elucidation of the source of outbreaks and the relationship of organisms associated with such outbreaks.

Dr. Pickett's letter also addressed a concern relating to the decarboxylase results. As stated in our article, the decarboxylase tests were performed by replicator methods on solid media. We have taken the time to repeat these tests and confirmed that all strains are positive after 24 h. Appropriate controls were tested each time. This method was described originally for the differentiation of members of the family *Enterobacteriaceae*. For this reason we tested all 20 isolates by Moller's formula for decarboxylase (2). Again the strains were positive in our testing system after 4 days of incubation, except for strain 20, which was lysine decarboxylase and arginine dihydrolase negative. Strain 20 was the epidemiologically unrelated strain.

REFERENCES

1. **Gilardi, G. L.** 1991. *Pseudomonads* and related genera, p. 434. *In* A. Balows, W. J. Hausler, Jr., K. L. Herrmann, H. D. Isenberg, and H. J. Shadomy (ed.), Manual of clinical microbiology, 5th ed. American Society for Microbiology, Washington, D.C.
2. **MacFaddin, J. F.** 1979. Biochemical tests for identification of medical bacteria. Waverly Press, Baltimore.

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Identification of *Salmonella typhi* by PCR among Recipients of Oral Typhoid Vaccine Lots

PCR-based investigations by Song et al. at the Asan Medical Center in Seoul, Korea, were carried out with two pairs of oligonucleotide primers to identify the 343-bp fragment of the flagellin gene of *Salmonella typhi* (6). Amplified DNA was detected from peripheral mononuclear cells in 11 of the 12 culture-confirmed cases. By the nested PCR, *S. typhi* DNA was reported in clinically suggested cases of typhoid fever that were even negative by blood culture. The specificity of their PCR-based assays was established by using a local isolate and *S. typhi* ATCC 19430, eight *Salmonella* species lacking *d* antigen, and nine other microorganisms. Except for with the two *S. typhi* strains, there were no amplification products in agarose gel electrophoresis and Southern blot hybridization with any organism. Nevertheless, the specificity of the flagellin-based PCR assays (6) could ideally be established during investigations with various strains of oral typhoid vaccines.

The attenuated Vi-negative *S. typhi* Ty21a strain vaccine, which has a reduced enzyme quantum for lipopolysaccharide synthesis and a restricted capacity to produce lipopolysaccharides (4), has been in extensive use since the 1970s. Presently, *S. typhi* Ty21a is an attractive option and is preferred by travelers over an injectable typhoid vaccine (5). The recent phase I trials with the live oral temperature-sensitive strain of *S. typhi*, (ts)51-1, are also encouraging. There is a freedom from adverse reactions, and during the vaccine's intestinal passage in the vaccinees, the characteristics of the parent strain have remained unaltered (1). *S. typhi* Ty21a strains with deletions in the *aroA* and *aroC* genes have been employed to express a nontoxic 50-kDa fragment of the tetanus toxin (fragment C from a gene incorporated into the chromosome). The strain does not harbor any antibiotic resistance markers and could well emerge as an effective bivalent oral typhoid-tetanus vaccine (3). Moreover, attenuated *S. typhi* strains have also been constructed by introducing deletions in *aroC* and *aroD* or deletions in *cya* and *crp* into one of the two wild strains, Ty2 and ISP 1820. These defined mutations in the aromatic biosynthesis pathway in the cyclic AMP global regulatory system attenuate *S. typhi.* The mutant strains CVD 908 and Chi 3297 have been highly immunogenic but do differ from the wild strain in their propensity to induce fever (7).

Flagellin-based PCR (6) should greatly assist in a specific diagnosis of *S. typhi* from aberrant sites, as the organisms localize in the gallbladder, kidneys, bone marrow, dermal cysts, and tuboovarian and foot abscesses (2). Furthermore, technological modifications in the assay to detect *S. typhi* in saliva, urine, and other purulent fluids would be invaluable from a diagnosis of enteric and nonenteric manifestations of *S. typhi*. The specificity for wild versus attenuated vaccine strains of *S. typhi* would be invaluable for a differential diagnosis of enteric fever among recipients of monovalent or hybrid Ty21a vaccines.

REFERENCES

1. **Bellanti, J. A., B. J. Zeligs, S. Vetro, Y. H. Pung, S. Luccioli, M. J. Malavasic, A. M. Hooke, T. R. Ubertini, R. Vanni, and L. Nencioni.** 1993. Study of safety, infectivity and immunogenicity of a new temperature-sensitive (ts) 51-1 strain of *Salmonella typhi* as a new live oral typhoid fever vaccine candidate. Vaccine **11**:587–590.
2. **Chagla, A. H., M. N. H. Chowdhry, and A. M. Kambal.** 1986. Foot abscess due to *Salmonella typhi*—a case report. Trop. Geogr. Med. **38**:309.
3. **Chatfield, S. N., N. Fairweather, I. Charles, D. Pickard, M. Levine, D. Hone, M. Posada, R. A. Strugnell, and G. Dougan.** 1992. Construction of a genetically defined *Salmonella typhi* Ty2 aroA, aroC mutant for the engineering of a candidate oral typhoid-tetanus vaccine. Vaccine **10**:53–60.
4. **Germanier, R., and E. Furer.** 1975. Isolation and characterisation of gal E mutant of *Salmonella typhi*: a candidate strain for a live oral typhoid vaccine. J. Infect. Dis. **141**:553–558.
5. **Rahman, S., W. Barr, and E. Hilton.** 1993. Use of oral typhoid vaccine strain Ty21a in a New York state travel immunization facility. Am. J. Trop. Med. Hyg. **48**:823–826.
6. **Song, J.-H., H. Cho, M. Y. Park, D. S. Na, H. B. Moon, and C. H. Pai.** 1993. Detection of *Salmonella typhi* in the blood of patients with typhoid fever by the polymerase chain reaction. J. Clin. Microbiol. **31**:1439–1443.
7. **Tacket, C. O., D. M. Hone, R. Curtiss, S. M. Kelly, G. Losonsky, L. Guers, A. M. Harris, R. Edelman, and M. M. Levine.** 1992. Comparison of the safety and immunogenicity of Δ*aroC* Δ*aroD* and Δ*cya,* Δ*crp Salmonella typhi* strains in adult volunteers. Infect. Immun. **60**:536–541.

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