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Comparison of Resistance of Bacteria and Embryonic Tissue to Germicidal Substances. V. Iodine.

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Lambert^{1, 2} immersed fragments of human tissues in a dilute broth culture of *Staphylococcus aureus* for a few minutes and then in various dilutions of iodine for one hour. The tissue fragments were washed in physiological salt solution, then embedded in plasma and examined for growth of bacteria and tissue after several days of incubation. He found that human connective tissue cells and histiocytes were, in general, more easily killed than *Staphylococcus aureus*. Of the compounds tested iodine approached most closely the "ideal" disinfectant, killing bacteria in strengths that did not seriously injure human connective tissue cells or wandering cells.

Lambert and Meyer³ placed fragments of rabbit spleen in a suspension of *Staphylococcus aureus* for one minute followed by immersion in graded solutions of iodine for 20 minutes. Tissue cultures were then prepared in hanging drops of homologous plasma, following 2 washings of the tissue in physiological salt solution. A second set of hanging drop cultures was made from non-infected tissues similarly exposed with appropriate controls of untreated tissues. They found that some of the classic germicides such as iodine and mercuric chloride approached nearer the "ideal" than certain of the newer preparations.

Buchsbaum and Bloom⁴ prepared chick tissue cultures in which the various dilutions of iodine were embedded in chick plasma. The test organism, *Staphylococcus aureus*, was added to the embryonic fluid. They stated that an antiseptic killing the bacteria at concentrations that would not harm the cells would have an index of 1.0 or greater. Iodine was given an index of 0.5.

In previous papers of this series,⁵⁻⁸ comparisons were made of the

¹ Lambert, R. A., *J. Exp. Med.*, 1916, **24**, 683.

² Lambert, R. A., *J. A. M. A.*, 1916, **67**, 1300.

³ Lambert, R. A., and Meyer, J. R., *PROC. SOC. EXP. BIOL. AND MED.*, 1926, **23**, 429.

⁴ Buchsbaum, R., and Bloom, W., *PROC. SOC. EXP. BIOL. AND MED.*, 1931, **28**, 1060.

⁵ Salle, A. J., and Lazarus, A. S., *PROC. SOC. EXP. BIOL. AND MED.*, 1935, **32**, 665.

resistance of *Staphylococcus aureus* and embryonic chick heart tissue to phenol, Merthiolate, Metaphen, Mercurochrome and Hexylresorcinol. A *Staphylococcus aureus* phenol coefficient and a toxicity index were determined for each germicide. The methods followed were the same as those described in the first communication.⁵

The highest dilution of phenol required to kill *Staphylococcus aureus* in 10 minutes but not in 5 minutes was 1:65. For iodine* it was 1:20,000. This gave iodine a *Staphylococcus aureus* phenol coefficient of 308.

Birkhaug,⁹ employing Tincture of Iodine U. S. P., reported a *Staphylococcus aureus* phenol coefficient of 38 by the same method.

The tissue culture results are summarized in Table I.

TABLE I.

Germicide	Highest dilution showing no tissue growth = A	Highest dilution showing no growth of <i>Staph. aureus</i> = B	Toxicity index = A/B	<i>Staphylococcus aureus</i> phenol coefficient
Phenol	1:840	1:65	12.9	
Iodine	1:1,800	1:20,000	0.09	308

The results of tests obtained from all of the germicides so far completed are given in Table II.

TABLE II.

Germicide	Toxicity index	<i>Staphylococcus aureus</i> phenol coefficient
Iodine	0.09	308
Hexylresorcinol	3.0	108
Metaphen	12.7	92
Phenol	12.9	—
Merthiolate	35.3	70
Mercurochrome	262.0	0.6

Theoretically the smaller the toxicity index the more nearly perfect the chemotherapeutic agent. It is seen from the above results that iodine is far superior to all of the chemicals so far studied when tested by the tissue culture technique. It gave not only a smaller toxicity index but a greater *Staphylococcus aureus* phenol coefficient.

⁶ Salle, A. J., and Lazarus, A. S., PROC. SOC. EXP. BIOL. AND MED., 1935, **32**, 937.

⁷ Salle, A. J., and Lazarus, A. S., PROC. SOC. EXP. BIOL. AND MED., 1935, **32**, 1057.

⁸ Salle, A. J., and Lazarus, A. S., PROC. SOC. EXP. BIOL. AND MED., 1935, **32**, 1119.

* Lugol's Solution (Liquor Iodi Compositus, U. S. P.) was used in all tests.

⁹ Birkhaug, K. E., J. A. M. A., 1930, **95**, 917.

Lambert¹ stated: "An ideal antiseptic is obviously one that will kill the infecting agent without at the same time injuring body cells."

"Iodine stands out as the one chemical tested to which cells were found to be more resistant than were Staphylococci. A good growth of cells was seen after exposure to a 1:2,000 solution of iodine for one hour, a strength sufficient to sterilize the tissue completely in most instances."

"These experiments afford further experimental evidence of the value of iodine as an antiseptic, and indicate that, at least in weak aqueous solution it should not, as is often stated, injure or irritate the tissues."

Our results are in harmony with those obtained by the above worker.