Infections Caused by Arterial Catheters Used for Hemodynamic Monitoring

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Utilizing a semiquantitative technique for culturing vascular catheters, we prospectively studied the risk and profile of infection caused by arterial catheters used for hemodynamic monitoring in 95 patients with a high risk of nosocomial infection. Of 130 catheters, 23 (18 per cent) produced local infection (≥15 colonies on semiquantitative culture) and five septicemia (4 per cent). Sixteen of the 23 local infections and all septicemias occurred with catheter placements exceeding four days (p < 0.001). Other factors associated with an increased risk of infection included insertion by surgical cut-down rather than percutaneously (ninefold increased rate of bacteremia, p = 0.008) and the presence of local inflammation (12-fold increase, p = 0.009). Systemic antimicrobial therapy (given to 80 per cent of the entire group and to four of the five with septicemia) did not protect against catheter-related infection but may account for the predominance of enterococci, Candida and gram-negative bacilli in these infections. Twelve per cent of all nosocomial bacteremias occurring in this critical care unit population originated as an arterial catheter. Indwelling arterial catheters pose a significant risk of bacteremic infection to critically ill patients. The percutaneous mode of placement is preferred; when prolonged arterial cannulation is required, the site should be rotated every four days. Local pain or inflammation, or clinical signs of sepsis without an obvious source should prompt removal and culture of the catheter.

Indwelling arterial catheters are widely used for hemodynamic monitoring. Whereas recent reports have shown that the fluid within the monitoring system, particularly within the transducer assembly, is liable to contamination by gram-negative bacilli which can result in bacteremia [1-3], the risk and features of infection deriving from the arterial catheter itself have not been well characterized. The first report of septicemia originating from an arterial catheter was not published until 1970 [4], and eight prospective studies of intra-arterial monitoring systems identified only two bacteremias ascribed to a catheter [5-12]. Notably, catheters were not routinely cultured in most of these studies (see “Materials and Methods”), raising the question of whether significant numbers of catheter-related infections were not identified or with bacteremias that may have been detected, the relationship to an arterial catheter was not appreciated.

Infusion-related sepsis—bacteremia deriving from infection of the cannula wound or from contaminated infusate—is probably the most insidious and least frequently recognized nosocomial infection [13,14]. We report the results of a prospective study of 130 arterial catheters used for hemodynamic monitoring of adult patients and, based on our

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findings, propose guidelines for prevention of arterial catheter-related infection.

MATERIALS AND METHODS

Background. In the University of Wisconsin Hospitals, intra-arterial hemodynamic monitoring is employed only in an intensive care unit. Houseofficers, wearing sterile gloves, insert arterial catheters after first disinfecting the site with 1 per cent tincture of iodine or povidone-iodine. In most cases, an attempt is made to cannulate the radial or ulnar artery percutaneously with a 5.7 cm, 18-gauge Teflon® catheter; when percutaneous cannulation fails, the catheter is inserted by surgical cutdown. Femoral arterial catheters, inserted percutaneously, are used primarily in patients undergoing cardiovascular surgery, or in patients with burns of the upper extremities. The brachial or dorsalis pedis arteries are rarely cannulated. After insertion, the catheter is firmly anchored and a topical iodophor ointment (Betadine®) is applied to the site, which is then covered with an occlusive dressing.

Patency of the catheter is maintained by continuous infusion of heparinized 0.9 per cent saline solution (3 ml/hour) through a Sorenson Intraflo® device (Sorenson Research Company, Salt Lake City, Utah). Since 1977, disposable transducer domes (Goulds Statham, Oxnard, CA) have been in routine use and are discarded after a single use; the transducer is sterilized with ethylene oxide gas after use with each patient. Prior to 1977, reusable transducer domes were employed and, after use, these were washed with soap and water, and rinsed with 70 per cent alcohol; domes were sterilized with ethylene oxide gas when they had been used for longer than 72 hours.

All infusion tubing is changed routinely every 48 hours. Each day the catheterization site is redressed by the patient's nurse at which time the site is examined for signs of local inflammation, and iodophor ointment is reapplied.

Clinical and Microbiologic Aspects. During four periods in 1976 and 1977, we strove to obtain and culture all arterial catheters in use in our hospital. During one period, 6 ml of infusedate was withdrawn from the infusion site and cultured. Decisions to remove catheters were made solely by patients' physicians. At the termination of the infusion, the catheter was removed aseptically by a research nurse and the site was examined for the presence of local inflammation, distal embolic lesions and purulence. Details of our protocol for removing and culturing vascular catheters have previously been reported [15,16].

In the laboratory under a monitored laminar flow hood, catheter segments were cultured on 5 per cent sheep-blood agar using a semiquantitative technique we have developed and standardized for culturing segments of vascular cannulas [15,16]. Briefly, each catheter segment was transferred from a transport tube (Culturette®, Marion Corp.) onto the surface of the blood agar plate and, using a bladed forceps, was rolled back and forth 4 to 5 times across the agar surface. Growth of 15 or more colonies on a semiquantitative plate is regarded as positive, denoting local catheter-related infection, and is associated with a 15 per cent to 40 per cent rate of concordant bacteremia. Five milliliters of the sample of infusedate was cultured in an equal volume of brain heart infusion broth, and 1 ml was incorporated into a pour plate; both media were incubated at 37°C for at least 72 hours and, if negative, for another two days at 25°C before discarding.

Blood for cultures was obtained from patients with fever or other signs of infection. For each catheter, the following data were noted: demographic information on the patient and underlying diseases, systemic antimicrobial therapy given while the catheter was in place, and all data on any suspected or proved infections. In addition, the location of the arterial catheter and mode of placement, the condition of the insertion site, and the number of hours the catheter had been in place were recorded. Each patient was observed for at least three days after removal of the catheter to identify late-appearing local inflammation or infection due to the catheter.

The significance of differences between patients with and without catheter-related infection was determined using a one-tailed Fisher exact test for discrete data and two-tailed student's t-test for continuous data.

Definitions. Inflammation at the catheter site: Presence of lymphangitis, purulence, or at least two of the following: erythema, tenderness, increased warmth or induration.

Local infection of the catheter site: Fifteen or more colonies on semiquantitative culture of the catheter [15].

Catheter-related septicemia: (1) isolation of the same species in significant numbers (≥15 colonies) on semiquantitative culture of the catheter and from blood cultures obtained by separate venipunctures, (2) clinical (or autopsy) and microbiologic data disclosed no other apparent source of the bacteremia or fungemia and (3) clinical features consistent with blood stream infection.

Septicemia due to contaminated infusedate: (1) isolation of the same species from infusedate and from blood, but semiquantitative culture of the catheter was negative for the infecting microorganism, (2) no other identifiable source of septicemia, and (3) clinical signs and symptoms consistent with blood stream infection.

RESULTS

General Characteristics of the Study Patients and Their Arterial Infusions. Over the two year period, 130 catheters were obtained from 95 patients (range, 1 to 7 catheters; mean, 1.4 catheters per patient). These patients ranged in age from 16 to 95 years (mean, 48.9 years), and 65 per cent were male. Fifty-two catheters (40 per cent) were obtained from medical patients with respiratory failure, 40 (37 per cent) from surgical patients with multiple organ failure following major operations, and 30 (23 per cent) from patients with severe traumatic injuries; 112 catheters (86 per cent) had been inserted by percutaneous puncture and 18 (13.8 per cent) by surgical cutdown. The majority of catheters (93, 72 per cent) had been inserted into a radial artery, 13 (10 per cent) had been inserted into a brachial artery, 15 (12 per cent) in a femoral artery and 8 (6 per cent) in a dorsalis pedis artery. Catheters had been in place from one to 14 days (mean 4.4 days).

Forty-nine catheters (38 per cent) were obtained from patients with a culture-proved focus of infection unrelated to the catheter such as pneumonia, cholangitis, surgical wound infection or pyelonephritis; 37 (28 per cent) of these catheters were exposed to bacteremia originating from these infections. Eighty per cent of the
study population was receiving systemic antibiotics during the period of time the catheter was in place.

**Infection.** Twenty-three (18 per cent) of the 130 arterial catheters produced local infection as defined by a positive semiquantitative culture. The microbiologic profile of these infections is shown in Table I. Candida albicans was recovered most frequently [eight catheters] followed by enterococcus [five catheters], Staph. epidermidis [four catheters] and Klebsiella pneumoniae [three catheters]. Five of these catheters produced septicemia as well as local infection, two with enterococcus, one each with C. albicans and K. pneumoniae, and one polymicrobial, with enterococcus, K. pneumoniae and Escherichia coli.

Three factors were associated with a significantly increased rate of both local and bacteremic catheter-related infection (Table II): insertion of the catheter by surgical cutdown, cannulations exceeding four days and inflammation of the catheterization site.

**Figure 1** depicts the relationship between infection and the duration of catheter placement: 16 of 23 local infections (p < 0.001) and all five catheter-related septicemias (p = 0.03) occurred with cannulations exceeding four days. Although the mean duration of

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### Table I

**Microorganisms Recovered from 23 Arterial Catheters Showing Significant Growth on the Semiquantitative (SQ) Plate**

<table>
<thead>
<tr>
<th>Microorganism</th>
<th>No. of Isolations* from SQ Culture-Positive† Catheters (Cases of Related Septicemia)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Candida albicans</td>
<td>8 (1)</td>
</tr>
<tr>
<td>Enterococcus</td>
<td>5 (3)</td>
</tr>
<tr>
<td>Staph. epidermidis</td>
<td>4</td>
</tr>
<tr>
<td>Staph. aureus</td>
<td>4</td>
</tr>
<tr>
<td>Klebsiella pneumoniae</td>
<td>3 (2)</td>
</tr>
<tr>
<td>Diphtheroids or Bacillus sp.</td>
<td>2</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>1</td>
</tr>
<tr>
<td>Candida sp.</td>
<td>1</td>
</tr>
</tbody>
</table>

* Five catheters yielded more than one isolate in significant numbers.  
† ≥ 15 colonies.

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### Table II

**Factors Associated with Infection Caused by Indwelling Arterial Catheters**

<table>
<thead>
<tr>
<th>Factor</th>
<th>No Infection</th>
<th>Number of Catheters</th>
<th>Bacteremia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total catheters</td>
<td>107</td>
<td>23 (17.7)</td>
<td>5 (3.8)</td>
</tr>
<tr>
<td>Age (yr), mean ± SEM</td>
<td>49.8 ± 3.4</td>
<td>42.3 ± 4.4 NS†</td>
<td>58.6 ± 5.0 &lt;0.05</td>
</tr>
<tr>
<td>Serious underlying disease</td>
<td>52</td>
<td>12 (19) NS</td>
<td>3 (4) NS</td>
</tr>
<tr>
<td>Unrelated focus of infection</td>
<td>39</td>
<td>10 (20) NS</td>
<td>3 (6) NS</td>
</tr>
<tr>
<td>Systemic antibiotic therapy</td>
<td>87</td>
<td>16 (16) NS</td>
<td>4 (4) NS</td>
</tr>
<tr>
<td>Catheter location (artery)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radial</td>
<td>80</td>
<td>13 (14) NS</td>
<td>5 (5) NS</td>
</tr>
<tr>
<td>Femoral</td>
<td>8</td>
<td>8 (50) &lt;0.01</td>
<td>0 (0) NS</td>
</tr>
<tr>
<td>Brachial</td>
<td>12</td>
<td>1 (8) NS</td>
<td>0 (0) NS</td>
</tr>
<tr>
<td>Dorsalis pedis</td>
<td>7</td>
<td>1 (13) NS</td>
<td>0 (0) NS</td>
</tr>
<tr>
<td>Method of placement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percutaneous puncture</td>
<td>95</td>
<td>17 (16)</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Surgical cutdown</td>
<td>12</td>
<td>6 (33) &lt;0.05</td>
<td>3 (17) 0.008</td>
</tr>
<tr>
<td>Duration of placement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤4 days</td>
<td>64</td>
<td>7 (10)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>&gt;4 days</td>
<td>43</td>
<td>16 (27) &lt;0.001</td>
<td>5 (8.5) 0.02</td>
</tr>
<tr>
<td>Local inflammation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>98</td>
<td>18 (16)</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Present</td>
<td>9</td>
<td>5 (35) &lt;0.05</td>
<td>3 (21) 0.009</td>
</tr>
</tbody>
</table>

*NOTE: Figures in parentheses represent per cent.  
† Positive SQ culture (≥15 colonies).  
P value; NS = not significant.
placement for cutdown catheters (4.3 days) was almost identical to the mean duration for catheters inserted percutaneously (4.4 days). Catheters inserted by surgical cutdown were associated with a twofold increased incidence of local infection (33 per cent, \( p < 0.05 \)) and a ninefold increase in septicemia (17 per cent, \( p = 0.008 \)). The presence of local inflammation was associated with a twofold increased incidence of local infection (35 per cent, \( p < 0.05 \)) and a 12-fold increase in septicemia (21 per cent, \( p = 0.009 \)).

No contamination of infusion was detected in the 22 infusions sampled.

Demographic parameters, underlying diseases and the location of the catheter did not significantly affect the incidence of catheter-related infection nor did the receipt of systemic antibiotics. The rate was 25 per cent in patients who did not receive antibiotics and 16 per cent in those who did (\( p = \text{NS} \)). Four of the 12 septicemias occurred in patients who received systemic antimicrobial therapy.

Of the five cases of septicemia deriving from an arterial catheter, four patients responded promptly to removal of the catheter and administration of antimicrobial therapy by intravenous injection, becoming afebrile within 48 to 72 hours. The condition of one 39-year-old man with hemorrhagic pancreatitis and severe respiratory tract failure continued to deteriorate, even after a radial artery catheter that had been in place for 192 hours was removed, and he died 48 hours later in profound shock, having received 25 mg of amphoterine B. Disseminated candidiasis was found at autopsy. Histopathologic examination of the cannulated segment of the artery showed infiltration of intraluminal thrombus and the arterial wall by pseudohyphal forms. The surviving patients with catheter-related septicemia were treated with parenteral antibiotics for 12 to 22 days (mean, 17 days). None of these patients exhibited Osler nodes in the distribution of the cannulated artery and in none did endocarditis develop.

Of the 37 catheters exposed to bacteremias or fungemia from preexisting, unrelated sites of infection, five were subsequently positive on semiquantitative culture for the blood stream pathogen. These cases are not tabulated in this report as primary catheter-related septicemias. In each case, however, signs of sepsis did not remit until after the catheter was removed.

COMMENTS

The hazards of iatrogenic infection in intravenous therapy have been well characterized [14-17]. In contrast, until recently [1-3], the potential of arterial pressure monitoring systems to produce serious infection was not widely appreciated. A single case of septic endarteritis was reported in 1970 [4], but no study prospectively examined the risk of infection caused by arterial catheters until Gardner and co-workers [11] cultured 300 connective radial artery catheters and found eight positive for growth in broth; none was considered to have produced septicemia. Most of these catheters had been inserted and cared for by one person, most had been in place for less than four days, and all had been used for monitoring patients who had undergone cardiovascular surgery, patients who experience a relatively low rate of nosocomial infection. Moreover, none of the 36 catheters from patients who died was cultured. Other published experiences with arterial catheters in similar populations with a low risk of nosocomial infection [5-10,12], did not prospectively evaluate for catheter-related infection. Most of these reports provide little microbiologic data, and only two septicemias were attributed to the catheter in 564 cannulations in the seven series.

The data from our study—4 per cent of all arterial catheters causing septicemia and 12 per cent of all bacteremias occurring in study patients (five of 42) originating from an arterial catheter—point out that arterial catheters used for hemodynamic monitoring pose a significant risk of infection and must receive stringent aseptic care. This relatively high incidence of catheter-related septicemia is comparable to rates of bacteremic infection reported with venous catheters [14,17] and may have three bases:

1. This was a prospective study, especially with regard to identifying infection. In all patients with fever or other signs of infection blood cultures were obtained and, as part of the study protocol, every catheter was cultured. We have previously shown that the semi-quantitative method for culturing catheters used in this study is as sensitive and is considerably more specific for identifying catheter-related infection than the culture technique used in most hospitals, immersing the segment in liquid media [15,16]. Schimpff et al. [18], in a prospective study of nosocomial infections in "seriously traumatized patients," identified two bacteremic infections originating from the 19 arterial catheters cultured during the study. Similarly, in two prospective studies of nosocomial infection in patients undergoing cardiovascular surgery, 32 per cent [19] and 50 per cent [20] of the arterial catheters were positive on culture.

2. This was a highly susceptible patient population. Most of our patients had multiorgan failure; in 49 cases, the patient had a culture-proved infection unrelated to the catheter during the time the arterial catheter was in place. It is clear that critically ill patients in intensive care units experience a very high rate of nosocomial infection of all types, exceeding 50 per cent by the end of one week of confinement [18,21]. Most of these infections derive from surgical operations or from invasive devices such as indwelling urethral catheters, endotracheal tubes and vascular cannulas of all types. Studies of one of us (unpublished data, D.G.M.) indicate that vascular cannulas are a major cause of nosocomial bacteremia and candidemia in patients within in-
tensive care units; most of these infections will not be recognized as deriving from a cannula unless the cannula is cultured—which occurs infrequently in most hospitals.

[3] Because most of our patients required prolonged ventilatory support and hemodynamic monitoring, many of the catheters in this study were in place for prolonged periods; one third for longer than five days, increasing the risk of catheter-related infection.

Inflammation about the insertion site occurred in 10.8 per cent of the 130 cannulations. Although many of the factors contributing to catheter-associated inflammation are still uncertain [17], it appears that there is a causal relationship between inflammation and infection of catheter wounds [14–16]. This was borne out in the present study: both local and bacteremic infections were strongly associated with local inflammation (Table II). It must be pointed out, however, that the absence of inflammation should not be used to exclude consideration of catheter-related infection; there were no signs of inflammation in 13 of 18 local infections and in two of the five septicemias.

Two factors besides local inflammation correlated strongly with an increased risk of infection, both local and bactereemic (Table II): catheter placement by surgical cutdown rather than by percutaneous puncture (ninefold increased rate of bacteremia) and placements exceeding four days (16 of the 23 local infections and all five septicemias).

Uncontrolled studies suggest that venous catheters inserted by cutdown are associated with a considerably higher rate of catheter-related sepsis, averaging 6 per cent in several series [14]. Our study protocol did not specifically analyze the difficulty of cannulation as a risk factor, but catheters were often placed by cutdown in this series when attempts at percutaneous cannulation were unsuccessful. In a recent study of infections caused by intra-arterial catheters used for regional cancer chemotherapy, we found that cases in which selective arterial cannulation was difficult, or in which the catheter later required manipulation or repositioning, were associated with a significantly increased risk of catheter-related bacteremia [22]. These data suggest that with arterial catheters for hemodynamic monitoring the percutaneous mode of placement be used in preference to insertion by cutdown, whenever possible.

The strong relationship between catheter-related infection and the duration of catheter placement demonstrated in this study with arterial catheters (Figure 1) has long been known to apply with peripheral venous cannulas of all types [14]. Most vascular catheter-related septicemias begin as local infections of the wound caused by microorganisms that invade the intracutaneous tract during insertion of the catheter or thereafter [14,15]. The longer a catheter is in place, the greater the likelihood of microorganisms reaching the vessel and producing septicemia. Multiple studies have shown that with peripheral venous catheters, the risk of bacteremic infection rises sharply after 48 to 72 hours of placement [17]. Little comparable published data exist to guide the management of arterial catheters used for hemodynamic monitoring. The experience we report, from a hospital in which heterogeneous and variably skilled people insert arterial catheters, suggests that these catheters, especially when inserted by percutaneous puncture, can be left in place relatively safely for up to four days. We postulate that the greater distance between the skin surface and arteries as compared to between the skin and more superficially located peripheral veins, accounts for the longer period of grace apparent with arterial catheters. However, local inflammation, distal embolic lesions or unexplained signs of sepsis should always prompt immediate removal and culture of an arterial catheter and the monitoring apparatus, regardless of how long the infusion has been in use.

Candida, enterococci and gram-negative bacilli predominated in arterial catheter-related infections in this study (Table I), in sharp contrast to the microbiologic profile of infection caused by venous catheters where staphylococci account for over one half of bacteremic infections [17]. Nearly 80 per cent of our patients were receiving systemic antimicrobial therapy during the time the arterial catheter was in place. Broad-spectrum antibiotics have a profound influence on the flora of treated patients [23,24]. Moreover, simply being severely ill, of itself, predisposes to floral shifts towards a predominance of gram-negative bacilli [24,25]. Similar to what has been reported with venous catheters [17], systemic antimicrobial therapy did not protect against arterial catheter-related infection; four of the five septicemias occurred in patients receiving antibiotics (Table II).

Applying a topical combination antibiotic ointment to the catheter wound may confer some protection against infection with venous catheters [14], but the microbial pathogens that predominate in arterial catheter-related infections are frequently resistant to the drugs contained in these preparations (polymyxin, nemoycin and bacitracin). If a topical agent is to be used on arterial catheter sites, an iodophor ointment might be preferable. But it should be pointed out that two controlled studies of iodophor ointment in prevention of venous catheter-related sepsis found no [26] or only marginal [27] benefit from application of topical providone iodine (Betadine).

It must be re-emphasized that other elements of the hemodynamic monitoring system besides the catheter pose a risk of infection to monitored patients, namely, the delivery apparatus containing fluid. Microorganisms can gain access to fluid from multiple extrinsic sources during therapy [such as contaminated flush solutions [1] or contaminated ice used to chill syringes [2]], and are perpetuated by failure to reliably sterilize reusable
transducer components (the cause of six outbreaks of bacteremic infection or hepatitis since 1973 [5]). Disposable transducer domes, now available, should in therapy obviate this latter problem, but it is now clear that the permanent components of the transducer assembly must be sterilized with ethylene oxide gas or glutaraldehyde as well between use with different patients [3,28,29]. Although the incidence of septiemia caused by contaminated fluid is unknown at the present time, it is probably 10-fold lower than that of cannula-related sepsis [14]. In this study, all 22 specimens of fluid cultured were negative. The use of normal saline solution in intra-arterial infusions, which does not support the growth of most microbial pathogens [30], probably provides an element of protection against introduced fluid contaminants in hemodynamic monitoring [29].

The clinical features of bacteremic infection deriving from arterial catheters are indistinguishable from those of venous catheter-related sepsis [14]. All five of our patients in whom sepsis developed were examined by us, and none had Osler's node distal to the catheter as have been reported in cases of septic endarteritis originating from radial artery catheters [4,31]. In four of the cases, signs of systemic infection rapidly resolved after removing the catheter; all of these patients received a course of intravenous antimicrobial therapy based on the in vitro susceptibility patterns of the blood stream isolates. Removing the catheter is clearly the most important aspect of management of vascular cannula-related sepsis including that due to arterial catheters. Antibiotics are often ineffective until use of the implicated infusion is totally discontinued [13,17].

Five other catheters in this series appear to have become colonized hematogenously from distant unrelated sites of infection and subsequently perpetuated and amplified pro-existing septicemias. Henzel and DeWeese [32], Morganson et al. [33] and Maki et al. [16] have reported “rebound” sepsis derived from hematogenously colonized catheters. The relatively high frequency of this phenomenon in this study (five instances in 37 catheters exposed to bactemia) might be related to the high frequency of thrombus formation in cannulated arteries—ranging from 19.3 per cent [11] to 38 per cent [7]—thrombus which may be liable to becoming colonized by blood-borne microorganisms originating from distant sites of infection. These observations suggest that if an arterial catheter has been exposed to high-grade bactemia, irrespective of the source of bactemia, it may be most prudent to empirically replace it.

Guidelines for cleansing and sterilizing pressure monitoring systems and for care of the infusion apparatus have been published [3,34]. Based on the findings of this study, we propose the following guidelines for care of arterial catheters used for hemodynamic monitoring:

1. Consider wearing sterile gloves when inserting an arterial catheter.
2. Disinfect the site with an iodine-containing antiseptic such as tincture of iodine or an iodophor [17]. Use sterile drapes.
3. Make a concerted effort to insert the catheter by percutaneous puncture rather than by surgical cutdown. Anchor the catheter firmly with tape or a suture.
4. Before applying a sterile dressing, it may be worthwhile to apply iodophor ointment to the insertion site.
5. Record the time and date of insertion of the catheter on the dressing and in the patient's narrative record. Unless there are extenuating circumstances, arterial catheters used for hemodynamic monitoring should not be left in place for longer than four days, especially catheters that have been inserted by cutdown.
6. Inspect the insertion site every 24 to 48 hours at which time topical ointment may be reapplied and the site redressed.
7. Catheters that have been exposed to high grade bactemia should ideally be replaced.
8. Evaluate each patient daily with regard to catheter-related infection. Local pain or inflammation, embolic lesions distal to the catheter, unexplained fever or especially bacteremia without an obvious source should prompt removal of the entire infusion apparatus as well as the catheter; both the catheter [15,16] and a sample of remaining infusate [30] should be cultured. Any purulence that can be expressed from the catheter wound should be gram-stained and cultured. At least three blood cultures should be obtained by separate venipuncture.
9. Removing the catheter is the single most important therapeutic maneuver in the management of catheter-related sepsis. Patients who are clinically septic, with purulence that can be expressed from the wound, and, certainly, those who have positive blood cultures, should receive systemic antimicrobial therapy. An aminoglycoside antibiotic such as gentamicin, tobramycin or amikacin and a drug effective against Staph. aureus such as methicillin, a cephalosporin, clindamycin or vancomycin would seem most appropriate for initial therapy, based on the microbiologic profile of infections identified in this study.
REFERENCES


