Proportions of *Streptococcus sanguis*, an Organism Associated with Subacute Bacterial Endocarditis, in Human Feces and Dental Plaque

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The relative absence of *Streptococcus sanguis* in human feces, in contrast to its high concentration on teeth, supports the concept of the mouth as the likely bacterial source in cases of subacute bacterial endocarditis involving this organism.

Alpha-hemolytic streptococci form the single most numerous group of bacteria associated with subacute bacterial endocarditis (15). Of these streptococci, *Streptococcus sanguis* (*Streptococcus s.b.e.; reference 18) has been found in over one third of the cases (5, 8, 10, 12, 14). Early attempts to determine the habitat of *S. sanguis* in humans were unsuccessful (7, 18). It was shown, however, by Carlsson (2, 3) that streptococci forming zooglea on sucrose-agar and considered to be *S. sanguis* preferentially colonize the tooth surface and are constantly present in dental plaque in high numbers. It was, consequently, suggested by Carlsson that the tissues surrounding the teeth are the main sites of entrance of *S. sanguis* in the blood stream (2).

In recent years, dextran-producing streptococci such as *S. sanguis* have received considerable attention from dental researchers (J. D. de Stoppelaar, Ph.D. Thesis, Elinkwijk, Utrecht, 1971). During studies on the ecology of *S. sanguis*, its presence in human feces was investigated.

Stool specimens (75 to 100 mg) were obtained from 40 individuals who were residents of a state institution for the mentally retarded (Lincoln State School, Lincoln, Ill.). The subjects ranged in age from 2 to 37 years and were not receiving any type of medication. Dental plaque samples were also obtained from the same individuals, 3 months after collection of the feces samples, by scraping buccal tooth surfaces with sterile periodontal scalers. The feces samples were dispensed in vials with 5 ml of Trypticase soy broth (BBL containing small glass beads and were then shaken on a Vortex mixer to homogenize the material. The plaque samples were dispensed in vials with VMG II medium (11) and similarly homogenized. Samples of appropriate dilutions, after 10-fold serial dilutions of the suspensions in Trypticase soy broth, were streaked on Mitis-Salivarius agar (Difco) plates. All fecal and plaque samples were cultured immediately after collection. After 2 to 3 days of aerobic incubation at 37 C, the percentage of the total number of streptococci which was *S. sanguis* was determined by utilizing colonial morphology as the basis for identification (2). The colonies were examined and counted on plates containing from 50 to over 1,000 colonies by using a stereoscopic microscope with 15x magnification.

*S. sanguis* colonies were characteristically zoogleic in nature, firmly attached to the agar surface, of very hard consistency, and often deformed the surrounding agar (2). To determine whether fecal strains producing zoogleic colonies, similar to those produced by oral *S. sanguis*, were similar in other respects to oral *S. sanguis*, two or three colonies were picked from each of five plates inoculated with feces from five of the subjects and the strains were characterized as outlined by Carlsson (2–4). The characters of all strains were found to agree closely with isolates identified as *S. sanguis* obtained from dental plaque of subjects from various populations (4, 5, 17; J. D. de Stoppelaar, Ph.D. Thesis, Elinkwijk, Utrecht, 1971). All isolates were gram-positive, alpha-hemolytic, facultative, chain-forming cocci. They were negative with respect to the production of catalase, oxidase, and indole and with respect to the reduction of nitrate. No growth was observed in 6.5% NaCl broth, and few strains grew at 45 C. All strains reduced and coagulated 0.005%, but not 0.1%, methylene blue milk. All isolates produced acid from glucose, fructose, sucrose, and lactose but not from mannitol, sorbitol, or starch. The terminal pH in glucose broth ranged from 4.4 to 4.8; gas was not produced. In 5% sucrose broth, but not in glucose broth, all strains increased the viscosity of...
the medium and produced material which was precipitable from the culture supernatant fluid with one part of ethanol. About half of the strains closely resembled *Streptococcus* s.b.e. (18) or Carlsson's oral *S. sanguis* group 1B (4). These strains hydrolyzed arginine and esculin, produced acid from inulin, trehalose, salicin, and cellobiose, and were variable in this respect with raffinose and melibiose. The other strains resembled Carlsson's oral *S. sanguis* group 1A (4). These strains were unable to hydrolyze arginine or esculin or produce acid from cellobiose and salicin. They fermented raffinose and melibiose and were variable in the fermentation of inulin and trehalose.

*S. sanguis* could not be detected in the feces of most of the subjects, and only in a few subjects did this organism constitute more than 1% of the facultative streptococci (Table 1). Moreover, in about one-third of the subjects, no *S. sanguis* colonies were observed on plates with 1,000 or more colonies of other streptococcal types. In contrast, *S. sanguis* was found in all plaque samples and constituted more than 10% of the facultative streptococci in over half of the subjects. In adult subjects, facultative streptococci have been found to comprise, in general, about 0.1% or less of the total anaerobically cultivated bacteria of feces (13, 16), whereas this percentage for dental plaque is on the order of 25 or higher (2, 3, 6). Since *S. sanguis* comprises only a small percentage of the facultative streptococci in feces (Table 1) but from about 20 (Table 1) to 50% (2, 3) of the facultative streptococci in dental plaque, the population density of this organism in feces is at least on the order of 5,000 to 10,000 times smaller than that in dental plaque. It is of interest to note that *S. mutans*, which has also been found to be associated with subacute endocarditis (1, 5), likewise appears to have the teeth as its usual habitat (3) and forms only a very small part of the cultivable fecal flora (9).

Although the infecting organisms in subacute bacterial endocarditis cases are of diverse origin, the human oral cavity has for a long time been considered as an important source. The fact that both *S. sanguis* and *S. mutans* preferentially colonize tooth surfaces but are relatively rare in feces supports the concept of the oral cavity as the likely bacterial source in subacute bacterial endocarditis cases involving these organisms.

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**TABLE 1. Distribution of the 40 subjects according to the percentage of *Streptococcus sanguis* of total aerobically cultivated streptococci in feces and dental plaque**

<table>
<thead>
<tr>
<th>Determination</th>
<th>Percentage of S. sanguis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.01-1.0</td>
</tr>
<tr>
<td>Feces</td>
<td></td>
</tr>
<tr>
<td></td>
<td>31</td>
</tr>
<tr>
<td>Dental plaque</td>
<td>0</td>
</tr>
</tbody>
</table>

* No *S. sanguis* found on plates with 50 or more colonies. The percentage of *Streptococcus sanguis* in feces ranged from less than 0.03 to 33 (mean, less than 1.8) and in dental plaque from 1 to 99 (mean, 22.3).

**LITERATURE CITED**