per minute. Minute volume determinations were then done, giving a value of 2.41 liters per minute. After regular rhythm was restored with quinidine, his minute volume rose to 3.37 liters per minute, a gain of 40%.

Case 4. Admitted to the Minneapolis General Hospital with mitral stenosis and auricular fibrillation. This patient had already been digitalized and the ventricular rate had already been reduced to around 60-70 per minute. After a few days in the hospital, the minute volume was determined as 2.38 liters per minute. She was quinidinized and the regular rhythm restored. Her minute volume rose to 2.90 liters per minute—a rise of 22%.

7044 C

A Rapid Method for Quantitative Estimation of Arsenic in Arsphenamine.*

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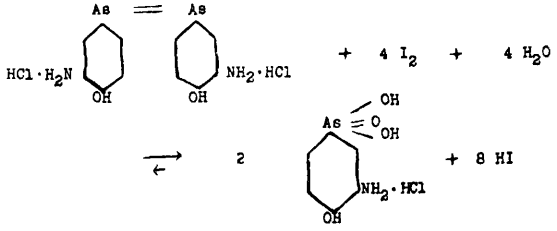
The direct titration of the arsenic in arsphenamine with a standard iodine solution was first used by Gaebel,[1] who also found that the reaction was a reversible one, namely



The titration of inorganic arsenious compounds with iodine is also a reversible reaction, but may be carried to completion, as shown by Washburn and Strachan,[2] by maintaining the pH of the reaction mixture between 9 and 4. Gaebel found, however, that this was not the case with the reaction between arsphenamine and iodine.

* A part of the funds used in this research were supplied from the Medical Research Fund granted by the Board of Regents of the University of Minnesota.

[1] Gaebel, G. O., *Arch. Pharm.*, 1911, **249**, 241.

[2] Washburn, E. W., and Strachan, E. K., *J. Am. Chem. Soc.*, 1913, **35**, 681.

Myers and Du Mez[3] from a comparative study of several methods of quantitative determination of the arsenic in arsphenamine, rejected Gaebel's titration method because of the low results obtained. Nevertheless, the direct titration of both arsphenamine and neoarsphenamine with iodine has been employed by a number of workers, most of whom have not taken into account the fact that the reaction does not go to completion. The method has been used quite extensively, for instance, for the simultaneous oxidation of arsenic and sulphur in the differential analysis of the composition of neoarsphenamine and sulpharsphenamine. The accuracy of the conclusions drawn from such simultaneous analyses, particularly in regard to the sulphur determinations, depends, of course, upon the absolute accuracy of the values assigned to the arsenic oxidation.

Macallum,[4] quoting 3 analyses of a single sample of arsphenamine, with a 3.5% titration error between samples, and assuming 31.3% arsenic content for the arsphenamine (anhydrous arsphenamine contains 34.2% arsenic; with 1 mol. of CH_3OH 31.85%; with 2 mols. of H_2O 31.57%) derived the relationship of 7.755 mols. (theoretical 8 mols.) of iodine for the titration of arsphenamine with iodine. Elvove,[5] in making differential analyses of the composition of samples of neoarsphenamine and sulpharsphenamine, employed the factor thus derived by Macallum.

It was felt, therefore, that the quantitative determination of sulphur fractions in neoarsphenamine and sulpharsphenamine by the simultaneous oxidation of arsenic and sulphur were of doubtful value, unless it could be shown that the reaction between the iodine and arsenic attained a constant point of equilibrium under the conditions of the titration, and the equilibrium point of the reaction was accurately determined. Under such circumstances the direct titration of arsphenamine with iodine would also constitute a far more rapid method for the determination of the arsenic content of samples of arsphenamine than any of those in present use.

A comparative study of the results obtained by the direct titration method with those obtained by the gravimetric method was, therefore, undertaken. The results obtained confirm Gaebel's statement that the reaction between arsphenamine and iodine is incomplete, and cannot be carried to completion by the addition of mild alkalies such as sodium bicarbonate, borate or acetate. Friedman[6] has shown that the reaction becomes progressively less com-

[3] Myers, C. N., and Du Mez, A. G., *U. S. Pub. Health Rep.*, 1918, **33**, 1003.

[4] Macallum, A. D., *J. Am. Chem. Soc.*, 1922, **44**, 2578.

[5] Elvove, E., *U. S. Pub. Health Rep.*, 1924, **39**, 750.

[6] Friedman, L., *J. Lab. and Clin. Med.*, 1925, **11**, 528.

plete in strongly acid solutions. We have found the titration satisfactory provided the initial pH is not below 2, the approximate pH of the di-hydrochloride of arsphenamine.

TABLE I.
Comparative Analysis of Arsphenamine by Gravimetric and Iodine Titration Methods.

Sample	% As (Grav.)	% As (I_2titr.)	Mols. I_2	Ratio G/I_2
A_1	31.57	29.81	7.555	1.059
A_2	31.65	29.84	7.543	1.061
B_1	31.17	29.55	7.584	1.055
B_2	31.31	29.54	7.548	1.060
C_1	31.55	29.70	7.532	1.062
C_2	31.40	29.67	7.560	1.058

Number of analyses to date—12.

We are able to conclude, therefore, that unless the solution is strongly acid, the reaction between arsphenamine and iodine reaches a point of equilibrium when 7.55 ± 0.03 mols. of iodine (theoretical 8.0) have been used. Consequently, by means of the conversion factor $8.0/7.55 = 1.060$ we can convert the amount of iodine actually used in a given titration into the amount which would be used theoretically if the reaction could be carried to completion, from which figure the percentage of arsenic in the sample is calculated.

The method is extremely rapid, the end point is sharp (unless the solution is too acid) using starch as an indicator, and the conversion factor has been found to be applicable to all samples of arsphenamine so far tested. Samples of arsphenamine contaminated with oxidizable sulphur compounds would, of course, give too high values for the arsenic content.

7045 P

Relation Between Colloidal Properties and Toxicity of Arsphenamine and Neoarsphenamine.*

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Bauer,[1] Klemensiewicz,[2] Sherndal,[3] Raiziss and Gavron,[4] and others, have demonstrated that both arsphenamine and neoarsphen-

* A part of the funds used in this research were supplied by a grant from E. R. Squibb & Sons, New York; a further portion was supplied from the Medical Research Fund granted by the Board of Regents of the University of Minnesota.