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Duodenal Isolation of *Salmonella typhi* by String Capsule in Acute Typhoid Fever

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Three of seven volunteers with acute typhoid fever had *Salmonella typhi* isolated from the duodenum using a string capsule device. The string capsule device provides a simple method for culturing *S. typhi* from the duodenal contents. Its possible use in typhoid carriers is discussed.

The string capsule is an accurate, simple, and nontraumatic method for sampling duodenal mucus for the presence of *Giardia lamblia* (2) or *Strongyloides stercoralis* (1). Whether the string capsule can be used for isolation of enteropathogenic bacteria is unknown. In one study, 152 string cultures, obtained from a group of normal Jamaican subjects, failed to detect any enteropathogens (1).

The purpose of this study was to test the ability of the string capsule culture to isolate *S. typhi* in duodenal contents. The study group consisted of eight nonvaccinated volunteers who developed acute typhoid fever while participating as controls in a vaccine efficacy study. All volunteers were healthy, informed, freely consenting inmates of the Maryland House of Correction at Jessup, Md. (Each volunteer agreed to participate after the nature of the study had been explained. No coercion was used, and each man was free to withdraw at any time. The conditions relating to volunteer studies outlined in the Declaration of Helsinki were adhered to in these studies.)

String capsules were kindly supplied by Health Development Corp., Palo Alto, Calif. The string capsule device consisted of a length of nylon yarn coiled into a weighted gelatin capsule. A thread attached to the yarn protrudes from the capsule and allows for the yarn to uncoil as the capsule is swallowed and for retrieval of the yarn from the intestine.

Seven of the eight volunteers swallowed the string capsule before antibiotic treatment during the first week of illness. An additional volunteer swallowed the capsule 24 h after initiating chloramphenicol therapy, as did one of the men who participated before therapy. One of the original volunteers also was sampled by capsule three additional times during a period of relapse.

String capsules were swallowed before sleep, and the string was retrieved in the morning. The final 12 inches of bile-stained string was cut off and dropped into selenite F broth. After 24 h of incubation at 37 C the broth was streaked on MacConkey and Shigella-Salmonella agar. Isolated lactose-negative colonies which developed after a 24-h incubation (37 C) were identified as *S. typhi* by standard methods (3). Blood, stool, and rectal swabs taken within 24 h after removal of the string were cultured by methods previously described (7).

S. typhi was isolated from three of the seven strings retrieved from volunteers with acute typhoid fever. The results of accompanying stool and blood cultures in these seven patients are presented in Table 1. In one patient, isolation of *S. typhi* by string capsule preceded both blood and stool culture isolations.

Two patients swallowed string capsules 1 day after chloramphenicol therapy was started; neither patient had *S. typhi* isolated by the string capsule. Blood and stool cultures for *S. typhi* were also negative at this time. One of the patients had been tested prior to receiving antibiotic therapy and had *S. typhi* isolated by string culture at that time.

The volunteer tested three times during relapse had *S. typhi* cultured from the first two string culture attempts. Stool culture was also positive at both these times.

Acute typhoid fever is accompanied frequently by colonization of the gall bladder with *S. typhi* (4, 8). Although this biliary infection is usually transient, it may become chronic, especially if a locus minoris resistentiae such as a stone (11) or worm (10) is present.

Culture of duodenal aspirate is important in the detection of typhoid carriage. Individuals can excrete *S. typhi* in the bile and yet be undetected by stool culture (5, 6, 9). Because of patient discomfort and the time required for tube placement, duodenal aspiration has not been widely used. The string capsule device provides a useful and simple method for cultur-

TABLE 1. *Comparison of stool, blood, and string capsule cultures in volunteers with acute typhoid fever*

Patient	Days past infection	Cultures on day of string sample			First positive stool culture[a]
		String	Stool	Blood	
1	8	−	+	+	−1
2	34	+	−	−	−2
3	8	−	−	+	+2
4	12	−	−	+	NI[b]
5	8	−	−		−2
6	11	+	−	−[c]	+13
7	9	+	+	+	SD[d]
No. of isolates/total attempts (%)		3/7 (43%)	2/7 (29%)	5/7 (71%)	

[a] Isolations made within first 96 h of infection are excluded. −, Days before string culture; +, days after string culture.
[b] NI, No isolation.
[c] Blood culture became positive 1 day later.
[d] SD, Same day.

ing duodenal contents for the presence of *S. typhi*.

This capsule device should be useful as a simple outpatient method for defining typhoid carriers, with duodenal aspiration being recommended for those who are negative by the string capsule culture.

Trials comparing the efficacy of duodenal aspiration and string capsule in isolating *S. typhi* from chronic carriers are warranted.

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