Colonization of Bacteria on Polyvinyl Chloride and Teflon Intravascular Catheters in Hospitalized Patients

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Received 10 June 1983/Accepted 8 August 1983

During an 8-month period all intravascular catheters were removed by sterile technique upon completion of use and submitted to the hospital microbiology laboratory. All catheters were routinely cultured by the semiquantitative culture technique, with ≥ 15 colonies being defined as a positive result. Of the 687 Teflon catheters cultured, 6.9% were positive by culture, compared with 24.6% of 77 polyvinyl chloride catheters (P < 0.001). Also, colonization of coagulase-negative staphylococci on polyvinyl chloride was more than on Teflon. These data suggest that polyvinyl chloride catheters are colonized more frequently with organisms than are Teflon catheters; additionally, there is an increased affinity of coagulase-negative staphylococci for polyvinyl chloride as compared with Teflon, substantiating our previous observations with an in vitro system. We conclude that the type of catheter material may be important in determining the incidence of catheter-related infections and in selective colonization by coagulase-negative staphylococci.

Infections associated with intravascular devices represent a serious but potentially preventable source of morbidity and mortality in hospitalized patients. Nonsterile insertion techniques, prolonged use of intravascular (IV) catheters, administration of irritating infusates, and other similar factors may predispose patients to catheter infections, although the exact mechanisms that initiate infection are poorly understood.

Bacterial colonization of IV catheters appears to be a key step in this process and likely precedes the development of clinical catheter infection. Why certain bacteria tend to cause these infections whereas other organisms are less frequently encountered in this setting is unclear. In an earlier in vitro study, we demonstrated that coagulase-negative staphylococci, but not Escherichia coli, had a significantly greater affinity for polyvinyl chloride (PVC) than for Teflon (TEF) catheters, as evidenced by quantitative bacterial cultures and scanning electron microscopy. The present study was designed to analyze differences in rates of bacterial colonization of PVC and TEF catheters during clinical use and to compare the bacterial species involved.

(This work was presented in part at the 83rd Annual Meeting of the American Society for Microbiology, New Orleans, La., 1983.)

MATERIALS AND METHODS

Catheter data. Infection control policy in our hospital requires that all IV catheters except hyperalimentation lines be removed within 3 days by sterile technique and be submitted to the microbiology laboratory for semiquantitative cultures. During the period of 1 January to 31 August 1982, all IV catheter samples thus received were identified by patient name, date, type of catheter, and catheter material.

Microbiological processing. The distal tips (4- to 6-cm lengths) of submitted catheters were processed by the blood agar roll technique for semiquantitative culture by the method of Maki et al. (7). Blood agar plates were incubated for 18 h at 36°C and examined visually for colonies. A colony count of ≥ 15 colonies per roll culture plate was defined as a positive result. All bacteria were then identified by standard microbiological techniques (4), including use of the API 20E system (Analytab Products, Plainview, N.Y.).

Data analysis. At the conclusion of the study, data on 787 catheter specimens were stratified by catheter type, composition, and culture results. There were 687 TEF catheters, of which 201 were 24-in. (ca. 61-cm) long-line catheters used for measuring central venous pressure. All 77 PVC catheters were long lines used for pulmonary arterial pressure monitoring. No hyperalimentation catheters were included. Twenty-three catheters were excluded from the study because they were of different materials. The chi-square test was used for comparisons of statistical significance.

To determine whether the duration of catheter use was similar for PVC and TEF catheters, the charts of 53 patients with IV lines were selected at random and
Catheter was found to be colonized with coagulase-negative staphylococci as compared with TEF catheters (85% versus 54%, \( P < 0.05 \)).

**DISCUSSION**

The results from our survey of clinical catheter colonization indicate that PVC catheters were colonized more frequently with bacteria than were TEF catheters and that colonization of PVC catheters was more likely to be due to coagulase-negative staphylococci, whereas TEF catheters were colonized with a wider variety of microorganisms. In a previous report (10), we described an in vitro system for comparing quantitative adherence of bacteria to different catheter materials. Coagulase-negative staphylococci were demonstrated to have a significantly greater affinity for PVC than for TEF catheters. In addition, the number of coagulase-negative staphylococci adherent to PVC catheters was significantly greater than the number of *E. coli*.

Christensen et al. recently reported a nosocomial outbreak of coagulase-negative staphylococcal septicemia related to the use of IV catheters (2). Interestingly, a retrospective determination of catheter types in use at the time of the outbreak indicated that all were PVC catheters (personal communication).

The reasons why coagulase-negative staphylococci appear to have greater in vitro and in vivo affinity for PVC than for TEF are not clear. The interaction of bacteria with other surfaces may depend on multiple factors, including intrinsic catheter surface features such as hydrophobicity (9), presence of trace materials (1), surface charge differences, microbial traits such as glycolcalyx or pilus production (3, 5, 8), or as yet unknown factors. The presence of fibrin, plasma products, and other materials circulating in the host may also participate in this interplay (11). Several studies have demonstrated some of the morphological features of bacterial adherence to catheter surfaces (3, 6, 8). Whether survival and growth of coagulase-negative staphylococci on

<table>
<thead>
<tr>
<th>Catheter type</th>
<th>No. of organisms(^a)</th>
<th>% Positive</th>
<th>Total</th>
<th>CNS</th>
<th>GNB</th>
<th><em>Staphylococcus aureus</em></th>
<th>Yeasts</th>
<th>Miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC</td>
<td>19/77(^b,c)</td>
<td>24.6</td>
<td>20</td>
<td>17</td>
<td>(85%)(^d,e)</td>
<td>2 (10%)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>All TEF</td>
<td>48/687(^b)</td>
<td>6.9</td>
<td>63</td>
<td>39</td>
<td>(61.9%)(^d)</td>
<td>10 (15.8%)</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Long-line TEF</td>
<td>26/201(^c)</td>
<td>12.9</td>
<td>35</td>
<td>19</td>
<td>(54.3%)(^d)</td>
<td>6 (17%)</td>
<td>1</td>
<td>6</td>
</tr>
</tbody>
</table>

\(^a\) CNS, Coagulase-negative staphylococci; GNB, gram-negative bacilli.

\(^b\) \( P < 0.001 \).

\(^c\) \( P < 0.02 \).

\(^d\) 0.005 < \( P < 0.10 \).

\(^e\) \( P < 0.05 \).
BACTERIAL COLONIZATION OF IV CATHETERS

Catheter tips in vitro and in vivo are by similar mechanisms is also not clear. Based on studies using scanning electron microscopy, Peters et al. (8) have suggested that the catheter surface is eroded by bacteria, especially coagulase-negative staphylococci, with microcolony formation on catheters. This could be a common factor for the in vitro and in vivo adherence phenomenon. Regardless of the mechanisms involved, there appears to be an affinity of coagulase-negative staphylococci for PVC catheters, both in vitro and in vivo. Further efforts to investigate these interactions may help to clarify the pathogenesis of catheter-associated infections and suggest a possible means for interrupting or preventing colonization of synthetic IV catheters. Such studies may result in a reduction in the number of clinical infections related to these catheters.

ACKNOWLEDGMENT

We thank Catherine A. Walther for typing and editorial assistance.

LITERATURE CITED