plus an excess.[1] By comparing the urinary output of sugar in a given period of time with the "excess" of sugar present in the blood, a definite mathematical relation is found to exist between the percentage of sugar in the urine, and that in the blood. The proportion between the two tends to approach a constant, in one and the same individual, on a given day. This applies to individuals with normally functionating kidneys. In those with defective kidneys there is no parallelism. The hyperglycemia in such individuals is usually greater in proportion to the glycosuria than it is in those with normally functionating kidneys.

Diuresis in diabetes mellitus plays an important rôle in determining the total amount of sugar eliminated in the urine, but has no influence on its concentration or percentage.

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## The relation of the sugar content and concentration of the blood to urine formation. (Preliminary report.)

By E. M. EWING.

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The present experiments were performed in an effort to establish a standard of comparison for further experiments involving the study of the fate of sugar injected into the circulatory system under various conditions.

Various amounts of a dextrose solution (40 gm. in 40 c.c. water) were injected into the femoral veins of dogs under local anesthesia, and 20 c.c. of blood drawn from the femoral artery at 15-minute intervals. Twenty c.c. of citrated dog's blood previously prepared were injected into the artery immediately afterward, thus maintaining the normal concentration of the blood as indicated by the specific gravity and hemoglobin percentage. The specific gravity, hemoglobin and sugar content of the blood were determined, and also the urine obtained by catheter was

[1] The largest amount of sugar which may be present in the blood (with constant blood volume conditions) without giving rise to a glycosuria, is estimated at 0.1 per cent. In determining the excess of sugar in the blood, 0.1 per cent. is deducted from the values of blood sugar obtained after correction for blood volume.

measured and its sugar content estimated. Specific gravity was determined with a 10 c.c. pycnometer; hemoglobin with the Sahli instrument; blood sugar and urine sugar by the Lewis-Benedict and Benedict methods, respectively.

I. Fisher and Wishart have presented evidence that (contrary to Starling's hypothesis) after the ingestion of 50 gm. of dextrose by a dog, there is a diminished formation of urine in spite of a dilution of the blood, as indicated by hemoglobin determinations.

Similar results were obtained also in the present series of experiments after *intravenous* injections, estimations of the specific gravity as well as the hemoglobin content of the blood being made. The following experiments indicate clearly that simple increase or decrease in the concentration of the blood following injection of crystalloids does not necessarily result in a corresponding increase or decrease in urine formation, and that there may be a definite diuresis without any material change in the concentration of the blood.

| Exper. | Injected. | Change in Sp. Gr. in 30 Min. | Urine in 30 Min. | Rate per Hour. |
|---|---|---|---|---|
| May 14, 7 K.... | 40 gm. dextrose, 10 min. | 1,0570[1] to 1,0592 | 14 c.c. | 28 c.c. |
| May 24, 9 K.... | 30 c.c. water, 30 min. | 1,0555 to 1,0551 | 9 c.c. | 18 c.c. |
| May 27, 8 K.... | 13 gm. dextrose, 30 min. | 1,0660 to 1,0631 | 3.25 c.c. | 6.5 c. c. |

II. Complete results of the experiments would be too bulky for publication, but the following summary will show the relation of blood sugar, blood concentration and diuresis. The weights of the animals are indicated along with the dates of the experiments; the figures for the blood sugar represent the highest points reached during the chosen periods; the maximum changes in the specific gravity of the blood during the period are indicated, and the urine formation is expressed in c.c. per hour.

| Exper. | Injection. | Blood Sugar. | Sp. Gr. Decreased. | Urine Rate per Hr. |
|---|---|---|---|---|
| May 14, 13 K..... | 40 gm. in 1 hr. | .57 | 1,0620 to 1,0580 | 33 c.c. |
| May 24, 9 K..... | 20 gm. in ½ hr. | .55 | 1,0630 to 1,0610 | 50 c.c. |
| May 21, 10 K..... | 20 gm. in 1 hr. | .28 | 1,0627 to 1,0607 | 10.5 c.c. |
| June 4, 9 K..... | 13 gm. in ½ hr. | .50 | 1,0573 to 1,0550 | 12 c.c. |
| June 5, 9 K..... | 13 gm. in 5 min. | .68 | 1,0570 to 1,0546 | 55 c.c. |
| May 27, 8 K..... | 13 gm. in ½ hr. | .57 | 1,0660 to 1,0632 | 7 c.c. |
| May 28, 8 K..... | 13 gm. in 5 min. | .6 | 1,0657 to 1,0610 | 64 c.c. |

[1] This change occurred 30 minutes after the injection, being preceded by a marked fall (as in Starling's experiment).

A glance at the above table will suffice to show that the flow of urine bears but slight relation to the degree of dilution of the blood as indicated by the specific gravity determinations. Diuresis is apparently the greatest when the percentage of blood sugar is highest. On the other hand, there is no question but what diuresis is absent in experiments showing excessively high blood sugar.

For the experiments of May 27 and 28, and of June 4 and 5, the same animals were used, the experiments differing only in that the rate of injection was rapid in one case and slow in the other. Here it seems that the presence of diuresis depends upon the rapidity of injection, and not upon the blood sugar content, which in both cases is excessively high.

III. The quantity of sugar per c.c. of urine was surprisingly *constant* when the blood sugar was above 0.4 per cent., *i. e.*, during the period following injection. In a series of experiments with the blood sugar varying from 0.4 to 0.6 per cent. the sugar per c.c. of urine varied from .045 to .052 gm., independently of the presence or absence of diuresis. Toward the end of the experiment, however, with blood sugar falling, and diuresis coming to an end, the sugar per c.c. of urine rises steadily. For example, in one experiment, at different periods, the blood sugar percentage was .5, .35, and .28; while for corresponding periods the urine sugar per c.c. was .05, .07, and .08 gm.

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## A method for the estimation of levulose in presence of glucose.

By LEON LOEWE (by invitation).

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The reagent consists of 0.2 per cent. aqueous solution of orcein (Kahlbaum) and 85 per cent. phosphoric acid (Eimer and Amend) in separate containers.

The qualitative test is carried out as follows: to 1 c.c. of the solution under investigation in a test tube, add from 6 to 8 drops of the orcein solution and 1 c.c. of the phosphoric acid. The test tube