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A Rapid Method for the Quantitative Estimation of Glucose in Urine by Fehling's Solution.

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A RAPID METHOD FOR THE QUANTITATIVE ESTIMATION OF GLUCOSE IN URINE BY FEHLING'S SOLUTION.

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My object in writing this short paper is to call the attention of physicians to a method of using Fehling's quantitative determination for glucose in urine, which effects a saving of fully one half the time usually required.

Before getting at the gist of my subject I desire to emphasize a few peculiarities of the behavior of urine to Fehling's solution, as it is upon the occurrence of these peculiarities that the *rationale* of the method I am about to describe is based.

Every one who has critically examined many specimens with Fehling's solution will have noticed two striking facts. The first of these is that some urines from which sugar can by various tests be positively excluded will decolorize the solution, and even give it an orange or opalescent-green tint. The second is that urines known to contain sugar fail to produce a characteristic precipitate with Fehling's test, giving instead appearances identical with those just de-

scribed, or filling the test-tube with a precipitate usually of a yellowish-green color, which never turns red and never satisfactorily settles to the bottom, and which is, moreover, so fine as to pass through most filters.

The reason for these disturbing variations from the classical action of the test, as described in the books, is to be found in the fact that urine contains normally two classes of bodies, one of which has the power of reducing copper oxide, and the other of redissolving such oxide when from any cause it has been reduced. Here, then, we have two substances of antithetical action, the final result of their presence being according as one or the other preponderates in quantity. The less sugar the specimen contains, the more disturbing these variations become, and it may happen that as much as one half of one per cent. of sugar is present without a characteristic precipitate being formed. Concentrated high-colored urines are, as a rule, more apt to show these peculiarities than dilute, pale urines. Two kinds of error are consequently likely: One that traces of sugar may be overlooked, the other that traces may be reported in urines containing none.

In another paper I propose to show how small quantities of sugar may be detected in spite of these disturbances, confining myself here only to the discussion of the quantitative determination by Fehling's solution.

The non-appearance of the red oxide and its replacement by a greenish-yellow precipitate, which persists in remaining in suspension for an indefinite length of time in the contents of the flask, are common sources of vexation to any one whose time is precious.

To avoid these difficulties, the following procedures should be employed:

First, use a flask capable of containing about 250 c. c., and, after adding the usual 10 c. c. of Fehling's solution, fill

half full of water, or till the solution is of a very pale blue. The reaction takes place much better and can be more closely observed than when the test solution is used in concentrated form. Secondly, the urine should be well diluted. Make a preliminary qualitative test to judge approximately of the quantity of glucose present and dilute accordingly. One in ten is a convenient strength. This, together with the thinning of the Fehling's solution, will insure proper dilution of the normal reducing and dissolving substances of the urine, and minimize their disturbing action.

The temptation to use the urine but slightly diluted or of full strength when the amount of sugar is small, so as to shorten the time necessary in using the burette, is very great, but will always be regretted if yielded to, for it generally ends in being obliged to undertake the whole analysis afresh after wasting considerable time.

Put the diluted Fehling's solution on to boil while preparing the dilution of urine and filling the burette. Then, when all is ready, in starting the process, allow only a small quantity—from one half to one c. c.—to flow from the burette before boiling again, removing the flame and allowing the ebullition to cease each time before adding more. *Boil hard* each time, as this causes the particles of oxide to cohere and fall to the bottom more quickly than otherwise.

Even under the most favorable circumstances—that is, when a red precipitate appears at once and falls quickly to the bottom as the reaction nears completion—a considerable time must always elapse before the supernatant fluid is sufficiently clear to allow the analyst to determine whether all the blue color has been discharged or not, especially as the fine particles of red oxide, when in suspension, give to an otherwise colorless fluid a violet shimmer. This settling may be hastened by adding a dash of cold water to the

contents of the flask; but Munk * has devised a method which is probably the greatest improvement in the use of Fehling's solution since the test was first proposed, and which it is the object of this paper to popularize.

This consists in adding a small quantity of a solution of calcium chloride to the mixture in the flask. (Munk recommends three to five drops of a 15-per-cent. solution, but in practice I simply make a pretty strong solution, and use as much as seems needed.) A voluminous, white, curdy precipitate is formed, consisting in part of calcium hydroxide and in part of calcium tartrate, the latter being less soluble in hot than in cold solutions. This precipitate, from its curdy, gelatinous nature, carries down with it the impalpably fine powder of the copper oxide, and quickly leaves a clear supernatant fluid in which the most delicate shade of blue is discernible, if present.

In practice I have found the following the best mode of procedure:

If the oxide comes down red in the beginning, I continue adding from the burette until the rapid falling of the precipitate to the bottom of the flask warns that the reaction is nearly complete. I then add about ten drops—or enough to give a pretty large quantity of precipitate—of the calcium-chloride solution. When the precipitate of copper is yellowish-green and shows no sign of turning red, I add the calcium-chloride solution as soon as I have satisfied myself of the latter fact. Great care must be used to boil slowly at first, allowing the flame of the burner to play gently, with frequent removals, about the bottom of the flask until the whole mass gradually boils. If this is not done, owing to the character of the precipitate, explo-

* I. Munk, Virchow's "Archiv," vol. cv (1886), p. 63. I have made an abstract of this article, which may be found in the "American Journal of the Medical Sciences" for October, 1886, p. 543.

sive boiling may occur, and the whole contents of the flask be suddenly landed on the ceiling—a monument to precipitancy for all time!

When boiling is once under way there is no more danger of such an accident occurring, and ebullition should be maintained for some minutes before the precipitate is allowed to settle. Should it be found, after the calcium tartrate with the copper oxide have settled to the bottom, that considerable copper still remains in solution to be precipitated, it will generally be necessary to add from time to time, as the urine is run out of the burette, a few drops more of the calcium-chloride solution, as the freshly precipitated calcium tartrate has greater clarifying powers than that which has already been used. Should the amount of precipitate become finally very large, more water should be added to the flask.

By the use of this method a sugar determination may be made in twenty minutes, and several can be done together in even less time each; whereas, under the common method, half an hour would be very short and very exceptional, and an hour or more—depending on the nature of the specimen—nothing unusual.

Two years' constant use, embracing specimens of all varieties of contrariness, warrants me in heartily recommending Munk's method to all who have many, or indeed any, quantitative determinations to make, and to whom time is valuable.

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