with the idea that specific messenger RNA molecules in pituitary cells may be relatively long-lived. In an effort to further clarify those subcellular events which occur prior to hormone secretion, we are currently investigating the effects of hypothalamic extracts on protein synthesis in rat pituitary tissue.

Summary. 1. Evidence obtained by radioautography and sucrose density gradient centrifugation indicated that macromolecular RNA was synthesized in explants of rat anterior pituitary tissue *in vitro*. 2. The rapidly labeled RNA was, in part, heavier than 28S. 3. After 4 hours of incubation, label was observed in cytoplasmic ribosomal RNA. 4. The rate of RNA synthesis in glands treated with hypothalamic or cerebral cortex extracts *in vitro* was found to be similar. 5. The decreased rate of RNA synthesis in pituitaries treated with hypothalamic extracts *in vitro* (*vs.* corresponding controls treated with 0.1 N HCl) could be partially overcome by preincubating the glands in radioactive Medium 199 prior to addition of the extracts. 6. The *in vitro* rates of RNA synthesis in pituitaries taken from animals previously injected with hypothalamic extracts or 0.1 N HCl were similar, although an initial lag in uptake of uridine-H^3 into the glands of the experimental group was observed.

The authors would like to thank Miss Andrea Mastro for help in the preparation of the radioautographs and Mr. John Davis for technical assistance.

1. Sinha, D. K., Meites, J., Endocrinology, 1966, v78, 1002.

2. Meites, J., Excerpta Med. Inter. Cong., Ser., 1964, v83, 522.

3. Mittler, J. C., Meites, J., Endocrinology, 1966, v78, 500.

4. Kragt, C. L., Meites, J., ibid., 1965, v76, 1169.

5. Guillemin, R., Recent Progr. Hormone Res., 1964, v20, 89.

6. Korner, A., Biochem. J., 1964, v92, 449.

7. Clever, U., Am. Zoologist, 1966, v6, 33.

8. Kenney, F. T., Wicks, W. D., Greenman, D. L., J. Cell & Comp. Physiol., 1965, v66, 125.

9. Kuff, E. L., Hymer, W. C., Biochemistry, 1966, v5, 959.

10. Giles, K. W., Myers, A., Nature, 1965, v206, 93.

11. Burton, K., Biochem. J., 1956, v62, 315.

12. Scherrer, K., Darnell, J., Biochem. Biophys. Res. Communs., 1962, v7, 486.

13. Hymer, W. C., Kuff, E. L., ibid., 1964, v6, 506.

14. Bray, G., Anal. Biochem., 1960, v1, 279.

15. Schmidt, G., Thannhauser, S. J., J. Biol. Chem., 1945, v161, 83.

16. Meites, J., Kahn, R., Nicoll, C., Proc. Soc. Exp. Biol. Med., 1961, v108, 440.

17. Hiatt, H., J. Mol. Biol., 1962, v5, 217.

18. Tamaoki, T., Mueller, G., Biochem. Biophys. Res. Communs., 1962, v9, 451.

19. Henshaw, E. C., Revel, M., Hiatt, H. H., J. Mol. Biol., 1965, v14, 241.

20. Corbin, A., Story, J., Experientia, 1966, v22, 694.

21. Shally, A. V., Saito, T., Arimura, A., Mueller, E., Bowers, C., White, W., Endocrinology, 1966, v79, 1087.

22. McShan, W. H., Meyer, R. K., ibid., 1953, v52, 215.

23. Adiga, P., Rao, P., Hussa, R., Winnick, T., Biochemistry, 1966, v5, 3850.

24. Bloemedal, H., Bont, W., Feltkamp, C., Cancer Res., 1966, v28, 1497.

Received April 17, 1967. P.S.E.B.M., 1967, v125.

Acoustic Profile of Deglutition. (32300)

ROBERT C. MACKOWIAK, HENRY S. BRENMAN, AND M. H. F. FRIEDMAN
Department of Physiology, Jefferson Medical College, Philadelphia, Pa.

During a series of studies on the physiology of swallowing, it became necessary to obtain a precise index of the occurrence of deglutition. Electromyography was among the several forms of energy detection which were investigated. Potentials were recorded from the anterior surface of the neck with bipolar surface electrodes. Although discrete signals were obtained during deglutition, this method was not found suitable for general use. A promi-

FIG. 1. Special contact microphone cemented to Velcro cuff for placement around the neck.

nent shortcoming was the amount of movement artifact recorded in the interval between swallows. Lateral motion and flexion of the neck created signal configurations which were difficult to distinguish from those produced by deglutition. In addition, poor signal-to-noise ratios obtained from surface electrodes required placement of electrostatic shielding around the subject.

In our study it was necessary not to restrict motion of the neck. We found that recording the acoustic energy generated during swallowing offered a more precise index of the occurrence, and had the advantage of low susceptibility to movement artifact. Also, a consistent acoustic profile could be obtained during the act of deglutition, and certain changes in the configuration of this profile were found to relate to the type of swallowed material.

Method. A special contact microphone (Sonotone RE-21030) was placed on the neck of adult human subjects (in good health, male and female) lateral to the midline. This device was held in place by a Velcro cuff placed as shown in Fig. 1. To determine the interaction of deglutition with the respiratory cycle, respiration was monitored with a specially designed nasal sensor(1). No infringement of respiration, swallowing, or motion of the neck was produced by the sensing devices. Signals were processed by Grass P5 and 7P1 preamplifiers and stored on a Roberts tape recorder. Sounds were later displayed on a Model 564 Tektronix Oscilloscope for time expansion analysis and comparison of acoustic patterns. In addition, recordings were submitted to Voiceprint Laboratories of Somerville, N. J., for sound spectrum analysis. Simultaneous ordinate recordings of all variables were made on a Grass Model 7 Polygraph. Recordings were made during passive swallows of saliva ("dry swallows") and during swallows of tap water from a cup *ad lib.* ("wet swallows").

Results. Fig. 2 is an oscilloscope tracing of 2 sequential swallows of water, displayed on the upper and lower traces respectively. The abscissa in both traces is 100 milliseconds per division. Three discrete temporally related acoustic bursts are seen in each swallow. The initiation of swallowing is accompanied by a 50-millisecond duration (alpha) signal. This is followed by a quiet interval, usually of 100-150-millisecond duration (ab-interval). The second acoustic component of the swallowing complex (beta) is usually the longest in duration and averages 150-200 milliseconds. Amplitudes of the alpha and beta components are generally similar. A third acoustic burst (delta) has been noted in most swallows utilizing water. This component generally follows the end of the beta signal by 300-400 milliseconds and is of short duration and low amplitude.

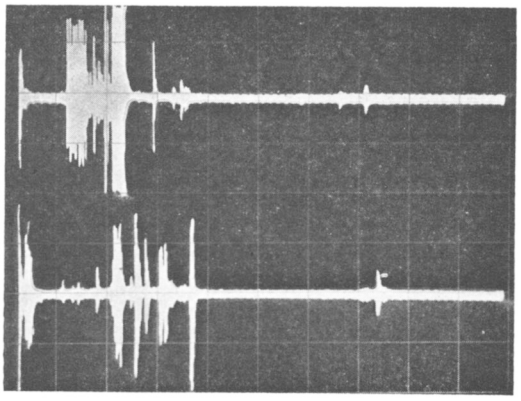

FIG. 2. Recordings on upper and lower trace of sequential swallows of water by the same individual. Vertical time lines at 100-millisecond intervals.

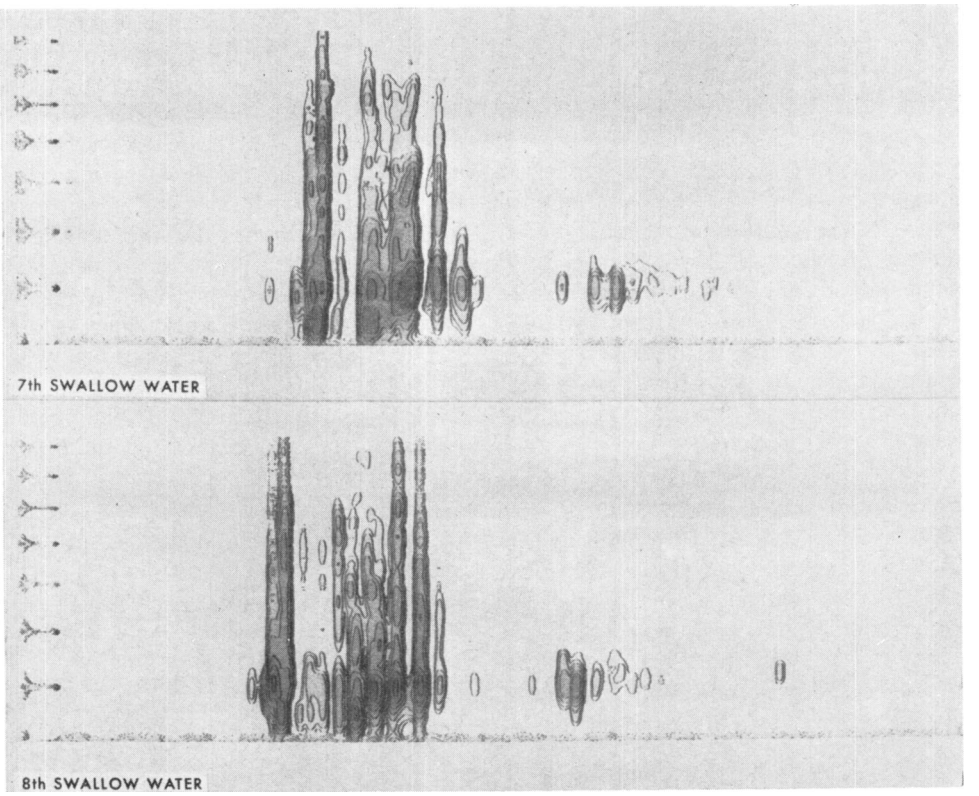

FIG. 3. Sound spectrum analysis (Voiceprint) of same 2 sequential swallows of tap water. Vertical scale indicates frequency with marks from 1 to 7 kilocycles on a semi-log scale. Horizontal scale is time. Degree of shading depicts intensity of sound at specific frequencies.

Fig. 3 is a sound spectrum analysis of the same swallows displayed by the oscilloscope recordings in Fig. 2. The ordinate in this figure is not related to amplitude of the recorded signal, but is a semi-logarithmic function of its frequency. Each division of the left hand scale is 1,000 cycles/second. Sound amplitude is represented by the degree of shading of the tracing, the deeper the shading the higher the intensity. The abscissa is a function of time. The temporal relationship of the alpha, beta, and delta sounds, and of their intervals, is similar to those of Fig. 2. Peak intensity of all 3 components is in the range of one kilocycle. The sound spectrum display gives the opportunity for frequency analysis of the various components of deglutition.

Spectral comparisons were made between so-called "dry" swallows and those during swallowing of a sip of water. Several important differences were noted between "dry" and "wet" swallows: (1) the absolute intensity of "wet" swallows was greater and they tended to be shorter in duration; (2) as shown in Fig. 4, "dry" swallows tended to

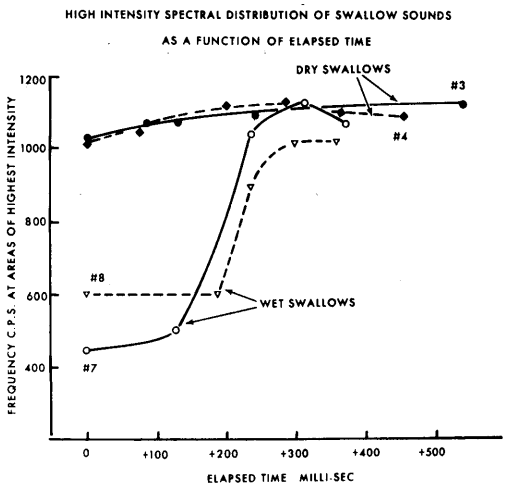

FIG. 4. Graph comparing frequency of peak intensity between "dry" and "wet" swallows along duration of swallowing complex.

show a peak energy at 1,000-1,100 cycles/second for the entire duration of the swallowing sound; "wet" swallows, on the other hand, began at a lower frequency (400-600 cycles/second), and increased in frequency to reach peak intensity at 1,000 cycles/second at the end of swallowing; (3) the delta or third component of the swallowing complex tended to be absent in "dry" swallows. The origin of this component is not known, but the nature of the temporal sequence suggests two possibilities: motion of the epiglottis at the end of deglutition or activity of lower esophageal areas as the swallowed fluid approaches the cardio-esophageal sphincter.

Transient apnea during deglutition was a feature of both "wet" and "dry" swallows. In the vast majority of cases, swallowing occurred during expiration or at the end of inspiration(2). No differences in the time of respiratory inhibition were noted between "dry" and "wet" swallows(3).

Conclusions. Sound produced by the act of swallowing was used to indicate the occurrence of this event. Minimal artifact was produced by this method which imposed no restriction on motion of the neck. A distinct and reproducible acoustic profile of swallowing was recognized. The nature of the swallowed material was found to have specific effects on the configuration of the swallowing complex. Further work requires the simultaneous use of cineradiographic equipment to delineate the physiologic events responsible for the generated acoustic energy. Transient apnea during the expiratory phase of respiration was seen with deglutition. This phenomenon was unrelated to the nature of the swallowed material, and was seen in both "wet" and "dry" swallows.

1. Mackowiak, R. C., Brenman, H. S., Friedman, M. H. F., Journal of Applied Physiology, 1967, v22, 1022.

2. Brenman, H. S., Mackowiak, R. C., Friedman, M. H. F., Proc. of the I.A.D.R., April, 1967

3. Friedman, M. H. F., Brenman, H. S., Mackowiak, R. C., Pierce, L., Fed. Proc. 1967, v26, 383.

Received April 17, 1967. P.S.E.B.M., 1967, v125.

Exposure of *Pseudomonas aeruginosa* to Hyperbaric Oxygen: Inhibited Growth and Enhanced Activity of Polymyxin B.* (32301)

GEORGE H. BORNSIDE

Department of Surgery, Louisiana State University School of Medicine, New Orleans

There has been new interest in the inhibitory effect of high pressure oxygen (HPO) upon the *in vitro* growth of a variety of pathogenic aerobic bacteria(1). Wiseman *et al*(2) found striking differences when the effect of HPO on the growth of aerobic bacteria on solid media was contrasted with that in liquid media. They reported that the results of counts of viable bacteria did not correlate with the size and appearance of colonies, and were unable to demonstrate any effect of HPO upon the activity of several antibiotics. Ollodart and Blair(3) reported the growth of *Escherichia coli, Staphylococcus aureus* and a pseudomonad to be enhanced in liquid cultures under oxygen at 1 atmosphere absolute (1 ATA) but to be inhibited at 3 ATA. Stark and Orr(4) found that growth in broth cultures aerated with 100% oxygen at 3 ATA was greatly retarded; the generation time for *E. coli* was 90 minutes compared to 20 minutes in controls.

The potentiality for growth inhibition on surface cultures and growth enhancement in deeper cultures suggests restrictions in the use of HPO therapy for bacterial infections with aerobes. Irvin *et al*(5) applied oxygen at 2 ATA to guinea pigs with experimental surface wounds infected with *Pseudomonas aeruginosa* and *Staph. aureus*, and observed inhibited bacterial growth during treatment with

* These studies were aided by Contract NR 103-664 between the Office of Naval Research and Louisiana State University.