Urinary Tract Infections Associated with Nontyphoidal *Salmonella* Serogroups

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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).

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 gastroenteritis, septicemia with or without focalized infection, and two syndromes (enteric fever and carrier state) traditionally associated with *Salmonella enterica* serotype Typhi infection (5). In addition to these four syndromes, a number of less-well-described extraintestinal illnesses due to *Salmonella* have been reported. Among these illnesses are urinary tract infections (UTIs) due to nontyphoidal *Salmonella* serotypes.

A retrospective survey conducted by the Centers for Disease Control (CDC) in 1982 identified 3,393 urine isolates of *Salmonella* submitted to their laboratories over a 12-year period (1968 to 1979). Of these cultures, most were recovered from infants younger than 1 year of age or from persons 60 years of age or older (10). In addition, 17 serotypes of *Salmonella* accounted for almost 75% of all urine isolates received by the CDC. More recent surveys of *Salmonella* bacteriuria have focused on risk factors associated with acquisition of UTIs. Such risk factors include immunocompromised conditions, underlying urologic abnormalities, and the handling of exotic pet reptiles such as iguanas (3, 8). While a significant number of isolates are typed on the basis 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 urinary 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 Senftenberg, while *S. enterica* Senftenberg and Meleagris 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

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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

<p>| Table 1. Relative incidence of different Salmonella groups in urine from 1992 to 1996 |
|---------------------------------|----------------------------------|-----------------------------------|</p>
<table>
<thead>
<tr>
<th>Group</th>
<th>No. (%) of Salmonella isolates recovered&lt;sup&gt;a&lt;/sup&gt;</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>C&lt;sub&gt;1&lt;/sub&gt;</td>
<td>3,087 (13.0)</td>
<td>160 (5.2)</td>
</tr>
<tr>
<td>C&lt;sub&gt;2&lt;/sub&gt;</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>E&lt;sub&gt;1&lt;/sub&gt;–E&lt;sub&gt;4&lt;/sub&gt;</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>

<sup>a</sup> A total of 23,832 isolates were recovered.