Is Routine Replacement of Peripheral Intravenous Catheters Necessary?

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Background: Guidelines developed by the Centers for Disease Control and Prevention, Atlanta, Ga, recommend that peripheral intravenous catheters be changed every 3 days. However, routine replacement of central venous catheters is no longer supported in their latest update.

Objective: To evaluate the risk to patients of having peripheral intravenous catheters left in place for as long as they are clinically indicated.

Methods: This observational study in a university-affiliated, 700-bed hospital was designed to evaluate the day-specific risk (incidence density) for phlebitis, catheter infection, and obstruction with catheters remaining in place as long as clinically indicated. All consecutive patients who required peripheral intravenous catheterization for 24 hours or more were enrolled during a 10-week period. Outcome variables are phlebitis, catheter-related infections, and obstruction. Evaluated risk factors include age, sex, underlying disease, anatomical insertion site, catheter diameter, first or subsequent catheter, duration of catheterization, type of admission, hospital location, type of infusate, and antibiotic therapy.

Results: A total of 609 catheters that were in place for 1 to 28 days were evaluated. Phlebitis, catheter-related infection, and obstruction occurred in 19.7%, 6.9%, and 6.0% of catheters, respectively. We were unable to demonstrate an increased risk after 3 days of catheterization. The day-specific risk indicated a linear function of all outcome variables.

Conclusions: The hazard for catheter-related complications—phlebitis, catheter-related infections, and mechanical complications—did not increase during prolonged catheterization. The recommendation for routine replacement of peripheral intravenous catheters should be reevaluated considering the additional cost and discomfort to the patient.

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About 150 million intravascular devices are purchased in the United States each year for intravenous therapy for approximately 30 million patients. It is estimated that 850,000 catheter-related infections and 25,000 to 100,000 catheter-related bloodstream infections occur in the United States each year. Close to 90% of these infections are observed mainly with central venous catheter use. However, in patients with peripheral intravenous catheters, 3 types of complications occur frequently: (1) phlebitis, (2) catheter-related infection, and (3) obstruction of the catheter. To minimize the complications associated with peripheral intravenous catheter use, the Centers for Disease Control and Prevention (CDC), Atlanta, Ga, recommends in its 1981 published guidelines routine replacement of peripheral intravenous catheters every 48 to 72 hours “because of a sharp increase in the rate of infection after this length of time.” Even in the updated guidelines in 1996 the CDC recommends rotating catheter sites at 48- to 72-hour intervals. However, new punctures cause discomfort for the patient and add to the cost of intravenous therapy, as do replacement of dressings and delivery systems. Several studies demonstrate that routine changes of dressings of peripheral intravenous catheters and routine changes of the delivery system every 24 hours are not cost-effective. Tully et al in 1981 and Maki and Ringer in 1991 demonstrated that use of new materials in the manufacture of catheters substantially reduces the rate of phlebitis even if catheters are used for longer than 2 days. The rate of complications decreased when polyvinyl chloride was replaced with polyethylene and later with fluorocarbon resins (Teflon) and polyurethane. Large studies with these ma-
PATIENTS, MATERIALS, AND METHODS

PATIENTS AND CATHETER SELECTION

The Kantonsspital Aarau is a 700-bed, university-affiliated tertiary care center in Aarau, Switzerland. An observational study was chosen to answer the study question.

The study population included consecutive patients from the Department of Internal Medicine (150 beds) and both the surgical and medical intensive care units (ICUs) (23 beds) of the Kantonsspital Aarau. From July 1, 1992, through September 9, 1992, all consecutive patients with peripheral intravenous catheters that were expected to stay in place for at least 24 hours were included in the study. Catheters that had fluorocarbon resins with injection ports (Venflon, BOC Om eda AB, Helsingborg, Sweden) were used exclusively, with 1.0-, 1.2-, 1.4-, or 2.0-mm diameters. The study has been approved by the local ethics committee. Informed consent was obtained from all patients enrolled in the study.

HANDLING OF THE CATHETERS

Physicians and nurses were not allowed to change a catheter without documented clinical indication throughout the study. Catheter insertion and care were standardized. Before insertion, the skin was disinfected with a solution of 0.1% povidone-iodine in isopropyl alcohol (Braunoderm, Braun Medical Ltd, Sempach, Switzerland). A self-adhesive dressing (Primapore, Smith & Nephew, Vibraye, France) was attached after fixing the wings of the catheter to the skin using self-adhesive tape (Spara-drap, IVS Ltd, France) was attached after fixing the wings of the catheter. An elastic bandage was additionally applied to reduce the risk of inadvertent withdrawal in non-ICU patients. The self-adhesive gauze was changed daily. The tapes were replaced only when they were soiled or insufficiently fixed. At this time, the insertion site was checked for signs of inflammation or infection. The skin was disinfected again before redressing. Infusion delivery systems were changed every 24 hours. This was standard procedure, although studies did not show cost effectiveness with this approach.

COLLECTION OF CLINICAL DATA

Daily dressing changes were personally observed by a designated investigator (T.B.) who checked the insertion site for local signs of inflammation or infection and for malfunction of the catheter. In addition, the following variables were recorded on the case report form: age, sex, underlying disease, temperature, type of infusate, antibiotic therapy, catheter diameter, anatomical insertion site, type of fixation, hospital location during insertion (ward, emergency department, operating room, or ICU), type of admission (regular or emergency), and duration of catheterization.

In cases of suspected or definite clinical complications, the catheter was removed. In the absence of clinical complications (phlebitis, malfunction, and obstruction), catheters were left in place as long as they were used for intravenous therapy. Idle catheters were not allowed.

MICROBIOLOGICAL INVESTIGATIONS

No disinfection was allowed before removal of the catheter to avoid false-negative results of the roll-plate cultures. When catheters were removed, the catheter tip was immediately sent in a sterile tube to the laboratory for semiquantitative cultures (SQCs) by the roll-plate technique described by Maki et al in 1977. Catheter tips were sent to the laboratory by a pneumatic tube system, allowing the cultures to be performed within 2 hours of withdrawal of the catheter.

STATISTICAL CONSIDERATIONS

To evaluate the risk factors, the following variables were analyzed: age, sex, anatomical insertion site (hand or forearm), catheter diameter (1.0, 1.2, 1.4, or 2.0 mm), first or subsequent catheter, type of admission (regular or emergency), hospital location (emergency department, operating room, ICU, or ward), type of infusate (glucose, saline solution, transfusion of erythrocytes), antibiotic therapy, phlebitis, and obstruction. In addition, underlying disease was recorded and stratified into high, moderate, or low risk as described by Tager et al.

Phlebitis, catheter culture results, and obstruction were outcome variables for the analysis. The Cox proportional hazard model was used to determine which of the variables associated with phlebitis, positive SQC results, or obstruction by univariate analysis independently predicted any of the complications. Kaplan-Meier plots were used to describe complication-free survival of the catheters.

DEFINITIONS

Phlebitis is indicated by the presence of at least 2 of the following signs or symptoms on examination of the catheter insertion site: redness, swelling, palpable venous cord, tenderness, or pain.

Catheter-related infection requires growth of more than 15 colony-forming units in the roll-plate culture to be considered significant colonization of the catheter.

Catheter-related bloodstream infection comprises positive SQC and blood culture specimens growing the same species without another apparent source for septicemia.

A catheter is considered to be obstructed if obstruction occurs without signs of inflammation at the insertion site. If signs of inflammation are additionally present, the case is recorded as phlebitis with an obstructed catheter.

RESULTS

A total of 451 patients (247 men and 204 women) were enrolled in the study, and 665 catheters were used. Ninety patients (20%) were in the ICU. The mean (±SD) pa-

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tient age was 64±16 years (range, 19-94 years) on the wards and 58±20 years (range, 13-92 years) in the ICU.

Of the 665 catheters, 609 were fully evaluable (Table 1). Fifty-six catheters were unavailable for culture because of inadvertent withdrawal (n=22), because of patient transfers to other hospitals (n=10), or because the catheter was not sent to the laboratory (n=24). Thirty-nine (70%) of the 56 catheters that were not cultured had no clinical complications, 6 (11%) showed phlebitis, and 1 (2%) was clotted.

Clinical complications occurred with 156 catheters (25.6%). Of that number, 120 (76.9%) were phlebitis and 36 (23.1%) were obstructions. Microbiological results are summarized in Table 2.

Kaplan-Meier curves indicated a linear function until day 14 for phlebitis, obstruction, positive SQC results, and any of the complications (Figure).

There was no significant increase in the dayspecific risk for any of the outcome variables after the second day. Hazard estimation using the Weybull model did not show a significant increase for any of the outcome variables over time when stratified into intervals of 0 to 5, 6 to 10, 11 to 15, and more than 15 days. Mean (±SD) duration of catheterization was 4.6±4.9 days, 4.4±4.0 days, and 3.9±2.6 days for catheters with obstruction, phlebitis, and positive SQC results, respectively, and did not significantly differ from that of those without complications (3.5±3.2 days). A total of 223 catheters were left in place more than 3 days (7.0±3.9 days), and 386 were left in place 3 days or less (1.9±0.8 days).

Only 4 of the colonized catheters were associated with phlebitis, and in 1 case of a clotted catheter the SQC specimen was positive. Sensitivity and positive predictive value for positive SQC results in catheters with clinical complications were 9.0% and 3.5%, respectively. In contrast, 38 catheters with significant growth did not show any clinical complications.

Results of the univariate analysis and the Cox proportional hazard model are summarized in Table 3 and Table 4, respectively.

COMMENT

We were not able to show an increased risk for catheter-related complications after 2 days of catheterization. There was a constant incidence density until day 15. This observation held true for all variables studied: phlebitis, catheter-related infection, and obstruction of the catheter. The study had a greater than 80% power to detect a 4% difference to the observed rate of complication. Our re-
sults are supported by a report by Fuchs that also indicates a linear increase in the rate of complications over time. An almost linear increase in phlebitis was shown in studies by Maki and Ringer until day 9 of catheterization. They demonstrated an increased risk for catheter-related infections after 3 days of catheterization. However, the day-specific risk of days 1, 2, and 3 was compared with pooled data from catheters in place for 4 days or more. The generalizability of our results may be limited if our complication rate would considerably differ from that of previously published studies. However, phlebitis occurred in 19.7% and positive SQC results in 6.9% of the catheter episodes, which is within the range reported by other authors. The distribution of the isolated microorganisms is similar to that reported in other studies. Catheter-related bloodstream infection did not occur in our study, which is in concordance with recent large studies.

Based on studies by Collin et al in 1975 and Band and Maki in 1980, routine replacement of peripheral intravenous catheters is still recommended by the CDC because of an increased rate of phlebitis infection after the second day. In these studies, steel needles, polypropylene, and catheters with fluorocarbon resins were used, and the incidence density was not reported. In addition, Band and Maki performed their study using steel needles in patients with hematologic malignancies. This is not a representative patient population of a general hospital setting in the 1990s. When compared with more recent studies, it is evident that use of new catheter materials results in lower complication rates.

Similar to the report by Fuchs, we could not confirm the observation of a high correlation between phlebitis and catheter infection. As outlined by Maki and Ringer, phlebitis may be primarily a physicochemical phenomenon. Thus, possible causes for phlebitis are mechanical irritation due to the catheter itself and the physicochemical properties of the infusate or intravenously administered pharmacotherapy such as osmolarity and pH. Nevertheless, catheter-related infection should be included in the differential diagnosis of inflammation at the insertion site. It may become life threat-

### Table 2. Roll-Plate Culture Results of the Catheter Tips

<table>
<thead>
<tr>
<th>Microorganism Isolated</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roll-plate cultures showing growth*</td>
<td>51...</td>
</tr>
<tr>
<td>&lt;15 CFU, all growing Staphylococcus epidermidis</td>
<td>9...</td>
</tr>
<tr>
<td>&gt;15 CFU (significant growth)</td>
<td>42 (100.0)</td>
</tr>
<tr>
<td>S epidermidis</td>
<td>36 (85.7)</td>
</tr>
<tr>
<td>Proteus mirabilis</td>
<td>2 (4.8)</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>1 (2.4)</td>
</tr>
<tr>
<td>Viridans streptococci</td>
<td>1 (2.4)</td>
</tr>
<tr>
<td>Corynebacterium xerosis</td>
<td>1 (2.4)</td>
</tr>
<tr>
<td>S epidermidis and enterococci</td>
<td>1 (2.4)</td>
</tr>
</tbody>
</table>

*Roll-plate culture, according to Maki et al. CFU indicates colony-forming unit.

Kaplan-Meier plots showing the proportion of catheters with phlebitis, obstruction, positive semiquantitative culture results of the catheter tip, and any of these complications.
In conclusion, the results of our observational study are consistent with those in recent publications, which support the idea not to change peripheral intravenous catheters routinely. Phlebitis, catheter-related infections, and obstructions occurred with 19.7%, 6.9%, and 6.0% of the catheters, respectively. We were unable to demonstrate an increased risk after 3 days of catheterization. The day-specific risk (incidence density) for phlebitis, catheter-related infections, and obstructions were recorded as outcome variables, and age, sex, underlying disease, anatomical insertion site, catheter diameter, duration of catheterization, type of admission, hospital location, type of infusate, and antibiotic therapy were compiled as potential risk factors.

Our data confirm the observation that the time during which the catheter remains in place is still the most important risk factor for any complication. However, with a constant incidence density, the risk depends on the total number of catheter days and not on the duration of a single catheter.

In conclusion, the results of our observational study are consistent with those in recent publications, which support the idea not to change peripheral intravenous catheters routinely. Phlebitis, catheter-related infections, and obstructions occurred with 19.7%, 6.9%, and 6.0% of the catheters, respectively. We were unable to demonstrate an increased risk after 3 days of catheterization. The day-specific risk indicated a linear function of all outcome variables.

**SUMMARY**

Guidelines developed by the CDC recommend that peripheral intravenous catheters be changed every 3 days. Routine replacement of central venous catheters is no longer recommended in their latest update. Similarly, we hypothesized that there is no increased risk for patients with peripheral intravenous catheters left in place as long as they are clinically indicated. This study evaluated the day-specific risk (incidence density) for phlebitis, catheter-related infections, and obstructions for such catheters.

**Methods**

All consecutive patients admitted to the Department of Internal Medicine and the ICUs who required peripheral intravenous catheterization for 24 hours or more were included. Phlebitis, catheter-related infections, and obstructions were recorded as outcome variables, and age, sex, underlying disease, anatomical insertion site, catheter diameter, duration of catheterization, type of admission, hospital location, type of infusate, and antibiotic therapy were compiled as potential risk factors.

**Findings**

A total of 609 catheters that were in place for 1 to 28 days were evaluated. Phlebitis, catheter-related infections, and obstructions occurred with 19.7%, 6.9%, and 6.0% of the catheters, respectively. We were unable to demonstrate an increased risk after 3 days of catheterization. The day-specific risk indicated a linear function of all outcome variables.

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**Table 3. Univariate Analysis of Potential Predictors for Phlebitis, Positive SQC Results, and Catheter Obstruction**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Phlebitis</th>
<th>Positive SQC</th>
<th>Obstruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.11</td>
<td>0.34</td>
<td>0.53</td>
</tr>
<tr>
<td>Sex</td>
<td>0.12</td>
<td>0.36</td>
<td>0.22</td>
</tr>
<tr>
<td>Catheter diameter</td>
<td>0.59</td>
<td>0.08</td>
<td>0.05</td>
</tr>
<tr>
<td>Type of infusion</td>
<td>0.58</td>
<td>0.13</td>
<td>0.60</td>
</tr>
<tr>
<td>Antibiotic therapy</td>
<td>0.25</td>
<td>HR = 0.42</td>
<td>HR = 2.50</td>
</tr>
<tr>
<td>High risk for NI</td>
<td>0.17</td>
<td>0.65</td>
<td>HR = 3.60</td>
</tr>
<tr>
<td>Hospital location of insertion</td>
<td>0.53</td>
<td>0.61</td>
<td>0.66</td>
</tr>
<tr>
<td>Type of admission</td>
<td>P = .21</td>
<td>P = .41</td>
<td>P = .63</td>
</tr>
<tr>
<td>Insertion site (wrist vs forearm)</td>
<td>0.09</td>
<td>0.93</td>
<td>HR = 2.68</td>
</tr>
<tr>
<td>Duration (&lt;2 d vs &gt;2 d)</td>
<td>HR = 0.29</td>
<td>P &lt; .001</td>
<td>0.29</td>
</tr>
</tbody>
</table>

* SQC indicates semiquantitative culture, according to Maki et al.2; HR, hazard ratio; and NI, risk for nosocomial infection, according to Tager et al.14

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**Table 4. Cox Proportional Hazard Model**

<table>
<thead>
<tr>
<th>Outcome Variable</th>
<th>Hazard Ratio</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obstruction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate risk for NI†</td>
<td>4.434</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>High risk for NI†</td>
<td>5.256</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Insertion site (wrist vs forearm)</td>
<td>3.626</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Positive SQC‡</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antibiotic therapy</td>
<td>0.393</td>
<td>.02</td>
</tr>
<tr>
<td>Any complications§</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antibiotic therapy</td>
<td>1.436</td>
<td>.02</td>
</tr>
</tbody>
</table>

* Clotted catheter without flow.
† NI indicates risk for nosocomial infection, according to Tager et al.14
‡ SQC indicates semiquantitative culture, according to Maki et al.2
§ Phlebitis, obstruction of the catheter, or positive SQC.
Interpretation

The hazard for catheter-related complications, phlebitis, catheter-related infections, and mechanical complications did not increase during prolonged catheterization. The recommendation for routine replacement of peripheral intravenous catheters should be reevaluated considering the additional cost and discomfort for the patient.

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REFERENCES


