

valuable piece of work on the action of chinisol alone, and in combination with salt, on blood corpuscles.

The merits of chinisol in combination with salt as a tissue disinfectant can be summarized as follows: Its stability, its ease of application, its applicability to first-aid treatment of wounds, its tendency to dry up pus, its non-irritability when applied in accordance with the technic here advocated, unless possibly after prolonged use; also the facts that it appears not to attack tendons and that it facilitates the separation of sloughs.

The full scientific treatise on this subject will be published shortly in the *Annals of Surgery*.

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The detection of small amounts of chloral in the presence of chloroform and formalin embalming fluid.

By **ALEXANDER O. GETTLER.**

[From the Chemical Laboratory of the Pathological Department of Bellevue Hospital and that of the Chief Medical Examiner of The City of New York.]

During the past five years the organs of many cases in which death was due to toxic substances, were submitted to complete chemical examination in this laboratory. Practically all of these were examples of sudden death occurring in the five boroughs of Greater New York for which the chief medical examiner or the medical assistant to the district attorney or both could find no anatomical cause. There were also a number of cases which were brought to my attention from other states. In this number, most of the commoner poisons, including chloroform, were represented. I have yet to encounter a case of straightforward chloral poisoning. Nevertheless, I became greatly interested in the question as to whether some of the so-called chloroform poisonings might not have actually been examples of chloral poisoning, and therefore, I made a study of various reactions to determine this point.

The several tests, namely, the isonitrile, the resorcin, the orcin

the alpha and beta naphthol, the Ragsky, the cyanide, the formic acid and the Vitalli Tornani, were studied, first, with relation to sensitiveness, second, as to the possibility of differentiating chloral from chloroform and, third, as to the interference of formalin with these reactions. The isonitrile and resorcin tests were found to be the most sensitive. By the former, chloral can be detected down to a dilution of .05 mgs. to the c.c. The resorcin test indicates chloral only to .25 mg. in one c.c., if the test is judged by the color alone; at this point the test is discarded if no red color appears. Chloral in amounts under .25 mg. per c.c. may still be present and detected by the appearance of a slight greenish fluorescence on diluting the reaction product with 10 c.c. of water. This fluorescence-giving property is sensitive to .05 mg. to the c.c. Both substances, namely, chloral and chloroform, respond equally well to the isonitrile test, the alpha and Beta naphthol, the Ragsky, the cyanide, the formic acid, the resorcin and the orcin tests. The reactions which are used for differentiating are as follows:

(a) The Vitalli Tornani test.¹ Its limitations are that it is sensitive only to the extent of 2 mg. in 100 c.c., that too much material must be used, and that it requires the use of a fairly large quantity of apparatus and, moreover, that all volatile halide compounds respond in a similar fashion.

(b) The Nessler test. This is given by chloral but not by chloroform and it is sensitive only to the extent of .25 mg. to the c.c. Furthermore, formalin gives a similar reaction and hence the test is useless when applied to embalmed material.

(c) The odor of chloroform in the distillate is possible, of course, only with large quantities of chloroform.

Formalin, which very often is present in the embalming fluid, interferes with the color reactions in that it likewise gives the same color, namely, a red or brownish-red.

The lethal dose of chloral is large, namely, 20 grams, but when one considers the instability of chloral, the rapidity with which the body detoxicates and excretes it, the time interval between the taking and the death of the individual (which is usually over 24 hours), the distribution in the various tissues and, finally, that

¹ Vitalli Tornani, *Chim. Tossic.*, 1893, p. 179. Vitalli e Tornani, *L'Orosi*, 1885, 7, 377.

steam distillation as ordinarily conducted in a general analysis recovers but a small fraction of the total amount present, it is obvious that only a few milligrams are to be expected. In several experiments I was able to recover, by steam distillation for a period of two hours, only 6 to 8 mg. from 100 mg. actually added.

In view of these facts, it is evident that the Vitalli Tornani test is to be used only when one is in a position to sacrifice practically all the material for this test alone. In a general unknown, however, this cannot, of course, be done, as a large part of the distillate is needed for testing the presence of various other volatile poisons.

The problem, then, resolves in finding a reagent which, first, is extremely sensitive to chloral, second, one for which only a small fraction of the suspected material need be used and, third, one which will react with chloral in a manner different from the reaction with chloroform and, fourth, if possible, one in which formalin will not interfere with the result.

A study of the following substances was made under different conditions of alkalinity (sodium hydroxide, sodium carbonate, calcium hydroxide).

Resorcin
Alpha naphthol
Beta naphthol
Orcin
Phloroglucin
Hydrochinon
Pyrocatechin
Phenol
Cresols
Thymol
Pyridine
Picric acid
Amino acids and boiling
Fatty oils and dehydrating agents
Yellow ammonium sulphide
Calcium sulph-hydrate
Sodium thiosulphate

The result reveals only two reactions which would serve the pur-

pose of differentiating chloral from chloroform and only one reaction in which formalin will not interfere.

The first reaction: phloroglucin and sodium carbonate with chloral, standing at room temperature for about one half hour gradually develops lilac to orange, to blood orange, to deep red. If extremely small quantities of chloral are present, the color develops to orange only, and if as low as .01 mg. in one c.c. is present, the color is a cross between orange and the light violet of the reagents themselves. Even in this extremely dilute solution a positive reaction may easily be recognized if compared with the control. Chloroform does not give this reaction. The color obtained with chloroform on the other hand is the slight violet of the reagents themselves. Formaldehyde and acetaldehyde interfere in that they give a reddish color. If the absence of aldehyde is shown by the reduced fuchsin test (which is not given by chloral), then the phloroglucin test may be looked upon as a sensitive method for purposes of differentiation. The technique is as follows:

To one c.c. of distillate add four drops of saturated phloroglucin and one c.c. of 20 per cent. sodium carbonate and allow to stand. Gradually the color develops, lilac to orange, to blood-orange, to deep red (sensitiveness, 0.01 mg. in one c.c.).

The reagents for the second method of differentiation are resorcin and sodium carbonate. Resorcin with sodium hydroxide and boiling have been used for a long time. Some workers, notably Schwartz,¹ the originator of the test, claim that besides the red color there is a green fluorescence given by both; others, notably Witthaus,² claim that only chloral gives the fluorescence. With the use of resorcin and sodium carbonate and at room temperature for one half hour I find, first, that with chloroform a green fluorescence never appears and that with chloral, even in minute amounts, fluorescence always occurs; second, that although the red color does not appear in very dilute solutions of chloral, the green fluorescence, especially if the reaction product is diluted with 10 c.c. of water, is always present; third, its sensitiveness is .01 mg. in one c.c.; fourth, formadehyde, acetaldehyde, formic acid, ben-

¹ *Ztschr. f. Anal. Chem.*, 1888, 27, 668.

² "Text-book of Medical Jurisprudence and Toxicology," Vol. 4, p. 1171.

zaldehyde, that is substances of an aldehyde character, do not give the reaction; fifth, if formadehyde is present together with the chloral, the reaction is not interfered with provided the test is done at room temperature. The technique follows:

To one c.c. of distillate are added 6 drops of saturated resorcin and one c.c. of saturated sodium carbonate solution or less if only traces of chloral are present. Let stand for one half hour, then dilute by adding 10 c.c. of water. A beautiful green fluorescence results. In cases of extremely small quantities of chloral, viewing by direct sunlight against a black, glossy background is of great advantage. Any development of color or fluorescence after many hours is of no consequence.

A series of 66 distillates from cases of suspected poisoning were examined by the above two described methods, with the following result:

No. of Case and Organ Used.	Modified Resorcin Test.	Phloroglucin Test.
19—Lungs.....	Negative.....	Negative
20—Brain.....	“	“
21—Brain.....	“	“
23—Liver.....	“	“
23—Stomach.....	“	“
24—Liver.....	“	“
25—Blood.....	“	“
26—Uterus.....	“	“
27—Brain.....	“	“
28—Liver.....	“	“
28—Stomach.....	“	“
29—Brain.....	“	“
30—Liver.....	“	“
31—Brain.....	“	“
31—Stomach.....	“	“
32—Brain.....	“	“
32—Liver.....	“	“
33—Brain.....	“	“
34—Brain.....	“	“
35—Brain.....	“	“
36—Liver.....	“	“
37—Stomach.....	“	“
37—Brain.....	“	“
38—Stomach.....	“	“*
40—Brain.....	“	“*
42—Brain.....	“	“
42—Stomach.....	“	“
44—Stomach.....	“	“*
44—Liver.....	“	“

45—Stomach.....	Negative.....	Negative
45—Brain.....	“	“
47—Liver.....	“	“
51—Brain.....	“	“
59—Stomach.....	“	“
63—Brain.....	“	“
64—Brain.....	“	“
65—Brain.....	“	“
65—Stomach.....	“	“
73—Stomach.....	“	“
74—Liver.....	“	“
75—Stomach.....	“	“
80—Lungs.....	“	“
94—Stomach.....	“	“
98—Stomach.....	“	“
98—Intestines.....	“	“
100—Brain.....	“	“
101—Lungs.....	“	“
102—Brain.....	“	“
109—Stomach.....	“	“
110—Liver.....	“	“
113—Brain.....	“	“
114—Liver.....	Slight red brown	Red brown*
115—Liver.....	Negative.....	Negative
116—Liver.....	“	“
118—Brain.....	“	“
119—Brain.....	“	“
121—Liver.....	“	“
123—Brain.....	“	“
127—Brain.....	“	“
130—Liver.....	“	“
131—Liver.....	“	“
132—Brain.....	“	“
134—Liver.....	“	“
S/11—Liver.....	“	“
S/12—Brain.....	“	“ *
S/13—Stomach.....	“	“

Among the above collection most of the more common volatile poisons were represented. No. 80 and No. S/14 contained chloroform, Nos. 38, 40, 44, 114, S/11 and S/12 contained formaldehyde. None of them contained chloral.

The phloroglucin test is applied only if the reduced fuchsin test is negative. Six of the above set gave a reduced fuchsin test, due to the formalin of the embalming fluid. The remaining 60 distillates gave a negative phloroglucin test. All the 66 distil-

* Distillates from embalmed material.

lates gave negative resorcin tests. This shows that chloroform and volatile substances of the various organs will not respond to the tests.

Portions of brain, liver, kidney, lungs, stomach and intestine to which small amounts of chloral had been added (100 to 200 mg.) were distilled with steam. In each case both the modified resorcin test and the phloroglucin test responded strongly positive.

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Immunity results from toxin-antitoxin injections.

By **WILLIAM H. PARK.**

[From the Department of Health of the City of New York.]

It has already been reported that three injections of toxin-antitoxin given to children susceptible to diphtheria produced in about 90 per cent. sufficient antitoxin to give a negative Schick test and that the remaining 10 per cent. could be immunized by a second series of injections. Also that this immunity had lasted for $2\frac{1}{4}$ years.

It still remained to be determined whether this immunity would continue unabated, and also whether it is possible to immunize infants while immune from the antitoxin transmitted to them through their mothers. Tests have just been completed on several institutions in which $3\frac{1}{4}$ years have elapsed since the toxin-antitoxin injections. The immunity continues as well developed as in $2\frac{1}{4}$ years. It is hoped therefore, that the acquired immunity may persist possibly for life as in the case of natural immunity. Our ability to immunize the infants with passive immunity is being tested on a large scale, some 1800 infants having been injected. Only fifty of these have reached a period for testing. These show an immunity of 70 per cent. against an average immunity of those at the same age (8 months) not treated of 30 per cent. It seems therefore, that a very fair success can be achieved in young infants and that with greater knowledge it is possible to hope for a complete success. Small children and infants in contradistinction to adults show almost no local or general reaction to the injections.