactory skin sterilization at the time of operation. Since the adoption of the preparation in this clinic as a pre-operative
Numerous white blood ions of this drug fully fact that large doses of had only slight transitory ad a few casts shows its. This has been demon- r pathological studies of the drug. A study of a radly Urological Institute t (8) has convinced the anently damaged by the Furthermore it has been ma and wounds in many oparent chemical damage. at solution into the peril was seemingly perfectly transplants grew so vigor- the new mercurochrome tion on the tissues. The he iodin, Kalmerid, picrie o the skin of a number of d with the last named solu- any instances sooner than ions.

PREOPERATIVE SKIN DISINFECTANT

Skin disinfectant there has not been a single complaint of pain at the time of its application or dermatitis afterwards.

SUMMARY

The alcohol-acetone-aqueous solution of mercurochrome which is made by dissolving 2 grams of mercurochrome in 35 cc. of distilled water and then adding 55 cc. of 95 per cent alcohol and 10 cc. of acetone is a very efficient pre-operative skin disinfectant.

Better skin sterilization is obtained with it than with iodin, "Kalmerid" and picric acid.

Its application is accompanied by no pain and is, therefore, of special value in cases operated upon under local anesthesia.

Regardless of the age of the patient or location of the operative field, no instances of dermatitis have occurred following its use in the Brady Urological Clinic.

The solution penetrates more deeply than iodin and "Kalmerid." It penetrates at least as deeply as picric acid and seems to be a little more uniformly distributed at its lower level of penetration.

It retains its high bactericidal properties at least 46 days as shown by the fact that a solution of that age was found to be completely germicidal in two minute tests on rabbit skin heavily inoculated with Staphylococcus aureus.

It has a relatively low toxicity as shown by the vigorous way that tissue cultures and transplants have grown after its use.

The color of the preparation is such that there can be no doubt as to the extent and thorough preparation of the operative field.

It should not be objectionable on account of its stain because the solution completely dries on skin in less than two minutes. Any stains accidentally obtained are readily removed by Dakin's solution.

CONCLUSION

We offer this new solution believing that it simplifies pre-operative preparation, assures as good, if not better, sterilization of skin than any of the other drugs in common use today and that it produces neither pain at the time of its application nor dermatitis following.
REFERENCES

(5) TRAUT, HERBERT: Personal communication.