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A CRITICAL ESTIMATE OF THE FERMENTATION SPECIFIC GRAVITY METHOD OF QUANTITATING SUGAR IN DIABETIC URINE.*

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In 1861 Roberts¹ described a method of quantitating the glucose present in diabetic urine, which he spoke of as "the clinical method," on account of its simplicity and ease of application. His method consisted in determining the decrease in specific gravity of the urine caused by the action of yeast. Yeast fermentation splits up the glucose present and its amount can be determined by multiplying the difference between the specific gravity of the urine before and after fermentation by 0.23. This gives the percentage of glucose present. Roberts compared the results obtained by this with those from other methods of that day for quantitating glucose, and showed the considerable accuracy of his method.

Of late years the method suggested by Roberts has been rather neglected. In its place titration with some form of copper sulphate solution, polari-

*Read in the Section on Medicine of the American Medical Association at the Fifty-eighth Annual Session, held at Atlantic City, June, 1907.

¹J'dinburgh Med. Journ., 1861, vii, 326.

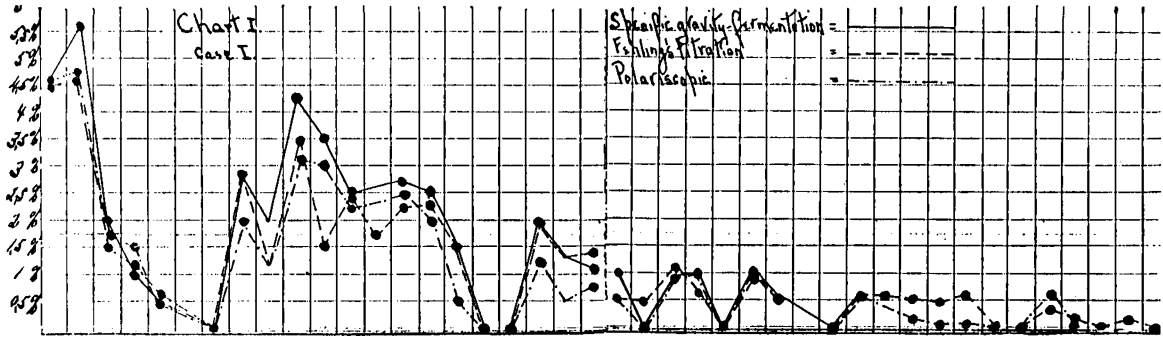


CHART I, CASE I. Results of estimating the sugar in diabetic urine by the three methods.

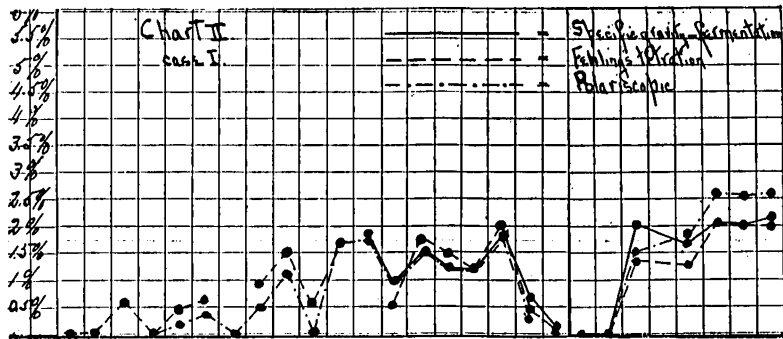


CHART II, CASE I (continued).

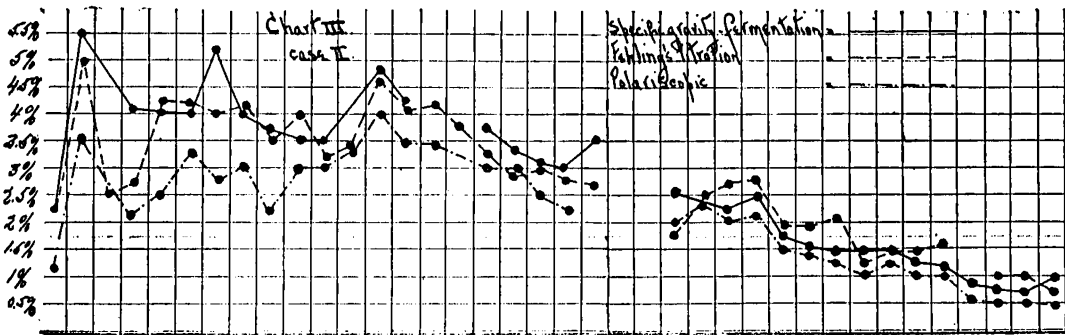


CHART III, CASE II. Results of estimating the sugar in diabetic urine by the three methods.

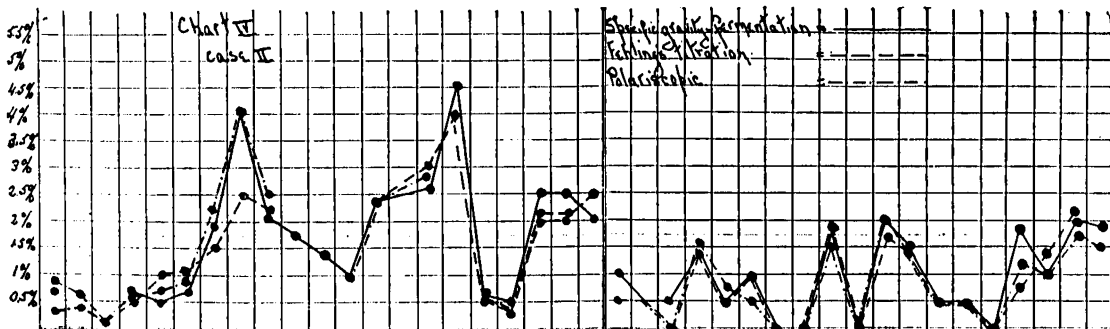


CHART IV, CASE II (continued).

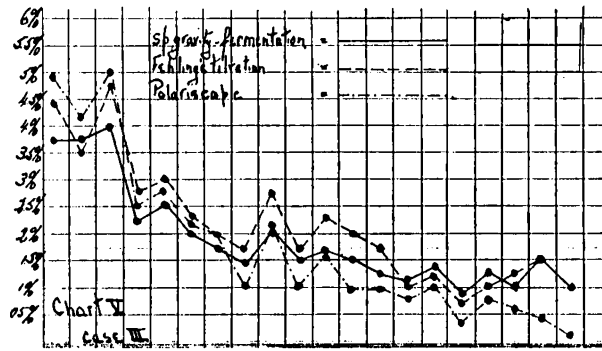


CHART V, CASE III. Results of estimating the sugar in diabetic urine by the three methods.

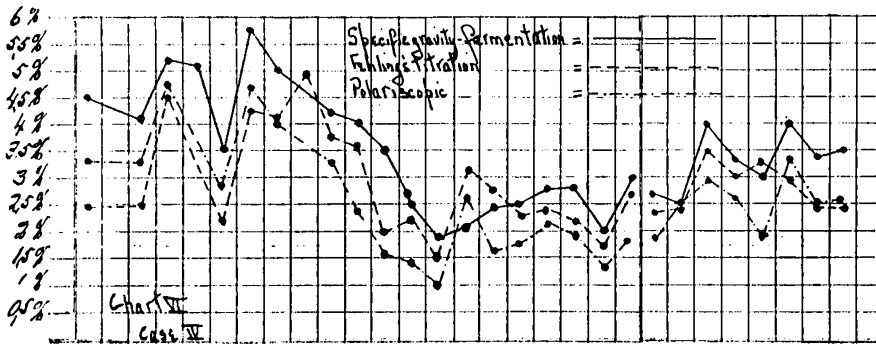


CHART VI, CASE IV. Results of estimating the sugar in diabetic urine by the three methods.

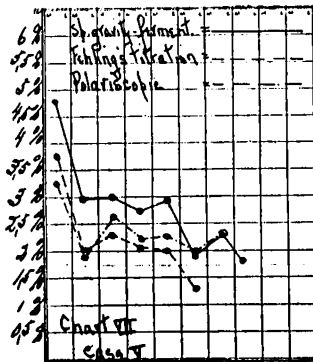


CHART VII, CASE V. Results of estimating the sugar in diabetic urine by the three methods.

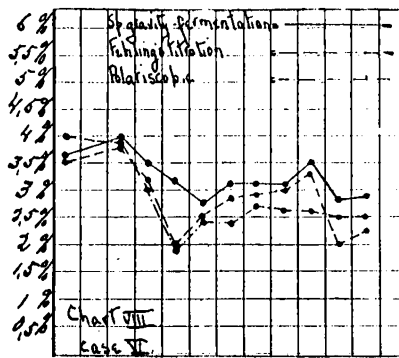


CHART VIII, CASE VI. Results of estimating sugar in diabetic urine by the three methods.

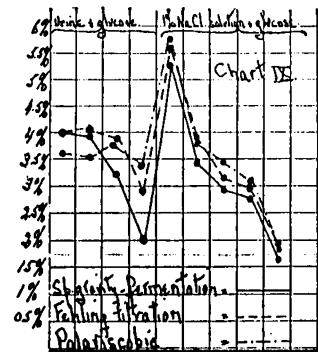


CHART IX. Results of estimating glucose dissolved in normal urine and in 1% solution of sodium chloride by the three methods.

scopic estimation, a fermentation method which measures the amount of carbon dioxide formed in the destruction of glucose, or other methods have been very generally used and comparison of the results of these various methods have been published by a number of observers.

Of all methods the fermentation-specific gravity one appears to be the simplest for the general practitioner, because it requires no laboratory and needs only a bit of yeast from the kitchen and the urinometer or specific gravity bulb, which every physician has. How accurate is such a simple method?

The question of accuracy is to be answered by comparing the results of this method with those

obtained with other methods. During the past two years I have been able, with the aid of picked students from the fourth-year class of the Harvard Medical School, working under my direction at the Massachusetts General Hospital, to make such a comparison. We have made daily quantitations of the sugar present in the urine of several diabetic cases by (1) the Fehling's copper sulphate titration method; (2) the polariscopic method; and (3) the fermentation-specific gravity method. The estimates have been made in part by myself, largely by the students under my supervision. It has been our attempt to apply each method with such care and attention to detail as might be expected of a careful clinician

working with adequate laboratory facilities. As a matter of fact, on the whole, more estimates of a given specimen were made and more attention was given to the avoidance of some of the commoner sources of error than it is fair to expect of even a very careful clinician. The polariscopic estimations were made with a Schmidt and Hensch half shadow saccharometer, and these results were controlled by a more accurate polariscope from the same makers.

The results of these estimations are graphically shown in Charts I to VIII. A glance at these shows a quite close agreement in the various quantitations. Chart III, which differs somewhat from the others, is from a case which during the first few days appeared to be excreting both levulose and glucose. At least this supposition would satisfactorily explain the considerable difference between the results of polariscopic estimation and those from the other methods. At the same time the urine on these days gave a strongly positive reaction with Seliwanoff's reagent, which reaction later disappeared. The occasional sudden variations seen in the other curves are probably due to errors in application of the method. All were typical cases of diabetes mellitus of moderate severity. In none was there coma or evidence of impending coma. The quantitations represent the per cent of glucose in a mixed specimen from the total 24-hour amount.

Chart IX shows the results of quantitating (*a*) normal urine to which glucose (Kahlbaum *c. p.*) has been added, and (*b*) 1% sodium chloride solution, in which glucose similarly was present. This shows a close analogy to the results obtained in diabetic urines.

To titrate a diabetic urine with Fehling's solution requires a considerable amount of time, care and laboratory equipment. The end reaction is not very sharp, and there is a considerable inherent error in the method. The polariscopic method requires an expensive instrument and the accuracy of the result is influenced by the presence of beta-oxybutyric acid, albumin, levulose and other possible constituents of diabetic urine.

The fermentation-specific gravity method as shown by the charts gives results as good as do the other methods. It is very simple in application, requires no laboratory equipment and involves a minimal cost for apparatus. All that is required is to take the specific gravity of the urine at room temperature, add a small bit of commercial yeast and place in a warm place, such as an incubator at 37° C., a heated room, near a stove or radiator, etc. Active fermentation soon begins and is evinced by bubbles and currents in the urine. When fermentation is finished the specimen partially clears and the evolution of gas ceases. A negative test with Fehling's or Nylander's solution proves the end of the process—12 to 18 hours is usually sufficient. The specimen is now allowed to return to the room temperature of the previous specific gravity determination, and the specific gravity redetermined. The difference between these two readings, mul-

tiplied by 0.23, gives the percentage of fermentable substance expressed in terms of glucose.

A number of specimens were carefully filtered before the second specific gravity determination was made. This made no appreciable difference. The specific gravity bulb used was such as is sold to the physicians at a cost of from fifty to seventy-five cents. Many comparative readings were made, using a more accurately graduated longer specific gravity bulb and calculating the necessary allowance for temperature changes. Here again the differences are very slight, so slight that they might well be neglected. It is, however, important to use the same specific gravity bulb for both readings, since these cheap instruments vary considerably in their 1,000 level. Moreover, the specimen should be approximately at the same temperature at each reading, or a specimen with and without yeast be kept side by side and simultaneous specific gravity readings be made after the completion of the fermentation in the one, as first suggested by Roberts, for any considerable temperature variation will affect the specific gravity enough to change materially the result of the determination. Observing these few precautions, the results obtained are about as accurate as those given by the other two methods. The great simplicity of the fermentation-specific gravity method renders the chance of error in application slight, and it can be strongly recommended to the general practitioner in following the metabolism of cases of diabetes mellitus.

The facts presented above are not new. Yet it has seemed worth while again to call attention to so simple a method of quantitating glucose in urine, and to commend it as a sufficiently accurate method to enable the practitioner to treat scientifically his cases of diabetes mellitus. This is the motive of the paper. An accuracy sufficient for more exact chemical work is not claimed.

THE TREATMENT OF FEVER CASES IN THE PUBLIC SERVICE.*

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DURING the eighteen months ending April 1, 1907, 1,525 cases have been treated in the general hospital department of the State Farm. Of these 1,525 cases, 25 have been primary or secondary cases of lobar pneumonia. Of these 25 pneumonia cases, one died. All the others made good recoveries. Six cases of typhoid fever were treated during this period, all of whom made good recoveries.¹

During the past three and one-half years, 38 cases of lobar pneumonia have been treated in this same hospital department of the State Farm with 3 deaths,—a mortality just below 8%. During this same period of three and one-half years, we have treated 30 cases of typhoid fever, all of whom made good recoveries.

* Read before the Massachusetts Association of City Physicians, Boston, April 2, 1907.

¹ Six additional cases of pneumonia, each are alcoholic, all of whom recovered, have been treated since April 1, 1907. No typhoid since April 1.