phase of the menstrual cycle. The dosage of progesterone used in this series was probably greater than that reported by the previous workers.

Summary. Whereas previously, sodium pregnandiol glucuronidate was found only in pregnancy or in women with functioning endometriums, it has now been demonstrated in the urine of 2 men suffering with Addison's disease who were treated with 30 mg of progesterone daily, and in one normal young male with the same treatment.

10649

A Technic for the Study of Gastric Absorption in Man.*

RICHARD WARREN.† (Introduced by J. H. Austin.)

From the Gastro-Intestinal Section (Kinsey-Thomas Foundation) of the Medical Clinic, Hospital of the University of Pennsylvania.

Recent studies in this clinic on the behavior of glucose solutions in the human stomach and duodenum[1] have indicated the need for a method to determine absorption from the isolated stomach. Experiments testing the absorption of drugs and foodstuffs by the gastric mucosa have been reported irregularly over a period of 60 years. In animals certain methods, some involving isolation of the stomach by obstructing ligatures or balloons[2, 3, 6] and others employing fistulas of the stomach and duodenum,[4, 5] have yielded clear-cut results, but they are not strictly applicable to normal man because each involves an operative procedure. In the intact human, because of the lack of a means of completely blocking the pylorus, the methods have been limited to the use of non-absorbable contrast materials for

* I wish to express my appreciation of the help given me by Dr. W. Osler Abbott, whose advice on tube construction and procedure in general has been invaluable, and by Mr. E. Freeman Hersey, who did the chemical analyses.

† Fellow in Gastro-Enterology and Assistant Instructor in Medicine, Medical School of the University of Pennsylvania.

1 Karr, W. G., Abbott, W. O., Hoffman, O. D., and Miller, T. G., to be published.

2 Tappeiner, H., *Z. f. Biol.*, 1880, **16**, 497.

3 v. Anrep, B., *Arch. f. Anat. u. Physiol.*, 1881, **2**, 504.

4 v. Mering, J., *Verhandl. des Kongresses der Innere Medizin*, 1893, **12**, 471.

5 London, R. S., and Polowzowa, W. W., *Z. f. physiol. Chem.*, 1908, **56**, 512.

6 Morrison, J. L., Shay, H., Ravdin, I. S., and Cahoon, R., in press.

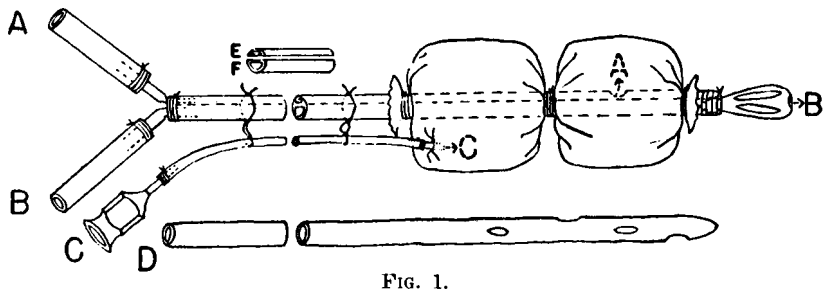

FIG. 1.

AB—Double lumen tube, length 115 cm, size 14 French. Lumen A is .07 x .2 cm, lumen B .3 x .2 cm. Distal balloon is 3.5 cm, proximal balloon 5 cm long, Rehfuss tip 1.8 cm long.

C—Single lumen 1/32" tubing attached to proximal balloon by a metal connection made from a No. 22 gauge needle. This tube is loosely bound to tube AB with the No. 5 silk thread that is used in the balloon bindings.

D—16 French Levin tube.

E and F—Bronze connections, 1.5 cm long, cast to fit the lumens of tube AB and to be inserted into them at binding sites.

comparison with test substances[7] and to attempts at pyloric closure by the use of "duodenal stimulants".[8] The latter technic in our hands was found to be unreliable. A mechanical method for pyloric occlusion has therefore been devised by which one may not only obtain satisfactory results, but which will unequivocally indicate technical errors when they occur.

Successful blockage of the pylorus in every attempt has been impossible because of the highly irritable state of that region: displacement of the occluding balloons and leakage past them tend to occur. Consequently it has been necessary to include procedures designed to detect failure of complete pyloric obstruction: fluoroscopy to show displacement of the balloons and an open tube in the duodenum to show leakage.

The apparatus used consists of 3 tubes (Fig. 1). A double-lumened tube of the Miller-Abbott type (AB) carries 2 balloons which obstruct the pylorus by holding it between them when they are inflated. The larger lumen (B), passing through the balloon system, communicates with a metal tip beyond and so allows for aspiration of duodenal contents during the experiment. The distal balloon is inflated via the smaller lumen (A) and the proximal one by a fine tube (C) running parallel to tube AB. A 16 French Levin tube with a catheter tip of the type familiar in clinical work serves to inject and to aspirate materials into and out of the stomach after the balloon system is in place.

Short segments of metal connecting tubing (E&F) are inserted

[7] Freund, I., and Steinhardt, P., *Deutsche med. Wchnschr.*, 1931, **57**, 1815.

[8] Shay, H., Gershon-Cohen, J., and Fels, S. S., *Ann. Int. Med.*, 1938, **11**, 1563.

into the lumens of the double-lumened tube at the sites where the ends of the balloons are to be bound and allow for tight binding without the possibility of constricting the lumens. The 2 balloons are made out of a single rubber condom. A 3-lumened tube may be used to replace the combination of the double-lumened and the small tubes. The present arrangement, however, has been used because of its greater pliability.

The experiment is done under fluoroscopic guidance. The fasting subject swallows the balloon system first, and the metal tip is allowed to slip into the duodenum. Tube D is then swallowed until its tip has reached the most dependent part of the stomach. The stomach is emptied of its fasting contents. Five cc of air are then injected into the distal balloon, and this set of tubes is withdrawn, leaving tube D undisturbed, until the partially inflated balloon is on the point of falling back into the stomach. An additional 25 to 45 cc of air, the amount in each instance depending on the activity of the

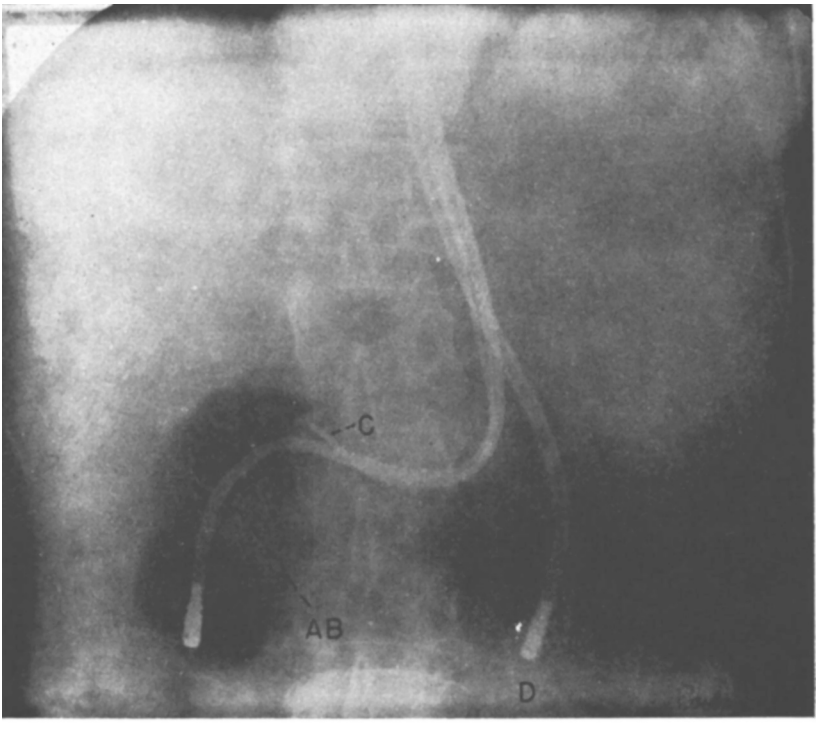

FIG. 2.

An early experiment indicating the fluoroscopic appearance of the apparatus in place. This apparatus is identical with that in Fig. 1 except for the character of the tips of the tubes.

duodenum and the amount of pressure resisting the injection, are introduced rapidly into the distal balloon. The subject is then instructed to put moderate traction on the 2-lumened tube with his hand in order to prevent its passage along the duodenum. The experimenter injects 50 cc of air into the proximal balloon while the tube is thus held. This should leave the balloons athwart the pylorus, one in the duodenal cap and the other in the antrum of the stomach. In some of the experiments it has been suspected that the proximal balloon was also in the duodenal cap. In either event it is obvious from their position as seen under the fluoroscope that none of the duodenal mucosa can be exposed for absorption. Fig. 2 shows the fluoroscopic appearance of the apparatus in place.

With the balloons thus in place test substances may be introduced into the stomach through tube D and later aspirated at the end of a predetermined period via the same tube. Subsequent lavage of the stomach with about 800 cc of water in divided portions thoroughly rids it of all traces of remaining test substance. As previously stated continuous aspiration through lumen B must be maintained throughout the experiment to allow for detection of any escape of gastric material into the duodenum.

For the purpose of determining the efficiency of the technic, glucose has been used as the substance to be tested. Of numerous experiments attempted the proportion of successes to failures has so far been about 3 to 5. The causes for failure in the unsuccessful experiments have been slipping of the balloons, vomiting of the test substance, faulty construction of the apparatus and escape of glucose past the balloons. These were all promptly recognized and the experiments discarded. Two sample successful experiments are tabulated in Table I.

That the glucose was lost in considerable amounts from the concentrated solution but in negligible quantities from the dilute solution is to be noted. A discussion of the significance of this fact is not within the scope of this paper and will be reserved for a later report.

TABLE I.
Gastric Absorption of Glucose.

	Amount injected			Test period, min.*	Duodenal specimen		Amount aspirated: Gastric specimen		Amount aspirated: Gastric wash	
Subject	cc	g	%		cc	g	cc	g	cc	g
H	250	12.5	5	34	17.5	0	274	11.23	617	.72
P	249	149.4	60	35.5	11	0	385	118.6	997	11.07

*Calculated from onset of injection to onset of wash.

Summary. A technic for the study of gastric absorption is presented by which the pyloric opening can be completely blocked without operation or disturbance of blood supply in human subjects that are in every way normal. Methods of detecting immediately failure of the blocking device insure against false surmise in the interpretation of results.

10650

Histological Changes in Skeletal Musculature of Paralyzed Suckling Young of E-Low Rats.*

IRA R. TELFORD, GLADYS A. EMERSON AND HERBERT M. EVANS.

From the Institute of Experimental Biology and the Division of Anatomy, School of Medicine, University of California, Berkeley.

Evans and Burr[1] first described the partial or complete paralysis affecting a high percentage of suckling young of vitamin E-deficient rats. Olcott[2] found that a degeneration of the cross striated musculature occurs in such paralyzed rats not unlike the nutritional muscular dystrophy earlier observed in herbivores by Goettsch and Pappenheimer,[3] Woodward and McCay,[4] Madsen, McCay and Maynard,[5] Victor,[6] and Morgulis and Spencer.[7] Lipschutz,[8] although not studying the musculature, reported that suckling E-deficient rats had definite lesions in the vestibular nuclei and their connections, and in the extra pyramidal tracts, proprioceptive tracts, and ventral horn cells of the cord. Olcott[2] observed "no abnormalities in the nerves,

* Aided by grants from the Board of Research and the Department of Agriculture of the University of California, from Merck and Company, Inc., and from the Rockefeller Foundation, New York. Assistance was rendered by the Federal Works Progress Administration, Project 8877 A-5. The following materials were generously contributed: brewers' yeast by The Vitamin Food Company of New York, cod liver oil by E. R. Squibb and Sons, and wheat germ from which oil was prepared by General Mills, Inc.

1 Evans, H. M., and Burr, G. O., *J. Biol. Chem.*, 1928, **76**, 273.

2 Olcott, H. S., *J. Nutrition*, 1938, **15**, 221.

3 Goettsch, M., and Pappenheimer, A. M., *J. Exp. Med.*, 1931, **54**, 145.

4 Woodward, J. C., and McCay, C. M., PROC. SOC. EXP. BIOL. AND MED., 1932, **30**, 241.

5 Madsen, L. T., McCay, C. M., and Maynard, L. A., PROC. SOC. EXP. BIOL. AND MED., 1933, **30**, 1434.

6 Victor, J., *Am. J. Physiol.*, 1934, **108**, 229.

7 Morgulis, S., and Spencer, H. C., *J. Nutrition*, 1936, **11**, 573.

8 Lipschutz, D., *Revue Neurologique*, 1936, **65**, 221.