Risk of bacteremia from temporary hemodialysis catheters by site of insertion and duration of use: A prospective study

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Background. Uncuffed, nontunneled hemodialysis catheters remain the preferred means to gain immediate access to the circulation for hemodialysis. Bacteremia is the primary complication that limits their use. The risk of bacteremia by site of insertion and duration of use has not been well studied.

Methods. Two hundred eighteen consecutive patients who required a temporary hemodialysis catheter were prospectively followed.

Results. Catheters were placed at 318 new insertion sites and remained in use for a total of 6235 days. The incidence of bacteremia was 5.4% after three weeks of placement in internal jugular vein and 10.7% after one week in femoral vein [relative risk for bacteremia 3.1 (95% CI, 1.8 to 5.2)]. The incidence of bacteremia was 1.9% one day after the onset of an exit site infection but increased to 13.4% by the second day if the catheter was not removed. Guidewire exchange for malfunction and patient factors did not significantly affect the risk of bacteremia.

Conclusions. Internal jugular catheters may be left in place for up to three weeks without a high risk of bacteremia, but femoral catheters in bed-bound patients should be removed after one week. Catheter exchanges over a guidewire for catheter malfunction do not increase bacteremia rates. Temporary catheters should be removed immediately if an exit site infection occurs.

Uncuffed, nontunneled hemodialysis catheters are an essential method of gaining immediate access to the circulation, but bacteremia complicates their use. Temporary catheters are usually inserted in the femoral vein in bed-bound patients, including the critically ill, or in the internal jugular vein in ambulatory patients. The latter site is used in dialysis programs in which the resources to immediately place cuffed, tunneled catheters are not available. The National Kidney Foundation-Dialysis Outcomes Quality Initiative (NKF-DOQI) guidelines recommend that temporary catheters should remain in place no longer than 5 days at the femoral vein and 21 days in the internal jugular site and subclavian site based on the cumulative risk of bacteremia [1]. The committee acknowledged that this recommendation was primarily opinion-based and that large prospective studies of bacteremia from temporary catheters had not been performed. This study was undertaken to better characterize the risk of bacteremia according to duration of use and site of insertion, particularly at the femoral and internal jugular sites.

METHODS

Patients were prospectively followed at St. Joseph’s Hospital (Hamilton, Ontario, Canada), which serves approximately 600 patients with end-stage renal disease and is a referral center for acute renal failure. All patients who received a temporary hemodialysis catheter (Arrow International, Reading, PA, USA) from December 1996 to December 1997 were followed from the day of catheter insertion to the day the catheter was no longer needed. Any given patient could receive multiple catheters at multiple insertion sites in order to maintain access. Baseline patient data were recorded at the time of insertion.

Catheters were inserted by attending nephrologists (9%), renal fellows (37%), medical residents with supervision (47%), radiologists (6%), and others (1%). Sterile technique included hand scrubbing, gown, glove, mask, and surgical drape. Skin was disinfected with 10% providone (Professional Disposables Inc., Mississauga, Ontario, Canada) and 70% isopropyl alcohol (Ingram and Bell Medical, Don Mills, Ontario, Canada) or 2% chlorhexidine (Novopharm Ltd., Toronto, Ontario, Canada) and alcohol. Exit sites were dressed with transparent dressings (Tegaderm; 3M, St. Paul, MN, USA).

Bacteremia was defined as a positive blood culture in a patient with signs of bacteremia. Bacteremia was
confirmed as catheter related when the same organism isolated from the blood was isolated from the catheter tip or when the signs of bacteremia resolved shortly after removal of the catheter and no other source was found [2]. Exit site infection was defined as purulent drainage from the exit site or when other signs of inflammation occurred (redness, pain, and swelling) in conjunction with a positive culture from the catheter tip [3].

Infection-free survival was calculated using the life table method. Risk factors were analyzed using the multivariable Cox proportional hazards model [4]. The entire catheterization period (all insertion sites) was modeled to analyze patient factors, and individual insertion sites were modeled to analyze site of insertion and guidewire exchange. The assumption of proportional hazards was verified by examining Schoenfeld residuals. Infection risk over time was evaluated by plotting the negative logarithm of the infection-free survival curve over time. Analysis was performed with SAS system software (version 6.12; Cary, NC, USA).

RESULTS
Catheters were placed in 218 patients. Seven patients transferred to another hemodialysis center with the catheter in place, so follow-up was complete on 211 patients over 6325 days. No other patients were excluded. Four hundred seventeen individual catheters were inserted at 318 new insertion sites. There were 193 internal jugular, 91 femoral, and 34 subclavian insertions.

Twenty-four catheter bacteremias occurred, resulting in a rate of 3.8 per 1000 catheter days. The risk of bacteremia varied significantly according to the duration of use and site of insertion (Table 1). For the femoral site, the bacteremia rate was 3.1% up to one week of placement, but increased to 10.7% by two weeks. The bacteremia rate at the internal jugular site was 5.4% up to three weeks of use, but increased to 10.3% by the fourth week. The relative risk of bacteremia at the femoral site compared with the internal jugular site was 3.1 (95% CI, 1.1 to 8.5). The risk of bacteremia increased weekly for femoral catheters but did not increase until the third week for internal jugular catheters (Fig. 1).

Fifty-eight exit site infections occurred. Eleven of 24 (46%) bacteremias were preceded by an exit site infection. The likelihood of bacteremia within one day of the exit site infection was 1.9% but increased to 13.4% by the second day (Table 2).

The risk of bacteremia at an insertion site did not increase with one or more guidewire exchanges for malfunction [relative risk 0.9 per exchange (95% CI, 0.5 to 1.5)]. The risk of bacteremia and/or exit site infection during the catheterization period (includes all catheters used for the patient) was not affected by age, male sex, diabetes, immunosuppression, admission to the intensive care unit, or chronic renal failure.

DISCUSSION
In 1961, Shaldon, Chiandussi, and Higgs first introduced temporary hemodialysis catheters, and these catheters continue to be the primary means of achieving acute hemodialysis access [5, 6]. The questions for clinicians are what is the risk of bacteremia and how long should catheters remain in place before the risk is too high. This prospective study found a bacteremia rate of 3.8 per 1000 catheter days, which is similar to other prospective studies of temporary catheters that range from 3.9 to 9.7 bacteremias per 1000 catheter days [7–11]. However, the incidence of infection and risk of infection over time vary significantly according to site of insertion. Although this concept was reflected in the NKF-DOQI guidelines on vascular access, which recommend removal of femoral catheters after five days of use and internal jugular catheters after three weeks of use, the authors acknowledged this guideline was predominantly opinion based. Our study shows that for bed-bound patients with femoral catheters, including the critically ill, the incidence of bacteremia rises rapidly after seven days of use. The study was not powered to distinguish meaningfully the different bacteremia rates between five and seven days of use. For ambulatory patients with internal jugular catheters, the incidence of bacteremia is acceptable until three weeks of placement. These observations support the current recommendations to remove catheters routinely to prevent bacteremia [1]. We do acknowledge, however, that a randomized comparison of routine removal at a given time compared with leaving the catheter in place has not been performed.

In contrast to other investigators [9, 10], we found that patients were not exposed to a constant risk of bacteremia over time, but rather the risk increased with duration of use. The increase was greater for the femoral catheters than internal jugular catheters. Because of this difference in risk, the incidence of bacteremia was greater at the femoral site during each week of use and the difference in risk, the incidence of bacteremia was greater at the femoral site after five days of use and internal jugular catheters after three weeks of use, the authors acknowledged this guideline was predominantly opinion based. Our study shows that for bed-bound patients with femoral catheters, including the critically ill, the incidence of bacteremia rises rapidly after seven days of use. The study was not powered to distinguish meaningfully the different bacteremia rates between five and seven days of use. For ambulatory patients with internal jugular catheters, the incidence of bacteremia is acceptable until three weeks of placement. These observations support the current recommendations to remove catheters routinely to prevent bacteremia [1]. We do acknowledge, however, that a randomized comparison of routine removal at a given time compared with leaving the catheter in place has not been performed.

An interesting relationship between exit infection and bacteremia was also observed. First, exit site infection is not a prerequisite for bacteremia. Approximately half

### Table 1. Likelihood of bacteremia from temporary hemodialysis catheters according to site of insertion and time of placement

<table>
<thead>
<tr>
<th>Interval weeks</th>
<th>Internal jugular</th>
<th>Femoral</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–1</td>
<td>1.7</td>
<td>3.1</td>
</tr>
<tr>
<td>1–2</td>
<td>4.6</td>
<td>10.7</td>
</tr>
<tr>
<td>2–3</td>
<td>5.4</td>
<td>18.1</td>
</tr>
<tr>
<td>3–4</td>
<td>10.3</td>
<td>29.1</td>
</tr>
</tbody>
</table>
Fig. 1. Hazard of bacteremia according to site of insertion and duration of placement. This plot of the negative logarithm of infection-free curve versus time provides an estimate of the hazard (risk) of bacteremia over weekly time intervals. The slope of the line estimates the hazard. At one week, the hazard (risk) of infection at the femoral site increases but remains relatively flat for the internal jugular site. At three weeks, the hazard increases at both the femoral (solid line) and internal jugular (dashed line) sites.

Table 2. Likelihood of bacteremia following exit site infection

<table>
<thead>
<tr>
<th>Number of days from onset of exit site infection</th>
<th>Probability of bacteremia</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.9</td>
</tr>
<tr>
<td>2</td>
<td>13.4</td>
</tr>
<tr>
<td>3</td>
<td>16.0</td>
</tr>
<tr>
<td>5</td>
<td>18.8</td>
</tr>
<tr>
<td>7</td>
<td>22.2</td>
</tr>
</tbody>
</table>

the bacteremias occurred without a preceding or concurrent exit site infection. This suggests that luminal contamination is an important source of bacteremia, an observation supported by Almirall et al, who found that three of nine hemodialysis catheter-related bacteremias were luminal related [9]. Indeed, interventions designed to reduce intraluminal contamination have shown preliminary success in reducing catheter-related bacteremia (abstract; Sodemann, J Am Soc Nephrol 8:173A, 1997). The incidence of bacteremia is less than 2% one day after the onset of exit site infection but jumps to 13% at two days and 20% by the end of the week. Second, once exit site infection occurs, bacteremia swiftly follows. In summary, temporary catheters are an essential means of acute hemodialysis access. Bacteremia remains the primary barrier to their long-term use. The risk of bacteremia from femoral catheters warrants their removal at one week. In contrast, internal jugular catheters maintain a low risk of bacteremia until three weeks of use. Exchange of a catheter over a guidewire to treat malfunction does not increase the risk of bacteremia. Exit site infection should prompt immediate removal of temporary catheters.

ACKNOWLEDGMENTS

M.J. Oliver is supported by a Kidney Foundation of Canada Fellowship. These data were presented in part at the 31st Annual Meeting of the American Society of Nephrology in Philadelphia, PA, USA. The authors thank the patients and nursing staff who participated in this study, and Dr. O. Indridason for his support and advice.

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REFERENCES