Mercurials as Disinfectants

Evaluation of mercurial antimicrobic action and comparative toxicity for skin tissue cells.

By Frank B. Engley, Jr.*
School of Medicine
University of Missouri

THE PROBLEMS involving the use of chemicals as antibacterial agents have been of particular interest to me as a bacteriologist (or should we say microbiologist since because of these chemicals taking care of many of the bacteria we have had to reach out for more organisms to work with). My first experience with them in laboratory work was some 18 years ago running, if you will pardon the expression, "phenol coefficient tests." Since that time I have been associated with problems involving antiseptics, disinfectants, preservatives, antibiotics, gaseous sterilization—in other words antibacterial agents.

Some ten years or more ago with Morton and North we were asked to carry out a study on mercurials for the Council on Pharmacy and Chemistry of the American Medical Association which was published in its journal in 1948. (1) This report suggested that mercurials did not fulfill all the conditions expected of antiseptics. The report had its desired result in that it stimulated considerable thinking, discussions, research and perhaps some controversy in the field. Unlike the theatrical or political figure who once said that it didn't matter what was written about him so long as they wrote something and spelled his name correctly—we in the field of scientific investigation would rather be quoted correctly than not at all. In this regard the report might not be the most misquoted or maligned report from certain quarters (not quaternaries) but it is in there with the best or the worst depending upon your point of view or the source of your income. In any regard, stimulation of thinking, discussion, research and perhaps some controversy (as they say in the business world) is good for any field—and what is good for any field is good for the country or vice-versa.

At this point it would be best to stress that testing of chemical antibacterial activity and evaluation of these tests is not a simple thing. Each test has its advantages and disadvantages—factors such as time, temperature concentration of drug, number of organisms, types of organisms, plus the investigator's own minor variations on the technique which defy putting in print or were cut out by the editor of a journal as superfluous, all affecting the findings.

So it is true that each test has its good and bad points, drawbacks, its pros and cons, and each chemical has its own special characteristics to suit it for some special use. There are people who argue one side or the other as to the relative merits of a test-tube test vs. an animal test vs. a "use" test. And then too, we have some who argue all sides for the sake of argument, or their chemical or just to be-cloud the whole issue.

Efficacy of Mercurials

WITH this background then let's come to the subject of the moment: Mercurials. I would like to present some evidence which raises questions in my mind as to the efficacy of mercurials as antiseptics, preservatives or antibacterial agents. These are very real, serious questions and doubts which I want to pass on to you for serious consideration.

Mercurial compounds have been used as disinfectants, antiseptics and preservatives for many years. It was probably the work of Koch (2) in 1881, some 75 years ago, that first stimulated the use of mercuric chloride by many workers as an antibacterial agent. His work with anthrax spores suggested that high dilutions of $HgCl_2$ would kill the spores of the organisms considered to be the most resistant of pathogenic bacteria. His work was with dried organisms and indicated that alcohol was poor in comparison: Both findings have been clarified considerably since then, as you well know, with bichloride shown to be highly bacteriostatic not cidal and alcohol to be fairly effective against spores in the wet stage.

In considering a chemical as an antibacterial agent, I personally feel that in the final analysis each chemical or group of chemicals

---

* Based in part on studies with Dr. Tom Wynn, present address Cook County Hospital, Chicago, and Dr. C. M. Pomerat, The University of Texas-Medical Branch, Galveston. Paper presented May 21, 1956 at 42nd midyear meeting, Chemical Specialties Manufacturers Association, Chicago.

should be put to every possible test. Then impartial groups should decide on the basis of all the tests whether the chemicals in question really do what is claimed for and expected of them. I am not recommending here that anyone screening drugs should do a thesis problem on each and every chemical. However, those chemicals brought to the fore as potential commercial antibacterial agents should face a battery of tests to see how they show up under a variety of conditions. Don't use any one tailor-made test that one knows the chemical will pass or fail. Any chemical can be shown to be good or bad depending on the test employed.

So, back to mercurials. The early work by Koch established that bichloride of mercury could keep anthrax spores from growing out even in very high dilutions in the routine testing media.

Along these lines it would be best to look first at the "phenol coefficients" of various representative mercurials. Using *Staphylococcus aureus* as the test organism and taking the highest dilution of disinfectant killing microorganisms after 10 minutes but not after five minutes contact at 37°C. we find the following: With phenol active at a 1:85 dilution the following phenol coefficients were calculated. (McCulloch. (3)

Compound	Dilution Active	Phenol Coef.
Mercuric chloride	16,000	189
Mercurochrome	160	1.8
Merthiolate	120,000	1412
Metaphen	140,000	1647
Phenylmercuric nitrate (After Birkhaug, (4) 1933)	192,000	2259
Iodine	....	22.3
Hexylresorcinol	....	66.6

These figures lead us to bring out a very important point. This test as carried out with the usual nutrient medium reveals the chemicals' ability only to inhibit growth. By using dilution and/or preferably neutralizing substances in the recovering media one can differentiate between bacteriostasis and bactericidal activity in such a test-tube test. In the case of mercurials, fortunately or unfortunately, depending upon your point of view, both synthetic, purified and naturally occurring neutralizing substances are readily available. It is because of these neutralizing substances containing available, —SH (sulfhydryl) groups that so much controversy has developed. It would only be of perhaps academic interest that cystine, glutathione, ammonium sulfide, thioglycollate and a number of other compounds could neutralize or, if you prefer, reverse the action of mercurials on organisms after exposure, except for the fact that body fluids and tissues contain neutralizers—the skin, perspiration, urine, blood, serum, tissue exudates and all. Thus it is of practical importance. Some chemicals may have their antibacterial action reduced or neutralized only by some weird chemical such as "itchigummi acid" which does not occur naturally or in the field of use; therefore, while of academic and scientific interest in studying mode of action or kinetics of the drug activity, the fact that the drug antibacterial action may be neutralized or reversed is not of significance in its utilization. This is not the case with mercurials. The neutralizers are found everywhere. As early as 1889 (Geppert) (5) showed that such was the case.

Thus our pretty phenol coefficient values given above do not mean anything unless we add a neutralizer to the recovery medium such as thioglycollate or preferably serum. The phenol coefficients drop precipitously with the mercurials tested in this manner, revealing little antibacterial action. The same is true if serum is added to the test medium. Bichloride of mercury turns out with negligible activity as do the organic mercurials. Discussions with certain individuals suggested that this might not be too important but let me remind you that even though this is known many still use bichloride as a supposedly trusted antibacterial agent especially in hospitals for so-called "sterilizing" of thermometers. In a survey we carried out in the past two years in one large hospital in a medical center—the nursing service tested thermometer glasses on various wards and at various times isolating staphylococci, streptococci and others, as well as our friend Escherichicoli "from the other side of the tracks." The original preparation may have some activity but continuing standing and accummulation of sputum and "crud" rapidly reduces any activity. This data does not include the story about a glass of bichloride that one of the patients drank thinking it was the ice water although it might have left him a little cold.

In the course of our studies (6) we applied the paper disc assay technique to the study of mercurials using exacting and standard methods for accurate determinations. Table 1 lists some of the representative compounds tested giving proprietary name and chem-

Table 1. Mercurials Tested

Name	Manufacturer	Chemical name	Conc. of use (per cent)
Merbak	Schieffelin	2-acetoxymercuri-4-diisobutyl phenol	0.1
Mercarbolide	Upjohn	orthchydroxyphenylmercuric chloride	0.1
Mercresin	Upjohn	orthchydroxyphenylmercuric chloride + secondary-amyl tricresols	0.1
Mercuric chloride*	—	mercuric chloride	0.1
Mercuric iodide*	—	mercuric iodide	0.1
Mercurochrome	H W D †	disodium 2, 7-dibrom-4-hydroxymercurifluorescein	2.0
Mercurophen	Sharpe & Dohme	sodium oxymercury-o-nitrophenolate	0.1
Merodicein	H W D †	monohydroxymercuridiiodoresorcinsulfonphthalein	0.2
Merthiolate	Lilly	sodium ethyl mercuri thiosalicylate	0.1
Metaphen	Abbott	anhydride of 4-nitro-3-hydroxymercuriorthocresol	0.2
Phenyl mercuric borate*	—	Phenyl mercuric borate	0.1

* Non-proprietary.
† Hynson, Westcroft & Dunning.

Table 2. Comparison of Antibacterial Activity of Mercurial Antiseptics by Paper Disc Assay Method (20 ML. Plate)

Compound	Dilution of use (per cent)	Nutrient agar inhibition zone (in mm.)
Phenyl mercuric borate	0.1	33
Mercresin	0.1	32
Mercarbolide	0.1	32
Merthiolate	0.1	32
Mercurophen	0.1	29
Mercuric iodide	0.1	28
Metaphen	0.2	25
Mercurochrome	2.0	24
Merbak	0.1	23
Merodicein	0.2	18
Mercuric chloride	0.1	18

ical name. Hereafter they will be called by proprietary name so that all will recognize the substance — you realize the difficulties of referring to Merodicein, for example, each time as monohydroxymercuridiodo-resorcinsulfonphthalein.

Table 3. Comparison of Antibacterial Activity of Mercurials Using Neutralizers by Paper Disc Method

Compound	Dilution of use (%)	Nutrient agar inhibition zone (in mm.)	Nutrient agar + 0.2% thioglycollate	50% Serum agar
Phenyl mercuric borate	0.1	33	—	—
Mercresin	0.1	32	—	—
Mercarbolide	0.1	32	—	—
Merthiolate	0.1	32	—	—
Mercurophen	0.1	29	—	—
Mercuric iodide	0.1	28	—	—
Metaphen	0.2	25	—	—
Mercurochrome	2.0	24	—	—
Merbak	0.1	23	—	—
Merodicein	0.2	18	—	—
Mercuric chloride	0.1	18	—	—

— = no inhibition zone.

Table 2 shows the zones of inhibition. The diameters of these zones were compared as shown using the dilution of use against *Staphylococcus aureus*. It indicates the relative activity of the various mercurials by this test. Tincture preparations gave the same data. This particular chart has been copied and quoted elsewhere but means nothing as it stands alone — like the phenol coefficient test data without neutralizer. With serum added to the medium, the same mercurial giving the large zone shows negligible activity. The table which should have been borrowed from our publication to give a more realistic picture would have been the next, (Table 3) which shows in each case with thioglycollate or with serum added no inhibition zones are present — meaning in essence no antibacterial activity under this method of test.

Table 4. Results of In Vivo Testing of Antiseptics

Authors	Disinfectant		Organism	Animals Inoc.	Animals % Dead
Nungester, Kempf 1942	Tinc. iodine	2.0%	streptococcus	29	48
	Tinc. mercresin	0.1%		31	94
	Tinc. merthiolate	0.1%		27	96
	Tinc. phemerol	0.1%		31	90
	Tinc. iodine	2.0%	pneumococcus	15	0
	Tinc. mercresin	0.1%		48	23
	Tinc. merthiolate	0.1%		40	55
	Tinc. phemerol	0.1%		52	67
	Tinc. phemerol	0.2%		56	16
	Tinc. vehicle			47	68

From "An 'Infection-Prevention' Test for the Evaluation of Skin Disinfectants," W. J. Nungester and Alice H. Kempf, J. Infec. Dis., 71:174, 1942.

In Vivo Tests

THE methods described above, the phenol coefficient and the paper disc assay procedures, are strictly test-tube tests. They have been criticized since they are not *in vivo* tests. At this time then let us examine some data on *"in vivo"* tests. In the literature as far back as 1923 Rodwald (7), with a vegetative Salmonella test organisms, showed that bichloride of mercury prevented its growth in subcultures but did not prevent this organism from killing mice when injections were made. More recent studies with the mouse-tail techniques, Nungester and Kempf (8) in 1942 (Table 4) revealed the mercurials to be less effective than iodine against the fairly resistant streptococcus. Slightly better results were obtained against the pneumococcus. The pneumococcus data perhaps should receive less attention here since it is not primarily a skin pathogen.

In our studies (Table 5) shown here with studies by Pierce and Tilden we strove to develop a combination *in vitro—in vivo* test with a known human pathogen also infectious for mice. We used a technique similar to a phenol coefficient test, but in addition to inoculating appropriate media following exposure of organisms to the chemicals, mice were injected with the mixture of chemical in its dilution of use and the organisms. The findings on a typical experiment are shown here and in Table 6 the significance is pointed out. Here are shown the death in mice and the lack or growth in a nutrient dextrose broth. If the broth findings above were taken as the true indicator, the chemicals would appear as good antibacterial preparations. However, the broth with neutralizers thioglycollate and serum allow the organism to grow out. This is in direct correlation with the findings in the animal test where the mice die from streptococcus infection. These preparations

Table 5. Results of In Vivo Testing of Antiseptics

Authors	Disinfectant		Organism	Animals Inoc.	Animals % Dead
Pierce-Tilden 1945	Tinc. "D.C.-12"	0.1%	pneumococcus	120	42
	Tinc. metaphen	0.1%		54	85
	Tinc. merthiolate			34	97
	NaCl	0.85%		143	98
Morton, North, Engley 1948	Mercurochrome	2.0%	streptococcus	8	63
	Metaphen	0.2%		8	25
	Merthiolate	0.1%		6	66
	Phenol	1.0%		4	0

From "Evaluation of Antimicrobial Agents," by M. E. Pierce and E. B. Tilden, J. Dent. Res., 24:05, Oct. 1945. "The Bacteriostatic and Bactericidal Actions of Some Mercurial Compounds on Hemolytic Streptococci," E. Morton et al., J.A.M.A., 136:37, Jan. 8, 1948.

Table 6. Comparison of In Vivo and In Vitro Methods of Evaluating Mercurial Antiseptic Activity

Compound	Conc. of Use (%) Mice	Mice Dead Mice Injected*	Dextrose Broth	Dextrose Broth + 0.1% thioglycollate	Dextrose Broth + 10% serum
Phenyl mercuric borate..	0.1	8/10	—	+	+
Merbak	0.1	9/10	—	+	+
Merthiolate	0.1	10/10	—	+	+
Mercurophen	0.1	9/10	—	+	+
Mercuric Iodide	0.1	8/10	—	+	+
Mercarbolide	0.1	8/10	—	+	+
Merodicein	0.2	10/10	—	+	+
Metaphen	0.2	7/10	—	+	+
Mercurochrome	2.0	10/10	—	+	+
Mercuric chloride	0.1	10/10	—	+	+
Water		10/10	+	+	+

* Mice injected and tubes inoculated with 0.1 ml. of a 1:2 dilution of the Streptococcus-mercurial mixture after a ten minute exposure at 32.34°C.

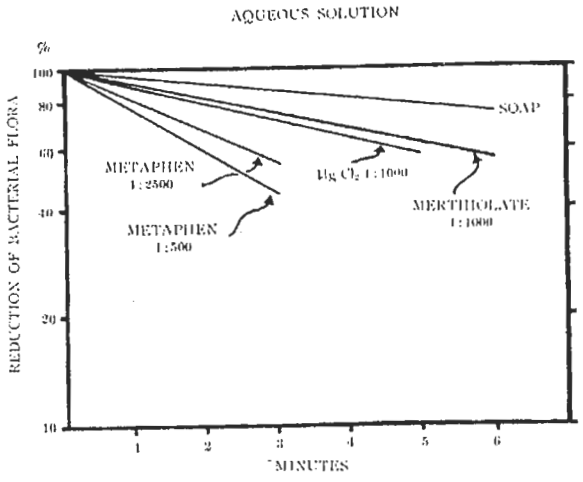
under this test do not do what an antiseptic should do—prevent infection.

The *in vivo* methods described above have been criticized not because they are not test tube tests but because they are not "use" tests. Some state that these *in vivo* and *in vitro* tests do not simulate actual usage. The major proponent of the use test Dr. Price (9) has suggested that while such tests are important procedures—the *in vitro* and *in vivo* tests are perhaps more accurate and quantitative then when using human subjects. His data using the hand washing—basin technique are of interest to us in this report. Graph 7 indicates the reduction of bacterial flora of the skin plotted against time with aqueous preparations and in Graph 8 a comparison of alcoholic preparations. The latter are more effective than water preparations but it should be noted that the solvent removes organisms faster alone then with the mercurials added. He further-more suggests that the mercurials combine with skin forming a layer over the organisms neither killing nor preventing them from growing.

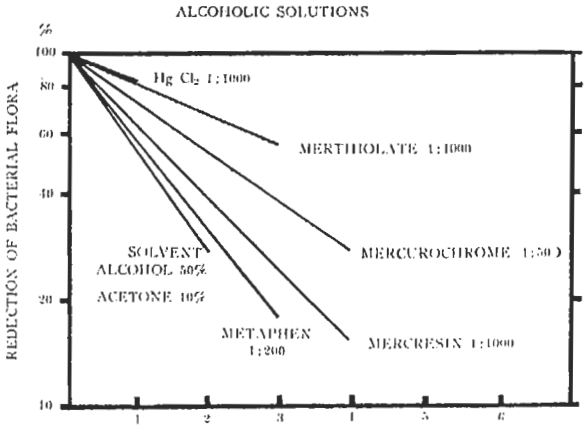
The use of mercurials as preservatives in vaccines and antisera is of considerable interest. These chemicals are added to protect against the introduction of organisms in multi-use containers in particular. We have always wondered about their efficacy in that both vaccines and antisera contain reactive groups to tie up these compounds. In a series of continuing experiments over the past several years we have begun to evaluate various preservatives in serum and vaccines under conditions of use. Employing stock vaccines and serum with and without preservatives and stored at varying lengths of time a contaminating dose of representative sporeformer (*Bacillus subtilis*) in the spore stage gram negative rod (*E. coli*) and gram positive coccus (*S. aureus*) were added. While the mercurial preservatives had good activity on initial addition, after storage of three, six or more months decreasingly

(*Turn to Page* 223)

Graph 7. A comparison of aqueous preparations tested by Price technique (from Price).



Graph 8. A comparison of alcoholic preparations by the Price technique (from Price).



Mercurials as Disinfectants

(*From Page* 205)

less to negligible residual activity appeared to be left, indicating that the chemical was tied up by the protein of the biological or otherwise inactivated. A check on a series of over one thousand bottles of various biologicals from clinics obtained after use revealed that up to five percent contained microorganisms. This would suggest that once these biologicals are in the hands of the users a problem still exists.

Regarding preservatives, one of the real problems existing in hospitals and clinics is the need for good preservatives in the routine eye dilators and nasal preparations of the decongestant type. Routine checks of these indicate a high percentage of contaminated solutions. In one instance we had direct evidence of upper respiratory cross-infection from the use of a common nasal dropper preparation in a clinic.

The toxicity of chemicals used as drugs on or in the body has been of considerable interest since man first began exposing himself to various chemicals many years ago. Unfortunately there have not been good techniques for toxicity determinations of certain types of chemicals which might be really indicative of toxicity for humans.

In the past, various techniques have been employed for testing the toxicity of skin antiseptics with more or less success. These tests have included toxicity tests in and on animals such as mice, in embryonic eggs, on leukocytes and in embryonic chick tissue culture using heart or spleen(6). Each of these tests have had advantages and disadvantages. The obvious one enjoyed by all is that they are not a true test of toxicity of the chemical for human skin tissue cells. Recently the opportunity offered itself for perhaps a more significant test procedure.

A few years ago in the tissue culture laboratory of the University of Texas Medical Branch, Dr. C. M. Pomerat and co-workers found that skin from grafting procedures produced epithelial sheets *in vitro* (in tissue culture). This offered a possible method for evaluating the toxicity of a number of chemicals such as local anaesthetics, antihistamines and antiseptics on the one test material of importance – skin itself. Some of these studies have been reported from these laboratories. In this report we wish to stress studies on mercurial compounds in particular and to compare their toxicity with representative antibiotics, phenolic derivatives, quaternary ammonium compounds and furans.

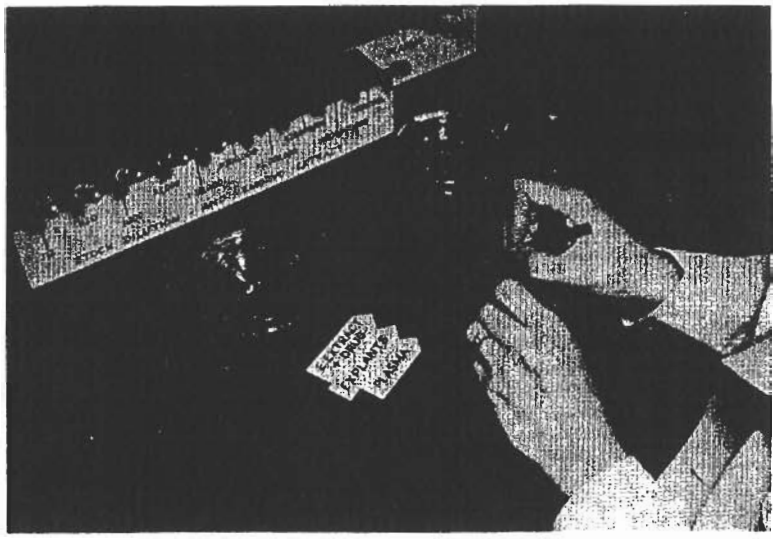
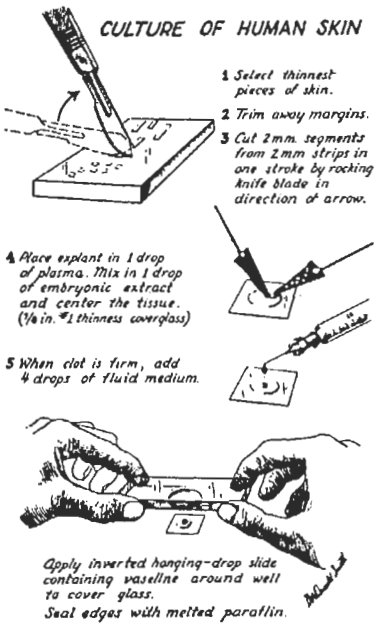


Figure 9. Preparation of serial dilutions in embryonic extract.

Figure 10. Steps in preparation of human skin cultures.



The technique used here consisted of the following: Serial dilutions of the chemicals under test were prepared in embryonic extract as shown in Figure 9. Thin slices of human skin were removed with sterile instruments and the tissue cut into fragments approximately 2mm square (Figure 10). Each explant was placed on a cover slip in plasma, and embryonic extract containing the drug dilutions was added. The tissue was centered on the cover slip and after a clot forms, the preparation was sealed onto a depression slide and incubated at 37°C for eight to ten days. Cultures were examined microscopically for growth at daily intervals and compared in growth with control skin tissue without chemicals added. Figure 11 shows a highly magnified view of some of the outgrowth from the skin. As will be noted it is pure epithelial cell growth not the fibroblasts such as the chick heart growth produces. Migration of epithelial cells usually began after 48-72 hours of incubation. Outgrowth from the edge of the explant was graded by quantitating the amount of the low power field it covered (at the 8th

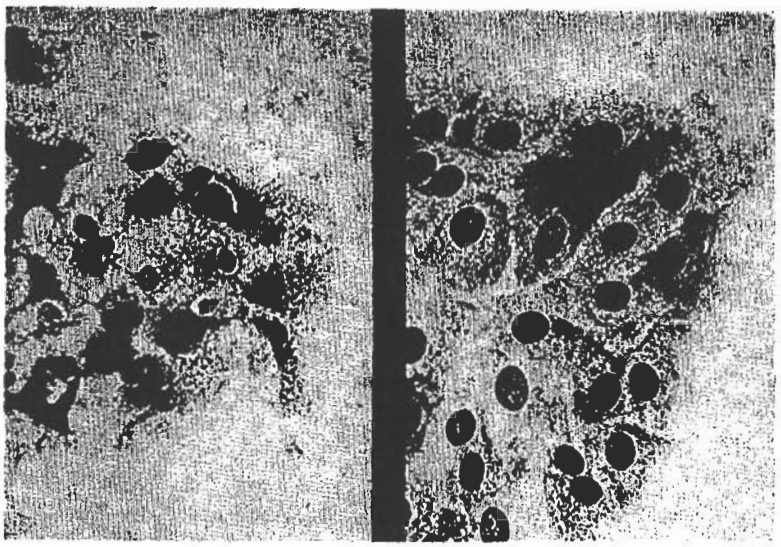


Figure 11. A highly magnified view of skin tissue culture showing epithelial cells.

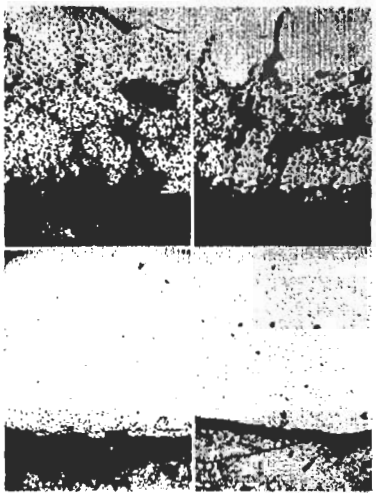


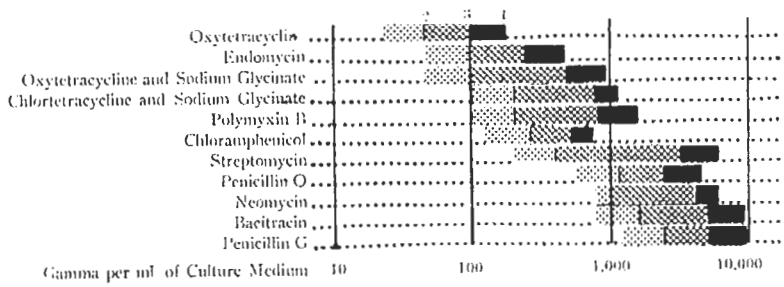
Figure 12. Magnified views of skin tissue culture showing 4+, 3+, 1+ and negative growth from top left to lower right.

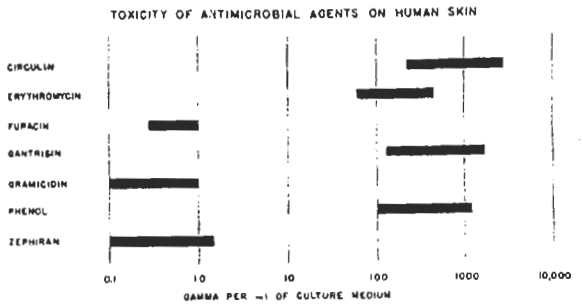
day). Figure 12 indicates the negative 1+, 3+ and 4+ outgrowth. From this data two values were determined, one the MID or minimal inhibiting dose—the smallest amount of chemical required to produce total inhibition of outgrowth and the second the LID the least injurious dose (the quantity of drug giving the slightest amount of injury as compared with the untreated control cultures). Thus we can set up a range of toxicity for any given drug. All drug concentrations given here are in gammas per ml of culture media.

In Fig. 13 are shown some of the early studies carried out by Dr. Pomerat's laboratory [in conjunction with the dermatology department under Clarence Livingood(10)], with antibiotics and shown here for comparison purposes. For reference if you wish (10,000 gammas = one percent). It is of interest to note the low level of toxicity that we might expect for penicillin. Bacitracin, one of those considered dangerous parenterally, is not toxic for the skin and it is used frequently as a local antibiotic without apparent difficulty. The same is true of neomycin. The cycline antibiotics here show an increased or high toxicity for the skin tissue cells. In Graph 14 note that our concentration showing toxicity is dropping. Another list of materials is shown here showing varying toxicity. As we progress from right to left increasing toxicity is demonstrated. Of particular interest here is phenol to use as a guide. It is usually used as a five percent preparation which is fairly toxic for skin. Here we show that 1000 gammas per ml. (0.1 percent) is toxic for the cells. We might point out here some recent data which is not shown in the graph. That is the data on iodine. We have found the MID to be between 833-416 micrograms per ml and the LID between 13 and 7.5 micrograms per ml. It should be noted that furacin shows up to be quite toxic—as has been shown by experience. A representative quaternary ammonium compound (Zephiran) appears highly toxic. Graph 15 compares mercurial compounds and shows how they fit in with other compounds in toxicity. It should be noted that furacin, gramicidin and Zephiran are in the same general range. Mercurochrome appears to be the least toxic ranging down through merthiolate. It should be kept in mind that its concentration of use is two percent while the others are usually 1:1000. One point should be made here. Bichloride of mercury has always been pointed out as an extremely toxic mercurial and the organic mercurials were supposed to be much less toxic but according to these data we find bichloride right in the middle of the organic mercurials in regard to cell toxicity.

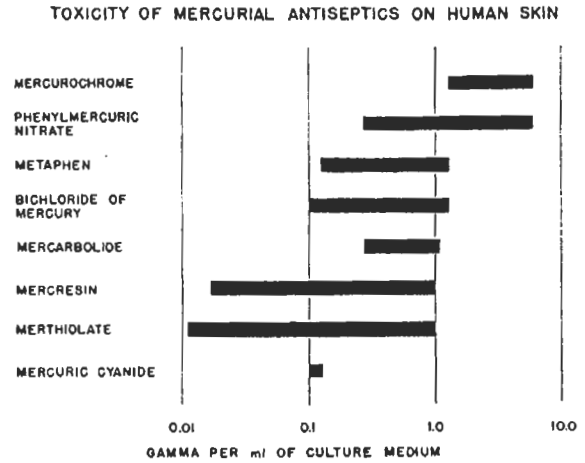
In the course of these studies the question arose as to how this test on skin compared with the use of other tissues. Was skin as sensitive or less sensitive in a test. Graph 16 compares bichloride of mercury on several other tissues with skin. Here it is shown that skin is more sensitive than cord, heart or spleen tissue cells.

Figure 13. Toxicity of antibiotics on human skin.





Graph 14. Toxicity of antimicrobials on human skin.



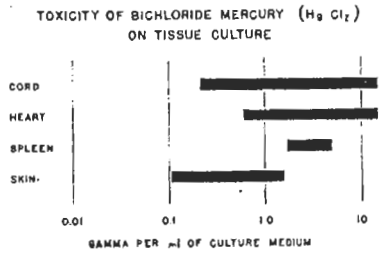
Graph 15. Toxicity of mercurial antiseptics on human skin.

In summary on the toxicity studies we can say that: a. human skin tissue culture may be used to compare and evaluate the toxicity of antiseptics and disinfectants in the test tube. b. mercurial antiseptics proved to be more toxic than the antibiotics in common usage but in the same range of toxicity as representative furan derivatives and quaternary ammonium (detergent) antiseptics. c. bichloride of mercury appears no more toxic by this test than organic mercurials. d. the procedure offers a better index of toxicity than testing on animals, animal tissues, chick embryos, white blood cells or other procedures now available.

References

1. Morton, H. E., L. L. North, and F. B. Engley, Jr., 1948. The bacteriostatic and bactericidal actions of some mercurial compounds on hemolytic streptococci. *In vivo* and *in vitro* studies. *J. A.M.A.* 136:36.
2. Koch, R., 1881. *Ueber Desinfection Mitt a. d. K. Gsndhtsamte,* 1:234.
3. MuCulloch, E. C., 1936. Disinfection and Sterilization. Lea and Febiger, Philadelphia.
4. Birkhaug, K. E., 1933. Phenyl mercuric nitrate. *J. Infect. Dis.* 53:250.
5. Geppert, J., 1889. Zur Lehre von den Antiseptics: Eine experimentalunter-suchung. *Berl. klin. Wchnschr.* 26:789.
6. Engley, F. B. Jr., 1950. Evaluation of Mercurial Compounds as Antiseptics. *Annals of the New York Academy of Science.* 53:197.

Graph 16. Toxicity of bichloride mercury (H_gCl_2) on tissue culture.



7. Rodewald, K., 1923. Ueber die Widerstandsfahikkeit von Geflügelcholera und Streptokokken gegenüber Sublimat, Carbolsaure and Trypaflavin, *Ztschr. f. Hyg.,* 99:117.
8. Nungester, W. J. and A. H. Kempf, 1942. An "infection-prevention" test for the evaluation of skin disinfectants. *J. Infect. Dis.* 71:174.
9. Price, P. B., 1951. The Meaning of Bacteriostasis, Bactericidal Effect and Rate of Disinfection. *Annals of The New York Academy of Science.* 53:76.
10. Pomerat, C. M., E. T. Everett, F. N. Hu and C. S. Livingood, 1951. Tissue Culture Studies on Human Skin I. A Method of Evaluating the Toxicity of Certain Drugs Employed Locally on the Skin. Texas Reports on Biology and Medicine. 9:282.

Wax from South Africa

(*From Page* 183)

structure conventional paraffin waxes made from petroleum. Other points of resemblance are white color, brittleness, and low viscosity when melted.

The product differs from conventional paraffin waxes in high temperature characteristics and in crystal size. Crystals are much finer and more like those of petroleum-derived microcrystalline waxes than of paraffin. Melting point is 215°F, compared with 150°F for the upper limit of paraffin waxes. Hardness at elevated temperatures is one of the characteristics exhibited by "Paraflint." Moore & Munger's modified Abraham consistometer, measures the product's hardness at 75 at room temperature, against 92 for carnauba, 72 for tank bottom wax, and 43 for refined paraffin (m.p. 150). At 130°F, "Paraflint" exhibits hardness of 49, compared with 62 for carnauba, 40 for tank bottom wax, and 28 for paraffin.

"Paraflint's" good hardness characteristics and the ability to take a high shine and buff makes it suitable for incorporation in polish formulations. In addition it is said to lend itself to oxidation in the production of emulsifiable waxes.

Typical physical data on "Paraflint" are as follows:

Melting Point	215°
Needle Penetration on 77°F.	1.0
Oil Content	less than 1.0%
Average Molecular	750 (approximate)
Acid, Saponification, Bromine Numbers	Nil
Ash Content	less than .01%
Color	White
Viscosity at 250°F.	9.5 centipoises
Specific Gravity at 77°F.	0.93/.95

Essentially odorless

—★—

Carbide Assigns Four

Four technical representatives have been assigned to sales offices of Carbide and Carbon Chemical Co., New York, after completing a six-week training course at the Mellon Institute of Industrial Research, Pittsburgh, it was announced recently. The assignments follow: N. R. Carbone, Los Angeles district office; J. R. Conaway, general sales office, New York; J. A. Francis, St. Louis district office; and A. F. Murray, Pittsburgh district office.