Total Parenteral Nutrition via Multilumen Catheters Does Not Increase the Risk of Catheter-Related Sepsis: A Randomized, Prospective Study

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The purpose of this study was to determine in a randomized, prospective manner whether administration of total parenteral nutrition (TPN) via multilumen catheters increases the risk of catheter-related sepsis (CRS). All patients receiving hyperalimentation during a 24-month period were randomized to receive either a double-lumen catheter (DLC) or a triple-lumen catheter (TLC). A total of 101 catheters were placed in 79 patients, of which 49 were DLCs and 52 were TLCs. The patients with DLCs received a total of 784 days of TPN, whereas patients with TLCs received a total of 754 days of TPN. CRS was associated with one (2.0%) of the 49 DLCs vs. one (1.9%) of the 52 TLCs. In comparison, the rate of CRS associated with single-lumen catheters (historical control) at our institution was 1.4% (P > .90). We conclude that the use of multilumen catheters in TPN therapy does not result in an increased risk of CRS.

Total parenteral nutrition (TPN) is required in many hospitalized patients who cannot meet their nutritional needs enterally. An important potential complication related to TPN administration is catheter-related sepsis (CRS) [1]. Some studies have suggested that the risk of CRS is increased by the use of triple-lumen catheters (TLCs) [2–4]. Previous studies have shown that administration of TPN through TLCs is associated with a higher risk of CRS than is administration through single-lumen catheters (SLCs) [2–4]. The rate of CRS related to TLCs has been reported to be as high as 10%–25%, compared with a rate of 0–6% associated with SLCs [2–4]. Thus, the use of TLC in TPN therapy has been deemed unsafe by some investigators. Because many of the patients who require TPN therapy are critically ill and have poor venous access, the use of TLCs in these patients would allow additional access ports for administration of compatible medications and intravenous solutions and eliminate the need for additional intravenous catheters.

The purpose of this randomized, prospective study was to determine whether multilumen catheters increase the risk of CRS when used for administration of TPN. In addition, the rate of CRS related to TPN administration at the Long Beach Veterans Affairs Medical Center (LBVAMC; Long Beach, CA) for the past 15 years was reviewed. Our data suggest that multilumen catheters are safe for administering TPN and do not increase the risk of CRS.

Methods

All patients who required central hyperalimentation from June 1994 to June 1996 at LBVAMC were offered the opportunity to participate in this open, randomized, prospective trial. Patients were randomized to receive catheters according to their social security numbers—those with an even number received a double-lumen catheter (DLC), while those with an odd number received a TLC. Informed consent was obtained from each patient in accordance with Veterans Administration guidelines. The study was approved by the Department of Veterans Affairs (Long Beach) Human Studies Committee and Research and Development Committee.

Both DLCs and TLCs were polyurethane 7F catheters (Arrow International, Reading, PA) that were made to be inserted over a guide wire by means of the Seldinger technique. All catheters were inserted by surgical or medical house staff by using a sterile technique and were sutured to the skin. Strict compliance with the sterile technique was ensured by having the nutritional support team (NST) nurse present at all procedures. The catheter was inserted into the internal jugular or the subclavian vein, depending on the preference of the individual inserting the catheter. Catheter insertion occurred at either an intensive care unit bed or medical/surgical ward bed at our institution.

A chest radiograph was obtained after the insertion of each catheter to ensure that no complications occurred during catheter insertion. Povidine-iodine ointment was placed at the insertion and suture sites, which were covered with occlusive dressings. Dressings were changed three times a week by the NST nurse, with staff nurses changing the dressings as needed if they became loose or soiled. All solutions were infused via infusion pumps. Intravenous tubing and connectors were changed every 48 hours, and no filters were used. All patients were monitored by the NST nurse 5 days a week for overall patient condition, strict compliance with protocol guidelines, and infection control purposes.

For each catheter, the proximal port was dedicated to the administration of dextrose–amino acid solutions. Lipid preparations, compatible antibiotics, and other compatible medica-
tions were administered through the other port(s). Blood administra-
tion, blood sampling, or monitoring of central venous pressure through the catheter was prohibited.

Catheter tips were cultured by the method described by Maki et al. [5] whenever there was clinical suspicion of wound infection at the catheter site or evidence of sepsis. At the time of catheter removal, blood for cultures was drawn through the catheter and from two peripheral sites.

Data collection continued while the patient was receiving TPN and up until the time that the catheter was removed. If a patient’s catheter required replacement, it was replaced with the same type as the patient was originally randomized to receive. Catheter changes, catheter removal, start and stop dates of TPN administration, catheter-related complications, and all medications administered through the catheter were recorded. Descriptive data recorded for each patient included age, sex, location of patient at the time of catheter insertion (i.e., intensive care unit bed or medical/surgical ward bed), and principal diagnoses. Infection rates were analyzed by the \( \chi^2 \) test.

Results

During the 2-year study period, 80 patients were identified for the study. All of these patients agreed to participate in the study. One patient was excluded from the study because of an underlying coagulopathy, which necessitated placement of his catheter into a femoral vein. One hundred one catheters were placed in 79 patients who required TPN (table 1). There were 49 DLCs and 52 TLCs. The patient profiles and principal diagnoses are shown in tables 1 and 2, respectively.

There was no statistically significant difference \( (P \leq .05) \) in the patient profile (age, sex, number of patients, or number of patients in an intensive care unit) or the principal diagnosis between the two groups. It should be noted that more patients with DLCs had catheters inserted through the internal jugular vein than did patients with TLCs, but the difference did not reach statistical significance \( (P = .06) \). TPN was administered through DLCs for a total of 784 days, while TPN was administered through TLCs for a total of 754 days. There were no protocol violations, mechanical complications, or catheter insertion complications.

CRS was defined as previously described by other investigators [1]. Specifically, criteria for CRS were as follows: an episode of fever, leukocytosis, and a positive catheter tip culture with no other infection present that resolved with the removal of the catheter, or a positive blood culture and a catheter tip culture that was positive for the same organism with no other source of infection identified. Two patients developed CRS during the study (table 3). Using the criteria described above, CRS occurred in one patient who had a DLC inserted into the internal jugular vein (2.0%; 1.28 infections per 1,000 days of catheterization) and one patient who had a TLC inserted into the subclavian vein (1.9%; 1.33 infections per 1,000 days of catheterization). The patient with the DLC was infected with \textit{Staphylococcus epidermidis} (13th day), and the patient with the TLC was infected with \textit{Candida parapsilosis} (21st day). Bacteremia also occurred in two patients with DLCs and two with TLCs during the course of the study, but another source was identified as the cause of the infection.

There was no significant difference in the rates of CRS between patients with DLCs and those with TLCs \( (P = .97) \). The duration of the indwelling catheters ranged from 2 to 65 days (figure 1). The average duration was 14.5 days for TLCs vs. 16 days for DLCs. \( \chi^2 \) analysis of CRS between each of the groups of patients with indwelling catheters for various

### Table 1. Characteristics of 79 patients with DLCs or TLCs for administration of TPN.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>DLC</th>
<th>TLC</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>37</td>
<td>42</td>
</tr>
<tr>
<td>Mean age (y)</td>
<td>64</td>
<td>60</td>
</tr>
<tr>
<td>No. of males/no. of females</td>
<td>37/0</td>
<td>42/0</td>
</tr>
<tr>
<td>No. with catheter site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal jugular vein</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>Subclavian vein</td>
<td>35</td>
<td>46</td>
</tr>
<tr>
<td>No. (% of ICU patients)</td>
<td>23 (62)</td>
<td>28 (67)</td>
</tr>
</tbody>
</table>

NOTE. DLC = double-lumen catheter; ICU = intensive care unit; TLC = triple-lumen catheter; TPN = total parenteral nutrition.

### Table 2. Diagnoses for 79 patients with DLCs or TLCs for administration of TPN.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>No. (%) of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malignant neoplasm</td>
<td>14 (38)</td>
</tr>
<tr>
<td>Gastrointestinal disease</td>
<td>19 (51)</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>2 (5)</td>
</tr>
<tr>
<td>Multiple organ failure</td>
<td>1 (3)</td>
</tr>
<tr>
<td>Respiratory disease</td>
<td>1 (3)</td>
</tr>
<tr>
<td>None available</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>37 (100)</td>
</tr>
</tbody>
</table>

NOTE. DLC = double-lumen catheter; TLC = triple-lumen catheter; TPN = total parenteral nutrition.

### Table 3. Incidence of catheter-related sepsis in 79 patients with DLCs and TLCs for administration of TPN.

<table>
<thead>
<tr>
<th>Variable</th>
<th>DLC</th>
<th>TLC</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of catheters</td>
<td>49</td>
<td>52</td>
</tr>
<tr>
<td>No. (%) with catheter-related sepsis</td>
<td>1 (2.0)</td>
<td>1 (1.9)</td>
</tr>
<tr>
<td>No. (%) with sepsis from other sources</td>
<td>2 (4.1)</td>
<td>2 (3.9)</td>
</tr>
</tbody>
</table>

NOTE. DLC = double-lumen catheter; TLC = triple-lumen catheter; TPN = total parenteral nutrition.
It should be noted that rates of CRS related to TPN therapy at LBVAMC before 1982 were alarmingly high, ranging between 15% and 30% per year; before 1982, only SLCs were used for TPN therapy. Because of the unacceptably high rates of CRS, an NST was formed in 1982 in an attempt to reduce the high rate of catheter-related infection. The NST is a multidisciplinary team consisting of a general surgeon, a gastroenterologist, a nephrologist, an infectious diseases specialist, a pharmacist, an NST nurse, an infectious diseases nurse, and a dietitian. The NST nurse was a dedicated member of the NST and monitored all TPN catheters on a daily basis. Since the inception of the NST, rates of catheter-related infections have decreased dramatically and have remained low (~1%–2% per year).

Our study addresses several important issues concerning the risk of infection related to the use of central venous catheters for TPN administration. First, our data showing low rates of CRS associated with multilumen catheters indicate that they are safe for usage in TPN administration. Previous studies by Pemberton et al. [4], McCarthy et al. [3], and Yeung et al. [2] demonstrated that the rates of CRS associated with TLCs were higher than those associated with SLCs, prompting these investigators to conclude that TLCs should not be used for TPN therapy. In a more recent nonrandomized study, Savage et al. [10] reported a lower rate (4.4%) of CRS associated with 1,135 central venous catheters, of which 879 were TLCs. Although these investigators did not specifically state what the rate of CRS associated with TLCs was, they suggested that TLCs may be safe for TPN administration.

Other studies have reported various rates of CRS ranging between 1.3% and 27% [7, 11–15]. Because of the wide difference in the experimental design of these studies, direct comparisons of the results are not possible. In the present study, the use of a TLC was limited to administration of compatible medications and intravenous solutions. The administration of blood products, withdrawal of blood, and measurements of central venous pressure were prohibited as these manipulations may increase the risk of catheter-related infections [4, 15, 16].

Discussion

The use of multilumen catheters for TPN administration is highly desirable because it provides multipurpose access to central circulation and eliminates the need for additional intravenous access. The major concern with the use of multilumen catheters for TPN administration is the presumed increase in the risk of CRS [4, 7]. Since many patients requiring TPN therapy are malnourished, critically ill, and immunocompromised, significant numbers are not able to survive episodes of CRS [1, 8, 9]. CRS related to TPN therapy is associated with mortality rates of up to 10%–20% [8]. Thus, prevention of CRS in this high-risk population is crucial.

The results of this study indicate that use of multilumen catheters in TPN administration does not increase the risk for CRS. The rates of CRS associated with both TLCs and DLCs were low (~2%) and in line with our experience at LBVAMC with SLCs (1.4%) [6]. It should be noted that rates of CRS related to TPN therapy at LBVAMC before 1982 were alarmingly high, ranging between 15% and 30% per year; before 1982, only SLCs were used for TPN therapy. Because of the unacceptably high rates of CRS, an NST was formed in 1982 in an attempt to reduce the high rate of catheter-related infection. The NST is a multidisciplinary team consisting of a general surgeon, a gastroenterologist, a nephrologist, an infectious diseases specialist, a pharmacist, an NST nurse, an infectious diseases nurse, and a dietitian. The NST nurse was a dedicated member of the NST and monitored all TPN catheters on a daily basis. Since the inception of the NST, rates of catheter-related infections have decreased dramatically and have remained low (~1%–2% per year).

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Our data also suggest that routine scheduled changes of catheters are not necessary to lower the risk of CRS. In the past, there have been various recommendations concerning the frequency of catheter changes. Some researchers have advocated routine changes as often as every 3–4 days to every 7–10 days [7, 11, 17, 18]; other investigators have reported that frequent changes were not necessary, and that changes may be done on an as-needed basis [1, 6, 10, 13, 19, 20]. In our study, the average duration of indwelling catheters was higher (14.5 days for TLCs and 16 days for DLCs) than that in other studies; however, the rates of CRS were low.

Finally, we believe that the low rates of CRS observed in the present study and in our institution during the past 15 years are attributable in part to the involvement of the NST, which sets strictly adhered to guidelines and monitors all activity related to TPN therapy. In support of the importance of strictly
adhered to protocols and involvement of an NST, Nehme [19] previously reported that the rate of CRS among patients receiving TPN who were managed by a variety of physicians was markedly higher than that among patients receiving TPN who were managed by a designated NST (26.2% vs. 1.3%, respectively). Other investigators have reached similar conclusions [3, 16].

In conclusion, the results of our study indicate that TPN may be administered safely through multilumen catheters. Multilumen catheters do not increase the risk of CRS when strictly adhered to guidelines are used. Central venous catheters need not be changed at frequent scheduled intervals but only when clinically indicated. Involvement of an NST to set guidelines and to enforce strict adherence to the established protocol appears to be important in reducing the rates of CRS. On the basis of the results of the present study, we recommend the use of TLCs for TPN administration.

References