Reprinted from GASTROENTEROLOGY
Vol. 32, No. 2, February, 1957
Printed in U.S.A.

RADIOACTIVE DILUTION INDICATOR

I. Measurement of Residual Fluid in the Fasting Stomach

Daniel Liebowitz, M.D., Howard H. Stone, M.D., Donald LeVine, M.D., Kenneth G. Scott, Ph.D., and Theodore L. Althausen, M.D.

With the technical assistance of Valda Creveling, B.S., and Lorraine Strei, B.S.

From the Department of Medicine and the Radioactivity Research Center, University of California School of Medicine, San Francisco, Calif.

The use of radioactive isotopes in measuring gastric secretion and pyloric emptying suggested that varying amounts of gastric secretion remained after conventional tube aspiration of the stomach. A dilution formula was therefore used to calculate the gastric contents remaining in the so-called "empty" stomach.

METHOD

The dilution indicator. Since negligible absorption of zirconium^{95}-niobium^{95} (Zr^{95}-Nb^{95}) occurs in the stomach, this isotope can be used as a tracer substance in measuring gastric section.[1] The affinity of the isotope for gastric mucus can be offset by chelating with a Versene (disodium dicalcium ethylenediamine tetraacetic acid).[2] The concentration of the isotope is readily measured in a scintillation counter, and the calculation involves a simple dilution formula.

Composition of the test meal. The composition of the test meal is as follows: Water, 318 cc.; Zr^{95}-Nb^{95}, 0.5 μc. in 1 cc. water; Versene, 37.5 mg. in 1 cc. water. Duplicate 10-cc. samples are removed from the test meal prior to its administration to determine the Zr^{95}-Nb^{95} concentration.

Procedure. Thirty-six patients, none with clinical evidence of gastric retention, were subjected to "complete blind" aspiration by the usual method of drawing out the gastric contents through a gastric tube after the patient had fasted for 14 hr. The patients were turned from one position to another and the tube moved back and forth to attempt complete emptying prior to the test. They were then kept in the left lateral decubitus during the procedure.

No attempt was made to prolong the blind aspiration beyond 3 min. Following this, the radioactive meal was administered, mixed by withdrawing and readministering the mixture of isotope and gastric contents three times through a 100-cc. syringe. Samples were then removed for determination of isotope concentration. This procedure lasted approximately 1 min.

The validity of this test is based on the assumption that none of the contents placed in the stomach are lost through the pylorus during the procedure. To prove this assumption a mixture containing 200 cc. of water and 100 cc. of a colloidal suspension of barium was introduced into the stomach of patients in the left lateral decub-

Submitted for publication March 7, 1956.

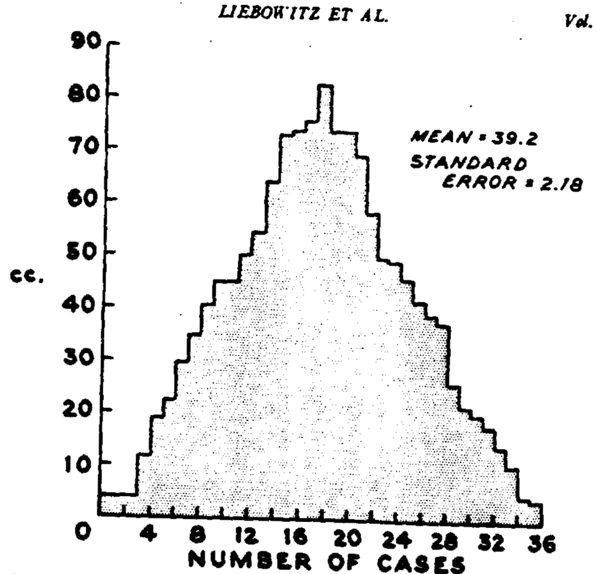

FIG. 1. Measurement of residual fluid in fasting stomach using radioactive dilution indicator Residual volume of gastric secretion in 36 patients after complete blind aspiration in the left lateral decubitus.

itus, and the same procedure was carried out. This experiment was performed 8 times in 5 patients. In each instance no barium was observed to leave the stomach during the 5-min. period of observation. This finding suggests that none of the contents of the stomach are lost through the pylorus during the 1-min. test period required by our procedure, providing the patient is kept in the left lateral decubitus. This observation is in general agreement with the impression of radiologists who have found that patients placed in the left lateral decubitus retain barium in the stomach for long periods of time.[2-4]

Calculations. The extent of dilution of a known volume (test meal) by an unknown volume (residual gastric contents) may be calculated by the following formula:

$$V_m \times C_m = V_1 \times C_1 \quad (1)$$

$$\frac{V_m \times C_m}{C_1} = V_1 \quad (2)$$

Solved for V_1 where V_m equals volume of radioactive test meal, C_m equals concentration of Zr^{95}-Nb^{95} in the radioactive test meal. C_1 equals the concentration of Zr^{95}-Nb^{95} in the diluted stomach contents and V_1 equals the unknown volume of the gastric residuum plus the volume of the test meal.

To calculate the volume of gastric residuum, the volume of the test meal (V_m) is subtracted from V_1.

* Similar studies could be made using dye dilution indicator techniques.

RESULTS

In 36 patients tested, the gastric volume left behind after supposed complete emptying of the stomach was found to be uniformly distributed from a low of 3 cc. to a high of 83 cc., with a mean of 39.2 ± 2.18 cc. (fig. 1). Over 75 per cent of the patients had a residual volume of 20 cc. or more.

SUMMARY

A new procedure employing radioactive zirconium^{95}-niobium^{95} as a dilution indicator permitted the measurement of any fluid left in the stomach after it was presumably emptied completely by the usual method of blind aspiration. Though the rapid introduction and withdrawal of 100 cc. of fluid into the stomach might act as a stimulus to gastric secretion, it is doubtful that enough secretion would be produced during the 1 min. required for mixing to give a falsely high gastric residuum. A significant residuum of gastric juice was found in over 75 per cent of the patients. This might provide a source of error where volume and acid output are measured by conventional aspiration.

Department of Medicine, University of California School of Medicine, San Francisco, Calif. (Dr. Leibowitz)

REFERENCES

1. LIEBOWITZ, D., STONE, H. H., LEVINE, D., SCOTT, K. G., AND ALTHAUSEN, T. L. Radioactive dilution indicator. II. Gastric analysis. Gastroenterology, [illegible]: 268, 1957.
2. ROSSITER, S. B. Personal communication.
3. GAINES, W. Personal communication.
4. STEINBACH, H. H. Personal communication