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A Comparison of Resistance of Bacteria and Embryonic Tissue to Germicidal Substances. VII. Potassium Mercuric Iodide.

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Mercuric iodide is relatively insoluble in water but is easily soluble in an aqùeous solution of potassium iodide. The complex salt potassium mercuric iodide, having the formula K_2HgI_4, is formed by the interaction of one molecule of mercuric iodide (HgI_2) with 2 molecules of potassium iodide (KI). The preparation contains about 25.5% of mercury.

Aqueous solutions of the salt have been extensively employed as disinfectants because they do not possess the corrosive action on instruments and tissues that characterizes aqueous solutions of mercuric chloride. Another advantage is that they do not precipitate albumin.

Potassium mercuric iodide is about one-half as toxic as mercuric chloride when administered to animals. In proportion to the mercury content, however, the 2 salts possess about the same toxicity.

In previous papers of this series[1-6] comparisons were made of the resistance of *Staphylococcus aureus* and embryonic chick heart tissue to phenol, Merthiolate, Metaphen, Mercurochrome, Hexylresorcinol, iodine, and iodine trichloride. Toxicity indices were determined by dividing the highest dilution of the germicide that killed the tissue by the highest dilution of the chemical showing no growth of the test organism. Theoretically the smaller the toxicity index the more nearly perfect the chemotherapeutic agent.

The methods employed were the same as those given in the first paper of this series. Wide jumps in the dilutions were first prepared to determine approximately the least concentration of the germicide required to destroy the bacteria in 10 minutes but not in 5 minutes. Usually one such preliminary series was sufficient. Occasionally a second series covering higher dilutions was necessary. Having determined the approximate amount of the germicide required, a series

[1-5] Salle, A. J., and Lazarus, A. S., PROC. SOC. EXP. BIOL. AND MED., 1935, **32**, 665, 937, 1057, 1119, 1481.

[6] Salle, A. J., and Lazarus, A. S., PROC. SOC. EXP. BIOL. AND MED., 1935, **33**, 8.

of dilutions covering a narrow range were then prepared to determine more accurately the least concentration necessary to kill the bacteria in the specified period of time. In every case the results were checked a second time. If the second series failed to check the first the tests were repeated until checks were obtained. The same procedure was followed to determine the least concentration of the germicide required to kill the living embryonic tissue, except that a period of 48 hours was used instead of 10 minutes.

A *Staphylococcus aureus* phenol coefficient was first determined for potassium mercuric iodide by the method of Reddish.[7] Phenol killed *Staphylococcus aureus* in a dilution of 1-65 in 10 minutes but not in 5 minutes. The highest dilution of potassium mercuric iodide required to kill the test organism under the same conditions was found to be 1-900. Therefore, the *Staphylococcus aureus* phenol coefficient was 13.8.

Lambert[8, 9] found that *Staphylococcus aureus* was killed by a 1-5,000 dilution of the germicide after one hour. Watson[10] stated that a 1-1,000 dilution killed *Staphylococcus aureus* in one hour; a 1-500 dilution killed *B. coli* in 10 minutes; and a 1-1,000 dilution required 24 hours to kill *B. subtilis*. The same author found that a 1-1,000 alcoholic solution of potassium mercuric iodide had more than 10 times the germicidal efficiency of a 1-100 solution of iodine in alcohol. Macfarlan[11, 12] also reported favorable results with potassium mercuric iodide when tested against several organisms. He concluded that potassium mercuric iodide is a powerful germicide exhibiting marked germicidal efficiency in high dilutions. Also, its potency is reduced to a relatively slight degree by the presence of organic matter. On the other hand, Candy and Bulloch,[13] in their work on the sterilization of catgut found that mercuric iodide, whether dissolved in a solution of potassium iodide or in methyl or ethyl alcohol, cannot be regarded as a germicide of any marked power.

Cultures were prepared from chick heart tissue obtained from

[7] Reddish, G. F., The Newer Knowledge of Bacteriology and Immunology, E. O. Jordan and I. S. Falk, University of Chicago Press, 1928.

[8] Lambert, R. A., *J. Exp. Med.*, 1916, **24**, 682.

[9] Lambert, R. A., *J. Am. Med. Assn.*, 1916, **67**, 1300.

[10] Watson, C. H., *Surg. Gynec. and Obstet.*, 1916, **22**, 114.

[11] Macfarlan, D., *J. Am. Med. Assn.*, 1914, **62**, 17.

[12] Macfarlan, D., *Am. J. Med. Sci.*, 1920, **159**, 586.

[13] Candy, H., and Bulloch, W., *Brit. J. Exp. Path.*, 1928, **9**, 179.

9-day-old embryos. The fragments of tissue were embedded in guinea pig plasma in Carrel flasks. The various dilutions of phenol and potassium mercuric iodide were made in dilute chick embryonic fluid. The plasma, after coagulation, was washed with Tyrode solution to remove the uncoagulable constituents, after which were added the various dilutions of germicide in embryonic fluid. Final observations were made at the end of 48 hours.

The results are summarized in Table I.

TABLE I.
Toxicity of Phenol and Potassium Mercuric Iodide to Chick Heart Tissue and Bacteria.

Germicide	Highest dilution showing no tissue growth = A	Highest dilution showing no growth of *Staph. aureus* = B	Toxicity Index = A/B	*Staph. aureus* phenol coefficient
Phenol	1-840	1-65	12.9	
Potassium mercuric iodide	1-12,000	1-900	13.3	13.8

Lambert[8, 9] found that human adult tissues were killed by one-half the concentration of germicide required to destroy *Staphylococcus aureus*.

It is concluded from the above results that potassium mercuric iodide is relatively very toxic and that it rated considerably lower than most of the germicides so far studied when tested by the tissue culture technique. Also, the figure for the phenol coefficient was next to the lowest. The germicides studied may now be placed in the following order on the basis of their toxicity indices: iodine .09; iodine trichloride 0.40; Hexylresorcinol 3.0; Metaphen 12.7; phenol 12.9; potassium mercuric iodide 13.3; Merthiolate 35.3; Mercurochrome 262.0.