

## Sensitivity of Moore Sewer Swabs for Isolating *Salmonella typhi*

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**Moore swabs (sewer swabs) have been used successfully to culture pathogenic organisms from wastewater. Sensitivity seems to depend on the size of the waterway sampled as well as the number of organisms present. In Santiago, Chile, we placed 24 swabs into the sewers draining the homes of 10 known chronic carriers of typhoid. Swabs were positive for *Salmonella typhi* in 5 of the 10 households (50%) and 6 of the 24 swabs placed (25%).**

In 1948, Moore used large gauze pads (sewer swabs) to isolate *Salmonella paratyphi* B from sewage outflow of a coastal English village (6). Two years later, using the swab technique, he was able to isolate *Salmonella typhi* and locate the home of a chronic typhoid carrier (7). The swabs were collected 48 h after placement and cultured in Selenite enrichment broth, with subculturing on Wilson and Blair solid medium (WB). By placing swabs in various sizes of sewers, Moore was able to trace back the source of contamination. He suggested that this technique was most successful when sewer swabs were placed in medium-sized sewers since the sensitivity seemed to be inversely related to the diameter of the sewer sampled (8).

The Moore swab, placed into flowing sewer water, apparently acts as a filter to trap and concentrate pathogenic organisms. The swab shows a more accurate microbiologic composition of the wastewater than water samples since the swab reflects the sum of organisms which have passed through it over time. The Moore swab has been used successfully to isolate viruses, mycobacteria, salmonellae, and vibrios from sewage (1, 4) and has proven useful for investigating the epidemiology of typhoid fever, including typhoid epidemics in industrialized nations (10) and studies of endemic typhoid in Chile (9).

The observation of Moore regarding the relationship of the effectiveness of his swab to sewer size was reconfirmed in the 1964 typhoid outbreak in Aberdeen, Scotland, in which Callahan and Brodie (2) found the sewer swab to be an insensitive tool for random sampling of large sewers. More recently, Barrett et al. (1) found the Moore swab to be both a practical and a sensitive tool for the isolation of *Vibrio cholerae* 01 from relatively small sewers. In a previous study, Sears et al. reported that Moore swabs can be used successfully to isolate *S. typhi* from polluted irrigation water in areas with endemic typhoid fever (9). To evaluate further the sensitivity and reliability of the Moore swab, we placed swabs in the small sewers draining the homes of known, chronic carriers of *S. typhi*.

As part of the projects designed to control typhoid fever in Chile, studies have been performed to locate chronic carriers of *S. typhi*. Through one of these previous studies, which evaluated the efficacy of amoxicillin therapy for treatment of the carrier state, a registry of chronic carriers was compiled. Ten carriers, who were unable to participate in this drug trial, were identified, and permission was obtained to place

Moore swabs in the outflow of the sewers draining their homes. The houses of these carriers had flush toilets connected to terra cotta or open pipe drainage. In the front yard of each home was an access panel to the sewer. Most of the houses shared a common sewer with at least one and often two other houses. Swabs were placed directly in the sewers of the homes of the 10 carriers and left for 48 or 72 h. Each sewer was sampled at least two (and usually three) separate times, and an effort was made to assure that the carriers remained home during the time the swabs were in place.

Moore swabs were prepared by wrapping sterile cotton gauze, six inches wide by four feet long (15 cm by 120 cm), around a stiff wire. This was attached to a nylon cord and placed directly into the draining sewage. Most swabs were placed on Friday and collected on Monday to help ensure use of the facilities by the carriers in the households. After 48 to 72 h, each swab was removed from the sewage and placed directly into a wide-mouth jar containing 500 ml of Selenite-F broth (BBL Microbiology Systems, Cockeysville, Md.).

The swabs in the Selenite were incubated at 41°C and subcultured between 18 and 24 h onto *Salmonella Shigella*, bismuth sulfite [WB]), and DCLS (desoxycholate citrate lactose sucrose) agar. (All broth and media were from BBL.) Subculturing was done directly from the broth as well as with a 10-fold dilution of the broth. At 24 h after the swab was removed, the Selenite broth was again subcultured directly and with a 10-fold dilution on the same solid media. Suspicious colonies from the solid media were placed in TSI agar slants. Those giving TSI reactions typical of *S. typhi* were confirmed with standard biochemical tests and by agglutination with appropriate antiserum (3). All isolates were then phage typed.

The homes of 10 asymptomatic, chronic carriers of *S. typhi* were visited. No carrier was taking antibiotics. At least two swabs were placed at different times in each of the sewers draining the homes of these carriers. Table 1 lists the households, the number of swabs placed in each sewer, and the number of times the cultures were positive for *S. typhi*. A total of 24 swabs were placed, and of these, 6 were positive (25%). Although only 25% of the swabs were positive, 5 of the 10 carrier households (50%) were found to have culture-positive swabs.

WB was the most effective medium for isolation of *S. typhi* from the swabs. In four of the six isolates, WB was the only medium on which *S. typhi* could be identified. In one case, an isolate was recovered from both *Salmonella Shigella*

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TABLE 1. Number of swabs positive for *S. typhi* from chronic typhoid carriers

Carrier household	Isolation of <i>S. typhi</i> by Moore swab	No. of positive swabs/no. of swabs placed in sewer
1	—	0/2
2	—	0/3
3	+	2/2
4	+	1/3
5	—	0/3
6	+	1/3
7	+	1/2
8	+	1/2
9	—	0/2
10	—	0/2

medium and WB, and in only one instance was *S. typhi* isolated from Salmonella Shigella and DCLS media without recovery on WB. Of the six isolates, four were recovered on the first subculture (18 to 24 h), both directly and in the 1/10 dilution. Only one isolate that was not recovered by direct isolation was recovered at the 1/10 dilution.

In this study, we placed Moore swabs into the small-diameter sewers draining the homes of known, chronic typhoid carriers in Santiago, Chile. When two or three swabs were placed over time in each sewer, we were able to successfully recover *S. typhi* from one-quarter of the swabs and one-half of the carriers. The ability to isolate typhoid bacillus from these sewers seems to increase with increasing numbers of swabs. We suspect that as more swabs are placed, the ability to find a positive one for each carrier increases. Since we had no way of confirming that the carrier in the household was shedding typhoid bacilli during the time the swab was in place, this isolation rate probably represents a low estimate of the true sensitivity of the swab.

In studies in England in 1954, Kwantes and Speedy (5), while investigating a paratyphoid outbreak with Moore swabs, found that carriers tried to avoid using the toilet facilities to escape detection. We do not know if the typhoid carriers in the households we sampled avoided using the toilet during our swabbing. Ideally, we would have preferred to have simultaneous stool cultures with swab cultures to correlate sensitivity, but due to the study design that was not possible. Even so, our finding that the Moore swab was successful in identifying *S. typhi* carriers 50% of the time suggests that in field epidemiologic situations, it is a useful and practical tool.

In a previous study of Moore swabs in Chile, Sears et al. were able to isolate *S. typhi* 11% of the time from fecally polluted irrigation canals (9). Moore swabs proved to be reliable, inexpensive epidemiologic tools for the isolation of *S. typhi* in Chile, an endemic area. In this study, we have sought to refine our previous observations and have attempted to determine the crude sensitivity of the Moore

swab in a field situation. Moore swabs will detect a known carrier at least 50% of the time if small sewers are sampled at least two separate times. Thus, the Moore swab is a reasonably sensitive method to isolate *S. typhi* and may have practical applications such as sampling the small sewers draining restaurants, food-processing plants, markets, or other institutions in which it could be important to detect carriers.

Moore, in his original studies, suggested that the sewer draining a block of homes was the ideal size for isolating *S. typhi* (8). We have taken this observation one step further and have shown that small sewers directly draining the homes of carriers can be sampled effectively for *S. typhi*. Our observations also reconfirm the utility of WB, as well as Selenite broth enrichment for isolating *S. typhi* and suggest that the use of WB alone may be sufficient since we would have missed only one isolate with such solitary use.

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