Salmonellosis is a major cause of morbidity in the United States, with an estimated 800,000 to 4 million cases occurring annually (4). At least four major groups of infection associated with salmonellosis are recognized. These groups include gastrointestinal infections, but sepsis was indicated for four patients. Histories from patients with other gastrointestinal infections, but sepsis was indicated for four patients. Histories from patients with no immunocompromised patients in their study and only 30095-1137/99/$04.00 © 1999, American Society for Microbiology. All Rights Reserved.

In an analysis of over 23,000 nontyphoidal strains of Salmonella submitted to the Microbial Diseases Laboratory between 1992 and 1996, two groups (C1 and E) were significantly recovered more often from the urinary tract than stool compared to more common groups such as B and D. An analysis of >60 urine isolates from 1996 suggests that most of these represent true urinary tract infections, as opposed to colonization or fecal contamination, by virtue of being isolated in pure culture and in high concentrations (>100,000 CFU/ml).

Salmonella isolates are mandated by state law to be forwarded to the MDL for serotyping, with the singular exception of Los Angeles county, which performs serotyping and forwards results to the MDL. Salmonella isolates are typed on the basis of a unique combination of somatic and flagellar antigens which are listed for each serotype according to the Kauffmann and White scheme (7). To determine somatic (grouping) and flagellar (typing) factors, alcohol and formalinized antigen suspensions of individual strains were prepared as described by Edwards and Ewing (2). Monoclonal and polyclonal antibodies to all antigens were prepared in house by the Biologics Unit of the MDL. The chi-square test was used for statistical analysis.

In a 5-year (1992 to 1996) retrospective analysis of 23,832 human isolates of nontyphoidal Salmonella strains, 799 (3.4%) originated from urine (females, 70.3%; males, 26.7%; sex not given, 3%). A large outbreak that included numerous urine isolates (n = 45) occurred during this interval. When these strains were corrected for, the percentage of total urine isolates dropped slightly to 3.1%. Examination of these 799 urine isolates indicated that serotypes belonging to groups C1 and E were isolated more often from urine than serotypes belonging to the other commonly encountered Salmonella groups, namely B, C2, and D (Table 1). These differences were statistically significant (P < 0.001). The most common serotypes of group C1 associated with UTIs were Montevideo and Oranienberg, while S. enterica Senftenberg and Meleagridis were the most common group E serotypes associated with urine.

To determine whether these Salmonella isolates represented true UTIs rather than asymptomatic colonization or contamination from feces, information on submittal forms for 67 urine isolates from 1996 were analyzed. For 29 patients (43.2%), Salmonella was recovered in pure culture at >100,000 CFU/ml; in an additional 21 persons (30.4%), Salmonella was recovered in pure culture in concentrations ranging from 10,000 to 100,000 CFU/ml. Eleven individuals had Salmonella isolated in mixed culture; for four of these strains, counts exceeded 100,000 CFU/ml of urine. Four persons had pyelonephritis (two with C1), one had renal failure, and one had a renal stone with which Salmonella counts were >100,000 CFU/ml of urine (group C1). It was not possible to determine from the information on the submittal forms how many persons had concomitant gastrointestinal infections, but sepsis was indicated for four patients. Histories from patients with Salmonella group C1 or E isolates in their urine showed little differences from histories recorded for all other urine isolates.

The frequency of Salmonella isolates associated with urinary
tract specimens in the present study (3.4%) is significantly higher than that reported by Wilkins and Roberts (9), who found that only 0.9% of more than 6,500 isolates were recovered from urine. This association appears to be serogroup related, because both groups C1 and E were recovered more often from urine than the more common groups, such as B and D. It is interesting to note that in a 1982 retrospective study of more than 3,300 urine isolates submitted to the CDC over a 12-year period, six *Salmonella* serotypes had relatively high isolation ratios for urine compared to stool. Of these six serotypes, two (Oranienburg and Infantis) belong to group C1 (10). It may well be that certain serotypes within groups C1 and E have a predilection for causing UTIs.

Retrospective analysis of accompanying laboratory data for >60 cases of salmonellosis associated with urine isolates suggests that this bacterium is a true and often unrecognized cause of UTIs. Supporting documentation for this hypothesis includes the high rate of isolation in pure culture (>70%) and in concentrations >100,000 CFU/ml (>40%). These findings support similar data from other recent investigations (1, 6). Further clarification of the role various groups of salmonellae play in UTIs seems warranted.

**REFERENCES**


**TABLE 1. Relative incidence of different *Salmonella* groups in urine from 1992 to 1996**

<table>
<thead>
<tr>
<th>Group</th>
<th>No. (%) of <em>Salmonella</em> isolates recovered</th>
<th>No. (%) of urine isolates in group</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>10,088 (42.3)</td>
<td>264 (2.6)</td>
</tr>
<tr>
<td>C1</td>
<td>3,087 (13.0)</td>
<td>160 (5.2)</td>
</tr>
<tr>
<td>C2</td>
<td>1,725 (7.2)</td>
<td>52 (3.0)</td>
</tr>
<tr>
<td>D</td>
<td>6,446 (27.0)</td>
<td>136 (2.1)</td>
</tr>
<tr>
<td>E1–E4</td>
<td>680 (2.9)</td>
<td>63 (9.3)</td>
</tr>
<tr>
<td>Other</td>
<td>1,806 (7.6)</td>
<td>123 (6.8)</td>
</tr>
</tbody>
</table>

* A total of 23,832 isolates were recovered.