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A prospective comparison of arterial catheter blood and catheter-tip cultures in critically ill patients

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To determine if a culture of blood obtained through an arterial catheter reflects culture of the catheter's tip, we studied 68 arterial catheters removed from 65 patients with and without suspected catheter infections. Cultures of blood obtained before catheter removal were compared to catheter-tip cultures. The arterial catheter blood culture was neither sensitive nor highly predictive of positive catheter-tip cultures. Suspicion of catheter infection was not associated with a significantly higher rate of positive catheter-tip or blood cultures.

Catheter-caused sepsis is a serious problem whose diagnosis usually requires removing the catheter to obtain its tip for culture. Catheter removal may compromise care of the critically ill by the temporary loss of laboratory and monitoring data obtained through the catheter. To determine if cultures of blood drawn through the arterial catheter could replace catheter-tip cultures, we compared arterial catheter blood and tip culture results in patients with and without suspected catheter infection.

METHODS

The study included all patients admitted to the LDS Hospital's Shock-Trauma Unit from June 1981 to March 1982, in whom a radial or femoral artery catheter was inserted. At the time of catheter removal, physicians completed a questionnaire to identify those catheters which were removed because of suspected catheter infection. Catheter-related infection was suspected when the patient showed evidence of sepsis despite appropriate treatment of an identified infection, or when the source of infection was not identifiable.

Before catheter removal, aseptic technique was used to withdraw 10 ml of blood through the 3-way stopcock lock of femoral artery catheters, and directly through the catheter port of radial artery catheters. Five-ml aliquots of blood were added under aseptic conditions to 100 ml of tryptose phosphate broth (aerobic) and to 100 ml of brain-heart infusion broth (anaerobic).

At the time of catheter removal, the protective dressing was removed and the insertion site was cleaned with a povidone-iodine solution and wiped dry with a sterile gauze pad. The catheter was then removed aseptically by the research nurse, one of the authors (F.T.), or an ICU nurse. The distal 2 to 3 cm of the catheter was cut off with sterile scissors or a scalpel blade and placed into a sterile test tube containing 2.5 ml of tryptose-phosphate broth. Arterial catheter blood cultures and the catheter tip were then immediately taken to the laboratory. There, a sterile, 0.01-ml calibrated loop was used to withdraw an aliquot of vortexed tryptose-phosphate broth. This aliquot was then plated on blood agar for semiquantitative culture. Ten ml of thioglycollate broth was added to the remaining tryptose-phosphate broth and catheter tip.

All cultures were incubated at 37°C and evaluated daily for 14 days, for bacterial and fungal growth. Isolates were identified by standard bacteriologic techniques. All culture data were analyzed using Fischer's exact test to determine statistical difference in measured variables.

RESULTS

Blood and catheter-tip cultures were obtained from 68 arterial catheters inserted into 65 critically ill patients (32 males and 33 females; mean age of 54 ± 20 yr). One male underwent an additional catheter insertion, and one female underwent two additional catheter insertions. Eleven patients died, and 54 patients were receiving antibiotics at the time of catheter removal. Thirty-two catheters were inserted femorally, and 36 catheters were inserted radially. Catheter duration in situ was 5.8 ± 5.1 days. Fifteen catheters were removed because of suspected catheter infection. Table 1 shows catheter blood and tip culture results in patients with and without suspected catheter infection. Table 2 shows organisms cultured from arterial catheter blood and tip cultures. For groups IA, IB and II, all with positive blood cultures, a wide variety of organisms was obtained; while for group III, in which the blood culture was negative and the tip culture was positive, *Staphy-*

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TABLE 1. Culture results

Group	Blood Culture	Catheter-Tip Culture	No. of Catheters	
			Infection Not Suspected	Infection Suspected
IA	+	+	2	1
IB[a]	+	+	1	0
II	+	−	5	2
III	−	+	7	3
IV	−	−	38	9
			53	15

[a] Group IB had a different organism in blood culture and catheter-tip culture.

TABLE 2. Culture results

(+)Arterial Blood and (+)Catheter-Tip Organism	No. of Patients
Group IA and IB	
Staphylococcus aureus	1
Candida	1
Pseudomonas	1
Escherichia coli and diphtheroids	1[a]
Group II	
Pseudomonas	1
Staphylococcus epidermidis	1
Enterococcus	1
Klebsiella	1
Diphtheroids	1
Bacteroides fragilis	1
Group III	
Staphylococcus epidermidis	9
Staphylococcus aureus	1

[a] Arterial catheter blood and catheter-tip cultures yielded different organisms.

lococcus epidermidis was the primary organism identified. Table 3 compares the sensitivity, specificity, and predictive value of arterial blood cultures in patients with and without suspected catheter-tip infection. None of the comparisons showed arterial catheter blood cultures useful in predicting catheter-tip culture results. The sensitivity of blood cultures in detecting positive tip cultures was only .21 for all patients studied. Sensitivity did not improve (.25) in those patients suspected of having an arterial catheter infection. Similarly, arterial catheter blood cultures had a low predictive value in determining positive catheter tips in all patients studied (.30), and in patients suspected of catheter infection (.33). There was no significant relationship between suspicion of catheter infection and positive catheter tip or catheter blood cultures (Table 4).

DISCUSSION

In critically ill and immunosuppressed patients, nosocomial infection is a major complication. Approximately 25,000 cannula-related septicemias occur yearly.[1] One device frequently used in the critical care setting is the arterial catheter, which provides rapid access to blood for laboratory studies and continuous physiologic monitoring of the seriously ill patient. However, the use of these devices has been associated with life-threatening infection.[2–4] Several techniques have been developed to assess catheter-related infection[5,6]; however, all require removing the catheter for culture. Because this may compromise access to blood specimens and continuous hemodynamic monitoring, it would be preferable to evaluate possible infection without removing the catheter. Theoretically, blood cultures withdrawn through the catheter would be expected to contain any bacteria found on the tip of the catheter. However, we found that blood cultures drawn through the arterial catheter lacked sensitivity for determining positive catheter-tip cultures. These results confirm and extend the observations of Singh et al.[7]

TABLE 3. Sensitivity, specificity, and predictive value of blood culture for catheter-tip culture

	Positive catheter	Negative catheter		
All patients				
Blood+	3	7	Sensitivity = .21	Specificity = .87
Blood−	11	47	Predictive value$^+$ = .30	Predictive value$^-$ = .81
Total	14	54		
Catheter infection suspected				
Blood+	1	2	Sensitivity = .25	Specificity = .82
Blood−	3	9	Predictive value$^+$ = .33	Predictive value$^-$ = .75
Catheter infection not suspected				
Blood+	2	5	Sensitivity = .20	Specificity = .88
Blood−	8	38	Predictive value$^+$ = .29	Predictive value$^-$ = .83

TABLE 4. Suspicion of catheter infection vs. culture results

	Infection Suspected	Infection Not Suspected	*p*-value
Positive catheter-tip culture	4	10	NS
Negative catheter-tip culture	11	43	—
Positive blood culture	3	8	NS
Negative blood culture	12	45	—

Several explanations may be responsible for this lack of correlation. Catheter-induced sepsis is generally attributed to either the infusion or the cannula.[1] Contaminated infusion fluid occurs much less frequently than cannula-produced bacteremia.[8] Two sources of cannula-related infection are contamination of the catheter tip by bacteremic spread from another source of infection, and the spread of a local infection down the transcutaneous cannula tract. Evidence suggests that most catheter-related septicemias are derived from the latter source.[9] This theory helps explain the decreased incidence of catheter-related sepsis with arterial versus venous catheters, because the greater distance of skin to the artery may hinder the spread of infection.

In order to be detected by the catheter blood culture, bacteria from the transcutaneous tract must reach the catheter tip. This would require bacteria to move against the high-velocity flow of arterial blood and travel a considerable distance to reach the catheter tip. It is unlikely that arterial blood withdrawn through the catheter, which represents blood proximal to the catheter tip, reflects the cannula tract infection but rather the blood-borne spread of bacteria to the tip. However, catheter-tip cultures reflect bacteria found in the transcutaneous catheter tract. This could explain the high incidence of *S. epidermidis* recovered from catheter tips.[10]

Our data support previous findings that clinical suspicion of catheter-related infection is not predictive of catheter-tip infection.[11] Our data further show that arterial catheter blood cultures are likewise not predictive of catheter infection.

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