

The flora of the human alimentary tract: stomach, duodenum, jejunum.

By B. ARONOVITCH, WARREN COLEMAN and MAX EINHORN.

[*From the Department of Medicine, University and Bellevue Medical College and the Third Medical Division of Bellevue Hospital, New York City.*]

The flora of the human alimentary tract has been the subject of numerous investigations, but such studies during life have, of necessity, been confined to the floras of the stomach and duodenum and of the feces, except when operations or post-operative fistulae have permitted approach to other portions of the tract. Obviously, many levels of the alimentary tract have thus been left unexplored.

To obtain a complete picture of the flora of the human alimentary tract in the living subject, and of the changes which the flora undergoes as the intestinal contents travels downward, the method pursued must permit the extraction at will of specimens from any level of the intestine. The introduction of the Einhorn intestinal tube makes it possible to fulfill these conditions. (It may be stated parenthetically that we do not yet know the extreme depth from which intestinal contents may be extracted. We have been able to obtain material from a distance of 135 inches from the lips and hope to make extractions from as far as the ileo-colic valve).

Our studies were begun in the fall of 1920. So far, we have confined our attention to the floras of the stomach, duodenum and jejunum. Certain technical difficulties which we encountered may be referred to:

Coiling of the tube in the stomach or below has occurred so often we have concluded that the true position of the tube can be ascertained only through roentgenographic examination. In all of our subjects, such examinations have been made after each extraction from below the stomach.

Unless the distal end of the intestinal tube is kept closed until the moment of extraction, it is impossible to tell when, or at what level, intestinal contents first enters the tube. Once it enters, the conditions obtaining within the intestine itself are removed and the development of the flora is unrestrained.

Extraction. All extractions were made in the morning before the subject had taken water or food, approximately 15 hours after the last meal.

Extractions from the stomach were made one hour after the tube was swallowed; extractions from the duodenum (below 24 inches) were made three hours after swallowing; for longer tube-lengths, intervals of eighteen hours to thirty-six hours were allowed.

All specimens were delivered to the laboratory within half an hour and at once submitted to the various procedures.

Eight subjects were utilized for the study; some of them were under observation for several months. All were patients in Bellevue Hospital. Sub. I suffered from chronic arthritis and Sub. II from arthritis deformans. (The attempt was made to utilize patients from the Lenox Hill Hospital also, but the distance of this hospital from the laboratory caused too much delay between the extraction and the study of the specimens).

Results. The results obtained in the eight subjects are summarized below. The Table presents the details of the examinations of two subjects at three levels of the alimentary tract.

Stomach Contents—Number of Organisms. The number of viable organisms and spores in the stomach contents were uniformly low except in Subject II in whom the numbers, exclusive of spores, were always high. (It may be added that there was no obvious discharge of pus from this subject's mouth).

Varieties of Organisms. Eleven different varieties of organisms were identified in the gastric contents. Some seven varieties of Gram-positive, spore-bearing bacilli, some of them pleomorphic, were isolated but not identified. The greatest variety of bacteria was found in Sub. I with relatively small total numbers.

The occasional presence in the stomach of organisms, commonly identified with the intestine is probably due to regurgitation from the duodenum.

Cultural Properties. Acid production was the rule in dextrose-broth and litmus-milk. The production of gas was not constant and the quantity was small. Milk was coagulated and the curd was partially or completely digested. Loeffler's serum showed only slight digestion occasionally. Gelatin was partially or completely liquified.

Duodenal Contents. (28 inches from lips). *Number of organisms.* Except in Sub. II, the numbers of viable organisms and spores in the duodenal contents also are small, yet a slight tendency to an increase in numbers is noticeable. In Sub. II the increase is definite. The wide fluctuations in the numbers on different occasions in Sub. II was not discovered.

Varieties Isolated. There is no increase in the varieties of organisms isolated from the duodenal contents, but the diversification of the flora in the individual subject is, as a rule, greater.

The Gram-positive, spore-bearing bacilli are present with the same constancy. *Staphylococcus albus* has disappeared in two subjects. *Streptococci* have appeared in two additional subjects and bacteria, commonly classified as intestinal, such as *B. Coli*, *paracolon bacillus*, *B. acidophilus* and the *enterococcus*, are found with greater frequency.

Cultural Properties. Acid production is still the rule in dextrose-broth and litmus milk. Gas production, though limited in quantity, is slightly more evident. Milk is coagulated and the curd is digested. Loeffler's medium exhibits slight digestion. Gelatin is more frequently liquefied.

Jejunal Contents. (34 inches to 135 inches). *Number of organisms.* In Sub. I, the number of viable organisms, at depths of 87 inches to 135 inches from the lips is strikingly small. In Sub. II, at depths of 90 inches to 115 inches, a decided increase in numbers has occurred, though wide fluctuations may still be noted. In Sub. IV there is a progressive increase to the depth of 60 inches. In Sub. VII there was no increase in numbers down to 60 inches, and in Sub. III the increase was negligible. In only two subjects, Sub. I and Sub. II, were extractions made from below 60 inches.

Cultural Properties. The production of acid in dextrose-broth and litmus-milk is still the rule. Gas is produced more frequently and in greater quantity, especially by flora from the deeper levels. Litmus-milk is coagulated and the curd is digested. Loeffler's medium is only rarely and partially attacked. Gelatin is partly or completely liquified.

Varieties Isolated. Fifteen varieties of organisms were isolated from the jejunal contents, *B. mucosus capsulatus* and *B. proteus* having appeared for the first time. But it may be noted that the total number of examinations of jejunal contents was

	GASTRIC CONTENTS			DUODENAL CONTENTS			JEJUNAL CONTENTS		
	Subject No. 1	Subject No. 2	Subject No. 1	Subject No. 2	Subject No. 1	Subject No. 2	Subject No. 1	Subject No. 2	Subject No. 2
Length of tube.....	Tube in stomach			28 inches			120 inches		
Number of bacteria per c.c. { aerobic Number of spores { anaerobic	200 500 Few	>10 >10 Few	310,000 144,000 2,400,000 Few	1,430,000 2,400,000 Few	>100 >100 Few	>10 >10 Few	>10,000 45,000 Few	100 190 Few	13,000,000 3,260,000 Few
B. coli Paracolon B. aureus Staph. aureus Staph. albus B. subtilis Gram + bacilli (spores) Yeast	B. coli Streptococcus Gram—cocci Staph. aureus Gram + bacilli (spores) Yeast	B. coli Paracolon Gram—cocci M. tetragenus	Streptococcus Gram—cocci Staph. aureus Staph. albus B. acidophilus Gram + bacilli (spores) Yeast	B. coli Paracolon Gram—cocci M. tetragenus	Gram + bacilli (spores) Yeast	Gram + bacilli (spores) Yeast	Gram + bacilli (spores) Yeast	B. coli Paracolon	B. coli Streptococcus B. alcalig. facalis Staph. aureus Staph. albus B. acidophilus Gram + bacilli (spores) Yeast
Organisms isolated.....									Enterococcus B. lact. aerog. B. cloacae B. subtilis
Slightly acid	Acid				Slight or no acidity			Acid Gas	Acid Gas
Dextrose-broth fermenta- tion tube.....	Acid Gas Coagulation Slight diges- tion				Acid Gas Coagulation Digestion			Acid Gas Coagulation Digestion	Acid Gas
Lactofluid's medium.....					No digestion			No digestion	No digestion
Gelatin	Slight or no liquefaction	Complete liquefac- tion			Slight liquefac- tion			Slight or no liquefaction	Complete liquefac- tion

greater. The diversification of the flora became greater in some of the subjects as lower levels of the jejunum were reached; in the majority of them bacilli of the colon group assumed greater prominence. The Streptocci persist in Sub. II and the question arises whether their continued presence indicates a definite localization (infection) in the alimentary tract.

ABSTRACTS OF COMMUNICATIONS

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The determination of iodine in large samples of foodstuffs.

By J. F. McCLENDON and O. S. RASK (by invitation).

[From the Laboratory of Physiological Chemistry, University of Minnesota Medical School, Minneapolis, Minnesota.]

The method of Kendall was found satisfactory for estimating small amounts of iodine as low as 0.02 mg. where destruction of large amounts of organic matter was not involved. If, however, the size of the sample is increased there is a corresponding decrease in accuracy. In order to reduce the bulk of material the following processes were carried out: Cereal grains were made into beer without removal of any solid matter and the alcohol volatilized after making the beer alkaline. In the combustion, the fumes were passed through an alkaline solution to catch the iodine. After the iodine was in the form of I_2 it was shaken out with carbon tetrachloride and then this carbon tetrachloride shaken with a dilute solution of SO_2 to get the iodine into water solution again as iodine. By these processes both organic and inorganic inert constituents may be eliminated.